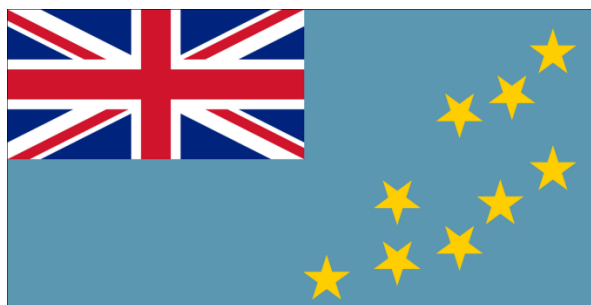


Survey of the Regional Distribution and Status of Asbestos-Contaminated Construction Material and Waste - Best Practice Options for its Management in Pacific Island Countries

Report for Tuvalu



**Prepared for the Secretariat of the Pacific Regional
Environment Programme (SPREP)**

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Contact Details

John O'Grady
Director
Contract Environmental Ltd
14 Wookey Lane,
Kumeu 0841
Auckland, New Zealand
jogrady@actrix.co.nz
ph +64 21 311 532

Dave Robotham
Associate Environmental Consultant
Geoscience Consulting (NZ) Ltd
P O Box 373
Christchurch 8140
New Zealand
david@nzgeoscience.co.nz
ph +64 3 328 9012

Gareth Oddy
Senior Environmental Scientist
Geoscience Consulting (NZ) Ltd
P O Box 373
Christchurch 8140
New Zealand
goddy@nzgeoscience.co.nz
ph +64 3 328 9012

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Executive Summary

PacWaste (Pacific Hazardous Waste) is a four year (2013-2017), €7.85 million, project funded by the European Union and implemented by Secretariat of the Pacific Regional Environment Programme (SPREP) to improve regional hazardous waste management in 14 Pacific island countries plus Timor Leste, in the priority areas of healthcare waste, asbestos, E-waste and integrated atoll solid waste management.

Asbestos-containing wastes and materials are a major issue for many Pacific Island countries with a history of use of asbestos-containing building materials in construction. All forms of asbestos are carcinogenic to humans and inhalation of asbestos fibres that have become airborne can cause serious lung disease or cancer.

SPREP's regional priorities for asbestos management include conducting an inventory of the distribution of asbestos-containing materials (ACMs) in thirteen Pacific island countries, assessing the risks posed to human health by asbestos, progressive stabilization of high-risk facilities such as schools and occupied dwellings, and final disposal of ACM wastes in suitable locations.

PacWaste has commenced with a series of baseline surveys that will collect and collate information about the current status of all three hazardous waste streams targeted (healthcare waste, asbestos, E-waste) and its management in the South Pacific region and will identify best practice options for interventions that are cost-effective, sustainable and appropriate for Pacific island communities. These remedial interventions will be implemented in priority countries identified through the baseline survey.

This report aims to meet part of the objectives of SPREP'S Pacific Regional Solid Waste Management Strategy 2010–2015 and the regional hazardous waste strategies, 'An Asbestos Free Pacific: A Regional Strategy and Action Plan 2011'.

This report covers the Tuvalu component of a survey of the regional distribution and status of asbestos-contaminated construction material, and best practice options for its management, in selected Pacific island communities. The objectives of the survey are summarised as follows:

- To assess the status of, and management options for, asbestos throughout the Pacific region; and
- To develop recommendations for future management interventions, including a prioritised list of target locations.

The work was carried out by a consortium led by Contract Environmental Ltd and Geoscience Consulting (NZ) Ltd, under a contract to the Secretariat of the Pacific Regional Environment Programme (SPREP), with funding provided by the European Union.

This report presents the information gathered for Tuvalu during a field visit undertaken by Gareth Oddy between the 8th and 16th of August 2014. The visit was organised through the Department of the Environment.

Survey Methodology

The survey work undertaken in Tuvalu included meetings with key government agencies, area-wide surveys of residential properties across the Island of Funafuti, and targeted investigations of public and commercial buildings. There are 9 main islands in Tuvalu but the survey was limited to the Funafuti on the island of Fongafale, mainly for logistical reasons. The most recent census data for Tuvalu (2012) indicates that there are approximately 639 households on Funafuti, and this represents about 41% of the total number of households in Tuvalu.

A statistical method was adopted for the survey of residential properties. This involved calculating the minimum sample size required from the total population to give the required confidence level and margin of error. In this case a sample size of 350 houses was required out of the 639 in total on Funafuti to give a result with a margin of error of $\pm 3.5\%$ at the 95% confidence level. The statistical approach requires that the residential properties be selected at random.

In addition to residential households, the survey sought to identify public buildings and government-owned industrial and commercial properties containing ACMs. The primary focus of this part of the survey was on public buildings that would potentially present the most prolonged and thus significant risks for public exposure. Commercial and industrial buildings were included if they were observed in close proximity to residential housing or public areas.

The basic approach taken for all property types was an initial visual assessment, usually from the roadside or property boundary, followed by closer inspection if the buildings appeared to contain potential ACMs, such as fibreboard cladding, roofing materials, or pipes. The information collected in the close-up inspections was recorded on the spot using a tablet-based application designed specifically for this project. In addition, samples of any suspect materials were collected for testing.

The collected samples were sent by courier to EMS Laboratories Incorporated in California, USA. Analysis was by Polarised Light Microscopy, which is a semi-quantitative procedure for identifying asbestos fibres, with a detection limit in the range of 0.1 to 1% on a surface area basis.

Risk Assessment

A systematic risk assessment approach was adopted in order to assess the relative risks of each building identified as containing ACMs. The method used was that given in the UK HSE guidance document '*Methods for the Determination of Hazardous Substances (MDHS100) Surveying, sampling and assessment of asbestos-containing materials (2001)*' and UK HSE guidance document '*A comprehensive guide to Managing Asbestos in premises (2002)*'. The method uses a simple scoring system to allow an assessment of the relative risks to health from ACMs. It takes into account not only the condition of the asbestos, but the likelihood of people being exposed to the fibres.

The risk assessment approach adopted presents algorithms that allow a score to be calculated for each ACM item observed or confirmed by laboratory analysis. The sites with high scores may present a higher risk to human health than those with lower scores.

Survey Outcomes

ACM has been identified by this study to be present at several locations in Tuvalu. Based on the algorithm adopted as part of the risk assessment to prioritise asbestos management, this study has identified that there are only two sites (apart from residences) in Tuvalu that are considered moderate to high risk with regards to the occupant's and/or public's potential exposure to asbestos. The remaining sites identified are considered to present a low to very low risk to human health.

With regard to residences Tuvalu had a population of 10,387 in 2012 across the nations' 9 islands and total land area of 25.6 km². The population were reportedly housed in approximately 1,568 residential households with over a third of those households in Funafuti on Fongafale Island.

The Table below provides a summary of the Tuvalu census data and conclusions based on the survey results.

Household Survey	No of Households
Total of Households in Funafuti (2012 Census)	639
Households Surveyed	350
Households PACM Suspected (Cladding Only)	161
Extrapolating to full Funafuti Population (95% Confidence Level) - No of houses with suspected asbestos cladding:	294 +/- 3.5%
Conclusion from Results	No of Households
Total Cladding Samples taken	38
Cladding Samples Positive	7
Percentage of Cladding Positive	18.4
Based on 18.4%, no of houses inspected that have asbestos cladding	30
Extrapolating to full Funafuti Population (95% Confidence Level) - No of houses with asbestos cladding:	55 +/- 3.5%

Assuming that the 18.4% figure is correct for the number of houses in Funafuti that have cladding that contains asbestos is 55+/-3.5%. The total 2012 number of private residences in Tuvalu is 1568. By direct proportion based on the above figure, the number of residences in Tuvalu with asbestos cladding is therefore 130 – 140 houses. This extrapolation is largely speculative as the margin of error will increase significantly and also there is no guarantee that the Tuvalu outer islands have the same types of cladding. In the absence of other data this extrapolation does, however, at least provide some indication of the Tuvalu-wide situation.

It is also understood that there was a recent AusAID rainwater harvesting programme that resulted in the removal and replacement of asbestos roofs in Funafuti. There may, however, still be dwellings in the outer islands that have asbestos roofs in unknown numbers.

Cost Estimates

Pacific-wide cost estimates have been calculated for several remediation scenarios as, shown in the table below:

Summary of Costs for Various Remediation Options (Costs rounded to nearest \$US)

Remediation Method	Cost per m ² (face area) \$US
Encapsulation	
Roofs:	
Encapsulate roof where there is no ceiling present below the roof	50.00
Encapsulate roof where there is an existing ceiling below the roof that needs to be removed and replaced	91.00
Cladding:	
Encapsulate wall cladding where there is no internal wall sheeting	26.00
Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated	18.00
Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/m ² (face area)	66.00
Removal and Replacement	
Roofs:	
Remove and replace roof	96.00
Cladding:	
Remove and replace cladding	76.00
Miscellaneous	
Remove and replace floor tiles*	80.00
Pick up debris, pipes	40.00

**\$US80 is the lower end of the cost spectrum for removing and replacing vinyl floor tiles and the cost could easily double (or more) for difficult removal projects. To balance this out, the vinyl tile matrix is stable and there is little risk of asbestos exposure unless they are badly deteriorating. Vinyl floor asbestos projects could therefore be lower down on the priority list.*

The above removal and replacement rates assume asbestos waste disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Recommendations and Prioritised List of Actions

Remediation of sites has been prioritised based on the level of risk posed to the building occupants and public at each site according to the risk assessment methodology. The quantities of ACM observed at the sites were used to estimate costs for abatement. A summary of the recommended actions and estimated costs are included in the table below.

Site Name	ACM	Risk Score	Recommended Remedial Actions	ACM Area (m ²)	Estimated Cost (\$ USD)
Sanus service station	Front wall fibreboard cladding	23	ACM cladding removal and replacement	80 m ²	6080
Meteorological Centre	ACM Roof on store building	19	ACM roof removal and replacement	110 m ²	10560
	Loose ACM on ground from previous roof	16	Pick up of loose ACM	0.25m ³	1500

The following should be noted:

- i. It would probably be best to remove and replace the asbestos cladding and roofing for small amounts as it provides a permanent solution.
- ii. Two residences were also identified high risk but the PacWaste project only has sufficient resources to cover public buildings and not residences premises at this time. If significant amounts of asbestos were discovered in residences in Tuvalu and it was decided to remediate Tuvalu residences, then it is probable that most of it would be cladding as opposed to roofing. It may therefore be appropriate to encapsulate the cladding with a suitable paint system if it is in good condition and resources are available.
- iii. There is some loose asbestos waste discovered around Funafuti – e.g. at Princess Margaret Hospital, by the roadside, and by the wharf (piping). This has been assessed as low risk but could be easily picked up and disposed of cheaply. It is recommended that this be done as well.

The following recommendations are therefore made in relation to asbestos on Tuvalu:

- a) It is recommended that the above higher priority asbestos work is carried out in Tuvalu as well as removal of all loose asbestos.
- b) Two residential dwellings were originally identified but it has been estimated that 55 houses in Funafuti may have asbestos, as well as many more in the outer islands of Tuvalu. It is therefore recommended that all houses with PACM on Tuvalu are tested for asbestos and that all the houses tested positive are remediated.
- c) If a large number of houses are found to contain asbestos cladding then encapsulation would be the most cost-effective option for remediation although ongoing management procedures then would be needed and re-encapsulation (i.e. re-painting) would be needed on a regular basis (10-15 years later). If a small number of houses are found to contain asbestos cladding then removal and replacement of the cladding should be considered pending available resources.
- d) Any asbestos roofs found on houses in Tuvalu should preferably be removed rather than encapsulated as encapsulation of roofs costs only a little less than removal and removal is a permanent solution.
- e) If a suitable cheap on-island disposal location can be found that was locally acceptable then on-island disposal would be the preferred disposal option. Otherwise the next preferred option is placement in a 20 ft shipping container and export to Brisbane for disposal in the Remondis Landfill as one option
- f) Before asbestos remediation takes place (and after if all the asbestos is not removed) it would be appropriate to set in place suitable asbestos management practices and

- procedures to deal with the ongoing risk posed to human health by asbestos exposure. This should be accompanied by an appropriate education and training programme.
- g) Consideration should be given to Tuvalu passing regulations under their Public Health Act to enable the above asbestos work to be carried out.

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Definitions

ACM: “Asbestos Containing Material” – ie any material that contains asbestos.

Amosite: Brown or Grey Asbestos

Asbestos: The fibrous form of mineral silicates belonging to the Serpentine and Amphibole groups of rock-forming minerals, including amosite (brown asbestos), crocidolite (blue asbestos), chrysotile (white asbestos), actinolite, tremolite, anthophyllite or any mixture containing one or more of these

AusAid: Australian Agency for International Development

CEL: Contract Environmental Limited

CES: Capital Environmental Services

Chrysotile: White Asbestos

Crocidolite: Blue Asbestos

EMS: EMS Laboratories Incorporated

External: Refers to the top or outside of roof sheeting or the outside of building/wall cladding

Friable: With respect to asbestos-containing material, means able to be crumbled, pulverised or reduced to powder by hand pressure when dry, and includes non-bonded asbestos fabric

GPS: Global Positioning System

Hazard: Is a potential to cause harm

IANZ: International Accreditation New Zealand

Internal: Refers to the underside of roof sheeting, or the inside of building/wall sheeting and structures therein

MDHS100: Methods for the determination of hazardous substances, surveying, sampling and assessment of asbestos-containing materials

MELAD: Ministry of Environment, Lands and Agriculture Development

Non-Friable: With respect to asbestos containing material means unable to be crumbled, pulverised or reduced to powder by hand pressure when dry

PACM: “Presumed Asbestos Containing Material” – ie any material presumed to contain asbestos, based on observation and knowledge of other relevant factors

PPE: Personal Protective Equipment

Practicable: Able to be done / put into practice having regard to:

- The severity of the hazard or risk in question
- The state of knowledge about the hazard or risk
- The availability and suitability of ways to remove or mitigate that hazard or risk
- The cost of removing or mitigating that hazard or risk

Risk: Is the likelihood of illness or disease arising from exposure to airborne asbestos fibres

SMF: Synthetic Mineral Fibres

SPREP: Secretariat of the Pacific Regional Environment Programme

SWAT: Solid Waste Agency of Tuvalu

1. Introduction

1.1 Purpose

This report covers the Tuvalu component of a survey of the regional distribution and status of asbestos-containing material (ACM) and wastes, and best practice options for its management, in selected Pacific island communities. The objectives of the survey are summarised as follows:

- To assess the status of, and management options, and human health risks for ACM in thirteen Pacific Island countries; and
- To develop recommendations for future management interventions, including a prioritised list of target locations.

The work was carried out by a consortium led by Contract Environmental Ltd (CEL) and Geoscience Consulting (NZ) Ltd (Geoscience), under contract to the Secretariat of the Pacific Regional Environment Programme (SPREP), with funding provided by the European Union. The majority of information relating to the distribution of ACM in Tuvalu was obtained during a field visit undertaken by Gareth Oddy between the 24th and 28th of July 2014. It was organised in collaboration with the Tuvalu Government and in particular the Environment Department.

1.2 Scope of Work

A copy of the Terms of Reference for this work is given in Appendix 1. It lists the following tasks:

1. *Collect and collate data on the location (geographic coordinates), quantity and condition of asbestos-containing building materials (including asbestos-containing waste stockpiles) in each nominated Pacific Island country;*
2. *Review, and recommend a prioritised list of local best-practice options for stabilisation, handling and final disposal of asbestos-contaminated materials in each nominated Pacific Island country (including review of existing local institutional, policy and regulatory arrangements);*
3. *Recommend and prioritise actions necessary to minimise exposure (potential and actual) of the local population to asbestos fibres for each nominated Pacific Island country. An approximate itemised national cost should be presented for each option identified;*
4. *Identify any local contractors who have the expertise and capacity to potentially partner with regional or international experts in future asbestos management work; and*
5. *Develop a schedule of rates for local equipment hire, mobilisation, labour, etc., to guide the development of detailed cost-estimates for future in-country asbestos remediation work.*

1.3 Background to Tuvalu

Tuvalu is a Polynesian island nation located in the Pacific Ocean, midway between Hawaii and Australia. It comprises three reef islands and six atolls and its nearest neighbours are Kiribati, Nauru, Samoa and Fiji. The capital is Funafuti located on Fongafale Island.

