The World Bank

Global Program for Safer Schools

Samoa Mission Report

Issue | 20 January 2016

Job number 238204-01

Ove Arup & Partners International Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

ARUP

Document Verification

ARUP

Job title		Global Program for Safer Schools		**Job number** 238204-01	
Document title		Samoa Mission Report		**File reference**	
Document ref					
Revision	**Date**	**Filename**	Arup Samoa Mission report.docx		
Draft 1	1 Oct 2015	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Acronyms

ADB	Asian Development Bank
APTC	Australia-Pacific Technical College
AUD	Australian dollars
CEAR	Comprehensive Environmental Assessment Report (part of EiA)
DFAT	Department of Foreign Affairs and Trade (GoA)
DMO	Disaster Management Office (GoS)
EWS	Early Warning System
GoA	Government of Australia
GoJ	Government of Japan
GoNZ	Government of New Zealand
GoS	Government of Samoa
GPSS	Global Program for Safer Schools
GGP	Grant Assistance for Grassroots Projects (GoJ)
IDA	International Development Association
IFRC	International Federation of Red Cross and Red Crescent Societies
INGO	International Non-Government Organisations
IPES	Institute of Professional Engineers of Samoa
JICA	Japan International Cooperation Agency
MESC	Ministry of Education Sports and Culture (GoS)
MFAT	Ministry of Foreign Affairs and Trade (GoNZ)
MNRE	Ministry of Natural Resources and Environment
MoF	Ministry of Finance (GoS)
MWTI	Ministry of Public Works Transport and Infrastructure (GoS)
NBCS	National Building Code of Samoa
NZ	New Zealand
PUMA	Planning and Urban Management Agency (GoS)
PEAR	Preliminary Environmental Assessment Report (part of EiA)
PREP	Pacific Resilience Program (WB)
PIC	Pacific Island Countries
SAT	Samoan Tala
TA	Technical Assistance
USD	United States dollars
WATSAN	Water and Sanitation
WB	World Bank

1 Introduction

Each year, natural disasters result in school buildings being destroyed or severely damaged leading to loss of life, injury and disruption to education. Global efforts to make schools more resilient have largely focussed on improving awareness and preparedness, so that teachers and children are better placed to take appropriate action in the event of a disaster. Less attention has been paid to the physical performance of school buildings, which is the focus of a new initiative by the Global Facility for Disaster Risk Reduction (GFDRR) - the Global Program for Safer Schools (GPSS). This is being designed as a technical assistance (TA) program targeting countries where there is on-going or proposed investment in school infrastructure.

Samoa has been identified as a country where a GPSS TA project is required as the World Bank has committed to support the education sector by investing in a pilot reconstruction / retrofitting programme of $0.575 million (USD) in Samoa through their Pacific Resilience Program (PREP).[1]

The aim of this study is to assess the vulnerability of existing school infrastructure in Samoa to natural hazards, some of which are anticipated to increase as a result of climate change, and contributing factors of risk in order to help the Government to develop with World Bank support a school reconstruction/ retrofitting programme through the PREP). The specific objectives of the study are;

- To undertake country diagnostics in order to make recommendations to the WB team, to enable them to formulate a GPSS TA project proposal which will include;
    - Understanding the drivers of risk and range of natural hazards and climate change impacts that may compromise the repair and retrofitting and operation of existing schools infrastructure;
    - Understanding the number and structural typology of existing schools infrastructure in Tonga;
    - Assessing the institutional and policy environment and regulatory framework within which schools infrastructure is planned, designed, constructed, operated, maintained, repaired and retrofitted in Samoa.This will inform recommendations for the institutional and policy actions necessary, for planning effective implementation of safer schools principles, improving the quality and enforcement of building codes, as well as building institutional capacity for risk reduction.
- To make recommendations for entry level investments to be financed by PREP.

[1] Pacific Resilience Program (PREP) is a World Bank package of International Development Association (IDA) financing and TA for PICs.

- To develop a methodology /roadmap for a nationwide retrofitting/ reconstruction (or relocation) program to bring all schools up to a "suitable" appropriate design standard.

2 Context

The Pacific Island Nations are vulnerable to natural hazards, such as tropical cyclones, flooding, storm surge, droughts, volcanic eruptions, earthquakes and tsunamis. The frequency and severity of climate related hazards is anticipated to increase as a result of climate change. Disasters resulting from these hazards can affect the economic, social, and physical environment and can have a lasting effect on the long-term development agenda in these nations.

Figure 1: Map of Samoa

Samoa is located in the South Pacific Ocean, and has a complex history involving the original Polynesian inhabitants, the United Kingdom, Germany, the United States and New Zealand In 1962 following 48 years of New Zealand occupation it gained independence. It is composed of two large populated volcanic islands (Upolu and Savai'i) and several smaller islands, and has a total land area of approximately 2,935 km^2. The current population of Samoa is estimated at 193,158[2], with approximately 80 percent of people living in rural areas.

Samoa is extremely exposed to natural hazards and was ranked 51st out of 179 countries in the Global Climate Risk Index 2012 report, which compares nation's exposure to extreme weather events. It is predicted to incur approximately SAT 23 million (US$10 million) per year in losses, on average over the long term, due to earthquakes and tropical cyclones.[3]

---

[2] http://countrymeters.info/en/Samoa

[3] http://reliefweb.int/sites/reliefweb.int/files/resources/Country-Note-Samoa.pdf

3 Methodology

The observations made in this report are the result of a 4 day field mission carried out by Arup Consultants from 14th to 17th September 2015 and a review of documentation as listed in Appendix A. Key stakeholder consultations included national government departments, school representatives and engineers.

During the mission a total of seven schools (Appendix C) were visited in order to gain an understanding of the different construction typologies and vulnerabilities. These schools were selected by the Ministry of Education, Sports and Culture (MESC) and the Disaster Management Office (DMO) (under Minister for Natural Resource and Environment (MNRE)). The schools were chosen to represent their priority schools for reconstruction or to be used for evacuation shelters.

During the mission, the draft GPSS Roadmap[4] was used as guidance to undertake a diagnostic of the school infrastructure sector in Samoa. The following sections of the report summarise the key findings related to; the existing infrastructure baseline (Section 4), the construction environment (Section 5) and financial environment (Section 6) in which school infrastructure is planned, designed, constructed and operated with entry level investments to be financed by PREP (Section 7) and Roadmap (Section 8).

