Baseline Study for the Pacific Hazardous Waste Management Project - Healthcare Waste

The collection, collation and review of data on the management of healthcare waste and best-practice options for its disposal in participating Pacific Island Countries

Niue

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

Prepared by:
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This document is issued in confidence to SPREP for the purposes of collection and collation of information on the regional management of healthcare waste and its disposal, as part of their broader strategy of improving hazardous waste management in Pacific Island countries, and specifically to assist in establishing sustainable healthcare waste management. This report presents the findings of this assessment. It should not be used for any other purpose.

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Executive Summary

Introduction

The Secretariat of the Pacific Regional Environment Programme (SPREP) is the Pacific region's major intergovernmental organisation charged with protecting and managing the environment and natural resources. SPREP works with and on behalf of its 21 member countries and territories to promote cooperation in the Pacific islands region, providing assistance to protect and improve the Pacific environment and to ensure sustainable development for present and future generations.

SPREP is implementing the Pacific Hazardous Waste Management (PacWaste) Project, a four year, €7,850,000 (2013 – 2017) project funded by the European Union and administered through SPREP. The project will provide fundamental on-ground improvement in the way priority high risk wastes are managed in Pacific Island Countries to help build a healthy, economically and environmentally sustainable Pacific for future generations. The PacWaste project is funded by the European Union under its 10th European Development Fund (EDF 10). The project focuses on three priority hazardous waste streams including asbestos, E-waste and healthcare waste.

ENVIRON was engaged by SPREP to collect and collate information on the regional management of healthcare waste and its disposal, as part of their broader strategy of improving waste management in Pacific Island Countries, and specifically to assist in establishing sustainable healthcare waste management. This report presents the findings of the assessment conducted for Niue.

Current Healthcare Waste Management in Niue

Niue Foou Hospital is the only hospital on the island nation of Niue and as such was the only one assessed for Niue as part of this project. Information regarding the waste management process occurring, from ward-level waste generation through to ultimate treatment and disposal was collected during an audit of the hospital conducted on 20 May 2014.

A minimum standards framework has been developed to set a benchmark for the sustainable management of healthcare waste in the Pacific Island region. This framework is drawn from the *Industry code of practice for the management of biohazardous waste (including clinical and related) wastes*, Waste Management Association of Australia (2014), Draft 7th edition, taking into account the Pacific Island hospital and environmental context.

Using information obtained from the audit, Niue Foou Hospital was assessed against this framework. Table ES1 highlights the key areas of concern in terms of health services delivery by the hospital, as part of this assessment.

A full description and definitions of minimum standards applicable for healthcare waste management, as well as a comprehensive assessment against each of the criteria is presented in **Appendix C**.

Target areas have been rated as follows:

	Meets minimum standards assessment criteria
	Partially meets minimum standards assessment criteria.
	Does not meet minimum standards assessment criteria.

Table ES1: HEALTHCARE WASTE – KEY ISSUES FOR NIUE

Scale	Category	Item	Minimum Standard Criterion	Niue Foou Hospital
Healthcare Facility	Policy	Infection Control	Infection control policy incorporates principles of waste management within it	
Healthcare Facility	Management Committee		A waste management committee has been formed that has representatives from a broad range of departments and meets at least twice per year. A clear set of objectives has been developed for this committee. It reports to the senior management of the hospital.	
Healthcare Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types	
Healthcare Facility	Training	Follow-up & refresher courses	All staff receive waste management education during induction. All staff receive refresher training annually. Waste management training is delivered following an adverse incident to the relevant staff/ward/department.	
Healthcare Facility	Training	Training responsibility	A hospital officer has responsibility for ensuring all training occurs as required and that records are maintained of all training and attendance.	
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.	

Niue Foou Hospital is one of the better equipped hospitals observed in the region, in terms of its approach to infection control and, to a less specific extent, waste management. It has a functioning waste management planning system in place, good segregation practices and appropriate containers, new and functional wheelie bins and internal transport systems, a well-functioning 660 storage bin (for holding bags of healthcare waste until weekly incinerator runs), a structured training program in place (albeit only every 2 years and delivered from flown-in New Zealand expertise who are more infection-control than waste management skilled) and basic but workable healthcare waste treatment systems.

Key Issue – Quarantine Waste

The Niuean Department of Forestry and Fisheries (DAFF) operates an incinerator for quarantine purposes which is not optimal.

While actual waste volumes were not collected during the visit, these are likely to be small because Niue is serviced by only one flight a week (which increases to two in peak season) and also has seasonal international yachting arrivals.

The combination of small healthcare waste volumes and small quarantine waste volumes begs the question of whether Niue needs two incinerators on the island.

A new incinerator large enough to deal with both types of waste is a possible consideration, since DAFF, DoE, the hospital and the current quarantine incinerator are all located nearby. It could be housed either at the hospital or with DAFF but, as was the case in other countries, Quarantine staff perceived greater handling risks with healthcare waste and were

dismissive of any possible solution that involved them treating it. Conversely Niue's Foou's public health officer was not concerned (at least from a health and safety perspective) with the possibility of handling quarantine waste at a future treatment facility located on hospital grounds.

Analysis of Options for Sustainable Healthcare Waste Management in Niue

Where non-treatment waste management aspects were observed to be performing below the Minimum Standards Framework, this framework is referenced for recommended actions.

For treatment of healthcare waste, various options used around the world were considered in the Pacific Islands context, via a two stage process:

- Stage 1: High-level costs and benefits (cost, lifespan, technical feasibility and how that relates to the Pacific Island regional context); and
- Stage 2: A Niue specific feasibility assessment, using an analysis of 10 criteria (**Appendix D**)

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. Niue Foou Hospital has a wood-fired simple technology enclosed single chamber incinerator, installed in 2006. It is a hardy design, which is evidenced by the fact that its condition is reasonable considering it has had no weather protection in its 8 years at Niue Foou.

In terms of the small quantities of sharps and non-sharps waste generated, the existing approach destroys the infection hazard. On the surface of it, Niue Foou does not necessarily demand investment in either replacement or maintenance of its existing incinerator infrastructure.

However, this unit is 8 years old and will experience issues with its internal refractory structure at some point. It is managing the infection hazard but it is not managing the disposal hazard, as the temperature of operation does not destroy the sharps and they are currently being stored (after incineration) indefinitely on account of community and government opposition about dumping them at landfill, which was historically the case.

Also, Niue is a signatory to the Stockholm Convention on Persistent Organic Pollutants (POPs) and has a National Implementation Plan (NIP) which specifically states that:

> "Consideration of BAT/BEP [Best Available Technology/ Best Environment Practice] measures need to be undertaken when any new facility is developed for the disposal of medical or quarantine wastes."

Recommendations

Table ES2 provides a summary of the recommendations for Niue.

*Where a recommendation is **unique** to the circumstances of a particular hospital, because of issues identified that are **unique** to that hospital, the recommendation (and associated implementation action) is appended with the annotation **U2H**.*

Table ES2: Recommendations for Niue Foou Hospital

Recommendation 1a: Develop an Infection Control Policy & Procedures	
Description	• A documented and locally relevant Infection Control Policy and Procedures, including direct linkage to Recommendation 3 (Audit Program)
Output	• An agreed *Infection Control Policy and set of Procedures*, specific to Niue Foou Hospital outlining procedures and guidelines, definitions, segregation techniques with direct reference to the Waste Management Policy and Procedures. • Accountability for healthcare waste management through clearly defined roles and responsibilities
Monitoring & Evaluation Indicators	• Plan approved by Department of Health • The Plan should be regularly monitored, reviewed, revised and updated.
Costs ($US)	• Establishment – Low, if existing regional systems (such as those for Fiji) are used as starting points and document drafting assistance is provided by SPREP or other training providers • Ongoing – Low
Recommendation 1b: Appointment of a Responsible Officer and/or Waste Management Committee	
Description	Development of and resourcing a structure of accountability for ensuring waste management practices (i.e., Policies and Procedures), are developed for the hospital, implemented and there is a clear direction for continual improvement.
Output	• Accountability for healthcare waste management through clearly defined roles and responsibilities.
Monitoring & Evaluation Indicators	• Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies.
Costs ($US)	• Establishment – Low; • Ongoing - Low
Recommendation 2: Implement Segregation Signage	
Description	Supply of **signage** to explain the colour-coded segregation system as well as **posters** to promote it.
Output	More informative visual cues for staff to carry out rigorous segregation practices
Monitoring & Evaluation Indicators	• Wastes are segregated at their place of production. • Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. • Zero Needle Stick Injuries.
Costs ($US)	• Establishment – Low; • Ongoing - Low

Recommendation 3: Establish a Waste Segregation Auditing Program/ refresher training capacity	
Description	• Development and delivery of a structured healthcare waste audit program • Establishment of that in the waste management planning system and the training program • Review the program delivered by *Middlemore Hospital* to establish elements for refresher trainer conducted more regularly (at least annually)
Output	• An established segregation audit program for Niue • Improvement of personnel skills and competency in managing healthcare waste
Monitoring & Evaluation Indicators	• No/very little cross contamination between waste streams demonstrated by waste audits • Zero Needle Stick Injuries.
Costs ($US)	• Establishment – Low- if regional synergies are utilised • Ongoing – Low- if regional synergies are utilised
Recommendation 4a: Improved Infectious Waste Treatment Infrastructure [U2H]	
Description	a) Investigate the feasibility/ workability of the procurement of a **new incinerator** for the combined treatment of healthcare and quarantine waste, housed, secured and operated by Niue Foou Hospital, with maintenance support contract b) Depending on the timing of a): • provide shelter and fencing to current treatment infrastructure • Encapsulate treated sharps in concrete
Output	A disposal system that reduces the potential hazard posed by healthcare waste, while endeavoring to protect the environment.
Monitoring & Evaluation Indicators	Assessment of the following should be regularly undertaken for new and existing incinerators: • Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures above 800ºC only) • Maintenance program – are maintenance issues dealt with promptly? • Ensure burn times are sufficient to reduce waste ash volumes
Costs ($US)	• Establishment – High (approx.. $50,000+ for high temperature unit, including housing and commissioning costs; • Ongoing – medium (fuel and maintenance)
Recommendation 4b: Improved X-Ray Liquid Waste Management [U2H]	
Description	• Discharge of spent fixer and developer solutions to the onsite septic system should be stopped immediately. • Spent fixer and developer solution wastes should be stored in plastic containers (for example jerry cans) until one of two solutions are determined: o Installation of an onsite silver recovery unit or o Collection of spent silver solution by the equipment supplier
Output	A disposal system that reduces the potential hazard posed by silver, chromium or other heavy

Table ES2: Recommendations for Niue Foou Hospital	
	metal-containing waste, while protecting the environment and potentially recovering a resource that allows treatment cost recovery.
Monitoring & Evaluation Indicators	• X-Ray Liquid Waste is no longer sent to septic tank systems so septic tanks' system performance improves • Recovery or take-back solution is simple to administer
Costs ($US)	• Establishment – Low (<$2,000); • Ongoing – a sustainable cost recovery/ income stream

Implementation actions are suggested for each recommendation, classified as short, medium and long-term priorities.

1 Introduction and Background

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ENVIRON was engaged by SPREP to collect and collate information on the regional management of healthcare waste and its disposal, as part of their broader strategy of improving waste management in Pacific Island Countries, and specifically to assist in establishing sustainable healthcare waste management. This report presents the findings of the assessment conducted for Niue.