The map of Tuvalu is shown in Figure 1.

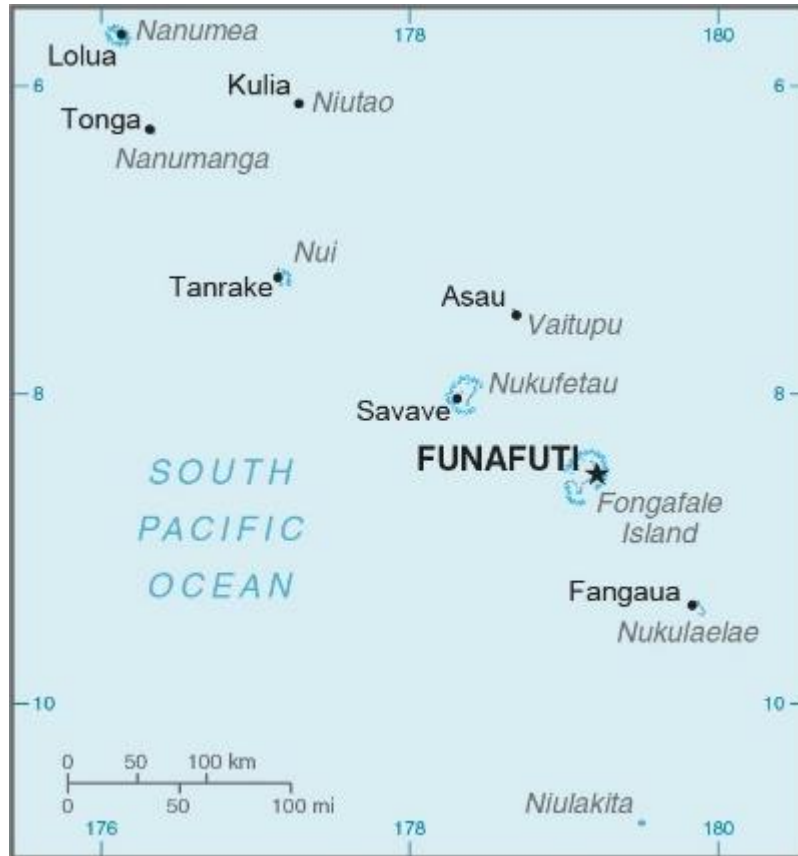


Figure 1 – Map of Tuvalu

Tuvalu has a population of 10,837 (2012 census) and the total land area of the islands of Tuvalu is 25.6 square kilometres. Fongafale Island holds 57.1% of the total population (5602). There are 1579 houses (1568 private).

Tuvalu was formerly a part of the Gilbert and Ellice Islands colony, from 1916 to 1974, which formed part of the British Western Pacific Territories (BWPT). Tuvalu became fully independent within the Commonwealth in 1978 and in 2000 it became a member of the United Nations.

1.4 Report Content and Layout

Section 2 of this report gives details of the methodology used for the study including the approach used for determining the survey coverage, the identification of specific target sites, procedures for site inspections and data capture, and sample collection and analysis. In addition, the relative importance of different sites was assessed using a risk assessment methodology, which is described in section 3.

The results of the survey are presented in section 4 of the report, with supporting information on the laboratory results given in section 5, and the risk assessment results in section 6.

Section 7 provides a generic discussion of possible management options for ACMs, and this is followed in section 8 by a specific analysis of the most appropriate options for those ACMs identified in Tuvalu.

Section 9 provides a review and analysis of existing national policies and legal instruments relevant to ACM management, while local contracting capabilities and costs are noted in section 10.

Section 11 contains a review of Tuvalu Policies and Legal Instruments.

Section 12 of the report provides a final discussion and a list of recommended actions, including cost estimates for those sites identified as priority targets for remediation.

Additional supporting information is given in a series of appendices.

2.0 Survey Methodology

2.1 Pre-Survey Desk Study

The survey work undertaken during the visit to Tuvalu included meetings with key government agencies, area-wide surveys across the Island of Fongafale and specific investigations of 38 sites.

Prior to conducting the surveys and visiting Tuvalu, the survey team completed a desk study to enable a more targeted assessment of buildings potentially containing ACM. The desk study included contacting relevant local Government agencies in advance of the trip to discuss and evaluate if the agencies were aware of any buildings where ACM was a concern. In addition, the consultation aimed to evaluate local regulations and practices with respect to ACM identification, removal and disposal practices.

The Tuvaluan Government did not hold any reports on the presence or significance of asbestos in Tuvalu. Following consultation with several Ministerial departments, two contacts were provided who had conducted asbestos investigations/removal in Tuvalu in the past.

Information provided by Ms Mazzone of CBS Power Solutions (CBS) on 16 December 2014 indicated that CBS had conducted the asbestos removal at the former power station in November 2014. CBS provided a summary of the removal process, their training qualifications, a selection of photos taken during the removal process and a clearance certificate issued by the Fijian Ministry of Employment, Productivity and Industrial Relations.

Discussions held between Mr John O'Grady of CEL and Mr Peter Ollivier of Spiire New Zealand Limited revealed that Spiire had conducted an asbestos survey of three buildings in Tuvalu in June 2014. The samples were collected from the Fisheries building, storage building and lean to shed located close to the main wharf on Funafuti. Asbestos was not detected in the three samples.

Information provided by both CBS and Spiire is provided in Appendix 4.

A second objective of the desk study was to evaluate the population distribution on the survey islands in order to prioritise which population centres and, if possible, which individual buildings should be included in the survey. The most recent census data was sought and reviewed in order to ensure a sufficient statistically representative number of residential buildings were included in the survey. This included a review of 'PopGIS 2.0 Tuvalu' which is an online GIS displaying population distribution across the nation.

Where population centres were identified, existing aerial photographs and geographically positioned photographs (where available) provided on Google Earth were reviewed. The review of Google Earth photographs enabled the survey team to appreciate the typical types of building construction materials in the centres, an approximate age of the buildings and in certain cases possible asbestos containing material (PACM). Conclusions on any PACM observed in the photographs were to be verified during the surveys.

2.2 Survey Coverage

The survey concentrated on Funafuti on the island of Fongafale due to the majority of historical development and population being located there.

According to the Tuvalu Central Statistics Office, 2012 population census, Tuvalu had a population of 10,837 in 2012 across the 9 islands with a total land area of 25.6 km². The total population is housed in approximately 1,568 private residential dwellings with 639 of those households in Funafuti.

Due to the distribution of the population of Tuvalu spread over 9 islands and the difficulties in accessing each island, a survey of each residential household was not feasible in the timeframes and budget of the project. A statistical approach was therefore adopted to ensure a sufficient number of residential properties were included in the survey to allow a confident estimate of the number of houses with certain characteristics related to asbestos to be made.

The statistical approach adopted is a technique commonly used in household marketing surveys, political polls and the like. For a specified total population size you calculate the required sample numbers required to give a target level of uncertainty, or conversely, you can determine the uncertainty level associated with an actual sample number.

The statistical approach required that a random method was used for selecting residential buildings to be surveyed and included in the sample size. In practice this involved selecting a cluster of properties at random when viewed from the road. The surveyor then undertook a more detailed inspection of the properties. Where possible, samples of the building material were collected and tested in the field for indications of asbestos fibres.

2.3 Identification of Target Sites

In addition to residential households, the survey sought to identify public buildings and government-owned industrial and commercial properties containing ACM. The primary focus of the survey was on residential properties and public buildings that would potentially present the most prolonged and thus significant risks for public exposure. Commercial and industrial buildings were also included in surveys where they were observed in close proximity to residential housing and public areas.

The asbestos surveys had three main objectives. Firstly, it was, as far as reasonably practicable within the time available, to record the location, extent and product type of any presumed or known ACMs. Secondly, it was to inspect and record information on the accessibility, condition and surface treatment of any presumed or known ACMs based on worst case scenarios. Thirdly, the survey aimed to determine and record the asbestos type, either by collecting representative samples of suspect materials for laboratory identification, or by making a presumption based on the building age, product type and its appearance.

A list of the people and organisations contacted during the visit is given in Appendix 2, and the key points arising from the discussions are summarised in Appendix 3.

During the initial day of the survey, the surveyor attended meetings with representatives from the Tuvalu government department responsible for hazardous waste; Solid Waste Agency of Tuvalu (SWAT). The representatives provided information regarding potential state assets containing asbestos as well as current waste disposal practices in Tuvalu.

The remainder of the survey consisted of inspecting residential areas and government-owned facilities including (but not limited to) schools, hospitals and healthcare centres, power stations, water treatment facilities, research centres and government administration buildings.

2.4 Site Assessment Data Capture

Information was collected from each survey site using a tablet-based application designed specifically for this project. The software requires certain information to be recorded including location, type of facility, whether asbestos was identified, type, volumes, and most applicable remedial methodology. The software also allows for pictures to be taken of the sites and uses a Global Positioning System (GPS) to record where the pictures were taken. Information provided by owners/occupants of the building relating to its age, state of repairs, and previous ACM knowledge was also recorded in the software.

The use of the application ensures that data is collected in a uniform manner across all of the surveyed countries regardless of the survey team members. Copies of all of the individual site assessment reports for Tuvalu are available via SPREP.

2.5 Sample Collection Methodology

Thirty eight individual facilities / properties (including 7 residential buildings) were identified as requiring a detailed site assessment due to their age, use, sensitive location or observations of PACM. In order to assess if PACM actually contained asbestos, samples were to be collected and analysed by a professional accredited laboratory in accordance with international standards.

Samples of PACM were collected if the following conditions were met;

- Permission was granted by the property owner;
- The work would minimise the disruption to the owner's operations;
- The sampling would not put the health and safety of occupants at risk;
- The areas to be sampled inside buildings were as far as possible unoccupied;
- Entry of other people not wearing personal protective equipment (PPE) to the sampling area was restricted;
- Where the material to be sampled could be safely pre-wet (i.e. excludes items with a risk of electrocution or where permission to wet a surface was not received); and
- Collection of a sample would not significantly damage the building material.

Where the above conditions were met, sampling was conducted following standard CEL / Geoscience Procedure and in accordance with international guidance provided by the United Kingdom Health & Safety Executive (UK HSE) and New Zealand Demolition and Asbestos Association (NZDAA).

The samples were collected in accordance with the following procedure;

- Sampling personnel were required to wear adequate personal protective equipment (PPE), as determined by the risk assessment (which may include disposable overalls, nitrile gloves, overshoes and a half face respirator with P3 filters);
- Airborne emissions were controlled by pre-wetting the material to be sampled, with a fine water mist.
- Damaged portions of suspected ACM were sought first where it was easier to remove a small sample. The sample size collected was approximately 5 cm²
- Samples were obtained using pliers or a screwdriver blade to remove a small section from an edge or corner;

- A wet-wipe tissue was used between the pliers and the sample material to prevent fibre release during the sampling;
- All samples were individually sealed in their own sealable polythene bag which was then sealed in a second polythene bag.
- After sampling, water was sprayed onto the sample area to prevent fibre release;
- Sampling points were further sealed by PVC tape where necessary;
- Samples were labelled with a unique identifier and in the survey documentation;
- Each sample was noted on a chain of custody form provided by the laboratory, and secured in a sealable container.

2.6 Sample Laboratory Analysis

The samples were sent by courier to EMS Laboratories Incorporated (EMS) located in California, United States of America. Analysis of the samples was performed by EMS using Polarised Light Microscopy. According to EMS the analysis method is a semi-quantitative procedure with a detection limit between 0.1-1% by surface area of the bulk sample, depending on the size of the asbestos fibres, sampling method and sample matrix.

Only a limited number of samples were collected due to the wide scope of the survey, which included all residential and public buildings on the island.. The collection of samples was based on the aforementioned considerations but also with the project scope in mind. Where similar building materials were encountered at numerous sites, a single sample was considered sufficient for use in drawing conclusions. Also, where a large amount of PACM was identified at a single site, one sample of each main material identified was considered sufficient for this stage of the assessment.

The results for these samples are discussed in Section 4, and copies of the laboratory reports are included in Appendix 5 of this report.

3.0 Risk Assessment Methodology

A systematic risk assessment approach was adopted in order to assess the risk that identified asbestos containing material presented to site occupants and if applicable the public. The risk assessment adopted was that provided by the UK HSE guidance document 'Methods for the Determination of Hazardous Substances (MDHS100) Surveying, Sampling and Assessment of Asbestos-Containing Materials (2001)' and UK HSE guidance document 'A Comprehensive Guide to Managing Asbestos in Premises (2002)'.

The documents present a simple scoring system to allow an assessment of the risks to health from ACMs. It takes into account not only the condition of the asbestos, but the likelihood of people being exposed to the fibres.

The method used presents algorithms that allow a score for each ACM item observed or confirmed by laboratory analysis, to be calculated. The sites with high scores may present a higher risk to human health than those with lower scores.

The risk assessment approach has two elements; the first algorithm is an assessment of the type and condition of the ACMs or presumed ACMs, and their ability to release fibres if disturbed. The final score for each ACM or presumed ACM depends on the type of ACM i.e. concrete vs lagging, the condition of the ACM, if there is any surface treatment and the actual type of asbestos (i.e. chrysotile (white), amosite (brown), or crocidolite (blue)).

The second algorithm considers the ACM setting, likelihood of the ACM actually being disturbed and exposure to a receptor(s). The setting assessment therefore considers the normal occupant activity in that area of the site and the likelihood of disturbance. Each ACM setting is scored and these scores are added to those for the material assessment to produce a total score.

3.1 ACM Assessment

The algorithm in MDHS100 considers four parameters that determine the risk from an ACM: that is the ability to release fibres if disturbed. The four parameters are:

- product type;
- extent of damage;
- surface treatment; and
- asbestos type.

Each of the parameters is scored and added to give a total score between 2 and 12:

- materials with scores of 10 or more should be regarded as high risk with a significant potential to release fibres if disturbed;
- those with a score between 7 and 9 are regarded as medium risk;
- materials with a score between 5 and 6 are low risk; and
- scores of 4 or less are very low risk.

The material assessment algorithm shown in MDHS100 is reproduced in Table 1.

Table 1: MDHS 100 Material assessment algorithm - ACM

Sample variable	Score	Examples of scores
Product type (or debris product)	1	Asbestos reinforced composites (plastics, resins, mastics, roofing felts, vinyl floor tiles, semi-rigid paints or decorative finishes, asbestos cement etc)
	2	Asbestos insulating board, mill boards, other low density insulation boards, asbestos textiles, gaskets, ropes and woven textiles, asbestos paper and felt
	3	Thermal insulation (eg pipe and boiler lagging), sprayed asbestos, loose asbestos, asbestos mattresses and packing
Extent of damage/deterioration	0	Good condition: no visible damage
	1	Low damage: a few scratches or surface marks; broken edges on boards, tiles etc
	2	Medium damage: significant breakage of materials or several small areas where material has been damaged revealing loose asbestos fibres
	3	High damage or delamination of materials, sprays and thermal insulation. Visible asbestos debris
Surface treatment	0	Composite materials containing asbestos: reinforced plastics, resins, vinyl tiles
	1	Enclosed sprays and lagging, asbestos insulating board (with exposed face painted or encapsulated), asbestos cement sheets etc.
	2	Unsealed asbestos insulating board, or encapsulated lagging and sprays
	3	Unsealed laggings and sprays
Asbestos type	1	Chrysotile
	2	Amphibole asbestos excluding crocidolite
	3	Crocidolite
Total score		Out of 12

3.2 ACM Setting Assessment

The location of the ACM is equally important as the type and condition of the ACM when considering the potential risk to human health. There are four aspects presented in MDHS100, however this algorithm has been modified in this assessment with ‘maintenance activity’ not considered.

The removal of maintenance activity from the algorithm is due to the level of awareness of asbestos by the building management and / or owners at the majority of the survey sites were considered to be low. Therefore any maintenance undertaken is likely to be ‘unplanned’ with little or no controls around asbestos exposure. In addition, the amount of maintenance activity was often extremely difficult to quantify through discussion with the building management contacts.

The three areas of the algorithm adopted for the ACM setting assessment are:

- Occupant activity
- Likelihood of disturbance
- Human exposure potential

Each of the above parameters are summarised below.