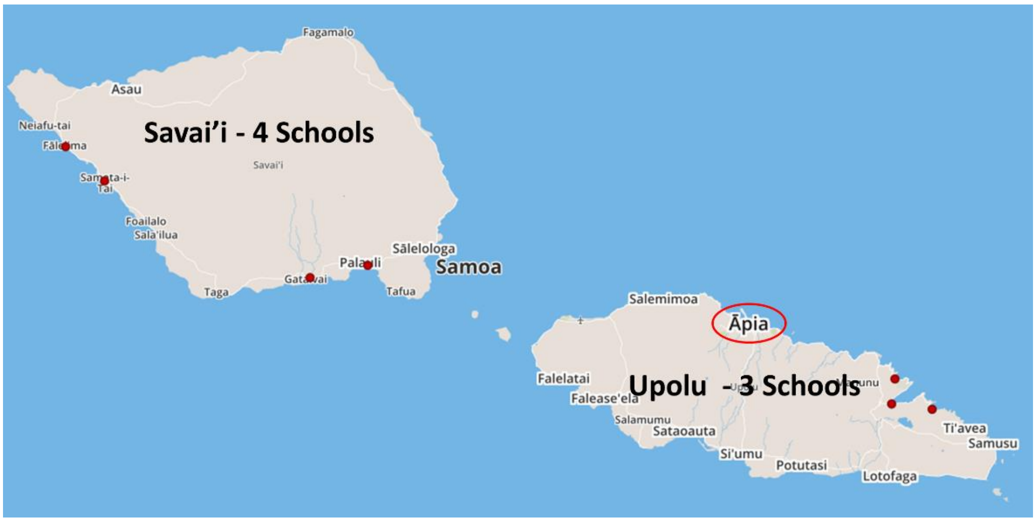


Figure 2: Locations of schools visited in Samoa

[4] Roadmap for Safer Schools, Guidance Note, Draft , Arup, 20th August 2015

4 Existing School Infrastructure Baseline

4.1 Hazards

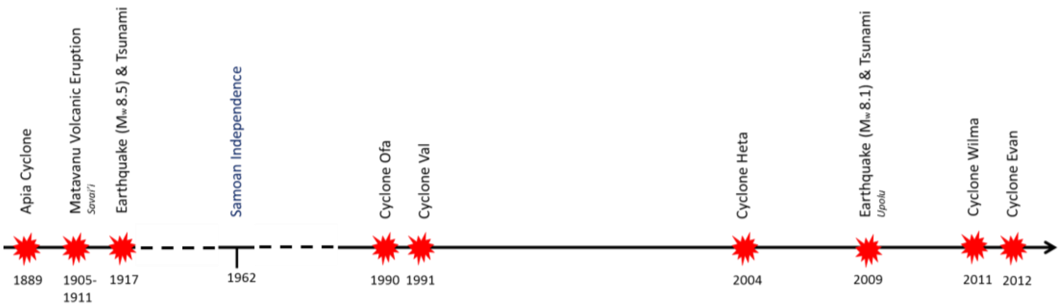


Figure 3: Timeline of major hazard events in Samoan history

Major events over the last decade have provided a distressing reminder of Samoa's exposure to natural hazards. Tsunami's and tropical cyclones, and to a lesser extent earthquakes, are the critical natural hazards posing a risk to infrastructure in Samoa. Tropical Cyclone (TC) Evan in 2012 caused approximately SAT 235.7 million (US$103.3 million) of damage to infrastructure and SAT 7.2 million ($2.7 million US) to school infrastructure[5]. This came only three years after the tsunami of 2009, which affected 2.5 percent of the country's population, causing 143 fatalities and associated economic losses equivalent to 20 percent of gross domestic product (GDP)[6].

Due to these events and increased advocacy about the risk of natural hazards in recent years, the risk of cyclones and tsunamis has become better understood across Samoa. This understanding is critical to the delivery of safe school infrastructure. Tsunamis are an extreme event and the government are preparing evacuation protocols and installing early warning systems (EWS). EWSs are proven to be effective in reducing loss of life but not in reducing risk to physical assets. The most effective means to reduce the tsunami risk is to minimise exposure by locating schools away from the coastline on high ground. In the case of reducing the vulnerability of schools due to earthquakes and tropical cyclones, which are a much more frequent event, it is critical that schools are appropriately planned, designed, constructed and maintained.

National level hazard and risk maps have been developed by the Pacific Catastrophe Risk Assessment and Finance Initiative (PCRAFI), funded through the World Bank, for insurance purposes. Detailed hazard maps for land use planning don't currently exist, although the Disaster Management Office (DMO) are planning to develop these.

There is currently a number of risk assessment and analysis projects being undertaken in Samoa which include;

[5] Samoa Post-disaster Needs Assessment, Cyclone Evan 2012, Government of Samoa, March 2013
[6] http://reliefweb.int/sites/reliefweb.int/files/resources/Country-Note-Samoa.pdf

- **PARTner:** Pacific Risk Tool for Resilience funded through the Government of New Zealand
- **PACSafe:** Risk analysis software which uses existing data from the PCRAFI and information from LIDAR mapping. This tool is due to be completed in the following months and will be used to ascertain risk to infrastructure.

Opportunity 1:

There is an opportunity to co-ordinate the outputs of previous projects and use the results to develop nation-wide hazard maps. Hazard maps can be used to undertake a risk analysis of school infrastructure and develop land use plans to inform the planning regulations.

4.2 Existing School Infrastructure

Samoa has 215 registered schools, 166 of which are public schools (primary and secondary colleges). Over 58,500 children are enrolled in schools and therefore at risk if school infrastructure is not safe and resilient to natural hazards.

Schools are typically constructed by donors or the Government. Once completed, responsibility for the facilities is transferred to the School Committee (made up of the School Principal and community) who often lack the skills and funds to carry out regular maintenance, which has resulted in an aging and deteriorating building stock.

Primary school education is compulsory (years 1-8) in Samoa and access to education is good, with a school located in every village. There is currently no demand to increase capacity, but the need to replace the existing infrastructure is increasing. Approximately 15% of all primary schools have less than 100 students, with some classes having fewer than five students. As result, there may be potential to consolidate the number of public primary schools. Demographic research, which includes mapping the school locations relative to population concentrations and enrolment numbers may be a good way of illustrating this to the MESC.

Data on school infrastructure in Samoa seems to be fragmented and is spread across different ministries. Previous damage assessments can also provide valuable information on school infrastructure. Consolidating this information in a geo-spatial database will be useful in assessing infrastructure improvements at scale.

School buildings play an important role in creating resilient communities; continuity of schooling is critical to rapid recovery and schools have the potential to act as a community refuge, distribution or resource centre in the immediate aftermath of a disaster. An on-going assessment of community facilities, including schools, for use of evacuation shelters is being undertaken by Ministry for Finance (MoF), MESC, DMO in partnership with International Federation of Red Cross and Red Crescent Societies (IFRC). Recognising the potential use of schools as evacuation centres may open up additional sources of government funding which can be used to carry out strengthening works, maintenance, and repairs and add additional features such as watsan facilities and storage rooms.

These assessments aim to identify some of the vulnerabilities e.g. building form (shape), building age etc. but predominantly focuses on the school's amenities and disability access. It is critical that schools are properly assessed by a qualified engineer to determine their exposure and vulnerability in order to identify appropriate schools and make recommendations to improve the performance of schools to be used as evacuation shelters. It should be noted that for a school to serve as an evacuation shelter with post disaster functions, it needs to be designed to a higher performance level (which typically exceeds code requirements which is aimed at life safety.

In Samoa the major public buildings and utilities are fully insured for natural disasters through the commercial insurance market[7] but it is unclear whether this includes school infrastructure and this requires further investigation. Developing a closer link between insurance premiums and the quantified risk of vulnerability of structures can be used as an incentive to building better structures.

Opportunity 2:

Collate existing school infrastructure information into a centralised geospatial asset management database This would provide government ministries with a powerful tool for the planning, prioritisation and management of infrastructure works.

A Structural Integrity and Damage Assessment (SIDA) methodology could be developed which is specific to the Samoan context. Local staff could be trained in the use of this tool, which could be used to develop a school infrastructure condition survey for all assets. Information gathered with this tool could be input into the GIS database and used to prioritise works for a broader retrofit or reconstruction investment programme.