1.1 Project Scope

This report covers the approach specified in the Request for Tender AP 6/5/6/2 '*The collection, collation and review of data on the management of healthcare waste and best practice options for its disposal in selected Pacific Island communities'* as it specifically relates to Niue and includes:

- Collection and collation of data on the current practice(s) used to dispose of hazardous healthcare waste in Niue. Data collected includes:
  - Basic background data on the operation of the site (number of beds, population served, current and projected rates of hazardous healthcare waste generation);
  - Healthcare waste separation and infection control practices;
  - Adequacy of supply of hazardous healthcare waste collection equipment;
  - Hazardous healthcare waste storage;
  - Hazardous healthcare waste transportation;
  - Hazardous healthcare waste disposal practice and annual operating costs;
  - Frequency and adequacy of infection control training;
  - Frequency and adequacy of waste disposal training;
  - Adequacy of supply of personnel protective equipment.
- Consultation with national authorities to review and identify best-practice option(s) and preferences for national hazardous healthcare waste management by considering

technical feasibility within the existing health infrastructure (including review of existing local institutional, policy and regulatory arrangements).

- Identification of local contractors who may have the expertise and capacity to potentially partner with regional or international expert's in future hazardous healthcare waste management including infection control training.

1.2 Report Structure

This report is structured as follows:

- an introduction to the project (**section 1**)
- discussion of current healthcare waste management in Niue, including the current regulatory framework and hospital details (**section 2**)
- a summary of existing waste management practices, waste streams and quantities, waste management and infection control framework, the waste management process that was reviewed, training and education programs and identified healthcare waste management issues (**section 3)**
- key healthcare waste management issues and any county-wide or regional themes that were identified (**section 4**)
- a summary of hospital and national authority consultation outcomes (**section 5**)
- an assessment of contractor roles and their capacity to sustainably manage and treat healthcare waste, including any training or education capacity (**section 6)**
- an analysis of the healthcare waste management and treatment options available, both regionally and specific to Niue, to address the key issues identified (**section 7**)
- recommendations and prioritization of actions necessary to enable sustainable hazardous healthcare waste management and disposal in Niue (**section 8**)

2 Healthcare Waste Management in Niue

2.1 National Regulatory Framework

A summary of relevant legislation that applies to environmental and waste management and human health in Niue is provided in Table 1.

Table 1: National Environmental Legislation Summary

Legislation	Type	Legislation Summary	Regulator/ Agency
Environment Act 2003	Act	This is the principal environmental law in Niue. It is the legal foundation of the ED and makes provisions for the administration of environment related matters, the enactment of a range of environmental regulations and the enforcement of environmental laws in Niue.	Department of Environment
		A general power to make Regulations is given to Cabinet. Regulations may be specifically made in relation to. - Waste management and pollution control measure - Regulation of hazardous substances and wastes	
Public Health Ordinance 1982	Act	To consolidate the laws relating to public health	Department of Health

2.2 Hospital Assessed - Niue Foou Hospital

Niue Foou Hospital is the only hospital on the island nation of Niue and as such was the only one assessed for Niue as part of this project. Table 2 summarises key contact personnel and key hospital administrative statistics.

Table 2: Hospital Details – Niue	
Hospital/Region	**Niue Foou Hospital**
Contact Name, Position	Grizelda Mokoia, NCD Coordinator/Public Health Officer
Pop Served	1,600
No. of Beds	10
Annual Average Occupancy Rate (%)	37%
OBD's [1]	1,621
No. Operations	182
No. of Births	19
Emergency Patients Attended	32
Out-Patients Attended	3,000
Total No. of staff	39
No. of staff per function	
Nursing/ Medical	22
Infection Control	1
Dedicated Waste Management – Internal Management	9
Dedicated Waste Management – Treatment Operation	0
Administration	4
Other	4

Notes:

1. OBDs = Occupied Bed Days (previous 12 months)
2. Infection Control staff are also included in Nursing/ Medical numbers

3 Existing Waste Management Practices at Niue Foou Hospital

This section describes waste management practices observed during the hospital audit. Information regarding the waste management process occurring, from ward-level waste generation through to ultimate treatment and disposal is described in Table 3.

Audit observations are then elaborated upon further for the remaining issue headings:

- Wastestreams, Treatment Constraints and Costs
- Waste Management and Infection Control Framework and
- Training.

A comprehensive list of all data collected from the site audit of Niue Foou Hospital is located in **Appendix B**.

Table 3: Waste Management Process - Observations

	Hospital Name	Niue Foou Hospital			
Generation & Segregation	Dedicated Containers/ Bags	Y			
	Colour Coding	Y			
	Sharps segregated & secure	Y			
	Signage Present	N			
Internal Handling	Degree of manual handling of bags	Low			
	Internal Transport Mode	Wheelie Bin			
	Spill Kit Present	Y			
Storage	Dedicated & Appropriate Area	Y			
	Loading/unloading acceptable	Y			
	Spill Kits Present	N			
	Monitoring & record keeping occurs	N			
Treatment	Treatment per Waste Stream		Tech. Type	Volumes (kg/week)	Stockpile Volume (kg)
	Healthcare Waste	✓	Incinerate (internal)	~30[1]	NA
	Sharps	✓	Incinerate (internal)		~20
	Pharmaceutical	✓	Incinerate (internal)	Not measured	NA
	Cytotoxic	×	NA	NA	NA
	General	✓	Landfill (w/o treatment)	Not measured	NA
	If incinerator present				
	Make, Model, Year commissioned	Medical Waste Gasifier, Biomass Energy Services & Technology (BEST), Somersby NSW Aust. (approx 2006)			
	Operating Temp (^{0}C)	Not known/ no gauges - 800^{0}C likely maximum			
	No. chambers	1			
	Condition	Reasonable			

[1] Based on capacity of incinerator and number of loads it runs per week.

Table 3: Waste Management Process - Observations			
	Hospital Name	Niue Foou Hospital	
	Comments	Incinerator is basic and sharps are not destroyed but appears sufficient for a small hospital's needs	
	Operational statistics	Per week	Per year
	Waste Throughput (kg)	30	1560
	Operating Hours (hr)	4	200
	Fuel	Wood	
	Fuel use (kg/litres)	50kg per load per (approx. 15kg waste)	
	Fuel use per kg waste burnt	3kg wood per kg waste	
	Technology siting and operation issues	Incinerator sited well but has no shelter structure	
	Offsite transport assessment	Fair	

3.1 Wastestreams, Treatment Constraints and Costs

Niue Foou Hospital generates general wastes, healthcare wastes (including, infectious waste, sharps and pharmaceutical wastes) in the approximate quantities described in Table 3. They do not generate cytotoxic waste. All of these wastes are incinerated.

No costs information was obtained; since waste disposal costs are internally borne by the hospital it is not directly measured.

A critical analysis of waste treatment capacity available at Niue Foou Hospital versus actual volumes treated is shown in Table 4. This demonstrates that the incinerator has a significant excess capacity above current needs, which is evidenced by the fact that the incinerator is only operated one day per week.

Table 4: Waste Treatment Capacity Analysis – Niue Foou Hospital Incinerator		
Waste Treatment Parameter	**Volume**	
Incinerator Design Capacity (kg per batch)	15	
No. batches run per day	2	
	Per week*	**Per Year**
Available Incinerator Capacity (kg)	150	7,800
Actual Incinerated Waste Throughput (kg)	30	1,560
Spare Capacity (kg) **	120	6,240

* Based on a 5 day week

** Theoretical spare capacity does not take into account other factors such as increased downtime maintenance that could be required under higher loads

3.2 Waste Management and Infection Control Framework

The following summarises the waste management and infection control framework at Niue Foou Hospital:

- There is a formalized waste management policy, plan and waste management procedures at Niue Foou. The Public Health Officer oversees waste management and a groundsman responsible for waste disposal.
- There is no dedicated waste management committee.
- There is no infection control policy.
- There is no formal waste auditing or inspections.

3.3 Training

Niue Foou is a small hospital and does not have its own structured in-house training program for infection control / waste management. However, it is the recipient of an externally provided infection control and waste management training program, run every 2 years, delivered by outreach services of ***Middlemore Hospital*** (Counties Manukau District Health Board). A Niuean trainer, based at Middlemore, visits Niue Foou to run this training, which covers topics in infection control, correct segregation of wastes, management of sharps, spill management and use of PPE.

The most recent training visit occurred in November 2013. All staff attend this training. Upon induction, new staff are given basic training in infection control by the Infection Control Nurse.

There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation. Quite the contrary in fact – public health staff were keen to accommodate us because for them it was an opportunity for an outside “expert” to help them to get improvements that they otherwise felt they were not empowered (or funded) to obtain.

4 Key Healthcare Waste Management Issues in Niue

This section takes the collected information from Section 3 and summarises and critically assesses it, for Niue Foou Hospital, in the context of a Minimum Standards Framework.

A key issues summary is also provided.

4.1 Minimum Standards Framework

A minimum standards framework has been developed to set a benchmark for the sustainable management of healthcare waste in the Pacific Island region. This framework is drawn from the *Industry code of practice for the management of biohazardous waste (including clinical and related) wastes*, Waste Management Association of Australia (2014), Draft 7th edition, taking into account the Pacific Island hospital and environmental context.

A full description and definitions of minimum standards applicable for healthcare waste management, as well as a comprehensive assessment against each of the criteria is presented in **Appendix C**. Target areas have been rated as follows:

Table 5: Assessment criteria rating system	
	Meets minimum standards assessment criteria
	Partially meets minimum standards assessment criteria.
	Does not meet minimum standards assessment criteria.

Table 6 highlights the key areas of concern in terms of health services delivery by Niue Foou Hospital, as part of this assessment.

Table 6: HEALTHCARE WASTE – KEY ISSUES FOR NIUE

Scale	Category	Item	Minimum Standard Criterion	Niue Foou Hospital
Healthcare Facility	Policy	Infection Control	Infection control policy incorporates principles of waste management within it	
Healthcare Facility	Management Committee		A waste management committee has been formed that has representatives from a broad range of departments and meets at least twice per year. A clear set of objectives has been developed for this committee. It reports to the senior management of the hospital.	
Healthcare Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types	
Healthcare Facility	Training	Follow-up & refresher courses	All staff receive waste management education during induction. All staff receive refresher training annually. Waste management training is delivered following an adverse incident to the relevant staff/ward/department.	
Healthcare Facility	Training	Training responsibility	A hospital officer has responsibility for ensuring all training occurs as required and that records are maintained of all training and attendance.	
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.	

4.2 Niue Foou Hospital – Key Issues

Niue Foou Hospital is one of the better equipped hospitals observed in the region, in terms of its approach to infection control and, to a less specific extent, waste management. It has a functioning waste management planning system in place, good segregation practices and appropriate containers, new and functional wheelie bins and internal transport systems, a well-functioning 660 storage bin (for holding bags of healthcare waste until weekly incinerator runs – see **Photo 1**), a structured training program in place (albeit only every 2 years and delivered from flown-in New Zealand expertise who are more infection-control than waste management skilled) and basic but workable healthcare waste treatment systems.

Of the remaining categories of healthcare waste management, the most significant issues observed were:

- There are no documented infection control plan and procedures in place (which seems out of place with the observed practices).
- Signage on walls in disposal areas is not present, although there is clear information on bags
- There is no waste segregation auditing program in place
- While the wood fired incinerator (**Photo 2**) appears to work for Niue Foou's needs, there were some issues related to its use:

1. The unit is fully exposed to weather, which will not only impact its longevity but limits the days it can be operated (However it has survived remarkably well so far.)