Occupant activity

The activities carried out in an area will have an impact on the risk assessment. When carrying out a risk assessment the main type of use of an area and the activities taking place within it should be taken into account.

Likelihood of disturbance

The two factors that will determine the likelihood of disturbance are the extent or amount of the ACM and its accessibility/vulnerability. For example, asbestos soffits outdoors are generally inaccessible without the use of ladders or scaffolding, and on a day to day basis are unlikely to be disturbed. However if the same building had asbestos panels on the walls they would be much more likely to be disturbed by occupant movements/activities.

Human exposure potential

The human exposure potential depends on three factors:

- the number of occupants of an area,
- the frequency of use of the area, and
- the average time each area is in use.

For example, a hospital boiler which contains friable asbestos cladding in a room which is likely to be unoccupied has much less exposure potential than in a school classroom lined with an exposed asbestos-cement roof, which is occupied daily for six hours by 30 pupils and a teacher.

The algorithm adopted for ranking the ACM setting is shown in Table 2.

Table 2: HSG227 (2002) Priority Assessment Algorithm - Setting

Assessment factor	Score	Examples of score variables
Normal occupant activity Main type of activity in area	0 1 2 3	Rare disturbance activity (eg little used store room) Low disturbance activities (eg office type activity) Periodic disturbance (eg industrial or vehicular activity may contact ACMs) High levels of disturbance, (eg fire door with asbestos insulating board sheet in constant use)
Likelihood of disturbance Location	0 1 2 3	Outdoors Large rooms or well-ventilated areas Rooms up to 100 m2 Confined spaces
Accessibility	0 1 2 3	Usually inaccessible or unlikely to be disturbed Occasionally likely to be disturbed Easily disturbed Routinely disturbed
Extent/amount	0 1 2 3	Small amounts or items (eg strings, gaskets) <10 m2 or <10 m pipe run. >10 m2 to ≤50 m2 or >10 m to ≤50 m pipe run >50 m2 or >50 m pipe run
Human exposure potential Number of occupants	0 1 2 3	None 1 to 3 4 to 10 >10
Frequency of use of area	0 1 2 3	Infrequent Monthly Weekly Daily
Average time area is in use	0 1 2 3	<1 hour >1 to <3 hours >3 to <6 hours >6 hours
Total		Out of 21

Each of the parameters is scored and added together to give a total score between 0 and 21. The setting score is then added to the ACM score to provide an overall value. The final value will help to rank the sites in order of priority for management and/or remedial action. The scoring system is detailed in Table 3.

Table 3: Risk Ranking Scoring

ACM Score	Setting Score	Total Score	Risk Rating
10 – 12	16 – 21	24 - 33	High risk – significant potential to release fibres if disturbed
7 – 9	11 - 15	17 - 23	Moderate risk
5 – 6	8 - 10	12 - 16	Low risk
0 – 4	0 – 7	0 – 11	Very low risk

4.0 Asbestos Survey

4.1 Residential Survey

The majority of residential dwellings observed on Funafuti were constructed using plywood or fibre board, concrete blocks and corrugated iron, but fibre board external walls were the dominant type. Photo 1 shows a typical building in Funafuti. Most shade houses were constructed using traditional materials consisting of tree branches as the pillars and woven palm fronds as the roof cladding.



Photo 1: typical structure in Funafuti showing fibre board cladding

Information on the population distribution of Tuvalu was provided by the 2012 population census produced by the Tuvalu Central Statistics Office. Tuvalu had a population of 10,387 in 2012 across the nation's 9 islands and total land area of 25.6 km². The population were reportedly housed in approximately 1,568 residential households with over a third of those households in Funafuti on Fongafale Island.

Table 4 below provides a summary of the Tuvalu census data and conclusions based on the survey results.

The survey sample size was based upon a 95% confidence level and 3.5% margin of error. With 639 households within the survey area, the minimum number of houses to be surveyed to ensure a statistically representative number was calculated to be 350.

Table 4: Statistical Summary and Conclusion

Household Survey	No of Households
Total of Households in Funafuti (2012 Census)	639
Households Surveyed	350
Households PACM Suspected (Cladding Only)	161
Extrapolating to full Funafuti Population (95% Confidence Level) - No of houses with suspected asbestos cladding:	294 +/- 3.5%
Conclusion from Results	No of Households
Total Cladding Samples taken	38
Cladding Samples Positive	7
Percentage of Cladding Positive	18.4
Based on 18.4%, no of houses inspected that have asbestos cladding	30
Extrapolating to full Funafuti Population (95% Confidence Level) - No of houses with asbestos cladding:	55 +/- 3.5%

Assuming that the 18.4% figure is correct for the number of houses in Funafuti that have cladding that contains asbestos is 55+/-3.5%.

The total 2012 number of private residences in Tuvalu is 1568. By direct proportion based on the above figure, the number of residences in Tuvalu with asbestos cladding is therefore 130 – 140 houses. This extrapolation is largely speculative as the margin of error will increase significantly and also there is no guarantee that the Tuvalu outer islands have the same types of cladding. In the absence of other data this extrapolation does, however, at least provide some indication of the Tuvalu-wide situation.

It is also understood that there was a recent AusAID rainwater harvesting programme that resulted in the removal and replacement of asbestos roofs in Funafuti. There may, however, still be dwellings in the outer islands that have asbestos roofs in unknown numbers.

Any programme to remediate asbestos in Tuvalu should therefore involve a detailed survey of all dwellings in Tuvalu including the outer islands with numerous samples taken of cladding in particular.

4.2 Targeted Survey Coverage

Following consultation with SWAT and the Department of Environment a number of buildings were short-listed for a detailed assessment. These included buildings of sufficient age to have been constructed of ACM, such as the former power plant, metrological station and government owned housing.

In addition, concerns were raised by the Department of Environment on recently imported building materials and the potential for these to have asbestos. As a consequence, recently built or repaired buildings with new fibre board were also surveyed. ACM roofs were, according to the department, quite common in Tuvalu in the past, and in particular those on many of the churches. According to Mr Tekinene many of the residential properties in Funafuti have had their roofs replaced recently due to the implementation of the AusAid rainwater harvesting programme.

The remainder of the survey consisted of visits to government buildings, including those which were likely to be frequented by large numbers of individuals. The buildings included (but were not limited to) schools, hospitals and healthcare centres, libraries, research centres, government administration buildings, power stations and waste disposal facilities. The specific sites visited in Tarawa are listed in Table 6 while the individual site assessment reports for these are available via SPREP.

Table 6: Specific Sites Surveyed in Tuvalu.

Site Name	Date of Assessment	Suspected PACM?	Samples Collected of PACM?
1. Public Toilet Wall, Vaiaku	24/07/2014	Yes	Yes
2. Sanus Service Station	24/07/2014	Yes	Yes
3. Magistrates Court House	24/07/2014	Yes	Yes
4. SWAT Office	24/07/2014	Yes	Yes
5. Pipe structure in sea	24/07/2014	Yes	Yes
6. Sports Ground	24/07/2014	Yes	Yes
7. The Pink House	24/07/2014	Yes	Yes
8. Storage Compound	25/07/2014	Yes	Yes
9. Timber Merchant	25/07/2014	Yes	Yes
10. Wash House	25/07/2014	Yes	Yes
11. New Apostolic Church	25/07/2014	Yes	Yes
12. National Library and Archives	25/07/2014	Yes	Yes
13. Residential 01	25/07/2014	Yes	Yes
14. Alapi Town Hall	26/07/2014	Yes	Yes
15. Nauti Primary School	26/07/2014	Yes	Yes
16. Old Hotel Wing	26/07/2014	Yes	Yes
17. Residential Dwelling	26/07/2014	Yes	Yes
18. Residential Dwelling 2	26/07/2014	Yes	Yes
19. Sensai Fuel Station	26/07/2014	Yes	Yes
20. Seventh Day Adventist Primary School	26/07/2014	Yes	Yes
21. Media Department	26/07/2014	Yes	Yes
22. Residential 04	26/07/2014	Yes	Yes
23. 3ts Restaurant	27/07/2014	Yes	Yes
24. Blue Ocean Restaurant	27/07/2014	Yes	Yes
25. Development Bank of Tuvalu	27/07/2014	Yes	Yes
26. National Bank of Tuvalu	27/07/2014	Yes	Yes
27. Residential 05	27/07/2014	Yes	Yes
28. Residential 06	27/07/2014	Yes	Yes
29. Saeava Fuel Station	27/07/2014	Yes	Yes
30. Solomai Shop	27/07/2014	Yes	Yes
31. Tuvalu Telecom	27/07/2014	Yes	Yes
32. Funafuti Landfill	28/07/2014	Yes	Yes
33. Princess Margaret Hospital	28/07/2014	Yes	Yes
34. Residential 07	28/07/2014	Yes	Yes
35. Tuvalu Council House	28/07/2014	Yes	Yes
36. Former Power House	28/07/2014	Yes	Yes
37. Meteorological Station	28/07/2014	Yes	Yes
38. Secondary School	28/07/2014	Yes	Yes

5.0 Laboratory Results and Findings

A summary of the laboratory analytical results is provided in Table 7 while the full laboratory report is given in Appendix 5. A total of 49 samples of suspected asbestos containing material were collected in the Tuvalu survey and the presence of asbestos was confirmed in 11 of those samples collected at 9 sites.

Table 7: Sample Analytical Results

Site Name	Sample Name(s)	Sample Description/ Material Type	Building	Asbestos Type and %
Public Toilet	TV01	West wall – fibre board		Not detected
Sanus service station	TV02	Front wall – fibre cement		Chrysotile 20% Crocidolite 2%
Magistrates court house	TV03	External north wall – fibre board		Not detected
SWAT office	TV04	North external wall – fibre board		Not detected
Pipework by wharf	TV05	200mm AC pipe		Chrysotile 20%
Sports Ground near ticket office	TV06	Loose PACM – fibre board		Not detected
The Pink House	TV07	Front façade – fibre board		Not detected
Tuvalu Library	TV08	West façade – fibre board		Not detected
New Apostolic Church	TV09	Vinyl floor		Not detected
	TV10	Building west façade – fibre board		Not detected
Timber Merchant	TV11	South façade – fibre board		Not detected
	TV12	Miscellaneous loose fibre board		Not detected
Storage Compound	TV13	Fibre board		Not detected
Public wash shelter	TV14	Fibre board		Not detected
Residential 01	TV15	Waste material – fibre board		Not detected
Nauti Primary School	TV16	Wall 2nd Floor – fibre board		Not detected
	TV17	2nd Floor - Vinyl Floor		Not detected
Residential 02	TV18	Waste building material – fibre board		Chrysotile 10%
Residential 03	TV19	North wall – fibre board		Chrysotile 10%
Alapi Town	TV20	Loose pacm – fibre board		Not detected
Sensai fuel station	TV21	West wall – fibre board		Not detected
Residential 04	TV22	West wall – fibre board		Not detected
SDA Primary School	TV23	2nd Floor – fibre board		Not detected
Development Bank of Tuvalu	TV24	South Façade – fibre board		Not detected
Saeava Fuel Station 2	TV25	West Façade – fibre board		Not detected
Residential 05	TV26	South facing wall – fibre board		Not detected
Tuvalu Telecom	TV27	South Façade – fibre board		Not detected
Residential 06	TV28	North Façade – fibre board		Not detected
Solomai shop	TV29	West Façade – fibre board		Not detected
McKenzie Yard	TV30	South cladding – fibre board		Not detected
Blue Ocean Restaurant	TV31	West wall – fibre board		Not detected
Meteorological Centre	TV32	Roof – fibre cement		Chrysotile 20%
Tuvalu Secondary School	TV33	Loose material – fibre cement		Not detected
	TV34	Vinyl floor		Not detected
	TV35	Board by entrance – fibre cement		Not detected
	TV36	External concrete cladding		Not detected
Former Power House	TV37	Roof west ridge - fibre cement		Chrysotile 20%
	TV38	Misc. board - fibre cement		Not detected
	TV39	Rope lagging		Not detected

Site Name	Sample Name(s)	Sample Description/ Material Type	Building	Asbestos Type and %
	TV40	External east wall panels - fibre cement		Chrysotile 20%
	TV41	External south concrete textured finish		Not detected
US Dozer adjacent to wharf	TV42	Brake Pad		Chrysotile 10%
	TV43	Gasket Insulation		Not detected
Council House	TV44	Waste material – fibre board		Not detected
Princess Margaret Hospital	TV45	Misc loose fibre cement		Chrysotile 7% Amosite 10%
	TV46	Misc loose fibre cement		Chrysotile 10%
Government Building	TV47	External textured surface		Not detected
PACM by road	TV48	North of road – fibre cement		Chrysotile 10%
Airport Departures	TV49	Vinyl floor		Not detected

Additional asbestos sample results were provided to the project team by Spiire, a New Zealand based company who were evaluating a possible building upgrade of the Fisheries Building at the Wharf. Three samples were collected on 27th June 2014 and analysed by Capital Environmental Services (CES) an IANZ accredited Laboratory. Asbestos fibres were not detected in any of the three samples analysed. The laboratory results and correspondence is provided in Appendix 4.

6.0 Risk Assessment

Utilising the algorithms described in Section 2 of this report, the laboratory analysis data for PACM samples (where available) and observations of the sites visited, each site was listed in order of priority in Table 8.

Table 8: Risk Ranking Scores – Tuvalu

Site Name	Sample No.	Building Material Type	Asbestos Type and %	Risk Ranking Scores		
				ACM	Setting	Total Score
Sanus service station	TV02	Front wall	Chrysotile 20% Crocidolite 2%	8	15	23
Residential 02*	TV18	Waste building material	Chrysotile 10%	5	17	22
Residential 03*	TV19	North wall	Chrysotile 10%	5	17	22
Former Power House	TV37	Roof west ridge	Chrysotile 20%	5	16	21
	TV40	External east wall panels	Chrysotile 20%	5	16	21
Meteorological Centre	TV32	Roof	Chrysotile 20%	6	13	19
Princess Margaret Hospital	TV45	Misc loose fibreboard	Chrysotile 7% Amosite 10%	7	9	16
	TV46	Misc loose fibreboard	Chrysotile 10%	6	9	15
PACM by road	TV48	North of road	Chrysotile 10%	6	7	13
Pipework by wharf	TV05	200mm AC pipe	Chrysotile 20%	4	1	5
US Dozer	TV42	Brake Pad	Chrysotile 10%	5	0	5

**Note that the PacWaste project does not have sufficient resources to target residential premises interventions at this time.*

The risk ranking scores presented in Table 8 indicate that the survey has identified five sites that are considered to currently present a moderate risk of asbestos exposure to the occupants. Photos 2 and 3 show the old power station and Photo 4 shows the decaying asbestos roof on the meteorological station. Two further sites present a low risk. One of these is the Princess Margaret Hospital which would normally be considered a higher risk, but the only positive asbestos material there is loose fibreboard. Two further sites are considered to present a very low risk. This risk assessment is based on current conditions, ACM condition and site use observed at the time of the survey. Should these change over time, reassessment of the risk presented would be required.

The ACM pipes adjacent to the wharf and the US Dozer located by the main road are considered to present a very low risk based on the likely and observed occupancy rates of the areas. It should however be noted that access to these areas is unrestricted with both sites located in public areas.

Access to the ACM identified should be managed by the owners of the land to prevent unauthorised access and possible exposure to the asbestos.



Photo 2: Wall cladding on the former power station



Photo 3: Asbestos roofing material on the former power station



Photo 4: Asbestos roof at the meteorological centre

7.0 Remedial and Management Options

7.1 General

Based on all of the country visits made by the consultants for the PacWaste asbestos surveys, it is evident that:

- a. The types of asbestos problems are relatively similar from country to country although there are very significant variations in incidence and quantity of asbestos.
- b. Most asbestos is non-friable, or at least was non-friable when installed. Often the asbestos has deteriorated significantly and, in part at least, could be considered friable because of the risk of release of significant amounts of fibres on a regular basis. Certainly where fibres have been involved the asbestos becomes friable.
- c. There has been almost no asbestos identified anywhere that was friable when installed. Remediation of the few friable (at least friable when installed) asbestos projects in the Pacific will need specialist management as exceptions.
- d. The predominant form of asbestos is Chrysotile (White) Asbestos, although incidences of Amosite (Brown) Asbestos and Crocidolite (Blue) Asbestos do occur occasionally. Chrysotile is hazardous, but not as hazardous as the other forms of asbestos.
- e. Labour rates are similar from country to country.
- f. There will most likely be a need to bring in specialist supervision for any remedial work, and rates for that supervision will be similar throughout the Pacific.
- g. The cost of materials in most countries is similar as almost all materials need to be imported from manufacturing countries with similar pricing structures.
- h. There is some level of awareness of asbestos management techniques in all countries (and certainly more in the countries where there are significant amounts of asbestos). Generally, however, there is little expertise available to perform professional asbestos removals to the standard that would be required in, for example, Europe, UK, USA or Australia.
- i. The correct equipment for properly managing asbestos remediation is not available in any of the countries visited, with the exception of some PPE and the simpler tools required for removal operations.
- j. Safe and acceptable remediation techniques will be the same everywhere.