The geo-spatial database presents a further opportunity to identify and prioritise which schools could be used as evacuation centres. All schools that meet evacuation centre standards should be clearly marked.

Exposure

Site selection and physical planning of sites do not appear to have been undertaken and schools were found to be exposed to hazards, such as, tsunamis, landslides and flooding. In some areas this is due to limited availability of land and where community preference mean that other community facilities took a higher priority for land selection.

Site investigations should be carried out to identify key risks and where mitigation measures may be required to reduce the exposure of school infrastructure if appropriate sites are limited;

- Flooding can be mitigated by building drainage systems for the site and elevating the school above flood levels
- Reducing the risk of landslides achieved by installing retaining walls or stabilising the slope to prevent erosion.

[7]http://www.pacificdisaster.net/pdnadmin/data/original/samoa_environmtl_risk_resource_mgmt_data_.pdf

It is critical that any future reconstruction or retrofitting program considers the exposure of the schools to minimise their risk to natural hazards. In areas prone to high winds the orientation of the buildings can significantly reduce the level of exposure.

Some sites visited, for example in Faga-loa, were in remote locations, with only one access route and poor communication links. These communities were particularly exposed and historically landslides have blocked routes in a disaster event preventing the community from evacuating and emergency supplies reaching the community. Early warning systems, improved communication links and formalised safe evacuation shelters are critical to improve the protection of communities in remote locations.

Some of the schools visited a lack of site planning in terms of building position and layout was observed. School buildings were often constructed very close to large trees which can fall on structures during a cyclone or earthquake. Furthermore, leaf litter on roofs from adjacent trees was leading to premature corrosion of roof elements and compromising rainwater collection which is often a schools only source of water.

Opportunity 3:

Hazard maps which have been integrated into a geo-spatial asset management database could be used to establish a preliminary overview of the exposure of school infrastructure to natural hazards..

There is an opportunity to develop guidance notes for site selection, site assessment and mitigation measures which could be used by communities and planning authorities to reduce the exposure of school infrastructure.

Vulnerabilities

21 Buildings in seven schools were surveyed using a Rapid Visual Assessment (RVA) form developed by Arup (Refer to Appendix D). The RVA is a tool which aims to identify the vulnerabilities in schools buildings which increase their susceptibility to damage from natural hazards. From these surveys three common structural typologies were identified as highlighted in Table 1. The key vulnerabilities that were observed are documented in Appendix E and summarised below;

- Many of the school buildings that were surveyed appeared to be non-engineered structures and often lacked a clear or sufficient lateral stability system. This makes them particularly vulnerable to cyclonic and seismic loads. In some cases where the building is in good condition bracing or additional shear walls can be added through retrofitting interventions.
- Structural forms were often irregular, with many buildings being longer than four times their width, or built in 'L' or 'C' shapes. An irregular structural form reduces the structural performance under earthquake loading. Providing seismic joints or separating the building wings in to regular rectangular shapes

(ratio width: length less than 1:3) will help improve the seismic performance of a building.

- Large roof overhangs and verandas we common to most of the schools visited, which increase the risk of roof uplift in strong winds unless they are sufficiently tied down. Another way to mitigate the risk of roof uplift is to separate the veranda structure from the main roof.
- Most buildings visited had gable ends. Hipped roofs generally perform better in high winds by reducing the height of the end walls and creating a more aerodynamic building shape. The removal of high level masonry walls can also decrease their vulnerability to earthquakes.
- Insufficient and poorly detailed connections between key structural elements was the key vulnerability observed; roofing sheets were nailed rather than screwed to the purlins, roof structures were not connected to the walls using hurricane straps and walls were not appropriately tied to the foundations. In areas of high winds (and earthquakes) it is critical that these connections are robust. In the absence of documentation, it is unclear whether the poor quality of connections was due to inadequate design, the absence of design information or a failure of builders to follow the design.
- Many schools across Samoa are degrading due to lack of maintenance and the severe coastal environment. Without regular maintenance, the decay of timber (especially if untreated), corrosion of roofing sheets and connections can lead to premature failure of buildings, particular when exposed to cyclonic wind loads. This highlights the importance of having clear material specifications and quality assurance processes to ensure quality, durable and appropriate materials are used. Sea sand is often used for making concrete and concrete blocks, which when not adequately washed can lead to corrosion of steel reinforcement and concrete spalling. Whilst this was not widely observed during the survey, it is important that quality control of sand extraction and sand washing is maintained through any future building program.

Model School Design

It is understood that educational standards which highlight the minimum performance requirements for schools have been developed by the MESC. Primary schools typically consist of 10 rooms (8 classrooms, one library and one staff room), arranged in different building configurations depending on the site constraints. There is however, currently no standard model school design endorsed by the MESC that is used in Samoa and school designs are typically developed on a case by case basis.

The MWTI have drawings of a 10 room school block, designed by Japanese donors in 2001 which in the absence of other designs is used as a model of best practice for people applying for a Building Permit. The design appears to be engineered, however there are aspects which could optimised to improve the building performance and reduce construction costs:

- Modification of the roof structure and veranda to reduce vulnerability to wind uplift.

- Rationalisation of wall reinforcement.
- Irregular shape on plan – The long linear layout of the block increases the vulnerability of the structure to earthquake loads.
- The design does not include guidance on how to adapt the 10 room linear block to different site conditions.
- Critical construction details are not clearly communicated.

The design drawings do not include any material specifications

Opportunity 4:

The design of the Japanese funded school should be reviewed by a qualified engineer and developed in to a model primary school design for Samoa that is adaptable, replicable, maintainable and appropriate for the local environment and construction capability. Development of a well communicated standard model school design and specification would provide a consistent approach to school construction that takes into account the relevant hazards and ensures compliance with the NBC. Material developed in this package should take into account the level of education and training of the construction workforce. The use of clear, visually conveyed and 3D documentation can assist in the presentation of construction details to workers who have not had formal training. Step by step, 'Lego' style construction manuals can also assist lower skilled workers/ communities to understand the staging of construction works. Any design that is developed must take into account the variability in site conditions and provide options and guidance on design modifications.

Building Typology	No. of Stories	Photo	Advantages	Disadvantages
Reinforced Masonry Concrete block with vertical and horizontal reinforcement	1		• Durable if material quality is managed • Seismic and cyclonic resistance if constructed properly • Use of local materials	• Slow to build • Requires an understanding of good seismic detailing • Requires skilled workers for correct assembly of reinforcement • (Note that unreinforced masonry was not seen in the schools visited, however it may be used in Samoa. It is not recommended due to poor seismic and cyclonic performance)
Reinforced Concrete Frame with Masonry infill	2-3		• Durable • Seismic resistance if constructed properly (infill walls must be tied to frame) • Use of local materials	• Slow to build • Masonry façade may not be tied in • Complex seismic reinforcement detailing • Requires skilled workers for correct assembly of reinforcement
Timber frame Lightweight timber frame with timber or plywood cladding	1		• Easy and quick to build • Timber frame is lightweight and ductile and thus is good for seismic performance	• Untreated timber susceptible to insect attack and weather degradation • Materials are imported • Requires regular maintenance • Vulnerable in high winds if not constructed properly.