2. Given its medium temperature (at best) operation, this incinerator does not destroy sharps. The hospital is currently unsure of the best way to dispose of burnt sharps, so is storing them at present in a pail near the incinerator area (**Photo 3**). They used to take them to the local dumpsite, but stopped the practice as they felt it was unsafe.

3. This incinerator has poorer emissions performance than a high temperature unit

4. Niue is a very small island nation with only 1,500 people. The Department of Agriculture, Fisheries and Forestry (DAFF) operate an incinerator for quarantine purposes which is <u>not</u> fit for purpose. Quarantine waste is limited to one weekly flight (for most of the year) and seasonal sailing-based waste. The combination of small healthcare waste and quarantine waste volumes begs the question of whether Niue needs two incinerators on the island.

    - This issue is discussed in more detail in the context of consultation undertaken with DAFF in section 5.

5. Another issue under the waste management umbrella was the appropriateness of current management of X-ray spent developer and fixer solution wastes, which is currently poured down the drain and consequently finds its way to the hospital's septic tank system, which was identified as having some effectiveness issues.

- Since film development is by chemical means, spent fixer solution is likely to contain silver at quantities damaging to the environment and chromium may be present in spent developer solution waste, which is also potentially an environmental pollutant, depending on its oxidation state.
- Silver-containing waste should not be disposed of into septic systems in any circumstances, as even in small quantities it can harm the system[2].

5 Consultation

In addition to public health and other hospital staff, discussions were held with:

- Mr. Sauni Togatule (Director for the Department of Environment (DoE)) - Sauni.Tongatule@mail.gov.nu)
- Mr. New Testament Aue (Quarantine Officer, Department of Agriculture, Forestry and Fisheries (DAFF)) - New.Aue@mail.gov.nu)

A common issue raised was the suitability of the current method of treating quarantine waste on Niue, and whether that was a relevant consideration in the context of this report.

5.1 Key Issue – Quarantine Waste

DAFF operates an incinerator for quarantine purposes which is not optimal because:

- It is a very basic 'kettle' style burner, with a loading lid at the top an emptying chute at the bottom, with no stack (**Photo 4**)
- Much of the ash residue is unburnt and has been left to spill out of the bottom chute and accumulate on the ground (**Photo 5**)
- The fuel it uses is likely to simply be a dousing with kerosene or similar
- The area that houses the 'incinerator' is totally open to the public and there is no weather protection for it.

DAFF is aware that this solution is not ideal and would like to see it replaced. While actual waste volumes were not collected during the visit, these are likely to be small because Niue is serviced by only one flight a week (which increases to two in peak season) and also has seasonal international yachting arrivals. Quarantine waste is predominantly food and drinks in aluminium cans and bottles plus other plastic, cardboard and other-metal food containers.

The combination of small healthcare waste volumes and small quarantine waste volumes begs the question of whether Niue needs two incinerators on the island.

A new incinerator large enough to deal with both types of waste is a consideration, since DAFF, DoE, the hospital and the current quarantine incinerator are all located nearby. It could be housed either at the hospital or with DAFF but, as was the case in other countries, Quarantine staff perceived greater handling risks with healthcare waste and were dismissive of any possible solution that involved them treating it. Conversely Niue's Foou's public

[2] Pacific Northwest Pollution Prevention Resource Center (PPRC) http://pprc.org/smallHC/Silver_Recovery/index.cfm

health officer was not concerned (from a health and safety perspective) with the possibility of handling quarantine waste at a future treatment facility located on hospital grounds.

6 Contractor Roles and Capacity

No in-country contractors were identified as providing or having the capacity to provide healthcare waste management support services. This includes training (in areas like waste management, infection control, technology operation and maintenance) and risk management.

However, as discussed in section 3.3, Niue Foou is the recipient of an externally provided infection control and waste management training program, run every 2 years, delivered by outreach services of ***Middlemore Hospital*** (Counties Manukau District Health Board).

7 Analysis of Options for Sustainable Healthcare Waste Management in Niue

Section 4 identifies key issues that need to be addressed in improving healthcare waste management in Niue. This section evaluates the potential options that could be employed to respond to these key issues.

Table 7 categorizes these key issues (A – D) against potential options that could be adopted to tackle them, as a collated list of high-level responses.

Table 7: Options for Sustainable Healthcare Waste Management in Niue

Key Issue Category	Key Issue	Options to address the issue
A. Waste Management Framework	There is no documented infection control policy or procedures linked (or not) to a **waste management plan**ning system in place and no waste management committee.	Establish a waste management framework focused firstly on infection control but ensuring there is also a: • Waste Management Plan • Responsible officer for implementation of waste management plan • Waste management committee, albeit with very small membership relevant to the size of the hospital
B. Signage, Segregation & Containers	**Segregation and containment** practices are good but there is no signage present	• Supply of signage to explain the colour-coded segregation system as well as posters to promote it.
C. Training & Audit	There is no structured waste segregation **auditing** program in place	• Development and delivery of a structured healthcare waste audit program • Establishment of that in the waste management planning system and the training program • Review the program delivered by Middlemore Hospital to establish elements for refresher trainer conducted more regularly (at least annually)
D. Treatment	The method for **treatment** of healthcare waste could be improved, and made more efficient in a broader sense, despite the fact that the infection risk is managed.	Treatment using one (or a combination) of the following for each hospital: 1. Rotary kiln (highest temperature) 2. Incineration (high, medium temperature) 3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land) 4. Autoclave 5. Chemical 6. Microwave 7. Encapsulation 8. Landfill (without disinfection) 9. Onsite burial 10. Shredding
D1 Treatment of spent X-Ray Solutions.	The method for **treatment** of X-ray film development waste solutions, (spent fixer typically contains between 3,000 and 8,000 parts per million of silver[3]) is unacceptable.	Discharge to septic system should be stopped immediately. Spent fixer and developer solution wastes should be stored in plastic containers (for example jerry cans) until one of two solutions are determined: 1. Installation of an onsite silver recovery unit 2. Collection of spent silver solution by the equipment supplier

[3] Pacific Northwest Pollution Prevention Resource Center (PPRC) http://pprc.org/smallHC/Silver_Recovery/index.cfm

7.1 Options for (Non-Treatment) Waste Management Aspects

Those options that do not relate directly to the waste treatment process tend to have limited alternatives that can address their respective key issue, given they typically relate to the fundamentals of hazardous waste management. These are:

- The waste management (and infection control) framework, including policies, plans, procedures, responsibility for implementation and audit of the functioning of the framework (A in Table 7)
- The waste management process, from generation to transport up to the treatment location (B in Table 7)
- Training systems for sustainable healthcare waste management (C in Table 7).

These areas have not been subjected to an options analysis, because the minimum standards framework has clear requirements with limited variation options.

7.2 Options for Treatment of Healthcare Waste

Healthcare waste treatment (key issue category D) has a range of alternative approaches, as summarized in Table 7. These have strengths and weaknesses that need to be considered in the context of criteria such as performance and cost of the technology itself, the waste types and volumes it is required to process, the environment it would be operating in and a range of factors specific to the Pacific Islands region and in some cases an individual country's circumstances.

Treatment solutions may involve a single technology, more than one technology for sub-categories of healthcare waste or combination of the technologies listed in Table 7. These alternatives have been assessed using a two stage process:

Stage 1: High-level costs and benefits

- Cost (capital, operating, maintenance)*
- Lifespan
- Technical feasibility (advantages and disadvantages) and how that relates to the Pacific Island regional context

* Costs are estimated at a high level for relative comparison purposes. Detailed quotations, particularly for equipment purchase and associated operating and maintenance costs will be required as part of any future procurement process to be managed by SPREP.

Stage 2: Local feasibility assessment (per country)

- comparative cost to implement
- comparative effectiveness across all HCWs
- health and safety considerations
- sustainability
- institutional and policy fit
- cultural fit

- barriers to implementation
- environmental impact
- durability and
- ease of operator use.

The stage 1 treatment technology options assessment is generic to the Pacific region so is included in the *Whole of Project – Summary Report*, Appendix E. This analysis highlights the following technologies as worthy of consideration for Niue's Stage 2 assessment:

1. Incineration (high temperature: >1,000^{0}C [4])
2. Incineration (medium temperature: 800 – 1,000^{0}C [4])
3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land: <400^{0}C [4])
4. Autoclave
5. Encapsulation (of sharps only, in combination with a form of disinfection).

7.2.1 Waste Treatment Systems Relevant for Niue

The Stage 2 local feasibility assessment (for Niue) took these first 4[5] technologies and assessed them against the ten dot point criteria listed in 7.2.

These criteria are explored qualitatively in **Appendix D**. Table 8 takes these qualitative descriptions and assigns a quantitative score from 1 – 5, to prioritise local applicability of technology options to the Niuean context, on a relative basis as follows:

1. Very low
2. Low
3. Moderate
4. High
5. Very High.

The treatment technologies suitable for the Niuean context are ranked in order of preference in Table 8:

[4] As defined in *Management of Solid Health-Care Waste at Primary Health-Care Centres - A Decision-Making Guide*, WHO (2005)

[5] Encapsulation is assessed separately as its potential applicability is only for sharps that have already been treated to remove the infection risk, whereas all other technologies have a wider application and are fundamentally standalone options.

Table 8: QUANTITATIVE **Treatment Technology Options Assessment - Local Feasibility (Niue)**

Stage 1-Approved Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility								Total Score out of 50	Rank
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment protected	Durability	Ease of operation		
Incineration at high temperature (>1000^{0}C)	1	5	4	4	4	4	3	3	3	3	34	1
Incineration at med. temperature (800 - 1000^{0}C)	4	4	3	3	2	4	4	2	2	4	32	2
Autoclave with shredder	2	4	4	3	5	2	2	4	2	2	30	3
Low temperature burning (<400^{0}C)	5	3	1	2	1	1	2	1	5	5	26	4

Notes:
- Scored on a scale of 1-5, where 1= very low; 2 = low; 3= moderate; 4 = high and 5 = very high
- Criteria given equal weighting
- Possible maximum score: 50

In support of Table 8's ranking:

- ***High Temperature Incineration*** is the promoted disinfection practice where units are modern, maintained, have sufficient waste volumes and locked in supplier maintenance and training contracts.
- ***Medium Temperature Incineration*** is acceptable in the medium term to remedy current unacceptable practices at sites too small to justify costs of expensive equipment.
- ***Autoclaving*** is an acceptable disinfection practice where units with shredder are affordable and locked in supplier maintenance and training contracts are in place.
- ***Low temperature burning*** is a borderline practice which can only be acceptable in the short term, in low population density environments, to remedy current unacceptable practices.

Based on the qualitative assessment in **Appendix D**, ***encapsulation*** ranks as an effective way to deal with the residual risk from already disinfected sharps: i.e., the risk of needle stick injury by healthcare workers or the community (waste disposal area) due to the fact that sharps are disinfected but not physically destroyed by the low-medium temperature of the current wood-fired incinerator at Niue Foou. Encapsulation is never recommended as an isolated form of treatment, as it does not disinfect or otherwise treat the hazard of the waste.

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed.

A substantial amount of data exists on the emissions generated from incinerators, but conversely, little studies have been conducted on all aspects of alternate technologies performance. While the literature is inconclusive on the requirements needed to effectively

manage the blood and body fluid contaminated and infectious components of the waste streams, there does seem to be consensus that hazardous components such as pharmaceuticals and cytotoxic wastes do need to be treated prior to final disposal to ensure there is no risks to the environment or health of humans and other species. No publication from a government environmental or health agency, or any article reviewed advocated any other preferred form of treatment for pharmaceuticals and cytotoxic wastes than incineration. In most instances the preference for anatomical waste was also incineration.