A case can therefore easily be made for a universal policy and set of procedures to be developed across the whole Pacific region for addressing asbestos problems.

7.2 Management Options

Where ACM or PACM has been identified then there are some management measures that can be taken immediately as follows:

- communicate with building/property owners, employees, contractors and others of its presence, form, condition and potential health risks associated;
- monitor the condition of the ACM;
- put a safe system of work in place to prevent exposure to asbestos.

7.2.1 Communicating ACM Hazard

Although every attempt was made during the survey work to communicate the potential level of risk apparent during the site visits, further consultation with the relevant regulator, site/building owners

and occupants will be required based upon the findings and specifically the laboratory confirmation of the presence of ACM. Where an immediate significant risk to human health was apparent during the surveys, regulators were informed and actions taken to manage/remedy the situation.

All site owners and employees should be made aware of the location of any ACMs in the buildings identified. This is particularly important for maintenance workers or contractors who may directly disturb ACMs while working. A means of communicating with contractors who come on site to carry out other work must also be set up to prevent disturbance of ACMs without implementing the correct controls. The means of communication could include a site induction sheet or training session on the hazards presented by the ACM on site together with a formal contractor acknowledgement sheet.

If the location is a private residence then an information sheet could be handed out and an education / awareness programme initiated.

7.2.2 Monitor ACM

ACMs which are in good condition, sealed and/or repaired, and are unlikely to be disturbed, are of a lower risk than those which are damaged and in certain situations can be left in place. Often, encapsulation and management is a safer option than removal, which can result in the ACMs being disturbed further and potential further exposure to the building occupants. The on-going operations at the site will also factor into whether the ACM can be left on site. It should be noted, however, that effective encapsulation, especially of roofing, can be expensive.

If ACMs are left in place, the condition of the ACMs will have to be monitored regularly and the results recorded. A useful way of monitoring the condition of the ACMs is to regularly take photographs, which can be used to compare the condition over time. When the condition of the ACM starts to deteriorate, remedial action can be taken. The time period between monitoring will vary depending on the type of ACM, its location and the activities in the area concerned, but as a minimum should be at least once every 12 months.

7.2.3 ACM Safe System

Where an ACM is going to be left in place, one option would be to label or colour-code the material. This may work in an industrial environment, but may not be acceptable in a suite of offices or suitable in public areas, for example, retail premises. The decision to label or not will in part depend on confidence in the administration of the asbestos management system and whether communication with workers and contractors coming to work on site is effective.

Labelling and colour coding alone should not be relied upon solely as the only control measure. The physical labels and colour coding may deteriorate over time without sufficient maintenance.

7.3 Remedial Options

The management options of ACM outlined in Section 7.1 above are administration controls that can assist with effectively managing the risk ACM presents. However, in certain situations, administration controls may not be sufficient or the risk posed by the ACM by way of its damaged condition or setting sensitivity may present an unacceptable risk. Remedial measures for managing the ACM may include one or a combination of the following;

- protect/enclose the ACM;

- seal/encapsulate the ACM;
- repair of the ACM;
- removal of the ACM.

7.3.1 Protection/enclosure of ACMs

Protecting ACMs means the construction or placing of a physical barrier of some sort to prevent accidental disturbance of the ACM. This may mean placing a bollard in front of a wall panel of asbestos insulating board to prevent accidental damage by fork lift truck movements. Enclosing the ACM involves the erection of a barrier around it, which should be as airtight as possible to prevent the migration of asbestos fibres from the original material. Enclosing the ACM is a good option if it is in reasonable condition and in a low sensitivity environment.

If enclosure is chosen as the desired management option it is important that the existence of the ACM behind the enclosure is notified to all who may work or visit the site. Labelling on the enclosure to indicate the presence of the hidden ACM would assist with communicating the hazard. The condition of the enclosure should also be periodically monitored and the results of the inspection recorded.

7.3.2 Sealing or encapsulation of ACM

Encapsulation of an ACM is only suitable if the ACM is in good condition and in a low sensitivity environment. The additional weight of the encapsulant is also an important consideration and this may unwittingly cause delamination and possible damage to the ACM.

According to the UKHSE (2001) there are two types of encapsulants; bridging and penetrating encapsulants. Bridging encapsulants adhere to the surface of the ACM and form a durable protective layer. Bridging encapsulants include high build elastomers, cementitious coatings and polyvinyl acetate (PVA). The different types of encapsulants available will suit different circumstances and ACMs and should therefore be selected by a specialist in asbestos management to ensure the correct encapsulant is chosen.

Of the bridging encapsulants, high-build elastomers can provide substantial impact resistance as well as elasticity, and are reported to provide up to 20 years of life if undisturbed. Cementitious coatings are generally spray-applied and are compatible with most asbestos applications. They provide a hard-set finish, but may crack over time. PVA is used for sealing of asbestos insulating board and may be spray or brush applied. PVA is not suitable for use on friable ACMs such as insulation or sprayed coatings. PVA will only provide a very thin coating and may not be suitable as a long-term encapsulant.

Penetrating encapsulants are designed to penetrate into the ACM before solidifying and locking the material together to give the ACM additional strength. Penetrative encapsulants are typically spray-applied and will penetrate non-friable and friable asbestos materials, strengthening them as well as providing an outer seal.

The selection, preparation and application of encapsulants requires skill, knowledge and experience with asbestos remedial work.

7.3.3 Repair of the ACM

To be readily repairable, the damage should be minimal, therefore repair should be restricted to patching/sealing small areas where cracks or exposed edges have become apparent. Where significant damage has occurred it may be more cost effective to remove the ACM.

The repair methodology selected will largely depend on the type of ACM to be repaired. For example, small areas of damaged pipe or boiler lagging can be filled with non-asbestos plaster and if necessary wrapped with calico (cotton cloth). Small areas of damaged sprayed asbestos can be treated with encapsulant and, if necessary, an open mesh scrim of glass fibre or calico reinforcement used. Damaged asbestos panelling or tiles can be sprayed with PVA sealant or a similar type of sealant such as an elastomeric paint. Asbestos cement products can be sealed using an alkali-resistant and water-permeable sealant or impermeable paint.

7.3.4 Removal of the ACM

Where ACMs have been identified that are not in good condition, or are in a vulnerable position and liable to damage, the remedial options described previously should be explored first. Where it is not practical to repair, enclose or encapsulate the ACMs, they will need to be removed. ACMs will also need to be removed if the area is due to undergo refurbishment which will disturb the ACM, or where a building is going to be demolished.

Rigorous safety procedures are required to be followed for the removal of ACM. Typically the following procedure should be followed for non-friable asbestos although some variations may be necessary from site to site.

- a) Place warning barrier tape around the site at a minimum distance of ten metres, where practicable, and place warning signs to clearly indicate the nature of work.
- b) The contractor shall wear protective disposable type overalls, gloves and at least a half face respirator with a P2 (and preferably a P3) replaceable filter.
- c) Wet down the ACM to be removed and carefully remove any fasteners using hand tools. Attempt to remove the ACM intact – do not break it up, or throw it into a waste bin or skip.
- d) Place asbestos material and debris in an approved asbestos waste bag and seal for disposal in accordance with local requirements. Sheets of asbestos cement product should be placed wet one on top of another into a skip lined with a heavy duty plastic liner, a portion of which remains outside the skip and is of sufficient size to cover the waste when the skip is full.

Vacuum asbestos removal area using a vacuum fitted with a high efficiency particulate air filter (HEPA filter).

Normally air monitoring is not required for the removal of non-friable asbestos containing materials, as if done correctly no excessive quantities of asbestos fibres should be generated. However, some operators prefer to undertake such monitoring to obtain evidence that no risks to health occurred during the removal exercise.

The whole project should be supervised by an experienced asbestos removalist. Certification processes are in place in several countries to make sure such removalists are suitably qualified and experienced.

In each case of an asbestos removal project a detailed **“Asbestos Removal Plan”** should be prepared that addresses the following matters:

1. Identification:

- Details of the asbestos-contaminated materials to be removed – for example, location/s, whether it is friable or non-friable, condition and quantity to be removed – include references to analyses.

2. Preparation:

- Consultation with regulators, owners and potentially affected neighbours
- Assigned responsibilities for the removal
- Programme of commencement and completion dates
- Consideration of other non-asbestos related safety issues such as safe working at heights
- Asbestos removal boundaries, including the type and extent of isolation required and the location of any signs and barriers
- Control of electrical and lighting installations
- Personal protective equipment (PPE) to be used, including respiratory protective equipment (RPE)
- Details of air monitoring programme
- Waste storage and disposal programme

3. Removal

- Methods for removing the asbestos-contaminated materials (wet or dry methods)
- Asbestos removal equipment (spray equipment, asbestos vacuum cleaners, cutting tools, etc)
- Details of required enclosures, including details on their size, shape, structure, etc, smoke-testing enclosures and the location of negative pressure exhaust units if needed
- Details of temporary buildings required for asbestos removal (eg decontamination units), including details on water, lighting and power requirements, negative air pressure exhaust units and their locations
- Other control measures to be used to contain asbestos within the asbestos work area. This includes dust suppression measures for asbestos-contaminated soil.

4. Decontamination:

- Detailed procedures for the workplace decontamination, the decontamination of tools and equipment, personal decontamination of non-disposable PPE and RPE, decontamination of soil removal equipment (excavator, bobcat etc).

5. Waste Disposal:

- Methods for disposing of asbestos waste, including details on the disposal of:
 - Disposable protective clothing and equipment and
 - Structures used to enclose the removal area

8.0 Selection of Possible Remedial Options

8.1 General

The flow chart presented below in Figure 2 has been adapted from that presented in UKHSE HSG227 ‘A Comprehensive Guide to Managing Asbestos in Premises’. It details the decision process adopted by this study in determining the most suitable management option for the majority of sites with ACM.

Figure 2: ACM Management Flow Chart

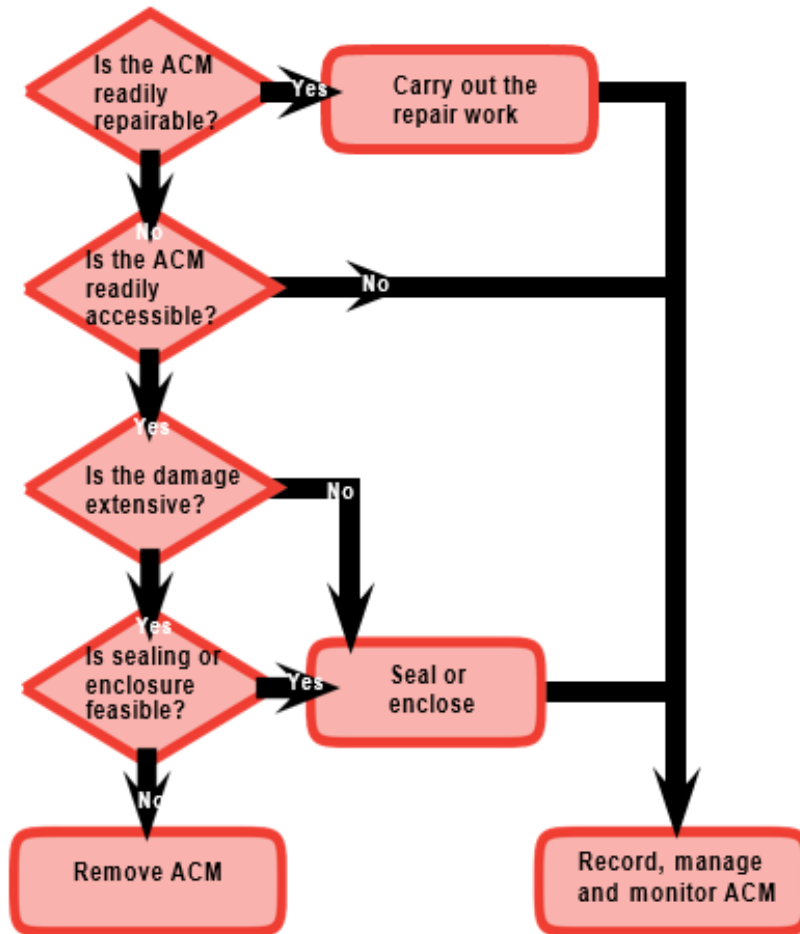


Figure adapted from; UKHSE HSG227 ‘A Comprehensive Guide to Managing Asbestos in Premises’.

Clearly there is a need to adopt a logical process such as above to select the correct management procedure in each case, and the flowchart above sets out such a procedure. There are some specific Pacific factors, however, that need to be considered.

8.2 Appropriate Asbestos Management for the Pacific

There are limited funds available for asbestos remediation in the Pacific and a wide range of health initiatives that may be deserving of funding besides asbestos remediation. It will therefore be necessary to prioritise which remediation projects are to be carried out, based on the risk ranking methodology and available funding. Whichever projects cannot be undertaken will need interim management until funding is available.

Management of un-remediated asbestos buildings is discussed in Section 7.2 above. The key factors in this management will be education and awareness so that minimising the generation of airborne fibres can be achieved.

Where remediation can be undertaken the first option that could be considered is encapsulation. Most asbestos roofs in the Pacific are, however, in a deteriorating condition and need to be encapsulated on the underside as well as the top surface. In most cases there is also a ceiling in place so the ceiling will need to be removed, as well as electrical and other services if they cannot be worked around. The top surface of the ceiling, as well as the services, must be treated as potentially contaminated with asbestos, especially if the asbestos roof is old, so the rooms below will need to be protected. The services and ceiling will then need to be returned or replaced as appropriate.

This process is expensive and, in fact may cause the project to be of a similar cost to removal and replacement of the roof. If there is no ceiling in place then the underside of the asbestos roof may, however, be able to be painted quite easily, although the project will still be an asbestos remediation project with all the resultant controls that must be put in place.

If an asbestos roof is encapsulated then it will still be necessary to replace any asbestos guttering and downpipes.

Asbestos cladding may be able to be satisfactorily encapsulated at a reasonable cost if it is in good condition. If there is also a wall cavity and an internal wall in good condition then there would be no need to encapsulate the inside of the asbestos cladding. Otherwise the inside would need to be encapsulated as well.

Encapsulation is discussed further in Section 8.3 below.

Removal of the asbestos roof would require all the appropriate asbestos management controls to be put in place as well as edge protection / fall arrest for safe working at heights and procedures for working on a brittle asbestos roof. Once the roof has been removed then the asbestos dust would need to be carefully vacuumed up in the ceiling space. Then a new roof would need to be put in place. With the hot conditions in the Pacific an insulating layer would also be required. Asbestos does have the merit of being cool to live under.

Removal is discussed further in Section 8.4 below.

8.3 Encapsulation

If encapsulation is to be used then several factors need to be considered as follows:

- Durability – the encapsulating system applied should last for a long time.
- There should be minimal (or preferably no) surface preparation involved as the high pressure washing and abrasive techniques normal for surface preparation for painting will generate a large amount of asbestos fibres.
- The encapsulant product should be simple to apply.
- Preferably the solar reflection should be enhanced by the use of light colours.

Normal priming type paints (especially oil or mineral turps based paints) generally do not bind well to asbestos cement roofs and cladding and special high quality alkali resistant primers are

recommended prior to using a typical high quality 100% acrylic based exterior undercoat and exterior top coat system.

Alternatively, a semi-gloss, two-component epoxy paint suitable for metal, concrete, asbestos, cement and heavy machinery can be used. Such epoxy resin based paints exhibit long lasting durability under harsh conditions, such as acid, alkaline, salt and very humid conditions. Such paint can be used as a primer coat as well.