Table 1: Construction Typologies of Schools Visited

5 Construction environment

5.1 Institutional Environment and Regulatory Framework

Responsibilities

The table below summarises who is responsible for school infrastructure during each stage of the implementation process.

Stage	Task	Body Responsible	Description
Planning	Needs Assessment	MESC	Community identifies need for a new school and alerts MESC. MESC appraises the communities request for assistance and prioritises works. Sometimes community liaises with and applies directly to a donor.
	Site Selection	Community	Schools are typically built on customary land and the site is agreed within the community.
	Development Consent	PUMA	PUMA review project proposals and if necessary seek the input from other authorities (DMO). PUMA will determine if an EiA is required. Depending on the nature of the development, a PEAR or CEAR is required to be submitted for approval.
Design	Delivery	Private Consultant	MESC, through a 10 week tender process, hire an engineering consultant who develop the design based on the MESC's standard education specifications.
	Building Permit	MWTI - Building Division	Drawings are submitted to the MWTI who review the design to ensure compliance with the NBCS and issue a Building Permit
Construction	Procurement	MWTI - Building Division	MWTI assess tenders and have a list of approved registered contractors. Contractors with a record of poor workmanship are blacklisted and are not permitted to work on public building projects.
	Contract Management	MESC	
	Supervision	MWTI- Building Division	If included in the original ToR the engineering consultant will have role to assure quality during construction. The MWTI's role remains provide periodic inspections to ensure quality.
	Occupancy Certificate	none	not required under current regulations
Operation and Maintenance	Ownership	School Committee	On completion of construction the school is handed over to School Committee. The MESC is responsible for supplying teachers and resources.
	Maintenance	School Committee	The School Committee can apply for funding from the MESC to carry out maintenance. Other funds are raised by the community directly.

During the stakeholder consultations it was observed that there are weaknesses in the planning, design, construction and operation and maintenance of school infrastructure, as explained in more detail below.

Planning

Site selection for schools is based on the community's requirements and the availability of customary land and PUMA has previously faced challenges in enforcing planning regulations. Whilst there is an understanding of tsunami risks, there appears to be little consideration of natural hazards such as landslides and flooding when determining where schools are located. Improving the way in which natural hazards are evaluated during the planning stage will assist to reduce the exposure of school infrastructure through improved site selection and physical planning of school sites. Where availability of land is limited, mitigation measures may be required to reduce the exposure to acceptable limits.

Design

The NBCS (1992) is out of date, and currently does not include retrofitting standards. It is in the process of being updated with a final draft due for cabinet review at the end of 2015. This is being led by the MWTI and is being updated based on the Australian and New Zealand Codes and contextualised to suit the predominant construction techniques used in Samoa. To ensure that the standards are broadly accessible, the new code should explicitly contain all the information that is required for simple buildings without excessive reliance on Australian and NZ standards. Overseas standards can be expensive, which can limit the access to and thus compliance with the code. Thought needs to be given to how the code is launched, made available and disseminated.

Currently the structural importance factor, which defines the performance level and design loads for a building, is not explicitly covered in the NBC. The importance level considered for the design of school structures appears to be at the discretion of the MWTI. If schools are to be used as evacuation centres, appropriate selection of the importance level and thus the design loads is critical. There is also no guidelines for retrofitting given in the current code, which would prove useful for the upgrading of school infrastructure.

The MWTI is responsible for enforcing the NBCS and issuing a Building Permit, however they have limited capacity and capability to thoroughly review all building approvals. Last year there were approximately 500 building permits issued and only 5 inspectors available in MWTI to review designs. None of the Building Inspectors are engineers and therefore lack the formal training to assist them to carry out their responsibilities. Furthermore, only buildings over one storey are required to have an engineering certificate and as a result most schools remain un-engineered.

Opportunity 5:

Once the code has been updated the MESC education standards should be reviewed and updated to align with the new code and international best practice.

There is an opportunity to provide training and guidance material to MWTI Building Inspectors to understand the key vulnerabilities of school infrastructure and best practice construction details. Training could be developed in line with the launch of the new building code to ensure the general building code requirements are understood.

Developing a standard school design will also simplify the review process for MWTI Building Inspectors

Construction Supervision

There seems to be a lack of quality assurance on site. On occasions, consultants are paid to provide this service, but this appears to be rare on school infrastructure projects. This challenge is compounded as not all schools are constructed by the government and many community built schools lack a suitable quality control process.

Periodic site inspections to monitor the quality of construction are the responsibility of the Building Inspectors, however due to a lack of resources and funding it is difficult for them to travel and fulfil this role. Furthermore, site inspection protocols do not currently exist in the building regulations, although these are soon to be developed by technical consultants from New Zealand and building occupancy certificates are not currently required to be issued on the completion of construction. These factors result in school buildings which are constructed with limited supervision, and no process in place to verify that construction is completed in accordance with design, or to an appropriate level of quality prior to handover to the community.

There are a number of ways the Building Division could operate more effectively, given the limited resources available;

i. Provide training to School Committees to monitor the construction of school infrastructure; to ensure contractors have requested the Building Inspectors to undertake their mandatory inspections and /or provided photographic evidence to the Building Division.

ii. Allow contractors who have a good track record to self-certify that their work complies with the Building Regulations, keeping photographic evidence. Contractors that don’t meet expected level of construction quality could be black listed from the government register, therefore incentivising contractors to comply.

iii. Create the role of a Review Consultant in the regulations, defined as an independent consultant who reviews the design and supervises construction of complex developments, to ensure that they comply with the Building Regulations. This would enable building inspectors to dedicate their time to simpler construction projects.

Opportunity 6:

There is an opportunity to develop a quality assurance methodology to be used by the MWTI for the delivery of school infrastructure. This tool would clarify the roles and responsibilities of each party during construction, and introduce a series of checklists and audits to ensure all schools are built to comply with the NBC, to a suitable level of quality.

Maintenance and Repair

A lack of quality assurance processes during construction places the burden of maintaining poor quality infrastructure on the community.

Prior to 2014, the Samoan School Grant Scheme, ($5million per year from the Australia and New Zealand Governments), provided funding to assist in the operations and maintenance of Samoan Schools. Funds were allocated to schools based on enrolments ($100/ pupil/year) with 10% of funding apportioned to maintenance works. Following the conclusion of this scheme, all school maintenance is now funded through the Government contributions (MESC) and fundraising efforts in the school communities directly. The extent to which government funding for maintenance actually reaches school committees is unclear.

Following a disaster event, the repair, retrofit and/or reconstruction to school infrastructure is often funded through bilateral and multilateral donors. The inevitable delays involved in funding reconstruction projects through donors, means that children's education can be disrupted for extended periods of time. In some villages this has meant using houses in the community as make shift classrooms which is inappropriate.

Regular maintenance plays a critical role in ensuring the ongoing structural integrity of school infrastructure. Through a well-managed maintenance program, the damage to infrastructure from extreme events can be minimised, decreasing the financial burden of re-construction and limiting the duration of school closures.

Opportunity 7:

There is an opportunity through Component 3 of the PREP (disaster risk profiling) to create a resilience strategy to expedite repairs in the immediate aftermath of a disaster. Through pre-approval of contractors and stockpiling of standard building materials, reconstruction efforts can be fast tracked which will aid the continuity of children's education which is critical to rapid recovery.