Since Niue does not generate cytotoxic wastes, limitations regarding this waste are not relevant for healthcare waste treatment choices at Niue Foou Hospital.

7.2.2 Treatment Investment Options for Niue Foou Hospital

Niue Foou Hospital has a wood-fired simple technology enclosed single chamber incinerator, installed in 2006. It is a hardy design, which is evidenced by the fact that its condition is reasonable considering it has had no weather protection in its 8 years at Niue Foou.

In terms of the small quantities of sharps and non-sharps waste generated, the existing approach destroys the infection hazard. On the surface of it, Niue Foou does not necessarily demand investment in either replacement or maintenance of its existing incinerator infrastructure.

However, this unit is 8 years old and will experience issues with its internal refractory structure at some point. It is managing the infection hazard but it is not managing the disposal hazard, as the temperature of operation does not destroy the sharps and they are currently being stored (after incineration) indefinitely on account of community and government opposition about dumping them at landfill, which was historically the case.

Also, Niue is a signatory to the Stockholm Convention on Persistent Organic Pollutants (POPs) and has a National Implementation Plan (NIP) which specifically states that:

> "Consideration of BAT/BEP [Best Available Technology/ Best Environment Practice] measures need to be undertaken when any new facility is developed for the disposal of medical or quarantine wastes."

7.2.2.1 Possible Quarantine Waste Synergy Option

High temperature incineration, in the context of one of the smaller style units such as the MediBurn 30, which is designed to treat Niue's estimated weekly waste volume in a single batch, would be excessive for the needs of Niue Foou Hospital alone. However the existing wood-fired incinerator does not have BAT/BEP emissions performance, and has waste treatment effectiveness and longevity shortfalls.

A new treatment system could be considered as a means of treating both healthcare waste and quarantine waste. Specifically, a new high temperature incinerator, which would have to be housed at Niue Foou Hospital due to Quarantine staff's handling concerns with healthcare waste. Existing basic units could be maintained at the respective facilities for back up purposes, although it is recommended that the quarantine unit should be fenced in this case.

Table 9 determines 'intervention' options that are suggested to improve treatment of healthcare waste in Niue. Shading in green indicates where investment is proposed, while orange shading shows where a technology consideration is also relevant.

Table 9: Technology Options Applicable for Niue Foou Hospital

Remaining Technology Options	Technology Applicability
Niue Foou Hospital	
Disinfection & Encapsulation (only sharps assessed)	Niue currently is uncertain what to do with its sharps disinfected in the onsite wood-fired incinerator, so they are currently being stored onsite in sealed plastic pails. While this incineration system is in operation, concrete encapsulation of these disinfected sharps in a metal drum, and subsequent burial would seem appropriate.
Incineration at high temperature (>1000^{0}C)	Under consideration in the medium term, as a combined treatment option with quarantine waste (currently managed by DAFF)
Incineration at med. temperature (800 - 1000^{0}C)	Status quo. Requires sheltering and fencing to improve its security, operability and durability.
Autoclave with shredder	Not compelling or cost-effective for Niue at present.
Low temperature burning (<400^{0}C)	Not applicable to Niue as it is already operating a superior solution.

Timing considerations for these options, in the context of other (non-treatment) options, is provided in the Section 8 (Recommendations).

8 Recommendations

The following section outlines recommendations and a proposed implementation plan for each recommendation to achieve sustainable management of healthcare waste in Niue. Further details and guidance on each recommendation are provided in **Appendix E**.

Table 10 provides a summary of the recommendations for Niue.

In terms of relative priorities of the five recommendations, they are all similar, based on the deficiencies addressed against the minimum standards framework. They are also inter-related, for example: segregation practices cannot be sustainably improved without the requirements and responsibility of the waste management framework; which in turn cannot be turned into active policies and procedures without the understanding and reinforcement that comes from training/ auditing. Effective treatment and use of PPE cannot be sustained without the reinforcement of training, effective segregation and the procedures and monitoring spelled out in the waste management framework.

However, the staggered timing of actions required to implement the recommendations, as outlined in section 8.1, and their different short, medium and long term approaches give an indication of priority of the recommendation actions themselves.

*Where a recommendation is **unique** to the circumstances of a particular hospital, because of issues identified that are **unique** to that hospital, the recommendation (and associated implementation action) is appended with the annotation **U2H**.*

Table 10: Recommendations for Niue Foou Hospital

Recommendation 1a: Develop an Infection Control Policy & Procedures	
Description	• A documented and locally relevant Infection Control Policy and Procedures, including direct linkage to Recommendation 3 (Audit Program)
Output	• An agreed *Infection Control Policy and set of Procedures*, specific to Niue Foou Hospital outlining procedures and guidelines, definitions, segregation techniques with direct reference to the Waste Management Policy and Procedures. • Accountability for healthcare waste management through clearly defined roles and responsibilities
Monitoring & Evaluation Indicators	• Plan approved by Department of Health • The Plan should be regularly monitored, reviewed, revised and updated.
Costs ($US)	• Establishment – Low, if existing regional systems (such as those for Fiji) are used as starting points and document drafting assistance is provided by SPREP or other training providers • Ongoing – Low
Recommendation 1b: Appointment of a Responsible Officer and/or Waste Management Committee	
Description	Development of and resourcing a structure of accountability for ensuring waste management practices (i.e., Policies and Procedures), are developed for the hospital, implemented and there is a clear direction for continual improvement.
Output	• Accountability for healthcare waste management through clearly defined roles and responsibilities.
Monitoring & Evaluation Indicators	• Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies.
Costs ($US)	• Establishment – Low; • Ongoing - Low
Recommendation 2: Implement Segregation Signage	
Description	Supply of **signage** to explain the colour-coded segregation system as well as **posters** to promote it.
Output	More informative visual cues for staff to carry out rigorous segregation practices
Monitoring & Evaluation Indicators	• Wastes are segregated at their place of production. • Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. • Zero Needle Stick Injuries.
Costs ($US)	• Establishment – Low; • Ongoing - Low

Recommendation 3: Establish a Waste Segregation Auditing Program/ refresher training capacity	
Description	• Development and delivery of a structured healthcare waste audit program • Establishment of that in the waste management planning system and the training program • Review the program delivered by *Middlemore Hospital* to establish elements for refresher trainer conducted more regularly (at least annually)
Output	• An established segregation audit program for Niue • Improvement of personnel skills and competency in managing healthcare waste
Monitoring & Evaluation Indicators	• No/very little cross contamination between waste streams demonstrated by waste audits • Zero Needle Stick Injuries.
Costs ($US)	• Establishment – Low- if regional synergies are utilised • Ongoing – Low- if regional synergies are utilised
Recommendation 4a: Improved Infectious Waste Treatment Infrastructure [UTH]	
Description	a) Investigate the feasibility/ workability of the procurement of a **new incinerator** for the combined treatment of healthcare and quarantine waste, housed, secured and operated by Niue Foou Hospital, with maintenance support contract b) Depending on the timing of a): • provide shelter and fencing to current treatment infrastructure • Encapsulate treated sharps in concrete
Output	A disposal system that reduces the potential hazard posed by healthcare waste, while endeavoring to protect the environment.
Monitoring & Evaluation Indicators	Assessment of the following should be regularly undertaken for new and existing incinerators: • Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures above 800ºC only) • Maintenance program – are maintenance issues dealt with promptly? • Ensure burn times are sufficient to reduce waste ash volumes
Costs ($US)	• Establishment – High (approx.. $50,000+ for high temperature unit, including housing and commissioning costs; • Ongoing – medium (fuel and maintenance)
Recommendation 4b: Improved X-Ray Liquid Waste Management [U2H]	

Description	• Discharge of spent fixer and developer solutions to the onsite septic system should be stopped immediately.
	• Spent fixer and developer solution wastes should be stored in plastic containers (for example jerry cans) until one of two solutions are determined:
	  o Installation of an onsite silver recovery unit or
	  o Collection of spent silver solution by the equipment supplier

Table 10: Recommendations for Niue Foou Hospital	
Output	A disposal system that reduces the potential hazard posed by silver, chromium or other heavy metal-containing waste, while protecting the environment and potentially recovering a resource that allows treatment cost recovery.
Monitoring & Evaluation Indicators	• X-Ray Liquid Waste is no longer sent to septic tank systems so septic tanks' system performance improves • Recovery or take-back solution is simple to administer
Costs ($US)	• Establishment – Low (<$2,000); • Ongoing – a sustainable cost recovery/ income stream

U2H - Unique to hospital

8.1 Implementation Priorities

8.1.1 Recommendation 1a: Develop an Infection Control Policy & Procedures

Develop a documented and locally relevant Infection Control Policy and Procedures, including direct linkage to Recommendation 3 (Audit Program)

An agreed Infection Control Policy and set of Procedures, specific to Niue Foou Hospital outlining procedures and guidelines, definitions, segregation techniques with direct reference to the Waste Management Policy and Procedures.

8.1.1.1 Short Term (0-6 months)

- Identify existing documents and systems that may have been used in the past as well as regionally relevant examples of Infection Control Policy and Procedures.
- Draft Infection Control Policy, linking closely with Niue Foou's existing Waste Management Plan documents

8.1.1.2 Medium Term (6 months-1 year)

- Based on local and regional examples, draft appropriate Infection Control Procedures, linking closely with Niue Foou's existing Waste Management Plan documents

8.1.1.3 Long Term (1year-3 years)

- Finalise the Infection Control framework documents
- Continually improve the mandatory standards of healthcare waste management

8.1.2 Recommendation 1b: Appointment of a Responsible Officer and/or Waste Management Committee

1. Appoint an **officer responsible** for the development and implementation of the Healthcare Waste Management Plan

2. Establish a **waste management committee**, appropriate to the scale of the facility (given the size of Niue Foou, simply establishing "1" may be sufficient).

A responsible officer or **waste management officer** would be responsible for the day-to-day operations and monitoring of the waste management system and is usually established as a separate post in larger hospitals (however, one appointee could be responsible for the waste management performance for a number of hospitals with a stated time fraction allocated to each hospital). It is important that the waste management officer be adequately resourced to enable them to undertake their role as well as supported by hospital management to ensure that all staff recognise the importance of adopting waste management practices that are in accord with all requirements.

A **waste management committee** has representatives from a broad range of departments and meets at least twice per year. A clear set of objectives has been developed for this committee. It reports to the senior management of the hospital.

8.1.2.1 Short Term (0-6 months)

- Responsible officer or healthcare waste management committee set up
- Definitions of responsibilities and key accountabilities of responsible officer(s) and/ or Waste Management Committee developed for inclusion in Waste Management Plan.

8.1.2.2 Medium Term (6 months-1 year)

- Nil

8.1.2.3 Long Term (1year-3 years)

- Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.

8.1.3 Recommendation 2: Implement Segregation Signage

Supply **signage** to explain the colour-coded segregation system as well as **posters** to promote it.

8.1.3.1 Short Term (0-6 months)

- Procurement of classification and segregation signage as well as instructional posters to promote good healthcare waste management practices (all hospitals)

8.1.3.2 Medium Term (6 months-1 year)

Nil

8.1.3.3 Long Term (1-3 years)

Nil

8.1.4 Recommendation 3: Establish a Waste Segregation Auditing Program/ Refresher Training Capacity

- Development and delivery of a structured healthcare waste audit program
- Establishment of the program in the waste management planning system and the training program currently provided by Middlemore Hospital (New Zealand).
- Review the program delivered by Middlemore Hospital to establish elements for refresher trainer conducted more regularly (at least annually)
- Training should be coordinated with other countries' needs in the region.