Another alternative is to use a special asbestos encapsulating system such as that offered by Global Encasement Inc (www.encasement.com). Global Encasement recommends for the Pacific a primer called "MPE" (Multi-Purpose Encapsulant) and a top coat called "Asbestosafe". MPE is promoted as not requiring any surface preparation and is described as a penetrating encapsulant. It does, however, require surfaces to be "clean and dry, and free of mould, mildew, chalking, dirt, grease and oil. In most cases old roofs in the Pacific would still therefore require surface preparation.

Based on coverage and cost per litre the Global Encasement paint systems are probably about 20-30% more expensive than high quality exterior acrylic paint systems and the cost of the paint (encapsulant) would in turn be about 40-50% of the overall cost of an encapsulating project, depending on labour costs. The additional cost of using a specialist coating like the Global Encasement systems may not therefore be that significant. Global Encasement do say that a 20 year life is expected while a high quality acrylic system is unlikely to last longer than 10-15 years. Global Encasement offer a guarantee for the 20 year life but it is a very limited and conditional guarantee.

The following steps would be typical for a roof asbestos encapsulation project:

- a) Prepare asbestos removal plan, set up asbestos boundaries and signage, prepare PPE and decontamination area.
- b) Set up scaffolding to both sides of building for access to roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems.
- c) Spray with a particle capture technology such as Foamshield (www.foamshield.com.au) to the inside of the ceiling space before removal of the ceiling. This will control any asbestos dust in the ceiling space before removal of the ceiling. Alternatively the ceiling space could be vacuumed thoroughly if safe access is possible to all the ceiling space.
- d) Lay down black plastic sheeting to the floor of each room, remove all ceiling linings and place all rubbish into suitable containers for disposal (plastic lined bins or fabric bags such as "Asbags" – see Photos 5 & 6 below) for correct removal & disposal. All ceiling material will need to be treated as asbestos-contaminated as debris and fibres fall from the roofing with roof movement and wear.
- e) Disconnect & remove all electrical items, ceiling fans, lights, extractor fans. Vacuum thoroughly and store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work.
- f) Vacuum the underside of the existing roof sheeting and all timber roof framing. After removal of ceiling materials and plastic, vacuum all the inside of the premises.
- g) Spray 3 coats of protective paint system (pre-coat, undercoat and top coat) to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated.
- h) Supply & fix appropriate ceiling sheeting to ceilings of all rooms. Supply & fix timber battens to all sheet joints & to perimeter of each room.

- i) Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets & perimeter battens.
- j) Reposition all wiring for lights & fans and connect up all fittings as previously set out.
- k) Spray 3 coats of specialist paint finish (pre-coat, undercoat and top coat) to all the exterior roof area according to painting specifications.
- l) Remove, and contain for disposal, asbestos gutters and downpipes from both sides of the building and supply & install new suitable box gutters (e.g. Colourbond) with down pipe each side leading to water tank.
- m) Remove asbestos boundaries and signage and decontamination area and decommission from site.

NB: All vacuuming will need to be done with a specialist vacuum cleaner fitted with a high efficiency (HEPA) filter.

Asbags are fabric bags in various sizes with lifting strops – see photos below. There are special ones for roofing sizes.



Photos 5 & 6: Asbags in use

8.4 Removal

Removal of friable asbestos will need to be carried out with specialist asbestos contractors who will not normally be available in Pacific countries.

Removal of non-friable asbestos roofs and cladding will need to be done according to appropriate protocols and will again need specialist supervision and training.

The following steps would be typical for a roof asbestos removal project:

- a) Prepare asbestos removal plan, set up asbestos boundaries and signage, prepare PPE and decontamination area.
- b) Set up scaffolding to both sides of building to assist in removal of roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems.
- c) Spray the entire roof with a water based PVA solution.
- d) Carefully remove the roof sheeting by unscrewing, (not breaking) the roof sheets. All roof sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheetting to be fully wrapped in plastic & taped shut. Roof sheeting and all materials, (ridging, barge flashing, gutters etc) to be loaded into suitable containers for disposal (plastic lined bins or fabric bags such as “Asbags”) for correct removal & disposal.

- e) Vacuum clean the existing ceiling & roof space, (rafters, purlins, ceiling joists) with a suitable vacuum cleaner fitted with a HEPA filter.
- f) Supply & fit heavy duty tarpaulins to keep the roof waterproof before installation of new roofing.

The new roof sheeting, insulation, guttering and downpipes should be durable (long life and resistant to corrosion from marine environments). Suitable insulation will also need to be installed to keep the building cool.

One option where a large amount of roofing is to be installed is to use a roof roll forming machine and form the roofs locally. Roofing materials could then be cut to suit and purchase of the sheet metal rolls would be cheaper than the finished roofing sheets. Of course the capital cost of the roll forming machine would need to be included in the cost calculations. It may also be appropriate to use aluminium rolls which would be corrosion resistant in marine environments.

Alternatively suitable roofing materials can just be imported such as Colourbond Ultra Grade, which is suitable for corrosive marine environments.

The following steps would be typical for a roof replacement project:

- a) Supply & fit suitable roof netting over existing purlins & fix in place ready to support suitable insulation such as 50mm thick, foil coated, fiberglass insulation.
- b) Supply & lay a top layer of sisalation foil over the fibreglass insulation blanket as a dust and moisture barrier.
- c) Supply & screw fix suitable roofing material such as Colourbond Ultra Grade corrugated roofing, including for ridging & barge flashings.
- d) Supply & fix suitable guttering such as Colourbond box guttering to both sides of the roof & include for one downpipe each side, feeding to a tank.

8.5 Options Specific to Tuvalu

Table 9 below shows the sites on Tuvalu that returned a positive result for ACM and the most suitable, cost effective remedial options based on the flow chart process described above.

Table 9: Possible Remedial Options – Tuvalu

Site Name	Building Material Type	Asbestos Type and %	Risk Score	Applicable Remedial Options			
				Repair	Isolate	Encapsulate	Remove
Sanus service station	Front wall fibreboard cladding	Chrysotile 20% Crocidolite 2%	23	x	x	x	✓
Former Power House	Roof west ridge	Chrysotile 20%	21	Removed by CBS (Fiji) Ltd Contractors in November 2014 as part of a solar power construction project. The method of disposal is unknown.			
	External east wall panels	Chrysotile 20%	21				
Meteorological Centre	Roof	Chrysotile 20%	19	x	x	x	✓
Princess Margaret Hospital	Misc loose fibreboard	Chrysotile 7% Amosite 10%	16	x	x	x	✓
	Misc loose fibreboard	Chrysotile 10%	15	x	x	x	✓
PACM by road	North of road	Chrysotile 10%	13	x	x	x	✓
Pipework by wharf	200mm AC pipe	Chrysotile 20%	5	✓	✓	x	x
US Dozer	Brake Pad	Chrysotile 10%	5	x	✓	x	✓

**Note that it is not intended that residential houses clad or roofed with asbestos containing materials be remediated as part of the PacWaste project.*

In order to assist with ensuring the most suitable and remedial approach is taken, a review of the National and International regulations governing asbestos has been undertaken.

9.0 Disposal

9.1 Relevant International Conventions

The three options for disposal of ACM and asbestos-contaminated wastes are as follows:

- a) Local burial in a suitable landfill
- b) Disposal at sea
- c) Export to another country with suitable disposal

These three alternatives are discussed below.

Several International Conventions may be relevant to sea disposal and export of asbestos. These conventions and their status as at 2011 are set out in Table 10 below.

Table 10: Related International Conventions

Country	Rotterdam Convention	Basel Convention	London Convention & Protocol*	Waigani Convention	Noumea Convention
Australia	Y	Y	Y*	Y	Y
Cook Islands	Y	Y		Y	Y
FSM		Y		Y	Y
Fiji				Y	Y
Kiribati		Y	Y	Y	
Marshall Is	Y	Y	*		Y
Nauru		Y	Y		Y
New Zealand	Y	Y	Y*	Y	Y
Niue				Y	
Palau				Not ratified	
PNG		Y	Y	Y	Y
Samoa	Y	Y		Y	Y
Solomon Is			Y	Y	Y
Tonga	Y	Y	Y*	Y	
Tuvalu			Y	Y	
Vanuatu			Y*	Y	

Source; SPREP (2011) 'An Asbestos-Free Pacific: A Regional Strategy and Action Plan'

Later in 2011 Palau also became a party to the Basel Convention.

The Rotterdam Convention (formally, the *Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade*) is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that producers within their jurisdiction comply.

The Convention covers asbestos as one of its listed chemicals but not Chrysotile asbestos. The Convention, however, is for the purpose of managing imports of products and not wastes.

The London Convention and Protocol, and the Noumea Convention and associated Dumping Protocol are both relevant to the issue of dumping at sea and hence are discussed in Section 9.3 below.

The Basel and Waigani Conventions are relevant to the issue of export of waste to another country and are hence discussed in Section 9.4 below.

9.2 Local Burial

In order for local burial of ACM and asbestos-contaminated wastes to occur in a local landfill that takes general refuse, there must be a suitable landfill available as follows:

- a) The landfill must be manned and secure so that no looting of asbestos materials can occur.
- b) The landfill must have proper procedures for receiving and covering asbestos waste. A suitable hole must be excavated, the asbestos waste placed in the hole, and the asbestos waste covered with at least one metre of cover material. The asbestos waste should be buried immediately on receipt at the landfill.
- c) Machinery must be available to enable the excavation and covering to occur.
- d) The location of the asbestos should be logged or an asbestos burial area designated.
- e) Records of dates and quantities should be kept.

The alternative to burial in a local landfill is to construct a special monofill for asbestos waste. This landfill could be lined and sealed once it is full. This process is expensive, however, and would only be justified where there is a large amount of asbestos for disposal.

The other factor to consider in relation to local disposal is whether such a practice is acceptable to the local people. A programme of consultation is necessary to determine if this is the case.

9.3 Disposal at Sea

The international convention governing sea disposal is the *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*, (the London Convention), which has the objective to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter (International Maritime Organization (IMO)). The 1996 "*London Protocol*" to the Convention which came into force in March 2006 updates the convention to prohibit the dumping of any waste or other matter that is not listed in Annex 1 to the Protocol.

Annex 1 to the Protocol covers the following wastes

1. Dredged material
2. Sewage sludge
3. Fish waste, or material resulting from industrial fish processing operations
4. Vessels and platforms or other man-made structures at sea.
5. Inert, inorganic geological material
6. Organic material of natural origin
7. Various bulky inert items – iron, steel, concrete etc.
8. Carbon dioxide streams from carbon dioxide capture processes for sequestration

Probably asbestos would come under the category of inert inorganic geological material.

Any dumping of such Annex 1 wastes requires a permit from the country of origin and is limited to those circumstances where such wastes are generated at locations with no land disposal (or other disposal) alternatives. The 1996 protocol also prohibits the exports of wastes or other matter to non-Parties for the purpose of dumping at sea.

The decision to issue a permit is to be made only if all impact evaluations are completed and the monitoring requirements are determined. The provisions of the permit are to ensure that, as far as practicable, any environmental disturbance and detriment are minimised and the benefits maximised. Any permit issued is to contain data and information specifying:

1. The types and sources of materials to be dumped
2. The location of the dumpsite(s)
3. The method of dumping
4. Monitoring and reporting requirements.

It should be noted that the overall thrust of the Convention (as amended by the Protocol), as set out at the start of the Protocol is to eliminate pollution of the sea caused by dumping and to protect and preserve the marine environment. The Protocol also recognises the particular interests of Small Island Developing States. It would be fair to say, therefore, that even if the dumping of asbestos met the requirements of the Convention and Protocol, it would probably be contrary to the overall thrust of the Convention and Protocol, particularly if such dumping was initiated by Small Island Developing States.

If asbestos was dumped at sea, the following information would be needed (in terms of Annex 2 of the Protocol), in order for a permit to be issued:

1. Full consideration of alternatives
2. Full assessment of human health risks, environmental costs, hazards (including accidents), economics, and exclusion of future uses.

The other relevant convention is the *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region* (1986), known also as the SPREP Convention or Noumea Convention. This Convention, along with its two Protocols, is a comprehensive umbrella agreement for the protection, management and development of the marine and coastal environment of the South Pacific Region. It is the Pacific region component of UNEP's Regional Seas Programme which aims to address the accelerating degradation of the world's oceans and coastal areas through the sustainable management and use of the marine and coastal environment. In order to protect the environment in the Pacific region, through the Noumea Convention the Parties agree to take all appropriate measures in conformity with international law to prevent, reduce and control pollution in the Convention Area from any source, and to ensure sound environmental management and development of natural resources.

One of two associated protocols is the Dumping Protocol which aims to prevent, reduce and control pollution by dumping of wastes and other matter in the South Pacific. Annexes associated with the protocol would permit the dumping of asbestos provided such dumping did not present a serious obstacle to fishing or navigation. A General Permit would be needed, however, that covers a

number of matters including impacts on the marine environment and human health and whether sufficient scientific knowledge exists to determine such impacts properly. Parties are required to designate an appropriate authority to issue permits.

Again the overall thrust of the Noumea Convention and its associated Dumping Protocol is to eliminate pollution of the sea caused by dumping and to protect and preserve the marine environment. Again it would be fair to say, therefore, that even if the dumping of asbestos met the requirements of the Convention and Dumping Protocol, it would probably be contrary to the overall thrust of the Convention and Dumping Protocol.

Given all the above, it may still possibly be the best option to dump the asbestos at sea. In order to successfully carry out such dumping several operating requirements would need to be met as follows:

1. The asbestos waste would need to be sealed completely and packed so that it could be loaded and unloaded satisfactorily. Probably it would best be wrapped in plastic and then placed in fabric bags fitted with loading strops. "Asbags" would meet these criteria and have a maximum 3 tonne capacity.
2. There must be a way of loading the asbestos waste satisfactorily. A shore-based crane could load asbestos in Asbags.
3. There must be a means of sea transport. A barge that towed a raft would be suitable, or a vessel with sufficient deck space.
4. There must be a safe way to unload the waste asbestos at sea. If a vessel was available with a crane with at least 3 tonne capacity at a reasonable reach then that would meet this requirement. Otherwise a shore-based crane or crane truck (Hiab) could be tied to a raft. The raft would need to have side protection around its perimeter and operating personnel would need life jackets.
5. A suitable dumping location would need to be found that a) was deep enough to ensure that no asbestos would ever return to shore; and b) had no environmental sensitivity. It is likely that such a location would be some distance from shore.

It is evident that an operation that was able to meet the permit requirements of Annex 2 of the London Protocol and the operating requirements listed above would be an expensive one. Dumping at sea would, aside from any other considerations, therefore only be considered if there was a large enough amount of asbestos waste to justify it.

9.4 Export to Another Country

The final disposal option that should be considered is export to another country. Asbestos waste is a hazardous waste in terms of both the Basel Convention and the Waigani Convention.

The *Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal*, (the Basel Convention), is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous wastes from developed to less developed countries. The Convention is also intended to minimise the amount and toxicity of wastes generated, to ensure their environmentally sound management as

closely as possible to the source of generation. The Basel Convention states clearly that the trans-boundary movement of hazardous wastes and other wastes should be permitted only when the transport and the ultimate disposal of such wastes is environmentally sound.

The *Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Trans-boundary Movement of Hazardous wastes within the South Pacific Region*, known also as the Waigani Convention, entered into force on the 21st October 2001. It represents the regional implementation of the international regime for controlling the trans-boundary movement of hazardous wastes. The objective of the Convention is to reduce and eliminate trans-boundary movements of hazardous and radioactive waste, to minimise the production of hazardous and toxic wastes in the Pacific region and to ensure that disposal of wastes in the Convention area is completed in an environmentally sound manner.

The two countries that border the Pacific and are able to receive asbestos waste are Australia and New Zealand. Both countries are parties to both the Basel Convention and the Waigani Convention. All Pacific countries that are part of the asbestos project are party to either the Basel or the Waigani Conventions or both. In terms of trans-boundary movement, therefore, asbestos wastes could be moved from these Pacific countries to Australia or New Zealand.

Australia is not known to have ever received asbestos waste but discussions with the Hazardous Waste Section of the Australian Department of the Environment confirmed that, in terms of the Basel and Waigani Consent requirements, there would be no problem importing asbestos waste into Australia if it was done properly and safely and met other legislative requirements such as Customs and Biosecurity.