Any model school designs which are developed should include details which minimise maintenance wherever possible. On completion of construction an occupancy certificate and maintenance manual should be provided to the community. This manual would highlight the key areas which require maintenance, the maintenance intervals and provide guidance how to carry out maintenance and minor repairs. Details in the manual should be presented visually wherever possible, with a level of detail that is relevant to audience for which it is intended

5.2 Construction Capability & Capacity

Samoa has good technical capability, albeit the number of professionally qualified engineers are limited. There are international (mostly New Zealand) firms that have offices in Samoa and can pull in additional resource as required through their regional networks.

Institute of Professional Engineers Samoa (IPES) is an organisation that has shown dedication to improving the quality of engineering and construction in Samoa. IPES is the licensing body of all engineers in Samoa and works to ensure all engineers working in Samoa are professionally qualified. IPES advocate that all engineering drawings are signed off by an IPES registered engineers.

Engineers have typically studied in New Zealand or Australia on scholarship schemes. Recently scholarship schemes have included a bond required by law in order to retain skills within the country. However, scholarships are not awarded based on a national skills shortage but awarded to the top 12-15 students in Samoa with many concentrating on other professions.

Opportunity 8:

Supporting IPES in their efforts to regulate the engineering industry, provide professional development to its members and improve legislation and building codes could assist to create lasting change in the infrastructure sector

Promoting the engineering profession and the importance of engineers in society to ensure resilient infrastructure and to encourage students to study engineering at university will also be essential to develop the construction capacity.

6 Financial Environment

6.1 Historic, current and planned investment

There are a number of current and historical school infrastructure investment programmes in Samoa which include:

- Japanese Embassy Grassroots Human Security Projects. The Japanese Embassy, through its Grassroots Human Security Grants Program provides regular funding each year to communities across Samoa. Communities apply for grants, which are typically capped at 10 million Japanese Yen (~US$85,000) and approximately 2-3 schools are funded through this program each year. Funds are provided directly to communities, who are encouraged to go through the required approvals processes within the relevant government authorities. Technical assistance to communities does not appear to be provided. It was observed at a number of schools that designs had been altered significantly, which had compromised the stability systems of these structures. Construction quality was variable and numerous buildings showed weaknesses in key construction details.
- ADB, with funding from Australia and New Zealand financed Education Sector Development Project 2000-2006 (ESP1). This program was designed to

respond to the GoS's education policies and strategies 1995–2005, which aimed to increase access to secondary education. Through the program twelve public junior secondary schools were upgraded to function as secondary colleges. More schools were subsequently assisted by a second ADB Education Sector Programme (ESP2) after 2006. The design and construction was tendered and a private engineering firm was hired to undertake the site supervision. These schools were not visited during the mission so the quality of the construction cannot be evaluated.

- The Chinese Government have donated a number of schools to the GoS in recent years. These projects are self-implemented by the donor and funds for the construction are not transferred through the government. There are concerns within government departments and IPES about the quality of construction of these buildings, the compliance of design with local codes and the use of construction techniques and materials that are unfamiliar to local industry, making it difficult to maintain.
- Following Cyclone Evan AusAid funded $8 million to repair vital infrastructure and rebuild schools and health clinics. A damage assessment of affected school infrastructure was undertaken by non-technical people within the MESC. Affected schools were categorized based on a general assessment of the extent of damage which may not have considered the key vulnerabilities of the original structure. This approach poses a risk that repair works were only superficial and do not address the key vulnerability issues of the original design and construction.

There needs to be greater clarity on who is taking design responsibility for both retrofitting and reconstruction projects and who is responsible for ensuring and assuring the quality of workmanship and materials in order that the construction meets the required design intent.

7 Recommendation for PREP Entry Level Investment

The prospective WB program aims to provide an entry level investment into the repair, retrofitting or reconstruction of school infrastructure. Two key opportunities are available for the utilisation of these funds (US$0.575m).

1) Reconstruct a single school
2) Develop a retrofitting program for a number of schools

Any investment in school infrastructure should be assessed in the context of a potential rationalisation of schools and the work by the DMO on identifying evacuation shelters. This will ensure that any money spent on infrastructure is part of a long term plan within the MESC and maximises community benefit.

A single school reconstruction would be simpler in scope and management due to the concentrated nature of the works. Using a model school design with a single contractor and good site supervision, the project could likely be rolled out quickly.

This approach may be a good way to get early results and build relationships within the ministry, providing scope for the development of a larger schools retrofitting or reconstruction program. It would have the disadvantage of addressing the needs of only a single community, but may serve as an example of how model schools could be rolled out across the country for future construction.

A retrofitting program would provide much needed funding for the upgrading of the existing building stock and would maximise reach by strengthening a large number of assets against damage due to natural hazards. Due to the lower probability of seismic damage compared to cyclone damage and the complexity of seismic retrofitting, it is recommended that a retrofitting program would focus on strengthening existing structures against cyclones. Works could be prioritised by focussing on structures which are shown to have sound walls and foundations (likely made from reinforced concrete block), with a focus on strengthening the connections across the roof structure. The disadvantage of a retrofitting program is the survey that is required to identify buildings to be included in the pilot program and that different interventions may be required for different building types.

Recognising the value of the existing building stock and the frequency of cyclone events, it is recommended that the entry level investment for the PREP may have the largest impact on the school sector by focus on retrofitting existing structures. By addressing the key vulnerabilities of structures before a disaster event, the extent of damage to existing building stock can be minimised which may represent the best value for money intervention.

Figure 4 below maps out the entry points for a WB reconstruction or retrofitting program depending on building condition and vulnerability factors.