A segregation auditing system, carried out on a regular basis (for example monthly) can be a very effective way of embedding learning of good segregation practice in all staff as well as monitoring performance against Infection Control Policy goals.

All staff and contractors should attend a waste management training session. This is to be conducted during all induction programs in the first instance. For those staff and contractors currently employed on-site, they should attend a dedicated training session so that they are fully aware of their roles and responsibilities in respect to waste management. Records should be maintained of all staff and contractors attendance at a training session to ensure that all personnel attend.

8.1.4.1 Short Term (0-6 months)

- Develop a waste audit program to capture a point in time picture of waste segregation performance across all wards and department. This should use regional programs as a basis and its design and frequency should be relevant to the scale of Niue Foou
- Review the program delivered by Middlemore Hospital to establish elements for refresher trainer conducted more regularly (at least annually).

8.1.4.2 Medium Term (6 months-1 year)

- Implement a program to ensure waste audits are conducted of all waste materials/systems in all wards/departments on a regular basis to identify incorrect waste management practices
- Results from these audits and corrective actions to be reported to the facility waste management committee and communicated to staff in all wards/departments.
- Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.
- Develop and document basics training for refresher purposes, based directly on the curriculum provided by Middlemore Hospital

8.1.4.3 Long Term (1 year-3 years)

- Continually improve the mandatory standards of healthcare waste management
- Fully embed auditing program in refresher training, Middlemore's training and waste management and infection control framework.

8.1.5 Recommendation 4a: Improved Infectious Waste Treatment Infrastructure [U2H]

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. It is recommended to:

a) Investigate the feasibility/ workability of the procurement of a new incinerator for the combined treatment of healthcare and quarantine waste, housed, secured and operated by Niue Foou Hospital, with maintenance support contract.

b) Depending on the timing of a):

- provide shelter and fencing to current treatment infrastructure
- Encapsulate treated sharps in concrete

8.1.5.1 Short Term (0-6 months)

- Establish a procedure to measure all waste disposed, both at the hospital and quarantine waste managed by DAFF. No investment decisions can be made without more concrete waste generation data.
    - If there is no measurement scale, this can be done by measuring the number of bags in the short term.
- Fence the existing incinerator area, including the 660 litre storage bin/ concrete base
- While the current incineration system is in operation, encapsulate disinfected sharps in a metal drum and fill with concrete then bury, either onsite or at landfill
    - Incinerate sharps separately, to disinfect, followed by concrete encapsulation and burial.
    - Incinerate non-sharps healthcare waste separately, to disinfect, followed by ash disposal to landfill (separate burning is suggested as only the sharps need to be encapsulated).
- Begin discussions with DoH, DoE and DAFF regarding the potential and feasibility of shared treatment infrastructure (see Medium Term)

8.1.5.2 Medium Term (6 months-1 year)

- Evaluate measured waste generation data to determine required capacity of new infrastructure
- Conduct a simple feasibility analysis for combining waste disinfection requirements in Niue between healthcare and quarantine waste treatment needs. This would involve a new high temperature incinerator, housed at Niue Foou Hospital, operated to accept both healthcare waste and quarantine waste:
- Combined treatment infrastructure for health care and quarantine waste and management of any potential risks of this would have to be assessed and deemed acceptable to all relevant regulatory agencies
- Existing basic units could be maintained at the respective facilities for back-up purposes, although it is recommended that the quarantine unit be fenced in this case.

8.1.5.3 Long Term (1-3 years)

- Feasibility analysis withstanding, *start the process of procurement of a new high temperature incinerator*– one that is sized according to combined waste throughput
- A critical aspect to purchase of infrastructure in the Pacific situation generally is the inclusion of a supplier support and maintenance contract.
- Key considerations with such a purchase are: capacity, purchase cost, operating costs, ease of operation, durability and life span.
- Procure, install and commission new infrastructure, with supplier support and maintenance contract.
- Recording of waste treatment quantities and operating conditions (e.g. burn temperatures per batch)
- Maintain training of operators as required.

8.1.6 Recommendation 4b: Improved X-Ray Liquid Waste Management

Immediately cease discharge of spent fixer and developer solutions to the onsite septic system. Spent fixer and developer solution wastes should be stored in plastic containers until one of two solutions are determined:

- Installation of an onsite silver recovery unit
- Collection of spent silver solution by the equipment supplier

8.1.6.1 Short Term (0-6 months)

- Immediately cease discharge of spent fixer and developer solutions to the onsite septic system.
- Store spent fixer and developer solution wastes should be stored in plastic containers until the solution is determined
- Discuss options with X-ray chemicals supplier – confirm what chemical constituents are present
- Obtain quotes for onsite silver recovery system (if silver is the contaminant of concern)

8.1.6.2 Medium Term (6 months-1 year)

- Determine which option is the most economically feasible and implement it.

8.1.6.3 Long Term (1-3 years)

Nil.

Appendix A

Photo Log

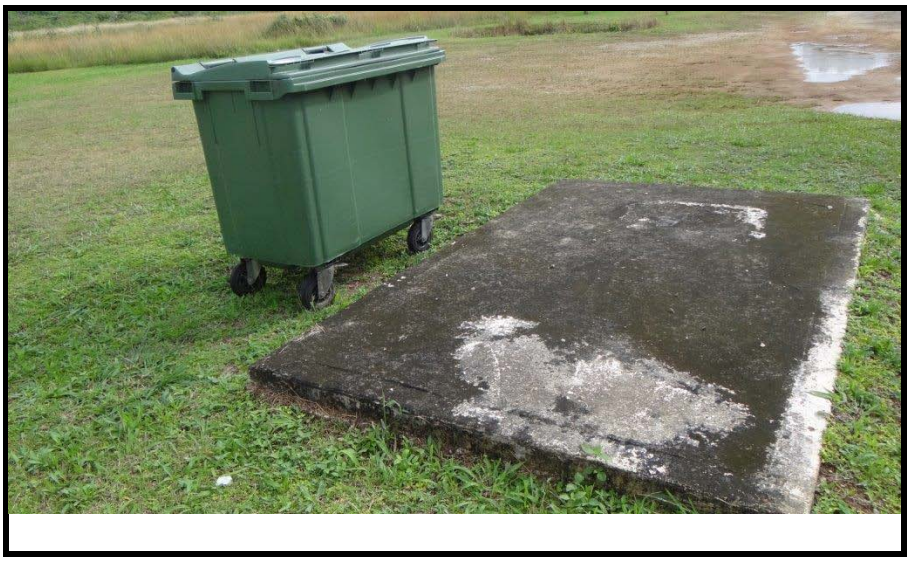

Photo 1: 660 Litre Waste Storage Bin next to waste storage pad, Niue Foou Hospital, Niue (taken 20/05/2014 by Geoff Latimer ref:DSC04861

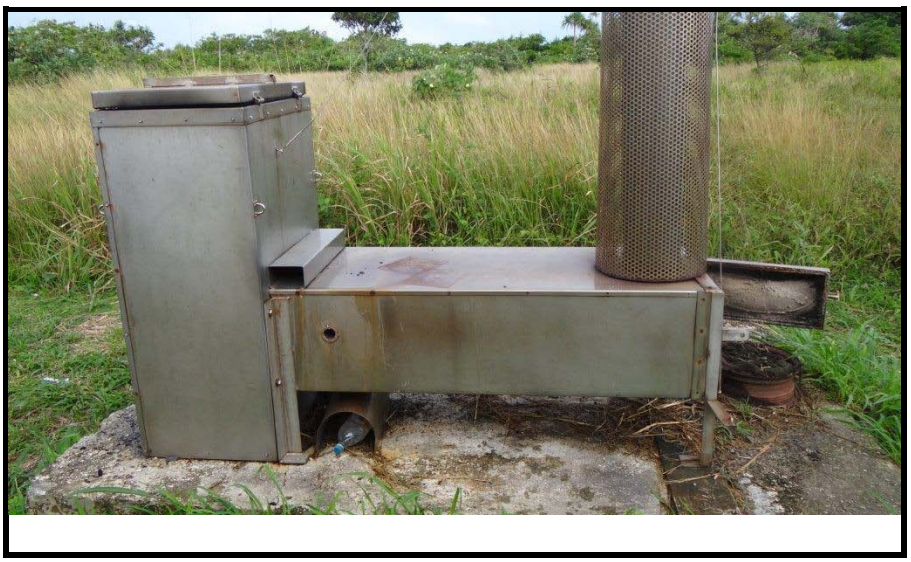

Photo 2: Wood fired incinerator, Niue Foou Hospital, Niue (taken 20/05/2014 by Geoff Latimer ref:DSC04870)

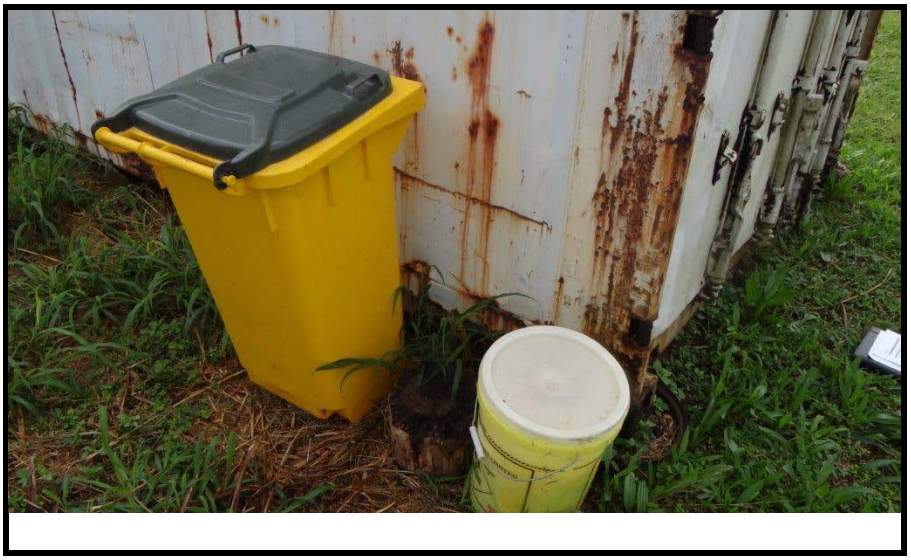

Photo 3: Ash storage bin and disinfected sharps storage pail, Niue Foou Hospital, Niue (taken 20/05/2014 by Geoff Latimer ref:DSC04864)