Permits are currently held to import asbestos waste into New Zealand from New Caledonia, French Polynesia and Niue. The New Zealand Government is currently funding a project to import a large amount of waste asbestos from Niue into New Zealand for disposal. This is being done under the Waigani Convention.

Potentially also, Fiji could accept waste asbestos from other Pacific countries as it has a well-run landfill at Naboro near Suva with all the controls necessary to receive asbestos. It does receive asbestos waste from within Fiji in a properly managed way. At present, however, Fiji is a party to the Waigani Convention but not the Basel Convention so it would only be able to receive asbestos waste from Waigani Convention parties.

A suitable landfill must be found in the importing country, a suitable ship and shipping route is needed, and biosecurity concerns need to be addressed. Asbestos is regarded as a Class 9 Dangerous Good for shipment purposes.

10.0 Cost Considerations

A typical example of local Pacific costs has been obtained from Central Meridian Inc in Nauru, which is a contracting company that has worked for 14 years in Nauru and employs about 60 staff (see Appendix 6). Costs will likely vary according to local conditions but rates have been cross checked against established rates in New Zealand, and also informally with contractors in other Pacific countries, and it is believed that the figures put forward are reasonable for preliminary budgeting purposes.

10.1 Encapsulation

For the encapsulation option, cost build ups have been prepared for roofs and wall cladding based on the Central Meridian estimate. The Central Meridian costs have been changed from AUD to USD at an exchange rate of 0.8, and the figures have been reduced by 10% based on the assumption that cheaper prices could be obtained by competitive tendering, and also based on reconciliation with established rates in New Zealand.

The full cost build ups are presented in Appendix 6 and a summary is presented as follows:

Roof Encapsulation

Costs:

- Encapsulate roof where there is no ceiling present below the roof: USD49.64/m² of roof (face area)
- Encapsulate roof where there is an existing ceiling below the roof that needs to be removed and replaced: USD90.79/m² of roof (face area)

Assumptions:

- Rates have been built up based on a roof of a single storey building with a floor area of 14m x 12m with a roof pitch of 30 degrees. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.

Cladding Encapsulation

Costs:

- Encapsulate wall cladding where there is no internal wall sheeting: USD25.92/m² (face area)

- Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated: USD17.92/m² (face area)
- Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/m² (face area)

Assumptions:

- Rates have been built up based on a single storey building with a floor area of 14m x 12m and walls 2.4m high. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.

10.2 Removal and Replacement

For the removal and replacement option cost build ups have been prepared for roofs and wall cladding based on the Central Meridian estimate. As for the encasement option, the Central Meridian costs have been changed from AUD to USD at an exchange rate of 0.8, and the figures have been reduced by 10% based on the assumption that cheaper prices could be obtained by competitive tendering, and also based on reconciliation with established rates in New Zealand.

The full cost build ups are presented in Appendix 6 and a summary is presented as follows:

Roof Removal and Replacement

Cost:

- Remove and replace roof: USD96.31/m² (face area)

Assumptions:

- Rates assume that the existing roofs are replaced with Colourbond Ultra grade roof sheeting (for sea spray environments) with 50mm of foil coated fibreglass insulation (to address heat issues).
- Rates have been built up based on a roof of a single storey building with a floor area of 14m x 12m with a roof pitch of 30 degrees. Extra will be required for scaffolding for buildings greater than 1 storey high.

- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- A 10% contingency has been allowed for tidying up any damaged or inadequate rafters purlins and barge boards.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.
- Rates assume asbestos waste secure wrapping and disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Cladding Removal and Replacement

Costs:

- Remove and replace cladding: USD76.04/m² (face area)

Assumptions:

- Rates assume that the existing cladding is replaced with a cement fibre board with treated timber battens to make water tight. An allowance has also been made to wrap the building in foil and to apply two coats of paint to complete the works.
- Rates have been built up based on a single storey building with a floor area of 14m x 12m and walls 2.4m high. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- A 10% contingency has been allowed for tidying up any damaged or inadequate framing.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.
- Rates assume asbestos waste secure wrapping and disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Table 11: Summary of Costs for Various Remediation Options (Costs rounded to nearest \$US)

Remediation Method	Cost per m ² (face area) \$US
Encapsulation	
Roofs:	
Encapsulate roof where there is no ceiling present below the roof	50.00
Encapsulate roof where there is an existing ceiling below the roof that needs to be removed and replaced	91.00
Cladding:	
Encapsulate wall cladding where there is no internal wall sheeting	26.00
Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated	18.00
Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/m ² (face area)	66.00
Removal and Replacement	
Roofs:	
Remove and replace roof	96.00
Cladding:	
Remove and replace cladding	76.00
Miscellaneous	
Remove and replace floor tiles*	80.00
Pick up debris, pipes	40.00

**\$US80 is the lower end of the cost spectrum for removing and replacing vinyl floor tiles and the cost could easily double (or more) for difficult removal projects. To balance this out, the vinyl tile matrix is stable and there is little risk of asbestos exposure unless they are badly deteriorating. Vinyl floor asbestos projects could therefore be lower down on the priority list.*

The above rates assume asbestos waste disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

10.3 Local Contractors

An objective of the study was to identify any local contractors who may have the expertise and capacity to potentially partner with regional or international experts in future asbestos management work. Attempts were made to identify and contact potentially suitable contractors prior to the visits in order to schedule meetings when the survey team was in the country. In addition key government officials were also requested to provide the details of potentially suitable contractors.

During discussions with Tuvalu Government officials including the Public Works Department it was apparent that there were no in-country contractors who regularly worked in the asbestos removal/repair field and would be considered suitable without basic initial training and supervision.

According to staff at the Meteorological station, the ACM roofs on four of the buildings were removed by local staff without the correct asbestos handling procedures, dust mitigation or PPE controls.

11.0 Review of Tuvalu Policies and Legal Instruments

11.1 National Laws and Regulations

As already mentioned, Tuvalu is a party to the London Convention and Protocol which will regulate any disposal of asbestos to sea. In addition Tuvalu has a Marine Pollution Act 1991 which, among other matters, requires a permit to dump waste at sea.

Tuvalu is also a party to the Waigani Convention which will regulate any trans-boundary movement of asbestos waste to any other Waigani member countries.

Tuvalu also has a Public Health Act 1926 which was amended in 1971 and 1974. It makes no mention of asbestos but empowers the Minister of Health to make regulations for the purpose of protecting and advancing public health. This offers a mechanism for regulating the management of asbestos.

11.2 National Strategies and Policies

With the exception of the SPREP (2011) 'An Asbestos-Free Pacific: A Regional Strategy and Action Plan' there are currently no national strategies or policies related to asbestos exposure or asbestos removal and management implemented in Tuvalu.

Tuvalu has confirmed its support for the aims and objectives of the PacWaste Project.

12.0 Recommended Actions for Minimising Asbestos Exposures

12.1 Discussion

ACM has been identified by this study to be present at several locations in Tuvalu. Based on an algorithm adopted as part of the risk assessment to prioritise asbestos management, this study has identified that there are only two sites in Tuvalu that are considered moderate to high risk with regard to the occupants' and/or publics' potential exposure to asbestos. The remaining sites identified are considered to present a low to very low risk to human health.

With regard to houses the Table 4 above presents a statistical summary. Based on the analytical results, 18.4% of houses in Funafuti have cladding that contains asbestos and if this correct, the survey that was done as part of this study leads to the conclusion that approximately 55 houses in Funafuti may have asbestos cladding. By direct proportion the number of residences in Tuvalu with asbestos cladding is therefore 130 – 140 houses, but this extrapolation is largely meaningless as the margin of error will increase significantly and also there is no guarantee that the Tuvalu outer islands have the same types of cladding. It is also understood that there was a recent AusAID rainwater harvesting programme that resulted in the removal and replacement of asbestos roofs in Funafuti. There may therefore still be dwellings in the outer islands that have asbestos roofs in unknown numbers.

Any programme to remediate asbestos in Tuvalu should therefore involve a detailed survey of all dwellings in Tuvalu including the outer islands with numerous samples taken of cladding in particular.

Remediation of sites has been prioritised based on the level of risk posed to the building occupants and public at each site according to the methodology described in Section 3.0.

The quantities of ACM observed at the sites were used to estimate costs for abatement. A summary of the recommended actions and estimated costs are included in Table 11 below.

Table 11: Prioritised Recommended Actions and Indicative Costs

Site Name	ACM	Risk Score	Recommended Remedial Actions	ACM Area (m ²)	Estimated Cost (\$ USD)
Sanus service station	Front wall fibreboard cladding	23	ACM cladding removal and replacement	80 m ²	6080
Meteorological Centre	ACM Roof on store building	19	ACM roof removal and replacement	110 m ²	10560
	Loose ACM on ground from previous roof	16	Pick up of loose ACM	0.25m ³	1500

The following should be noted:

- a. It would probably be best to remove and replace the asbestos cladding and roofing for small amounts as it provides a permanent solution.

- b. Two residences were included in the Table 9 above as high risk but the SPREP project doesn't cover residences. If significant amounts of asbestos were discovered in residences in Tuvalu and it was decided to remediate Tuvalu residences, then it is probable that most of it would be cladding. It may therefore be appropriate to encapsulate the cladding with a suitable paint system.
- c. There is some loose asbestos waste discovered around Funafuti – eg at Princess Margaret Hospital, by the roadside and by the wharf (piping). This has been assessed as low risk by could be picked up and disposed of cheaply. It is recommended that this be done as well.

The disposal method for Tuvalu's asbestos wastes also needs to be determined. The preference would be for disposal on Funafuti in the landfill, but Funafuti is low-lying with a high groundwater and ensuring permanent coverage may be difficult. It could be buried in a special lined cell and covered with concrete, assuming a suitable site for the cell could be obtained.

If no suitable disposal site can be found, then the other options are disposal at sea or export to another country as discussed in Sections 9.3 and 9.4 above. Both alternatives are permissible for Tuvalu although they would be expensive options.

Disposal at sea would require permits under the London Protocol and Tuvalu's own Marine Pollution Act. A suitable barge would be required with a crane mounted on it. Another crane for loading the asbestos on the barge would be required and a suitable deep dumping location would be needed. This option is probably impractical for Tuvalu and may be unacceptable to customary law that operates in Tuvalu. The process of obtaining permits would also be expensive as there would be a need to carry out expensive and detailed investigations before permits could be obtained.

Export from Tuvalu to another country would be viable and probably Brisbane in Australia would provide a suitable destination although shipping routes would need to be confirmed and obtaining Waigani consents for transit ports may be difficult and time-consuming. Perhaps sufficient waste could be generated to justify the shipment of at least one 20 ft container which can hold about 17 tonnes of asbestos waste, provided some residences were included as well.

Shipping costs for a container of asbestos from Nauru to Brisbane for disposal have been calculated at \$US768/tonne including disposal to the Remondis Landfill in Brisbane. There is a direct route from Nauru to Brisbane and a much higher shipping volume than from Tuvalu to Brisbane, so a safe figure from Tuvalu to Brisbane would be about 1.5 times that figure or \$US1150/tonne, which would be \$19,550 per container, plus the cost of the container. If a figure of \$25,000 per container is chosen then this would be a reasonable estimate and would probably be cheaper than constructing a special lined cell and covering it with concrete.

12.2 Recommendations

The following recommendations are therefore made in relation to asbestos on Tuvalu:

- A. It is recommended that the above higher priority asbestos work is carried out in Tuvalu as well as removal of all loose asbestos.
- B. Two residential dwellings are identified in Table 9 above but it has been concluded that approximately 55 houses in Funafuti may have asbestos cladding, as well as potentially many more in the rest of Tuvalu. It is recommended that all houses with PACM on Tuvalu are tested for asbestos and that all the houses tested positive are notified and included in an

- awareness campaign. They should be remediated (i.e. the asbestos removed or encapsulated) where resources permit.
- C. If a large number of houses are found to contain asbestos cladding then encapsulation would probably be the most cost-effective option for remediation although ongoing management procedures then would be needed and re-encapsulation (i.e. re-painting) would probably be needed 10-15 years later. If a small number of houses are found to contain asbestos cladding then removal and replacement of the cladding should be considered.
 - D. Any asbestos roofs found on houses in Tuvalu should preferably be removed rather than encapsulated as encapsulation of roofs costs only a little less than removal and removal is a permanent solution.
 - E. If a suitable cheap on-island disposal location can be found that was locally acceptable then on-island disposal would be the preferred disposal option. Otherwise the next preferred option is placement in a 20 ft shipping container and export to Brisbane for disposal in the Remondis Landfill as another option
 - F. Before asbestos remediation takes place (and after if all the asbestos is not removed) it would be appropriate to set in place suitable asbestos management practices and procedures to deal with the ongoing risk posed to human health by asbestos exposure. This should be accompanied by an appropriate education and training programme.
 - G. Consideration should be given to Tuvalu passing regulations under their Public Health Act to enable the above asbestos work to be carried out.

Appendix 1: Edited Copy of the Terms of Reference

Background

Asbestos-containing materials were in wide use in the past in Pacific Island countries for housing and building construction. The region is subject to periodic catastrophic weather and geological events such as tsunamis and cyclones which are highly destructive to built infrastructure, and as a consequence, asbestos has become a significant waste and human health issue in many Pacific countries. However, quantitative data on the location, quantity and condition of asbestos is not available for the region. This data is needed to define the problem and plan for future actions. This project will contribute to improved management of regional asbestos waste through collection, collation and review of such data on the location, quantity and status of asbestos-containing building materials in priority Pacific Island countries.

SPREP has received funding from the European Union under the EDF10 programme to improve the management of asbestos waste in priority Pacific Island countries.

The work for this consultancy is located in the following Sub-regions and countries;

- Sub-region A, (Nauru):
Nauru
- Sub-region B, (Micronesia):
FSM, Kiribati, Marshall Islands, Kiribati
- Sub-region C, (Melanesia):
Fiji, Solomon Islands, Vanuatu
- Sub-region D, (Polynesia):
Cook Islands, Niue, Samoa, Tonga, Tuvalu

Objective

Pacific asbestos status and management options are assessed and future intervention recommendations presented on a regional basis to identify prioritised areas for future intervention.

Scope of Work

The scope of work for this consultancy covers the following tasks:

Tasks

For each of the sub-regions and countries above, the Consultant will:

1. Collect and collate data on the location (geographic coordinates), quantity and condition of asbestos-containing building materials (including asbestos-containing waste stockpiles) in each nominated Pacific Island country.
2. Review, and recommend a prioritised list of local best-practice options for stabilisation, handling and final disposal of asbestos contaminated materials in each nominated Pacific Island country (including review of existing local institutional, policy and regulatory arrangements).
3. Recommend and prioritise actions necessary to minimise exposure (potential and actual) of the local population to asbestos fibres for each nominated Pacific Island country. An approximate itemised national cost should be presented for each option identified.

4. Identify any local contractors who have the expertise and capacity to potentially partner with regional or international experts in future asbestos management work.
5. Develop a schedule of rates for local equipment hire, mobilization, labour, etc., to guide the development of detailed cost estimates for future in-country asbestos remediation work.

Project Deliverables

1. Final report detailing the location, quantity and status of asbestos-containing building materials (including asbestos-contaminated waste stockpiles) for each Pacific Island country identified in the work region(s).
2. Final report providing recommendations for local best-practice options including local institutional and policy arrangements for national asbestos management for each Pacific Island country identified in the work region(s).
3. Final report identifying local labor and equipment hire rates and availability of in-country asbestos management expertise for each Pacific Island country identified in the work region(s).
4. Final report presenting costed priority actions necessary to minimise the exposure of the local population to asbestos fibres for each Pacific Island country identified in the work region(s).

Project Timeframe

All final reports completed and submitted to SPREP within twenty (20) weeks from signature of the contract.

Appendix 2: Organisational Details and List of Contacts

A2.1 Organisational Details

The visit to Tuvalu took place from 24 to 28 July 2014. The consultant undertaking the visit was Gareth Oddy of Geoscience Consulting. They were based in Funafuti for the entire visit.

The primary agency for liaison was the Tuvalu Department of Environment, and the following personnel were involved:

Mr Mataio Tekinene, Director of the Department of Environment

In addition, correspondence with the following other key government Departments and Authority's was undertaken in order to identify other potential ACM sites;

- Solid Waste Agency of Tuvalu (SWAT)
- Public Works Department
- Ministry of Foreign Affairs, Trade, Tourism, Environment and Labour

The Government officers were very helpful and provided considerable support during the visit for which the survey team are very grateful. Full contact details are given below for all those who assisted during the survey and subsequent reporting.