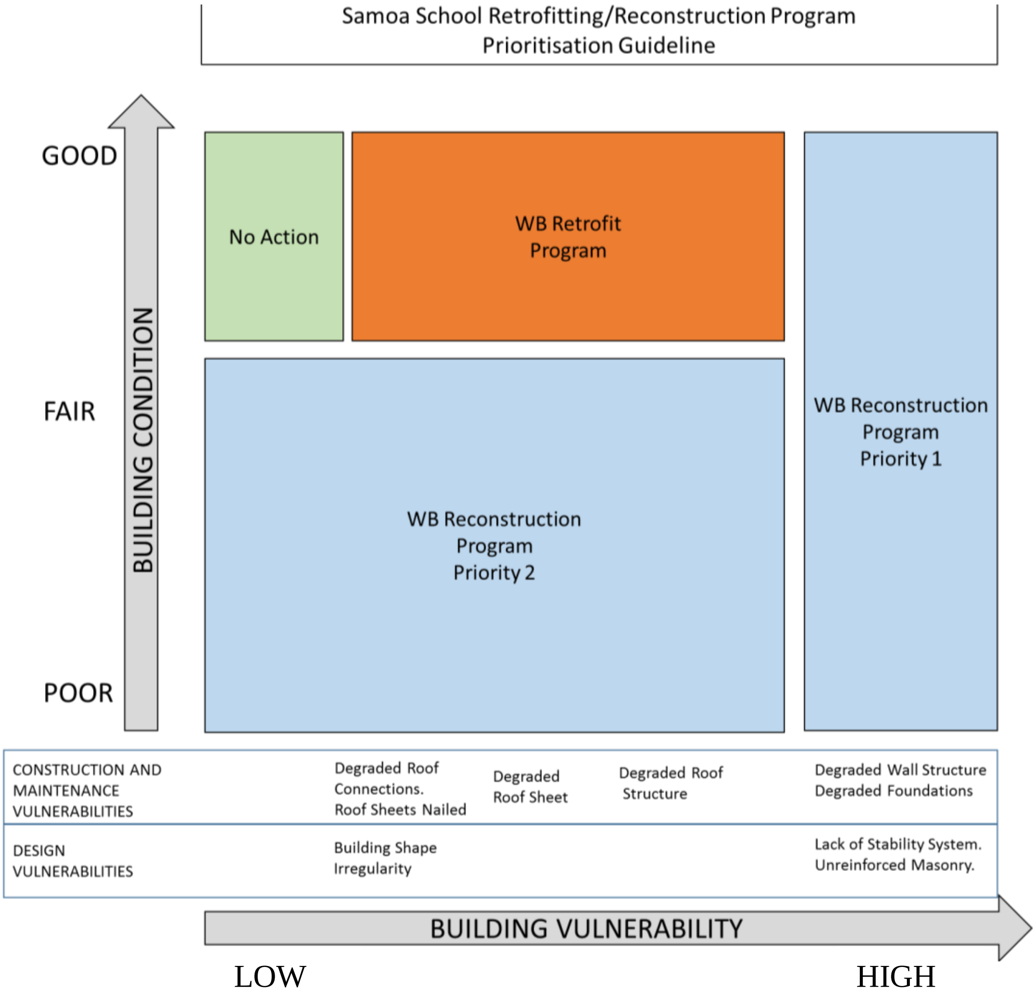


Figure 4 Entry points for a school infrastructure retrofitting /refurbishment program

8 Roadmap

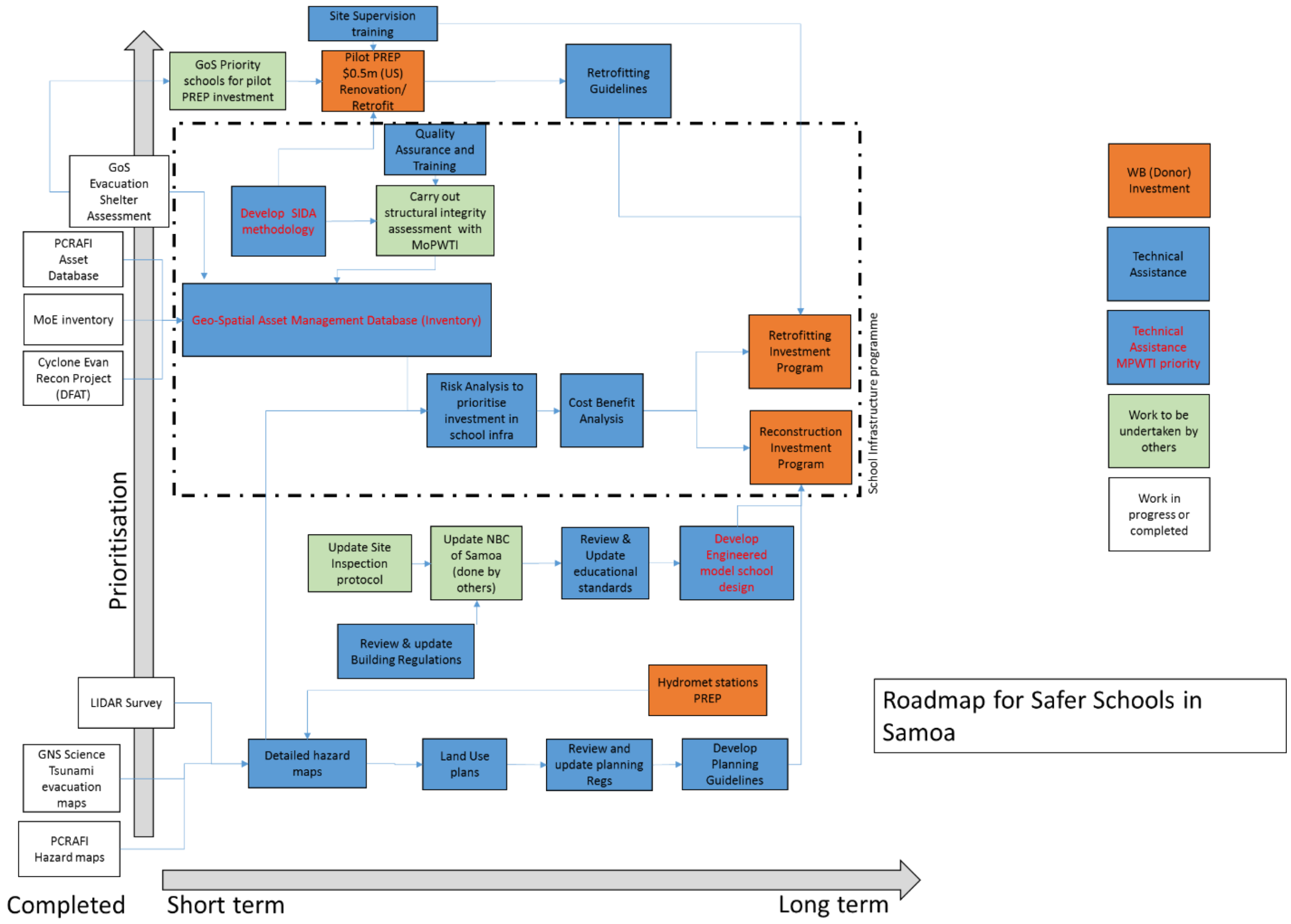


Figure 5 Roadmap for a Safer Schools Technical Assistance Program

To support the implementation of a school infrastructure retrofitting and reconstruction program and to improve the safety of school buildings it is recommended that the World Bank invest in the following opportunities to provide technical assistance in the preparation of tools, guidelines and training to build the capabilities of government agencies and the local construction profession.

Comprehensive School Infrastructure Program

Implementation of a broader retrofitting and reconstruction program requires the development of a geo-spatial database to establish a baseline of school infrastructure facilities, so that works and investment can be planned and prioritised to address the areas of greatest need and have the biggest impact. The MWTI echoed the need to establish a **GIS asset management database.** It is recommended that technical assistance is required to work with MWTI, MESC and DMO to collate the existing data and work that has been done through school infrastructure programs and develop a comprehensive database which can be used by all government agencies to manage school infrastructure assets. Training key staff in each of the ministries will be vital to ensure widespread adoption.

To address the gaps in the database it is recommended that technical assistance is provided to develop a robust and replicable **Structural Inspection Damage Assessment (SIDA) process.** The aim of the SIDA is to inform the development of a prioritized investment plan for the reconstruction, repair and retrofitting of school infrastructure. **Quality assurance and training** will also be required to build capacity of the Building Inspectors undertake the assessments nationwide.

Following the collection of the data it is recommended that a **risk assessment** is undertaken by a competent technical expert. This will include undertaking a **prioritisation analysis**, and designing intervention options for a **cost benefit analysis** to ensure that the works are prioritised based on the greatest impact for the investment available.