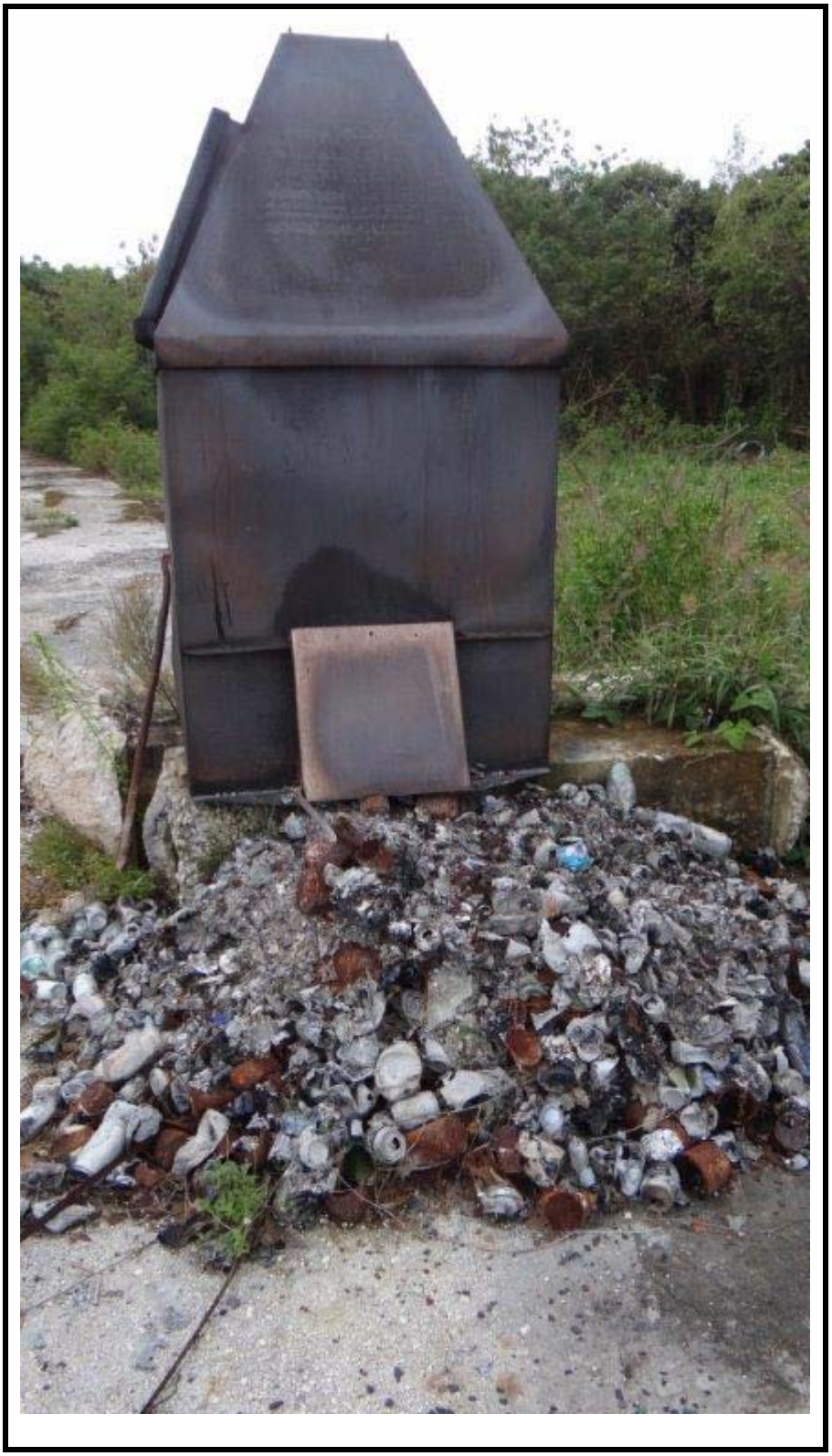

Photo 4: Quarantine Incinerator run by DAFF, Niue (taken 20/05/2014 by Geoff Latimer ref:DSC04878)

Photo 5: Unburnt waste at foot of Quarantine Incinerator, Niue
(taken 20/05/2014 by Geoff Latimer ref:DSC04881)

Appendix B

Collected Data from Hospital Audits in Niue

Table B1: Collected Data from Hospital Audits in Niue

HOSPITAL DETAILS	Region		Niue Island	
	Facility Name & Contact Information	Hospital Name	Niue Foou Hospital	
		Contact Name & Position	Bob Talagi, Hospital Manager	Grizelda Mokoia, Public Health Officer
		Email	Bob.Talagi@mail.gov.nu	Grizelda.Mokoia@mail.gov.nu
		Phone	+683 4100 ext.113	+683 4100 ext.114
	Key Services Data	Summary of Services Provided	Hospital services include emergency, outpatients, aged care, laboratory, pharmacy, dentistry, physiotherapy, X-ray and operating theatre	
		Pop Served	1500	
		No. of Beds	12	
		OBD's [1]	1621	
		No. Operations	182	
		No. of Births[2]	19	
		Emergency Patients Attended[2]	32	
		Out-Patients Attended[2]	3,000	
		No of Staff	39	
WASTE MANAGEMENT PROCESS	Waste Steams Managed	Estimates	Volumes (kg/wk)	Cost ext. ($US)
		Healthcare Waste	30	
		Sharps		
		Pharmaceutical		
		Cytotoxic		
		General		
		Recycling		
		TOTAL	30	$ -
	Generation & Segregation	Dedicated Containers/ Bags	Y	
		Colour Coding	Y	
		Sharps segregated & secure	Y	
		Signage Present	N	
	Internal Handling	Degree of manual handling of bags	Low	
		Internal Transport Mode	Wheelie Bin	
		Spill Kit Present	Y	
	Storage	Dedicated & Appropriate Area	Y	
		Loading/unloading acceptable	Y	
		Spill Kits Present	N	
		Monitoring & record keeping occurs	N	
	Treatment	Treatment per Waste Stream	Tech. Type	Int/Ext
		Healthcare Waste	Incinerate (external)	Internal
		Sharps	Incinerate (internal)	Internal
		Pharmaceutical	Incinerate (internal)	Internal
		Cytotoxic		
		General	Dump	External
		If incinerator present		

		Make, Model, Year commissioned	Medical Waste Gasifier, Biomass Energy Services & Technology, Somersby NSW Aust. (approx 2006)	
		Operating Temp (^{0}C)		
		No. chambers	1	
		Condition	Reasonable	
			Per week	Per year
		Waste Throughput (tonnes)	0.03	2
		Operating Hours (hr)	4	208
		Fuel	Wood	
		Fuel use (kg)	300	15600
		Fuel use per kg waste burnt	2	
		Technology siting and operation issues		
		Offsite transport assessment	Good	
WASTE MANAGEMENT FRAMEWORK	Waste Management Documents	Waste Management Policy	Y	
		Waste Management Plan	Y	
		Waste Management Procedure	Y	
		Waste Management Committee	N	
	Infection Control	Infection Control Policy	N	
		Infection Control Procedures	N	
	Auditing and Record Keeping	Audit Program	N	
		What is audited	Segregation	N
			Compliance P&P	N
			Int. transport	N
			Storage	N
			Treatment/ disposal	N
		Frequency		
	Training	Training Program	Y	
		Curricula	Infection Control	Y
			Waste Mgt	Y
			PPE	Y
			Treat. Tech operation	Y
		Duration / frequency of training	Every 2 years (major - delivered by Middlemoore Hospital, Auckland) plus as needs basis locally	
		Records of who has been trained	Y	
		Monitoring or refresher courses	Y	
PROJECTED ISSUES	Forecasting	10 year projections for waste management		
		Barriers to change		
		Other issues		
LOCAL CONTRACTORS		Potential in-country contractors	Who	Key Capability
			None in Niue	
			Counties Manukau District Health Board, Middlemore Hospital, Auckland	Training (Infection Control)

[1] *Occupied Bed Days (previous 12 months) annual average occupancy rate (as %)*

[2] *Previous 12 months*

Appendix C

Minimum Standards Assessment

Table C1: HEALTHCARE WASTE - MINIMUM STANDARDS FRAMEWORK* & ASSESSMENT FOR NIUE				
Scale	**Category**	**Item**	**Minimum Standard Criterion**	**Niue Foou Hospital**
National Authority	National Legislation	Definitions	A clear definition of hazardous healthcare wastes and its various categories has been developed and used by generators.	
National Authority	National Legislation	Annual Compliance Reporting	Hospitals required to annually report on waste generation and management	
	National Legislation	Technical Guidelines	Practical and directly applicable technical guidelines	
National Authority	Regulations	Annual Compliance Reporting		
National Authority	Policy	National healthcare waste management plan	A national strategy for management of healthcare waste has been published and is up to date (ie., within 5 years) and hospitals required to adhere to its requirements	
Healthcare Facility	Policy	Infection Control	Infection control policy incorporates principles of waste management within it	
Healthcare Facility	Policy	Waste Management Plan	Has been developed by the hospital and is based on a review of healthcare waste management and is current (within 5 years)	
Healthcare Facility	Responsible Person		An officer has been appointed to assume responsibility for waste management within the hospital, and has been allocated sufficient time and resources - this person could have waste management as part of other duties	
Healthcare Facility	Management Committee		A waste management committee has been formed that has representatives from a broad range of departments and meets at least twice per year. A clear set of objectives has been developed for this committee. It reports to the senior management of the hospital.	
Healthcare Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types	
Healthcare Facility	Segregation		Waste are correctly segregated in all wards/departments with use of containers that are colour coded for the different waste types	
Healthcare Facility	Containers		All areas have dedicated waste containers are suitable for the types of waste generated. All waste containers are colour coded and have correct wording on them. Sharps are deposited into containers that reduce potential for needle-stick injury	
Healthcare Facility	Storage	Interim storage in healthcare facility	Storage areas at ward/department level should be secure and located away from public areas. Storage areas should be sufficient in size to allow waste to be segregated and so as to avoid waste of different classifications being stored together.	
		Storage before treatment	Meets the standards stated in Appendix E, Recommendation 2, *Correct Storage*.	
Healthcare Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.	
	Internal Handling	Routing	Healthcare waste is not transported where clean linen and/or food are transported	
Healthcare Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure	

Healthcare Facility	Training	Curricula	A structured waste management training program has been developed that targets the different roles within the hospitals.	
Healthcare Facility	Training	Follow-up & refresher courses	All staff receive waste management education during induction. All staff receive refresher training annually. Waste management training is delivered following an adverse incident to the relevant staff/ward/department.	
Healthcare Facility	Training	Training responsibility	A hospital officer has responsibility for ensuring all training occurs as required and that records are maintained of all training and attendance.	
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.	
Healthcare Facility	Transport - External		A dedicated vehicle is used to transport untreated healthcare waste. This load carrying area of the vehicle is enclosed and constructed so that any spilt material is contained within this area. A split kit is provided.	N/A
Healthcare Facility	Treatment	Suitability of treatment for healthcare waste	The method for treating healthcare waste is in accord with required standards - this includes operating parameters and location of the treatment unit.	
Healthcare Facility	Economics	Cost Effectiveness	A process has been developed that cost all aspects of waste management and these costs are reported annually to the waste management committee.	
Healthcare Facility	Occupational Health and Safety	PPE	All waste handlers are provided with and use appropriate PPE including overalls/protective clothing, gloves and eye protection. Incinerator staff are provided with additional PPE such as face masks and noise protection. A system is in place to monitor correct use of PPE.	
Healthcare Facility	Occupational Health and Safety	Staff risk	Waste containers, locations, storage and management procedures for healthcare waste incorporate identified risks to staff in accessing the waste and/or having needle-stick injuries.	
Healthcare Facility	Occupational Health and Safety	Patient/Visitor risk	Waste containers, locations, storage and management procedures for healthcare waste incorporate identified risks to patients and visitors in accessing the waste and/or having needle-stick injuries.	
Healthcare Facility	Healthcare waste management emergencies	Spill Prevention and Control	Spill kits are provided or all types of healthcare waste in all wards/departments, storage areas and on trolleys and vehicles. Staff are trained on the use of spill kits. All incidents of spills of healthcare waste are investigated and where appropriate remedial actions implemented.	
Healthcare Facility	Future Planning	Planning for change	Hospitals have developed a process to benchmark waste generation so as to (amongst other requirements), plan of future hospital development in terms of services and numbers of patients.	
Local Council	Waste Treatment Facility	Landfill	Healthcare waste is disposed of at a dedicated location and covered immediately on arrival. Scavengers cannot access untreated healthcare waste.	N/A

* The minimum standards framework is drawn from the *Industry code of practice for the management of biohazardous waste (including clinical and related) wastes*, Waste Management Association of Australia (2014), Draft 7th edition, taking into account the Pacific Island hospital and environmental context.