A2.2. List of Contacts

Temate Melitiana

Permanent Secretary

Ministry of Foreign Affairs, Trade, Tourism, Environment and Labour

Government of Tuvalu

Funafuti

Tuvalu

tmelitiana@gov.tv;

Phone: (688) 20104

Ms. Pepetua Latasi

Acting Director

Department of Environment

Private Mail Bag

Funafuti

Tuvalu

pepetua@gmail.com/ platasi@gov.tv;

Phone: (688) 20179

Susana Telakau

Solid Waste Agency of Tuvalu (SWAT)
Director of Solid Waste Agency of Tuvalu (SWAT)
Ministry of Home Affairs
susey84@gmail.com/stelakau@gov.tv;
Phone: (688) 20164, (688) 900341

Mr. Ampelosa Tehulu
Director of Public Works Department
Public Works Department

Mafalu Lotolua
General Manager
Tuvalu Electricity Corporation
Mafaluloto2@gmail.com
Phone (688) 20352

Appendix 3: Summaries of in-Country Discussions

Susana Telakau, Solid Waste Agency of Tuvalu (SWAT)

SWAT is responsible for developing national solid waste management strategies; acting as sector regulator, including management of compliance and performance of all waste management operations in Tuvalu; supporting waste management operators by providing necessary technical expertise; reporting to the government on the national waste management program; and promoting community education and awareness on solid wastes.

In addition, SWAT is responsible for managing the island's dumpsite, a borrow pit, located on a strip of land at the northern end of Funafuti. During the survey SWAT escorted the survey team to the landfill. The borrow pit is located on a thin strip of land approximately 20 metres wide. The pit is unlined and the waste is not covered. The borrow pit was estimated to be approximately 2-3metres deep in the northern half of the site. According to SWAT, all waste, except hazardous waste is disposed of to the pit. Hazardous waste is stored in an aircraft hangar before being transported to a disposal facility in another country.

Ms Telakau also described several buildings that potentially may contain asbestos including the former power station. Asbestos is managed under the EPA to prohibit the discharge of hazardous substances. However, specific regulations regarding asbestos exposure are currently not in force in Tuvalu.

Mr. Ampelosa Tehulu, Public Works Department

The PWD is responsible for the water and electrical supply. Mr Tehulu indicated that the majority of the reticulated water supply is transferred through PVC pipes and that AC pipes are not present in Tuvalu.

Ms. Pepetua Latasi, Acting Director, Department of Environment

Following consultation with the Department of Environment a number of buildings were shortlisted for a more detailed assessment. These included buildings of sufficient age to have been constructed of ACM such as the former power plant, metrological station and government owned housing.

In addition, concerns were raised by the Department of Environment on recently imported building materials and the potential for these to have asbestos. As a consequence, recently built, repaired buildings with new fibre board were also surveyed. ACM roofs were according to the department, quite common in Tuvalu in the past. Following independence in 1975/76 several buildings contained ACM roofs and in particular many of the churches. According to Mr Tekinene many of the residential properties in Funafuti have had their roofs replaced recently due to the implementation of the AusAid rainwater harvesting programme.

Mafalu Lotolua, General Manager, Tuvalu Electricity Corporation

The TEC manager stated that asbestos had been previously identified on the former power station which was proposed to be demolished and replaced with solar power panels and associated infrastructure. Mr Lotolua stated that the asbestos removal would be completed by international speacilists.

Appendix 4: Spiire Asbestos Assessment – Fisheries Building



Report Number **116712**
02-Jul-14

Peter Olivier
Spiire New Zealand Limited
PO Box 6643
Wellington 6141

IDENTIFICATION OF ASBESTOS IN A BULK SAMPLE

Samples received on 30/06/2014 from Three buildings in Tuvalu. Sampled by Peter Olivier, on 27/06/2014.

Results

Sample #	Sample details	Analytical results
116712	Fisheries building - wall cladding	No Asbestos Found
116713	Storage building - wall cladding	No Asbestos Found
116714	Lean to Shed - wall cladding	No Asbestos Found

This report may not be reproduced, except in full. Results pertain to sample "as received".

Method: Australian Standard: AS 4864-2004, Method for the Identification of asbestos in bulk samples.


Asbestos types: Amosite or Brown asbestos; Crocidolite or Blue asbestos, and Chrysotile or White asbestos.

* Interpretations and opinions expressed in this report are outside the terms of this Laboratory's Accreditation.

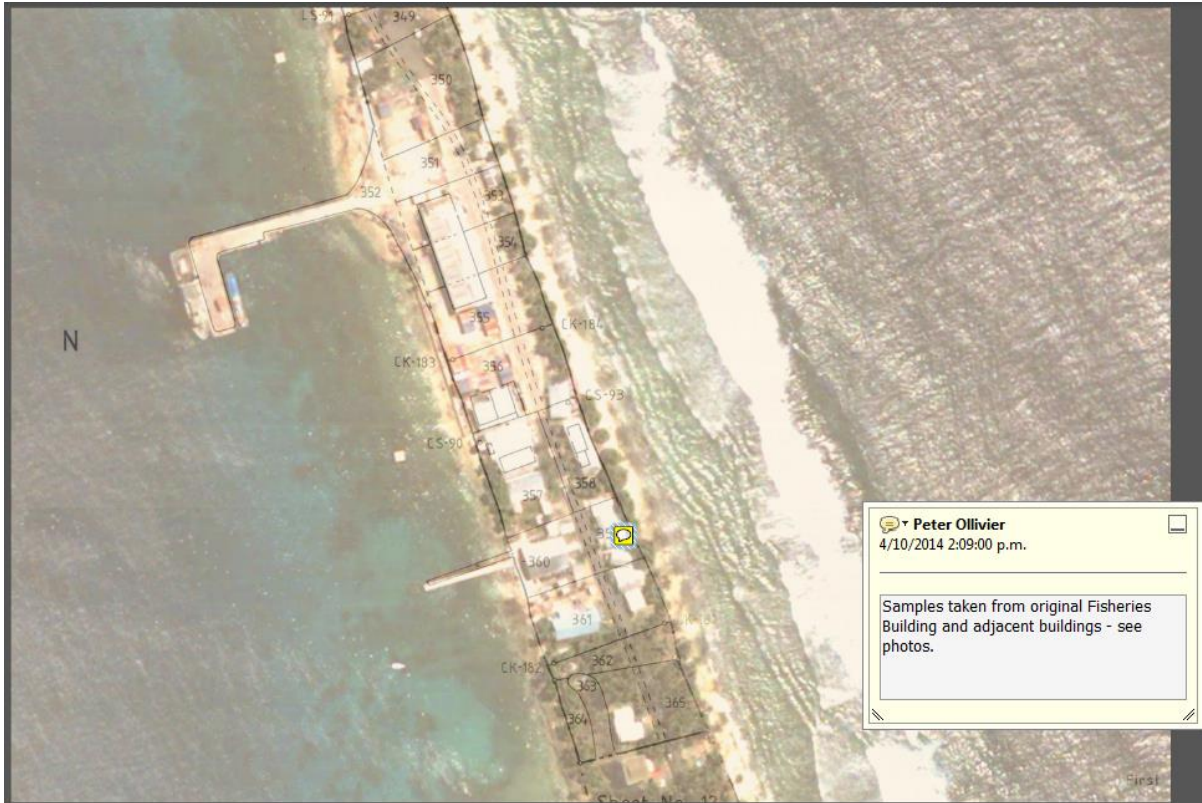
* Asbestos is a hazard. Provided it is incorporated into a stable matrix and no airborne dust is produced it presents minimal health risk. The Asbestos identified follows the definition of "asbestos" (even as a contaminant) in The Health and Safety in Employment (Asbestos) Regulations 1998.

IANZ ACCREDITED LABORATORY
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Capital Environmental Services (2005) Ltd
P.O. Box 38-328
Wellington Mall Centre 5045


Reported By
Linda Dwyer
Analyst

2-4 Bell Road South Gracefield Lower Hutt
Telephone 04-566 3311 Fax 04-566 3312
Email fibres@ihug.co.nz www.fibres.co.nz





Appendix 5: Laboratory Reports



EMS LABORATORIES INC.

117 W. Bellevue Drive, Pasadena, CA 91105-2548 626-568-4065

National Institute of Standards and Technology (NIST) NVLAP Lab Code 101218-0
 California Department of Health Services Environmental Testing Laboratory ELAP 1119
 County Sanitation Districts of Los Angeles County ID No. 10120
 AIHA Laboratory Accreditation Programs, LLC 101634

CUSTOMER: Contract Environmental
 119 Johnson Rd. West Melton
 Christchurch NZ
CONTACT: John O'Grady
REFERENCE: 11178 sprep-tuvalu
METHOD: EPA 800/R-93/116

PAGE #: 1 of 7
REPORT #: 0162207
PROJECT: PLM ANALYSIS
DATE COLLECTED: 07/29/2014
COLLECTED BY:
DATE RECEIVED: 08/01/2014
ANALYSIS DATE: 08/11/2014

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type (%)	Non-Asbestos Components (%)
0162207-001 TV1	White/gray, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-002 TV2	Gray, Non-homogeneous, Granular, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile 20% Crocidolite 2%	Non-Fibrous Material 78%
0162207-003 TV3	Gray/White, Non-homogeneous, Granular, crush, non-friable Note: 26°C, Acid	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%
0162207-004 TV4	Tan/Blue, Non-homogeneous, Granular, crush, non-friable Note: 26°C, Acid	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-005 TV5	Gray, Non-homogeneous, Granular, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile 20%	Non-Fibrous Material 80%
0162207-006 TV6	Tan/Blue, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%

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BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type (%)	Non-Asbestos Components (%)
0162207-007 TV7	Tan/Brown, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%
0162207-008 TV8	Tan/Blue, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-009 TV9	White/Green, Non-homogeneous, Rubbery, ash, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-010 TV10	Tan, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-011 TV11	Tan, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-012 TV12	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%
0162207-013 TV13	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%
0162207-014 TV14	Gray/Blue, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%
0162207-015 TV15	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%

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 PROJECT: PLM ANALYSIS

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type	(%)	Non-Asbestos Components	(%)
0162207-016 TV16	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	10% 90%
0162207-017 TV17	Beige, Homogeneous, Solid, melt, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0162207-018 TV18	Gray/blue, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0162207-019 TV19	Gray/Olive, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0162207-020 TV20	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	10% 90%
0162207-021 TV21	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	10% 90%
0162207-022 TV22	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	10% 90%
0162207-023 TV23	Gray, Non-homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	30% 70%
0162207-024 TV24	Gray, Homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	15% 85%

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BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type (%)	Non-Asbestos Components (%)
0162207-025 TV25	Gray, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 15% Non-Fibrous Material 85%
0162207-026 TV26	Gray/Green, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 20% Non-Fibrous Material 80%
0162207-027 TV27	Gray/Yellow, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 20% Non-Fibrous Material 80%
0162207-028 TV28	Gray, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 35% Non-Fibrous Material 65%
0162207-029 TV29	Gray, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 30% Non-Fibrous Material 70%
0162207-030 TV30	Gray, Non-homogeneous, Granular, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 30% Non-Fibrous Material 70%
0162207-031 TV31	Gray, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 20% Non-Fibrous Material 80%
0162207-032 TV32	Gray, Non-homogeneous, Granular, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	Chrysotile 20%	Non-Fibrous Material 80%
0162207-033 TV33	Gray, Non-homogeneous, Granular, tease, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 30% Non-Fibrous Material 70%

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 PROJECT: PLM ANALYSIS

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type (%)	Non-Asbestos Components (%)
0162207-034 TV34	Floor Tile, Green, Homogeneous, Granular, melt, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-035 TV35	Tan/Gray, Non-homogeneous, Granular, crush, non-friable Note: 28°C, 1.55	LAYER 1 100%	None Detected	Cellulose Fiber 10% Non-Fibrous Material 90%
0162207-036 TV36	Gray, Homogeneous, Granular, crush, non-friable Note: 28°C, 1.55 Oil	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-037 TV37	Gray, Non-homogeneous, Granular, crush, non-friable Note: 28°C, 1.55	LAYER 1 100%	Chrysotile 20%	Non-Fibrous Material 80%
0162207-038 TV38	White, Non-homogeneous, Fibrous, tease, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	None Detected	Cellulose Fiber 30% Non-Fibrous Material 70%
0162207-039 TV39	White, Homogeneous, Fibrous, tease, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	None Detected	Fibrous Glass 95% Non-Fibrous Material 5%
0162207-040 TV40	Gray/White, Non-homogeneous, Fibrous, crush, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	Chrysotile 20%	Non-Fibrous Material 80%
0162207-041 TV41	Gray, Non-homogeneous, Granular, crush, non-friable Note: 29°C, Acid	LAYER 1 100%	None Detected	Non-Fibrous Material 100%
0162207-042 TV42	Black/Gray, Non-homogeneous, Granular, crush, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	Chrysotile 10%	Non-Fibrous Material 90%

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PROJECT: PLM ANALYSIS

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY						
Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type	(%)	Non-Asbestos Components	(%)
0162207-043 TV43	Black, Homogeneous, Fibrous, lease, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	92% 10%
0162207-044 TV44	Gray, Non-homogeneous, Granular, lease, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	25% 75%
0162207-045 TV45	Gray, Non-homogeneous, Granular, crush, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	7% 10%	Non-Fibrous Material	83%
0162207-046 TV46	Gray/Green, Non-homogeneous, Fibrous, crush, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0162207-047 TV47	White, Homogeneous, Granular, acid, non-friable Note: 29°C, Acid	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0162207-048 TV48	Gray, Homogeneous, Fibrous, crush, non-friable Note: 29°C, 1.55 Oil	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0162207-049 TV49	Gray, Homogeneous, Solid, melt, non-friable Note: 29°C, 1.55	LAYER 1 100%	None Detected		Non-Fibrous Material	100%

CUSTOMER: Contract Environmental
119 Johnson Rd. West Mellon
Christchurch NZ

PAGE #: 7 of 7
REPORT #: 0162207
PROJECT: PLM ANALYSIS



Analyst - Wesene Sebhat

Approved Signatory Laboratory Director

The EPA method is a semi-quantitative procedure. The detection limit is between 0.1-1% by area and dependent upon the size of the asbestos fibers, the means of sampling and the matrix of the sampled material. The test results reported are for the sample(s) delivered to us and may not represent the entire material from which the sample was taken. The EPA recommends three samples or more be taken from a "homogeneous sampling area" before friable material is considered non-asbestos-containing. Negative floor tile samples may contain significant amounts (>1%) of very thin fibers which cannot be detected by PLM. Confirmation by TEM is recommended by the EPA (Federal Register Vol. 59, No. 146). Asbestos fibers bound in a non-friable organic matrix may not be detected by PLM. Alternative preparation methods are recommended. This report, from a NIST-accredited laboratory through NVLAP, must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. government. This report shall not be reproduced, except in full, without the written approval of EMS Laboratories, Inc. Samples were received in good condition unless otherwise noted.



Appendix 6: Build Up to Costs for Remediation Options

Four scenarios have been costed:

1. Encapsulate asbestos roofing
2. Encapsulate asbestos exterior wall cladding
3. Remove and replace asbestos roofing
4. Remove and replace asbestos exterior wall cladding

Build ups are mostly based on costs provided by Central Meridian Inc based in Nauru, cross checked against costs in New Zealand.

It is noted that the costs prepared are for preliminary budgeting purposes only. Costs may vary according to local requirements, but we anticipate that the amounts allowed will be adequate to get the work done.

For the cost build ups prepared we have taken the Central Meridian rates, priced in Australian dollars, and converted them to United States dollars at an exchange rate of 0.8. We have then deducted 10% for savings that we anticipate would be achievable through competitive tendering of the work.

Provision has also been made for the works to be overseen by a SPREP appointed asbestos expert. The actual cost for this item will depend on the programme of works achievable and it is noted that this expert could also complete any contract administration and act as engineer to the contract ensuring safety, quality and commercial requirements are achieved.

Central Meridian Quote



02.12.14

Quotation: 6814

Mr John O'Grady
Contract Environmental Ltd.