Implementation Support

Planning procedures in Samoa are undergoing a process of continuing improvement in an effort to regulate development in the built environment. To reduce the exposure of school infrastructure to natural hazards, there is an opportunity to provide technical assistance to PUMA, DMO and MNRE to create country wide **hazard maps and land use plans**. Tsunami, cyclone and earthquake hazard maps have already been developed through other projects. These would be complimented by mapping localised hazards such as flooding and landslides. Results from these studies should be incorporated into the GIS asset management database, for use by PUMA in assessing development applications. Furthermore, it is recommended that support is provided to the GoS to update **planning regulations** to reflect the results of the hazard and land use mapping exercises. **Planning guidelines** could also be developed to assist in site selection and the interpretation of new planning regulations.

A review and update of the **building regulations** should be undertaken to ensure that they align with the updated NBCS and site inspection protocols that are currently being updated by the MWTI. Of particular importance is the inclusion of a condition that all school buildings are engineered and certified by a professional IPES registered engineer, irrespective of their size.

In turn it is recommended that the current **educational standards** are reviewed and updated to international best practice for schools constructed in a similar context. These should be used to inform the development of an **engineered model school** design and specification, which will provide a consistent approach to school construction that takes into account the relevant hazards and ensures compliance with the NBCS. This approach would simplify a large scale school reconstruction program and introduce efficiencies of scale. It is recommended that the technical assistance provided liaises with the MWTI and local contractors to develop a design that is appropriate to the context.

Pilot PREP Investment

A Pilot PREP retrofitting investment offers a unique opportunity to capture the lessons learnt and experience in a **retrofitting guideline document** to enable others be able to retrofit school infrastructure to increase their resilience. This would also support the efficient roll out of a large scale school retrofitting program, and help standardise and streamline the works. It is recommended that the guidelines would include typical details and specifications which reflect the works that are required to address the key vulnerabilities for common structural typologies.

MWTI building inspectors typically come from and architectural, drafting or carpentry background. These staff would benefit from **training** to understand key engineering principles and vulnerabilities of buildings, which would help to ensure that the quality of construction in Samoa is improved. Training material developed and tested during the PREP pilot could be used to train builders as part of a larger scale retrofitting or reconstruction program.

Any works undertaken by contractors as part of the entry level PREP program or the wider school reconstruction and retrofitting programme should be supervised by a suitably qualified third party to provide quality assurance.

Appendix A

Document Register

A1 Document Register

Type	Title	Author	Year
Fact Sheets/ Brochures/ Articles	Project Update- Education	MESC, GoS	2014
	Strategic Plan 2006-2015	MESC, GoS	2006
	Report on the Samoa National Building Code Promotion and Application	UNDMP	1999
	Professional Engineers Registration	IPES	1998
	Building Permit Application Form	MWTI, GoS	2015
	Compliancy Confirmation Form	MWTI, GoS	2015
	Procedure for Building Permit Application	MWTI, GoS	2015
	Education: Do we have too many schools in Samoa?	Assoc. Prof. Penny Schoeffel. Centre for Samoan Studies, NUS	2013
	JICA Grassroots Grants- Guidelines	JICA	2012
	Dealing with Construction Permits in Samoa	World Bank	2015
Reports	School Assessment Report Cyclone Evan	MESC, GoS	2012
	SAMOA, Post-disaster Needs Assessment, Cyclone Evan 2012	GoS	2012
	Fagaloa Evacuation Centre Inspection	DMO, GoS	2015
	Samoa Evacuation Center Inspection Databas	DMO, GoS	2015
	PCRAFI Country Note, SAMOA	GFDRR, SPC, JICA, WB	2015
	Tsunami Modelling, Samoa	GNS Science	2011
Codes and Regulations	National Building Code of Samoa	GoS	1992
	Planning and Urban Management (Environmental Impact Assessment) Regulations	GoS	2007
	Planning and Urban Management Act	GoS	2004
	Samoa Building Code Legislation	GoS	2002

Appendix B

Mission Details

B1 Stakeholder Meetings

Organizations
World Bank, Arup
MNRE, World Bank, Arup
MoF, MNRE, World Bank, Arup
MESC, World Bank, Arup
MWTI, World Bank, Arup
IPES, Arup
School Visits- MESC, World Bank, Arup
School Visits- DMO, World Bank, Arup

Appendix C

Schools Surveyed

C1 Schools Surveyed

Locations of Schools Visited in Samoa

List of Schools Visited in Samoa		
School Name		
Island	Savai’i	
Year built	1970s	
Construction Type	Timber Frame.	
Year built	2012	
Construction Type	RC Frame with masonry infill	

School Name	
Island	Savai'i
Year built	2014
Construction Type	RC Frame with masonry infill

School Name	
Island	Savai'i
Year built	1990s
Construction Type	Timber frame with masonry skirt wall

School Name	
Island	Savai'i
Year built	1995
Construction Type	Timber frame

School Name		
Island	Upolu	
Year built	Refurbished 2014	
Construction Type	Reinforced Masonry	

School Name		
Island	Upolu	
Year built	unknown	
Construction Type	Reinforced Masonry	

Appendix D

Rapid Visual Assessment

D1 RVA Questions

Heading	Subheading	Question
1. Survey Details		
	Background Info	School Name
		Location
		Samoa - Upolu
		Samoa - Savai'i
		Tonga - Vava'u
		Tonga - Tongatapu
		Date
		Time
		Survey Number
		Arup Surveyor 1
		Arup Surveyor 2
		Photos Of Main Entrance
2. User Interview		
	Contact Details	Contact Name
		Contact Position
		Contacts Duration in Post
	School Details	Number of pupils on site
		Number of staff on site
3. Site Exposure		
	Topography	What is the slope of the site
		Is the site elevated above the surroundings
		Is the site at or near the base of a slope escarpment
		Are there deep cuts into the hill slope
	Water and Drainage	What is the distance to the nearest ocean river body of water
		<50m
		100m
		500m
		>1km
		Unknown
		What is the height above floodplain body of water
		<1m
		2m
		5m
		10m
		>10m
		Unknown

		Are there any man made drainage systems culverts on or near the site
		Photos of drainage systems
		Do the drains appear to be working
	Faults	Are there any linear features or vertical offsets on the site which could indicate an active fault
	Wind	Is the site sheltered shielded from wind eg with natural wind barriers trees
		No shielding
		Partial shielding
		Full shielding
	Vegetation	Are the buildings near large trees that can blow over
	Erosion	Are their signs of heavy erosion on the site
		Is there any evidence of slope stabilisation
		Are there any retention wall construction on or near the site
	Earthquake	Are there sufficient gaps between buildings to prevent pounding
		Is there sufficient space to unsafe structures and potentially damaging debris
	Evacuation	Are there good quality evacuation routes roads to from the school
	Communication	What communication links exist from the school to emergency services
		Radio
		Mobile phone
		Fixed phone
		Internet
4. Building Hazard Vulnerability		
4.1 Questions About the Building		Building identifier
		Photo of building entrance
		Who built the building
		Community - Unsupervised
		Community - Supervised
		Local Contractor
		International Contractor
		Who funded the building
		Community
		Government
		Donor - JICA
		Donor- DFAT
		Donor - MFAT
		Donor - ADB
		Donor - China