Appendix D

Qualitative Local Feasibility Assessment – Treatment Technology

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Niue)

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
Incineration at high temperature (>1000^{0}C)	$211,460 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Most effective – can treat all waste types and achieves complete sterilization, complete combustion and destroys waste	Some issues for operators (requires training & PPE); some potential issues for community (potential for smoke, some controlled emissions)	Equipment lifespan ~ 10 years plus; sustainability dependant on maintaining operator skills plus proper operation and maintenance	No legal barriers to incineration; loses a point for potential for smoke nuisance and the potential for minor contribution to combustion derived POPs – Niue is a party to Stockholm	Incinerators are currently used at Niue Foou and also DAFF (Quarantine) for disinfection purposes	Equipment breakdown and lack of local skills to maintain equipment – real barrier but can be managed through skills training & supplier support	Emissions of air pollutants and leaching from ash disposal to receiving environment are potential impacts. High temp operation minimises pollution & proper landfilling of ash restricts leaching.	Equipment lifespan ~ 10 years plus but will only last if maintained. High temperature equipment is prone to require a moderate level of maintenance	Requires skilled operators but modern equipment combined with training simplify operation
Incineration at med. temperature (800 - 1000^{0}C)	$69,820 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Can treat all waste types, achieves complete sterilization, incomplete combustion, may not destroy needles	Some issues for operators (requires training & PPE); potential issues for community (smoke, emissions not fully controlled)	Equipment lifespan ~ 5 years; sustainability dependant on maintaining operator skills plus proper operation and maintenance	No legal barriers to incineration; potential for smoke nuisance is med - high and the potential for contribution to combustion derived POPs &	Incinerators are currently used at Niue Foou and also DAFF (Quarantine) for disinfection purposes	Equipment breakdown and lack of local skills to maintain equipment – real barrier but can be managed through skills training & supplier support. Simpler infrastructure.	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment are potential impacts. Med. temperature operation	Equipment lifespan typically less ~ 5 years but will only last if maintained. Equipment is prone to require a moderate level of	Requires less skilled operators than high temperature equipment - training simplifies operation

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Niue)

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
					other pollutants is high – Niue is a party to Stockholm & NIP specifically requires BAT/BEP consideration for 'medical waste'			increases risks of air pollution, but likely to only be an option in isolated small communities.	maintenance	
Low temperature burning (<400^{0}C)	$6,485 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Not applicable for all waste types, relatively high disinfection efficiency, incomplete combustion, will not destroy needles	Some issues for operators (requires training & PPE); issues for community (smoke, emissions not controlled at all)	No equipment; sustainability dependant government & community acceptance which would be expected to decline with time	Potential for smoke nuisance is very high and the potential for contribution to combustion derived POPs & broader range of other pollutants is very high – Niue is a party to Stockholm & NIP specifically requires	Burning of rubbish not as prevalent in Niue as other Pacific countries. Landfilling waste commonly accepted. Likely community concern if healthcare waste was	No equipment operation reliability barrier; however burning rubbish not common practice in Niue so expect community/ Dept Env barrier	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment. Low temp operation provides no controls on air pollution. Risk of fire impact.	Simple, zero technology so there is nothing that can break down	Simple, zero technology so there is nothing that can break down and no specific training is required other than health and safety.

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Niue)										
Remaining Technology Options	**Comparatively low cost to implement**	**Comparative effectiveness across all HCWs**	**Local Feasibility**							
			Health & safety to workers & community	**Sustainability of solution**	**Institutional and policy fit**	**Cultural fit**	**Implementation barriers can be overcome?**	**Receiving environment not impacted**	**Durability**	**Ease of operation**
					BAT/BEP consideration for 'medical waste'	burned in an open situation				
Autoclave with shredder	$158,000 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Cannot treat all waste types, achieves complete sterilization when correctly operated, no combustion required, shredder destroys needles	Some issues for operators (requires training & PPE); small potential for odours and wastewater discharge (community)	Equipment lifespan ~ 10 years; sustainability dependant on maintaining operator skills plus longevity of equipment use given technology complexity	No legal barriers; no potential for smoke nuisance; some potential for odour nuisance; no air pollution (no combustion-POPs) and some potential for waste water management issues	Not familiar with use of sterilisers for waste – potential community issue with waste appearance if steriliser not operated correctly or shredder not used	Equipment breakdown and lack of local skills to maintain equipment – real barrier but can be managed through skills training & supplier support. Increased complexity of equipment (compared to incineration) increases barrier	No emissions of air pollutants/ smoke; some potential for odour impacts; still requires landfill or dump disposal of residue so some potential for leaching on burial. Some potential for waste water management issues	Equipment will only last if maintained. Adding shredder to autoclave technology increases mechanical parts that can go wrong. May require moderate level of maintenance	Requires skilled operators to achieve best level of disinfection.
Encapsulation (only post-disinfection sharps assessed)	Virtually zero additional cost to disinfection system costs	Not applicable to non-sharps waste. In the context of pre-sterilised	Encapsulation has handling issues for operators (requires	No equipment; sustainability dependant burial space available.	No legal barriers; no smoke nuisance; no odour nuisance;	No particular cultural fit concerns – volumes very small in Niue	Niue currently uncertain with how to dispose of treated but not destroyed sharps.	Encapsulation itself poses no smoke nuisance; no odour nuisance;	Highly durable due to its simplicity.	Simple procedure once operator understands

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Niue)										
Remaining Technology Options	**Comparatively low cost to implement**	**Comparative effectiveness across all HCWs**	**Local Feasibility**							
			Health & safety to workers & community	**Sustainability of solution**	**Institutional and policy fit**	**Cultural fit**	**Implementation barriers can be overcome?**	**Receiving environment not impacted**	**Durability**	**Ease of operation**
		sharps only: no combustion required and completely removes downstream needle injury risk	training & PPE) and no community issues	Quantities are very small in Niue.	no air pollution and some potential for leachate to groundwater, although limited inherent hazard		Potential local interest in this solution.	no air pollution and some potential for leachate to groundwater, although limited inherent hazard		and manages the risk of sharps handling and knows how to mix cement correctly.

Legend: Descriptions equate to the following scores:

	1. very low agreement with feasibility criteria
	2. low agreement with feasibility criteria
	3. moderate agreement with feasibility criteria
	4. high agreement with feasibility criteria
	5. very high agreement with feasibility criteria

Appendix E

Recommendation Guidelines

Recommendation 1: 1a: Develop an Infection Control Policy & Procedures

Recommendation 1b: Appointment of a Responsible Officer and/or Waste Management Committee

Healthcare Waste Management Plan

Hospital waste management plans should incorporate strategic objectives of the national healthcare waste management strategy as well as the following information:

- Location and organisation of collection and storage facilities
- Overview of the purpose of, and design specifications:
  - Drawing showing the type of waste container to be used in the wards and departments (e.g., sizes, colours and wording)
  - Drawing illustrating the type of trolley or wheeled container to be used for bag collection
  - Minimum specifications of sharps containers
- Required Material and human resources
- Responsibilities:
  - Including definitions of responsibilities, duties and codes of practice for each of the different categories of personnel of the hospital who, through their daily work, will generate waste and be involved in the segregation, storage and handling of the waste.
  - Definitions of responsibilities of hospital attendants and ancillary staff in collecting and handling wastes, for each ward and department.
- Procedures and practices
- Training
  - Description of the training courses and programs to be set up and the personnel who should participate in each.
- Implementation Strategy

It is important that it also is compatible with any National Waste Management Strategies to ensure consistency of approaches such as with external transport and disposal of treated residues.

Appointment of a Responsible Officer

A responsible officer or waste management officer would be responsible for the day-to-day operations and monitoring of the waste-management system and is usually established as a separate post in larger hospitals (however, one appointee could be responsible for the waste management performance for a number of hospitals with a stated time fraction allocated to each hospital).

It is important that the waste management officer be adequately resourced to enable them to undertake their role as well as supported by Hospital management to ensure that all staff recognise the importance of adopting waste management practices that are in accord with all requirements.

Appointment of a Waste Management Committee

A waste management committee should also be established to provide guidance and support to the waste management officer and assist in implementation of developed actions. In larger hospitals, a separate waste management committee should be formed. For smaller hospitals, such a committee could be either part of the responsibility of another related committee (e.g., infection control or quality assurance), or a sub-committee reporting back to this related committee.

This Committee should not necessarily undertake all activities themselves, but by the nature of the members and the professions/departments represented will ensure that there is a balanced approach to the investigations and analysis to ensure that patient and staff safety will not be compromised.

In addition, the Committee approach will enable advocates for such factors as environmental and economic performance to be heard in a balanced manner.

Waste Management Committee Members should serve for a minimum period of 2 years, with the option of reappointment.

The Waste Management Committee will work with hospital staff, stakeholders and the wider community to develop a culture of environmentally responsible waste management through information sharing and education.

Its members will ensure that waste management issues are considered on committees that deal with product evaluation, infection control and occupational health and safety, and in user groups such as Unit/Department Managers.

The Waste Management Committee should:

- Develop a waste management policy that meets current environmental legislation “due diligence” requirements. This policy is to include strategic directions for correct waste minimisation and management.
- Ensure that the hospital is meeting due-diligence requirements as specified by the Waste Management Team.
- Develop and implement a system to document waste and recyclable quantities on a spreadsheet to evaluate these quantities and therefore the waste minimisation programs that have been implemented, ensuring the results are circulated to all Unit managers/department managers on a regular basis.
- Review and submit subsequent reporting to Unit managers/department managers of the results of all implemented programs and trials.

- Work on implementing the most appropriate waste minimisation/management recommendations as agreed with hospital management and the Waste Management Team.
- Target in order the waste items that are contributing the most significant quantities of waste being generated and in particular waste segregation methods.
- Agree on the Waste Reduction targets for the hospital and outline the key objectives of the committee
- Review current work and waste management practices and develop waste management/minimisation initiatives.
- Conduct mini audits to review progress.
- Visually inspect waste and recycling containers to ascertain if staff are depositing appropriate items into them.

Recommendation 2: Recommendation 2: Implement Segregation Signage

The correct segregation of healthcare waste is the responsibility of the person who produces each waste item, regardless of their position in the organisation. The healthcare facility is responsible for making sure there is a suitable segregation, transport and storage system, and that all staff adheres to the correct procedures.

Ideally, the same system of segregation should be in force throughout a country, and many countries have national legislation that prescribes the waste segregation categories to be used and a system of colour coding for waste containers. Colour coding makes it easier for medical staff and hospital workers to put waste items into the correct container, and to maintain segregation of the wastes during transport, storage, treatment and disposal. Colour coding also provides visual identification of the potential risk posed by the waste in that container.

Labeling of waste containers is used to identify the source, record they type and quantities of waste produces in each area, and allow problems with waste segregation to be traced back to a medical area.

Waste containers specification and siting

Containers should have well-fitting lids, either removable by hand or preferably operated by a foot pedal. Both the containers and the bags should be of the correct colour for the waste they are intended to receive and labeled clearly.

All containers should be able to adequately contain the wastes deposited into it – to prevent the possibility of spills.

Sharps should be collected in puncture proof and impermeable containers that are difficult to open after closure.