PO Box 106
Republic of Nauru
Central Pacific
T 674 557 3731
AH 674 557 3813
E pfcmaururu@gmail.com
paulfinch1954@gmail.com

Cost estimates to undertake various asbestos removal work.

Dear John,

As requested I have detailed below costs to undertake various items of work involved in the removal of asbestos roof sheeting and replacement with colourbond corrugated roofing.

A full schedule of work to be undertaken during the removal and replacement process is detailed to - provide a clear build-up of costs and the relevant stages of work involved.

All work will be undertaken to the relevant NZ & Australian standards for asbestos removal & disposal.

REMOVAL OF EXISTING ASBESTOS ROOF SHEETING.

The costings detailed below are based on a roof area of 165m². This is a standard size of many of the houses on Nauru with asbestos roof sheeting.

The cost of set up & removal of existing roofing is based on our historical costs for undertaking a number of similar roof removals on the island.

There are additional costs included as detailed:

- (a) purchase of a 60 Litre Foamer unit at a price of \$5,000.00 (including ocean freight & 10% import duty.) The cost of this is spread over the removal of 20 roofs.**
- (b) purchase of specialist vacuum cleaner with HEPA filter at a price of \$2,000.00 (including freight & 10% import duty.)**
- (c) delivery to a central staging point for removal off island.**

Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective clothing, (PPE) for staff & disposal.

\$1,400.00

Set up scaffolding to both sides of building to assist in removal of roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems

\$2,200.00

Coat the roof with a sprayed on water based PVA solution.

\$1,250.00

Carefully remove the roof sheeting by unscrewing, (not breaking) the roof sheets. All roof sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic & taped shut. Roof sheeting and all materials, (ridging, barge flashing, gutters etc) to be loaded into 'Asbags' for safe removal.

All removed materials will be taken and stored at a suitable staging point ready to be loaded into containers for removal from Nauru.

\$4,465.00

Vacuum clean the existing ceiling & roof space, (rafters, purlins, ceiling joists) with a specific vacuum cleaner with a HEPA filter. (dispose of contents of cleaner into an 'Asbag' for correct disposal \$325.00

Supply & fit heavy duty tarpaulins to keep the roof waterproof before installation of new roofing. \$300.00

TOTAL COST FOR REMOVAL OF EXISTING ROOFING & GUTTERS \$9,940.00

INSTALLATION OF NEW ROOF SHEETING, INSULATION, GUTTERING, DOWNPIPES.

We have quoted for Ultra grade of colourbond roof sheeting. This has a greater protective coating & is better for an oceanside environment. (Long life heavy duty).

The sq metre costs & grade of materials for this work are the same as that for the TVET school project in Yaren we have recently completed to AusAID Standard.

Supply & fit 'Kiwisafe' roof netting over existing purlins & fix in place ready to support the 50mm thick, foil coated, fiberglass insulation. Supply & lay a top layer of sisalation foil over the fibreglass insulation blanket. \$2,541.00

Supply & screw fix Colourbond Ultra grade corrugated roofing, including for ridging & barge flashings. \$7,722.00

Supply & fix Colourbond box guttering to both sides of the roof & include for one downpipe each side, feeding to a tank. \$1,060.00

TOTAL COST FOR SUPPLY & FIXING OF NEW ROOF, ROOF INSULATION & GUTTERS & DOWN PIPES. \$11,323.00

NB A contingency of 10% may need to be added as necessary for repairs to roof purlins and rafters.

RETENTION OF EXISTING ASBESTOS ROOF SHEETING AND FULL ENCAPSULATION WITH CORRECT PAINT SYSTEM. INCLUDING REMOVAL & REPLACEMENT OF EXISTING CEILINGS.

The square area of ceiling to be replaced & painting to be undertaken is based on a house size of 14m x 12m in size. (168 m2)

Work involved in this process is as follows and detailed below:

Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective clothing, (PPE) for staff & disposal.
\$1,400.00

Set up scaffolding to both sides of building to assist in removal of roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems
\$2,200.00

Spray with Foamshield to the inside of the ceiling space before removal of the sheeting.
\$475.00

Disconnect & remove all electrical items, ceiling fans, lights, extractor fans. Allow to store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work. \$350.00

Lay down black plastic sheeting to floor of each room, remove all ceiling linings and place all rubbish into Asbags for correct removal & disposal. \$1,850.00

Vacuum with specialist cleaner the underside of the existing roof sheeting and all timber roof framing. After removal of ceiling materials vacuum clean all the inside of the premises with vacuum cleaner with specialist HEPA filter. \$350.00

Prepare correct paint product to seal & spray 2 coats of protective paint system to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated. A total of 3 coats to be applied. \$2,050.00

Supply & fix 4.8mm Masonite sheeting to ceiling of all rooms. Supply & fix 40x10mm timber batten to all sheet joints & to perimeter of each room. \$6,370.00 (Standard Ceiling liner)

Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets & perimeter battens. \$1,425.00

Reposition all wiring for lights & fans and connect up all fittings as previously set out. \$450.00

Prepare to apply 3 coats of specialist paint finish to all the exterior roof area according to painting specifications. \$2,250.00

Remove and dispose of correctly asbestos gutters to both sides of the building and supply & install new colourbond box gutters with down pipe each side leading to water tank. \$1,760.00

TOTAL COST FOR FULL PAINT ENCAPSULATION OF EXISTING ROOF SHEETING, INCLUDING FOR REMOVAL & REPLACEMENT OF EXISTING CEILINGS & ALL ASSOCIATED WORK. \$20,930.00

Thank you for the opportunity to provide a quotation & I await your instructions.

Yours truly,



Paul Finch
Central Meridian Inc.

Build up to Encapsulation of Asbestos Roofing

BUILD UP TO RETENTION OF EXISTING ASBESTOS ROOF SHEETING AND FULL ENCAPSULATION WITH CORRECT PAINT SYSTEM, INCLUDING REMOVAL AND REPLACEMENT OF EXISTING CEILINGS.

The costing detailed below are based on building area of 168m² (14m x 12m). For roof area multiply by 1.15 to account for the pitch, which gives an area of 193m².

This estimate assumes that there is an existing ceiling in place within the building, which would need to be treated as asbestos contaminated and removed. Once the ceiling was removed the building would need to be cleaned of asbestos fibres, the existing roof encapsulated, and the ceiling then reinstated. The items relating to the ceiling removal are shaded in blue, and if there was no ceiling then these items could be deducted from the budgeted costs.

The estimate does not include any costs related to removing items from within the building prior to starting works, or putting them back, or any costs relating to the disruption of normal activities in the affected building.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE) for staff.	1,400.00	1,120.00	1,018.18
Set up scaffolding to both sides of building to remove asbestos guttering from building and provide safe access to the roof. Set up anchor point for fall arrest systems.	2,200.00	1,760.00	1,600.00
Spray ceiling with Foamshield, or similar particle capture system, to the inside of the ceiling space before removal of the sheeting.	475.00	380.00	345.45
Disconnect and remove all electrical items, ceiling fans, lights, extractor fans. Allow to store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work.	350.00	280.00	254.55
Lay down black plastic sheeting to floor of each room, remove all ceiling linings and place all rubbish into sealed containment for correct removal and disposal to local landfill.	1,850.00	1,480.00	1,345.45
After removal of ceiling materials vacuum clean all the inside of the premises with a vacuum cleaner with HEPA filter. Then vacuum the underside of the existing roof sheeting and all	350.00	280.00	254.55

timber roof framing.			
Prepare correct paint product to seal and spray 3 coats of protective paint system to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated.	2,050.00	1,640.00	1,490.91
Supply and fix 4.8mm Masonite sheeting to ceiling of all rooms. Supply and fix 40x10mm timber batten to all sheet joints and to perimeter of each room. (Standard ceiling liner)	6,370.00	5,096.00	4,632.73
Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets and perimeter battens.	1,425.00	1,140.00	1,036.36
Reposition all wiring for lights and fans and connect up all fittings as previously set out.	450.00	360.00	327.27
Apply 3 coats of specialist paint finish to all the exterior roof area according to painting specifications.	2,250.00	1,800.00	1,636.36
Remove gutters to both sides of the building and supply and install new colourbond box gutters with down pipe each side leading to water tank. Transport asbestos contaminated materials to suitable nearby local disposal.	1,760.00	1,408.00	1,280.00
Oversight by SPREP appointed asbestos management expert	2,875.00	2,300.00	2,300.00
Total	23,805.00	19,044.00	17,521.82

Work back in to a m2 rate for encapsulating asbestos roofs where there is a ceiling present (per area of roof assuming the roof has a 30 degree pitch)

/ 193m2 90.79

Work our alternate rate for where there is no ceiling

Deduct ceiling related costs shaded in blue
Adjusted cost for a 168m2 building

-7,941.82

9,580.00

Adjusted m2 rate for encapsulating an asbestos roof where there is no ceiling present (per area of roof assuming the roof has a 30 degree pitch)

/ 193m2 49.64

Build Up to Encapsulating Asbestos Cladding

BUILD UP TO RETENTION OF EXISTING ASBESTOS WALL CLADDING AND FULL ENCAPSULATION (INSIDE AND OUT) WITH CORRECT PAINT SYSTEM.

The estimate assumes work is completed in a building 14m x 12m in size = 168m² (single storey - 2.4m high). Assuming windows and doors account for 10% of building exterior, the total cladding area would be approximately 360m².

This estimate assumes that there is no internal wall sheeting (eg plaster board) and that the asbestos containing material is exposed. For a scenario where there is internal wall sheeting in good condition within the building, only the exterior would need to be treated. Items where savings could be made in this scenario are shaded in blue.

In a situation where there is internal wall sheeting in poor condition that would need to be removed and replaced, an extra \$40/m² would need to be allowed for as an extra over cost.

The estimate does not include any costs related to removing items from within the building prior to starting works, or putting them back, or any costs relating to the disruption of normal activities in the affected building.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE) for staff.	1,400.00	1,120.00	1,018.18
Vacuum clean all the inside of the premises with Vacuum cleaner with specialist HEPA filter. Then vacuum the inside of the existing cladding and all timber framing.	350.00	280.00	254.55
Prepare correct paint product to seal and spray 3 coats of protective paint system to the outside of all the cladding. Ensuring that all surface areas are correctly coated. A total of 3 coats to be applied.	3,960.00	3,168.00	2,880.00
Prepare correct paint product to seal and spray 3 coats of protective paint system to the inside of all the cladding. Ensuring that all surface areas are correctly coated.	3,960.00	3,168.00	2,880.00
Oversight by SPREP appointed asbestos management expert	2,875.00	2,300.00	2,300.00
Total	12,545.00	10,036.00	9,332.73

Work back in to a m2 rate for encapsulating wall cladding inside and out (per face area of cladding) / 360m2 25.92

Work out alternate rate for where there is adequate internal wall sheeting which would mean that the interior of the asbestos cladding would not need to be encapsulated.

Deduct interior encapsulation costs -2,880.00
 Adjusted cost 6,452.73

Adjusted m2 rate for encapsulating asbestos cladding where there is adequate internal wall sheeting (per face area of cladding) / 360m2 17.92

Work out alternate rate for where the internal wall sheeting is in poor condition and would need to be stripped out and replaced.

Add in cost of removing the existing interior walls and replacing after encapsulation 14,400.00
 Adjusted cost (360m2 of cladding) 23,732.73

Adjusted m2 rate for scenario where internal wall sheeting is in poor condition and also needs to be stripped out and replaced. / 360m2 65.92

Build Up to Removing and Replacing Asbestos Roofing

BUILD UP TO REMOVAL OF EXISTING ASBESTOS ROOF SHEETING.

The costing detailed below are based on building area of 168m² (14m x 12m). For roof area multiply by 1.15 to account for the pitch, which gives an area of 193m².

The costs are as worked out with Central Meridian, who are an experienced contractor based in Nauru.

Transport and packaging costs are allowed for bring asbestos containing materials to a central point but disposal costs are excluded and treated separate.

Purchase of a 60 Litre FoamShield unit at a price of \$5,000.00 (including ocean freight and 10% import duty) is allowed for and the cost of this is spread over the removal of 20 roofs.

Purchase of specialist vacuum cleaner with HEPA filter at a price of \$2,000.00 (including freight and 10% import duty) is allowed for and the cost of this is spread over the removal of 20 roofs.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE) for staff.	1,400.00	1,120.00	1,018.18
Set up scaffolding to both sides of building to assist in removal of roof sheeting and to remove asbestos contaminated guttering from building. Set up anchor point for fall arrest systems.	2,200.00	1,760.00	1,600.00
Coat the roof with a sprayed on water based PVA solution.	1,250.00	1,000.00	909.09
Carefully remove the roof sheeting by unscrewing, (not breaking) the roof sheets. All roof sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic and taped shut. All removed asbestos contaminated materials will be transported to suitable nearby local disposal.	4,465.00	3,572.00	3,247.27
Vacuum clean the existing ceiling and roof space, (rafters, purlins, ceiling joists) with a specialised vacuum cleaner with a HEPA filter.	325.00	260.00	236.36

Supply and fit heavy duty tarpaulins to keep the roof waterproof ready for installation of new roofing.	300.00	240.00	218.18
Oversight by SPREP appointed asbestos management expert.	2,875.00	2,300.00	2,300.00
Total	12,815.00	10,252.00	9,529.09

Work back in to a m2 rate / 193m2 49.37

BUILD UP TO INSTALLATION OF NEW ROOF SHEETING, INSULATION, GUTTERING, DOWNPIPES.

The cost estimate allows for Colourbond Ultra grade roof sheeting and 50mm of foil coated fibreglass insulation. This has a greater protective coating and is better for an oceanside environment. (Long life heavy duty.)

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Supply and fit 'Kiwisafe' roof netting over existing purlins and fix in place ready to support the 50mm thick, foil coated, fibreglass insulation. Supply and lay a top layer of sisalation foil over the fibreglass insulation blanket.	2,541.00	2,032.80	1,848.00
Supply and screw fix Colourbond Ultra grade corrugated roofing, including for ridging and barge flashings.	7,722.00	6,177.60	5,616.00
Supply and fix Colourbond box guttering to both sides of the roof and include for one downpipe each side, feeding to a tank.	1,060.00	848.00	770.91
NB A contingency of 10% may need to be added as necessary for repairs to roof purlins and rafters.	1,132.30	905.84	823.49
Total	12,455.30	9,964.24	9,058.40

Work back in to a m2 rate / 193m2 46.93

SUMMARY OF COSTS TO REMOVE ROOF AND REPLACE WITH NEW ROOF

Cost to remove old roof	49.37
Cost to install new roof	46.93

**Total cost to remove and replace asbestos
roofing (per m2 of roof area)**

96.31

Remove and Replace Asbestos Cladding

BUILD UP TO REMOVAL AND REPLACEMENT OF ASBESTOS WALL CLADDING.

The estimate assumes work is completed on a building 14m x 12m in size = 168m² (single storey - 2.4m high). (Assume windows and doors account for 10% of building exterior, the total cladding area would be approximately 360m²).

If a building was two stories it is recommended that USD12.00 is added per m² for scaffolding. This figure is a rough estimate only but should provide adequate coverage.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE).	1,400.00	1,120.00	1,018.18
Coat the walls with a sprayed on water based PVA solution.	1,875.00	1,500.00	1,363.64
Carefully remove the existing cladding. All wall sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic and taped shut. Transport asbestos contaminated materials to suitable nearby local disposal.	6,697.50	5,358.00	4,870.91
Vacuum clean the existing wall cavities with a vacuum cleaner with a HEPA filter.	325.00	260.00	236.36
Wrap the building in building foil, supply and fix composite cement board sheeting to exterior of buildings. Supply and fix treated 40mmx10mm timber batten to all sheet joints.	18,000.00	14,400.00	13,090.91
Paint with 2 coats of acrylic paint to all new wall cladding sheets and perimeter battens.	3,060.00	2,448.00	2,225.45
NB A contingency of 10% may need to be added as necessary for repairs to framing.	3,135.75	2,508.60	2,280.55
Oversight by SPREP appointed asbestos management expert.	2,875.00	2,300.00	2,300.00
Total	37,368.25	29,894.60	27,386.00

Work back in to a m² rate for removing and replacing asbestos cladding (per face area of cladding)

/ 360m²

76.07