		When was it built
		Function of building
		Classrooms
		Offices
		House
		Watsan
		Dormitory
		Church
		Kitchen
		Maintenance/ Storage
		Number of room units in the building
		Is the building permanent or semi-permanent
		Permanent
		Semi-permanent
4.2 Building Configuration	Building Shape	What shape is the building
		Rectangle (L<4B)
		Rectangle (L>4B)
		Square
		L shaped
		T shaped
		Photo of sketch plan
	Soil, Foundations and Floor	Select soil type
		A - Hard rock
		B - Average rock
		C - Dense soil
		D - Stiff soil
		E - Soft soil
		F - Poor soil
		Comments on soil type
		Photos of floor foundations
		Select foundation type
		Pads
		Strips
		Raft
		Piles
		Mixed
		None
		Unknown
		Comments on foundation type
		Floor type

		Concrete Slab
		Crushed Coral
		Timber
		Earth
		Comments on floor
		Is there a damp proof membrane
		Is there evidence of rising damp
		Floor and footing condition
		0% (undamaged)
		10% (minor works required)
		50%
		100% (total destruction)
		Unknown
	Walls/ Columns/ Façade	Photos of walls columns facade
		Building stability system type
		Shear Wall
		Portal Frame
		Cantilever Columns
		Braced Frame
		Galvanised Iron Strapping
		Timber Strut
		Ply Sheet Bracing
		PVC Sheeting Bracing
		Absent
		Unknown
		Wall and column system
		Concrete Columns
		Timber Columns
		Concrete Block
		Timber frame
		Steel Frame
		Bamboo frame
		Stone
		Comments on stability and wall system
		Facade type
		Painted Block
		Cement Plaster
		Corrugated Iron
		Fibre Cement Sheet
		Asbestos
		Timber Cladding

		Bamboo Cladding
		Asbestos
		Facade fixing method
		Screws
		Nails
		Unknown
		Comments on facade
		Is there evidence of rot borer or termite attack in wall timbers
		Yes- Rot
		Yes- Borer/Termite Attack
		No
		N/A
		Cover to wall openings
		Timber- Shutters
		Timber- Louvre
		Metal- Shutters
		Glass- Fixed
		Glass- Louvre
		Mesh/Screen
		No Covering
		Comments on wall openings
		Wall cladding condition
		0% (undamaged)
		10% (minor works required)
		50%
		100% (total destruction)
		Unknown
	Roof	Photos of roof
		Roof structure
		Timber truss
		Timber beam
		Steel truss
		Steel beam
		Bamboo
		Concrete
		Roof slope pitch
		Flat (0-5 Deg)
		Gentle (10-25 Deg)
		Steep (30-45 Deg)
		Roof structure tie downs
		Looped Reinfocement from below

		Galvanised Iron Strapping
		U bolts
		Bolts and brackets
		Skew Nails
		Skew Screws
		Lashed (rope/fibre)
		Timber Dowels
		Absent
		Roof material
		Corrugated Iron
		Tiles
		Concrete
		Natangura
		Roof fixing methodology
		Screws
		Nails
		Unknown
		N/A
		Roof bracing
		Galvanised Iron Strapping
		Timber Strut
		Timber/ PVC brace sheeting
		Absent
		Unknown
		Is there evidence of rot borer or termite attack in roof timbers
		Yes- Rot
		Yes- Borer/ Termite Attack
		No
		N/A
		Are there large eaves or verandahs
		Yes- large eaves
		Yes- large verandahs
		No
		Photos of roof details
		Comments on roof issues
		Roof condition
		0% (undamaged)
		10% (minor works required)
		50%
		100% (total destruction)
		Unknown

	Building Categorisation	Reconstruction category
		Any other comments on building hazard vulnerability section
5. Water and Sanitation		
		Where does the school get water from
		District Supply
		Rainwater Tank
		Bore
		Well
		Creek/ River
		What toilets does the school have
		Toilet - Long Drop
		Toilet - VIP
		Toilet - Flushing
		None
		N/A
		No of toilets male
		No of toilets female
		Additional photos
6. Survey Close		
		Additional comments information
		Additional photos
		Detailed evaluation required
		Yes
		No
		Record completion
		Draft
		Complete

Appendix E

Key Vulnerabilities

E1 Exposure of School Infrastructure

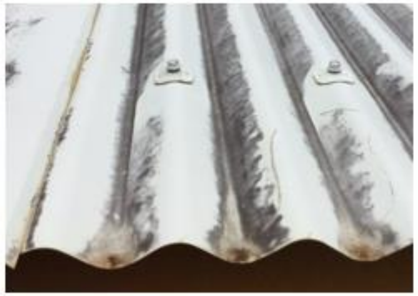
Exposure	Descriptiuon	Photo
Physical Planning	Locate structures away from large trees or unsafe structures which can fall on structures during a cyclone or earthquake • Roof was impacted by falling debris • Rainwater collection compromised by leaf litter	

Exposure	Descriptiuon	Photo
Site Location	• Schools built on exposed sites in close proximity to the coast in tsunami zones	
	• Schools exposed to localised flooding due to absence of site planning or drainage	
	• Schools built in areas with evacuation routes prone to landslides • Schools exposed to landslides in areas with steep slopes.	 

E2 Key Vulnerabilities

Vulnerability	Description	Photo
Age of Assets	Many schools are ~30 years old and are degrading due to lack of maintenance and the severe coastal environment	 
Structural Stability	Lack of stability system. Non engineered structures. Stability system in one direction only.	
Structural form	Irregular structural form Buildings have L>4B or are "C" or "L" shaped	 

Vulnerability	Description	Photo
Poor material quality	Sea sand is often used in concrete and for making concrete blocks. Salt content in the sand leads to corrosion of steel reinforcement and concrete spalling. Whilst this was not observed regularly in Samoa, it is vital that all material used is washed.	
	Timber degradation due to lack of maintenance and the use of untreated timber.	 
Material Selection	Materials selected must be appropriate for the conditions. Fibre cement sheet is brittle and prone to fracture. It is not recommended for use in schools where panels can easily be damaged by students. Once damaged, the underlying structure is prone to rot and weathering.	

Vulnerability	Description	Photo
Roof Connections	Poor connection details making schools vulnerable to high winds: • Skew nails in lieu of strapping at roof to wall connections • Connections corrode over time in the coastal environment. • Trusses are well constructed, but purlins are not strapped to trusses.	  
	• Nails are used in place of screws, which are vulnerable to uplift • Poorly galvanised nails initiate corrosion in roof sheet	 
Wall Connections	Poor connection details making schools vulnerable to high winds. • Bottom plate is partially anchored, but stud not anchored to bottom plate	

Vulnerability	Description	Photo
Wall Detailing	• Bond beams are required to provide horizontal connection between columns • High level masonry in gable ends is an EQ hazard	 
Poor workmanship	A lack of site supervision allows poor quality workmanship to go unchecked. • Rafter strapping provided to top plate, but strapping methodology is incorrect and ineffective • Inadequate cover to reinforcing bars in foundation	 

Vulnerability	Description	Photo
Appropriate Design	Large eaves • Wind loads at roof edges are higher than for all other areas of a structure. The use of large eaves on structures should be avoided, or where used, careful attention should be paid to the connection of these structures to the walls.	
	Verandahs • Verandahs experience higher uplifts that other areas of a roof. Wherever possible, verandahs should be detailed as separate structures. Where they are intergral with the main roof structure, careful attention should be paid to ensure robust connections	
	Maintaining timber above the splash zone. • In areas of heavy rainfall it is advised to elevate timber well above ground level where it is exposed to moisture and splashing from rain.