The appropriate waste receptacle (bags, bins, sharps containers) should be available to staff in each medical and other waste-producing area in a healthcare facility. This permits staff to

segregate and dispose of waste at the point of generation, and reduces the need for staff to carry waste through a medical area. Posters showing the type of waste that should be disposed of in each container should be displayed on the walls to guide staff and reinforce good habits.

Segregation success can be improved by making sure that the containers are large enough for the quantities of waste generated at the location during the period between collections, as well as a collection frequency that ensures no container is overfilled.

Setting and Maintaining Segregation Standards

Segregation requirements and methods should be clearly set out in the waste-management policy of a healthcare facility. It is important that the waste-management policy is supported and enforced by senior staff and managers. Managers and medical supervisors should know the relevant legislation and understand how to implement waste audits.

The 'Responsible Person' or Waste Management Committee should be responsible for seeing that segregation rules are enforced and waste audits are carried out to quantify the amount of waste produced.

Correct Signage

Signage indicating correct waste segregation practices is a valuable tool to provide ongoing guidance to staff. The success of the waste/recycling system will depend on having a clearly identified container for each type of material. This is achieved by the use of colour coded containers, symbols and wording. In addition, signage must be placed so that those wanting to dispose of materials can clearly and readily identify which container to deposit such materials into.
Once designed, signs should be located on walls above all waste containers as well as on the container itself.

Correct Storage

The storage area should be signposted with the bio-hazard symbol and other labeling appropriate to the types of waste stored in the area (e.g. healthcare) and includes the following:

- The base should be an impervious surface (e.g. concrete) surrounded by a bund appropriate to contain any spill.
- All loading/ unloading takes place within the bunded area in such a manner to ensure any spills are appropriately managed.
- The base and walls of bunded areas are free of gaps or cracks.
- No liquid waste, wash down waters or stormwater contaminated with biohazardous wastes are disposed of via the stormwater drainage system; and
- The bunded area drains to a sump or sewer to collect spills and wash waters. Cut-off drains, which drain to a sump, should be used instead of bunds if approved by the relevant authority.

- Loading/ unloading of waste is carried out in accordance with designated safe procedures, and relevant records are completed and maintained.
- Containers in which biohazardous waste are stored secured when loading/unloading is not taking place.
- Spill Kits for biohazardous waste located in the storage areas.

Storage for larger generators may involve a dedicated room that is constructed specifically for waste management, or could be via the use of appropriately sized mobile garbage bins (e.g., 240 or 660 litre).

Conditions related to security of healthcare waste include the following:

(a) The operator shall ensure that loading/ unloading of waste is carried out in accordance with designated safe procedures, and relevant records are completed and maintained.

(b) Containers in which healthcare waste are stored shall be secured when loading/unloading is not taking place.

Spill Kits for healthcare and cytotoxic waste shall be located in the storage areas.

Recommendation 3: Establish a Waste Segregation Auditing Program/ Refresher Training Capacity

All waste management strategies (particularly resource management programs), rely on all staff to participate and co-operate in order to ensure that objectives are met. Staff therefore should receive appropriate training/education to understand the inherent hazard and risks posed of healthcare waste and the importance of its management from generation to final treatment and disposal.

The Waste Management Committee (apart from ensuring staff education programs are developed and implemented), should also address other methodologies in order to ensure that staff receive information on waste reduction programs (e.g., signage, information sheets and flow charts).

One of the initial steps for developing a structured training program is to gain management support from hospital administration. The development of a training program can be facilitated by establishing core competencies related to healthcare waste management.

In the development of a training program, the following should be considered:

- Conduct of a training needs analysis
- Identification and prioritisation of employees that need to be trained.
- Defining the specific learning objectives for each target audience.
- Develop a detailed curriculum specifying the training plan for each session.
- Incorporate pre-evaluation and post evaluation of learners, evaluation of trainers, follow-up activities, and documentation into the training program.

- Develop training content or adapt available training materials, tailor training content to specific target audiences.
- Identify potential trainers and build training skills
- Develop a budget and secure funding
- Explore incentives for training (e.g. training in collaboration with a health professional society or university that can award certificates or professional credentials)

The following is an outline of a Staff Waste Management Education Program that could be developed:

- Introduction to the session
- Importance of good waste/environment management/ infection control
- Waste management hierarchy
- Waste minimisation principles
- Brief overview of legislation pertaining to waste management
- Hospital policies on environment/waste management/ infection control/ needle stick injuries
- Overview of waste types
- Issues relating to waste reduction
- Management responsibilities
- Identification of, and hazards associated with the different types of wastes generated Importance of effective waste segregation
- Infection control and sharps management
- Waste, handling, packaging and disposal routes for the different types of wastes generated
- Questions

All staff and contractors should attend a waste management training session. This should be conducted during all induction programs in the first instance. For those staff and contractors currently employed on-site, they should attend a dedicated training session so that they are fully aware of their roles and responsibilities in respect to waste management. Records should be maintained of all staff and contractors attendance at a training session to ensure that all personnel attend.

At a national and regional level, training programs could be in the form of train the trainer. The training of trainers approach allows rapid capacity building and widespread training outreach.

Training of Waste Disposal Treatment Operators

Incinerator/ healthcare waste treatment system operators should receive training in the following:

- Overview of healthcare waste management including risks and management approaches
- General functioning of the incinerator, including basic maintenance and repair training.
- Health, safety and environmental implications of treatment operations
- PPE, its correct use and removal and cleaning (if appropriate)
- Technical procedures for operation of the plant.
- Recognition of abnormal or unusual conditions
- Emergency response, in case of equipment failures.
- Maintenance of the facility and record keeping
- Surveillance of the quality of ash and emissions.
- Disposal of residues

Recommendation 4a: Improved Infectious Waste Treatment Infrastructure

The healthcare waste stream is diverse in that it contains a variety of chemical substances, organic materials, plastics, metals and materials that are potentially contaminated with pathogenic substances. The primary aim of treating this waste stream is to ensure that there is no potential negative impact to human health or the environment as a consequence of the components of this waste not being treated adequately.

This means that the treatment process should render the waste material so that there are no pathogens likely to cause harm as well as be conducted in a manner that reduces any environmental consequences.

There are a number of treatment processes for healthcare waste. However, not all of these are able to treat all types of healthcare wastes. Materials such as pharmaceuticals, cytotoxic and anatomical wastes can only currently be treated by incineration. Therefore, when selecting a process to treat healthcare wastes, the generator must be aware of the capabilities and limitations of each of the various treatment processes and ensure that only those wastes that can be thus treated are actually sent to such a facility, and the remainder sent to an incineration facility. This is part of any facilities due diligence process.

There are a number of means of treating healthcare waste that are in commercial use around the globe. The question arises as to what type of technology is best suited to meet the various waste categories/quantities generated, environmental requirements and that treatment is done safely and in a cost-effective manner. Treatment of healthcare wastes should achieve a change in the wastes biological or chemical hazard so as to reduce or eliminate its potential to cause disease or other adverse consequences, by meeting acceptable biological standards and to ensure that there is minimal adverse environmental impact in respect to water, soil, air and noise.

Management of wastes should be based on the **precautionary principle** in that a lack of data should not mean that options be undertaken when there is still a perceivable risk of damage (to human health or the environment). The literature and other sources of

information have clearly demonstrated a need for maintaining incineration as the most preferred option for at least the treatment of pharmaceutical and cytotoxic wastes – if not other components such as microbiological specimens and body parts. Only one technology has been demonstrated to be able to effectively treat all categories of healthcare waste. This technology is incineration (at high temperature, with sufficient residence time and appropriate air pollution control equipment).

A substantial amount of data exists on the emission generated from incinerators, but conversely, little studies have been conducted on all aspects of alternate technologies performance. While the literature is inconclusive on the requirements needed to effectively manage the blood and body fluid contaminated and infectious components of the waste streams, there does seem to be consensus that these hazardous components such as pharmaceuticals and cytotoxic wastes do need to be treated prior to final disposal to ensure there is no risks to the environment or health of humans and other species.

It is also very clear that there is little work been undertaken on the consequences of landfilling untreated healthcare waste, and in particular pharmaceuticals and cytotoxic wastes. The literature does relate to impacts resulting from untreated pharmaceuticals being discharged into the environment from hospital sewers and wastewater treatment plants and does indicate that there are potential negative environmental and health consequences. The implications of these studies could legitimately be applied to discharge of waters such as leachate or surface water runoff from landfills should these wastes be deposited untreated. According to the World Health Organization[6, 7], incineration is the preferred method for treating pharmaceutical and cytotoxic wastes. This is further supported by the United Nations[8, 9] in that they have also recommended incineration as the preferred method for treatment prior to disposal of pharmaceuticals and cytotoxic wastes. These recommendations are generally standard throughout the world in relation to these two specific waste types[10, 11].

There are other studies that have been conducted on what is referred to as “alternate treatment technologies”, and these have demonstrated that all of these technologies cannot effectively treat pharmaceutical and cytotoxic waste, with many also unable to treat anatomical waste.. Some jurisdictions do allow alternative means of treating anatomical waste prior to disposal to landfill, but these are by far in the minority and mostly related to ethical or religious rationales.

[6] World Health Organization Regional Office for Europe, EURO Reports and Studies 97, Management of Wastes from Hospitals and other Health Care Establishments, 1983.
[7] World Health Organization, Safe management of Wastes from healthcare Facilities, Geneva, 1999.
[8] United Nations Environment Programme – Technical Working Group on the Basel Convention, Draft Technical Guidelines on Biomedical and Health Care Wastes, 1999.
[9] Environment Australia, Basel Convention – Draft Technical Guidelines on Hazardous Waste: Clinical and Related Waste (Y1), March 1998.
[10] Health care Without Harm, Non-Incineration Treatment Technologies, August 2001.
[11] London Waste Regulation Authority, Guidelines for the Segregation, Handling, Transport and Disposal of Clinical Waste, 2nd Edition, 1994.

In Australia as an example where there is allowed a variety of treatment technologies for the range of clinical and related wastes, without exception, jurisdictions do not allow treatment other than incineration for anatomical waste, pharmaceuticals and cytotoxic wastes[12, 13, 14, 15, 16, 17]. This is also quite evident in a review of Australian State/Territory environmental agency licence conditions for approved clinical and related waste treatment technologies. In countries that do allow landfilling of clinical and related wastes, often these two specific waste categories are specifically excluded from this option[18].

In summary, no publication from a government environmental or health agency, or any article reviewed advocated any other preferred form of treatment for pharmaceuticals and cytotoxic wastes than incineration. In most instances the preference for anatomical waste was also incineration.

Recommendation 4b: Improved X-Ray Liquid Waste Management

See http://pprc.org/smallHC/Silver_Recovery/index.cfm

[12] National Health & Medical Research Council, National Guidelines for Waste Management in the Health Industry, Commonwealth of Australia, 1999.
[13] EPA Victoria, Draft Guidelines for the Management of Clinical and Related Waste, July 2003.
[14] NSW Department of Health, Waste Management Guidelines for Health care Facilities, August 1998.
[15] Queensland Government, Environmental Protection (Waste Management) Regulation, 2000.
[16] Australian/New Zealand Standard 3816:1998, Management of Clinical and Related Wastes.
[17] Australian and New Zealand Clinical Waste Management Industry Group, Industry Code of Practice for the Management of Clinical and Related Wastes, 3rd edition July 2000.
[18] Provincial Government of Gauteng (South Africa), Draft Health Care Waste Regulations, 11 September 2003.