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SPREP
Secretariat of the Pacific Regional Environment Programme

PacWastePlus
PACIFIC WASTE MANAGEMENT

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Pacific Disaster Waste Management Guideline:

Drafting a National Disaster Watse Management Plan (NDWMP) & Estimating Disaster Waste Volumes

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PO Box 240

Apia, Samoa

T: +685 21929

E: sprep@sprep.org

W: www.sprep.org

Our vision: A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

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Dr Vicki Hall (*Hall and Associates*); Dr David Haynes (*Going Troppo Consulting*); Ms Debra Mackeen (*Athena Waste Management*); and Mr John O'Grady (*Araspring Ltd*).

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- SPREP (2021). *Pacific Island Countries Regional Disaster Waste Management Guideline*. Apia, Samoa. 72p.
- University of Newcastle (2022). *Practitioner's Guideline and Introduction of Systems to enable Pacific Islands to Effectively Manage Disaster Waste*. Unpublished report to SPREP. 68p.

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Abbreviations

ACM	Asbestos Containing Materials
C&D	Construction and demolition waste
C&I	Commercial and industrial waste
CCA	Copper Chrome Arsenate (treated timber)
DWAT	Disaster Waste Assessment Taskforce
DWCP	Disaster Waste Contingency Plan
DWIP	Disaster Waste Implementation Plan
DWMP	Disaster Waste Management Plan
DWMPT	Disaster Waste Management Plan Template
DWPFT	Disaster Waste Procurement and Finance Taskforce
DWPRT	Disaster Waste Public Relations Taskforce
DWWG	Disaster Waste Working Group
FRDP	Framework for Resilient Development in the Pacific
GIS	Geographical Information System
GPS	Global Positioning System
kg	Kilogram(s)
m^3	Cubic metre(s)
MSW	Municipal solid waste
NDMO	National Disaster Management Office
PPE	Personal Protection Equipment
RDWMG	(Pacific Island) Regional Disaster Waste Management Guidelines
SDS	Safety Data Sheets
SFDRR	Sendai Framework for Disaster Risk Reduction
SPREP	Secretariat of the Pacific Regional Environment Program
UN	United Nations
WHS	Workplace Health and Safety

Measurements used in this Guideline

Measure	**Equivalent to**
10mm (millimetre)	1cm (centimetre)
100cm (centimetre)	1m (linear metre)

10,000m^2 (square metres)	1 hectare
1,000kg (kilogram)	1 tonne (metric)
1,000l (litre)	1m^3 (cubic metre)

FOREWORD

The increasing frequency and intensity of natural disasters across the Pacific have underscored the urgent need for more robust and integrated disaster management systems. Among the often overlooked yet critical aspects of disaster response and recovery is the management of disaster waste. Poorly managed disaster waste can hinder response efforts, pose serious environmental and public health risks, and delay recovery processes. It is within this context that the *Practitioner's Guideline on Drafting National Disaster Waste Management Plans* has been developed.

This Guideline serves as a practical tool for government agencies, disaster managers, environmental practitioners, and development partners involved in national planning processes. It provides a step-by-step approach to drafting a National Disaster Waste Management Plan (NDWMP), anchored in risk-informed planning and aligned with national disaster risk management frameworks and international best practices. The aim is to ensure that countries are better prepared to manage the waste generated by disasters in a manner that is safe, efficient, and environmentally sound. This guideline focuses on the management of hazardous and non-hazardous solid wastes arising from natural disasters.

The development of this Guideline has been informed by regional experiences, lessons learned from past disaster events, and contributions from technical experts and country stakeholders. It reflects a growing recognition that pre-disaster planning for waste management is essential to improving resilience and recovery outcomes.

This Guideline will support governments and stakeholders in strengthening their disaster preparedness and response capacities, and ultimately contribute to safer, cleaner, and more resilient communities. It takes a whole-of-society approach with stakeholders that include government, community, humanitarian organisations, waste management companies and emergency services.

The purpose of the guideline is twofold: it sets out to enable Pacific nations to prepare for the management of wastes generated by disasters; and manage the safe, environmentally responsible, efficient and lawful recovery and disposal of disaster waste materials.

Adoption of best practice in disaster waste management will enable a coordinated, safe and successful response to dealing with disaster waste and minimise the economic, social and productivity impacts. This will allow Pacific nations to recover and get back to normalcy more quickly, with positive gains for improved community well-being and economic benefits arising from appropriate and effective waste management.

Sefanaia Nawadra
Director General
Secretariat of the Pacific Regional Environment Programme

ABOUT THE GUIDELINES

Disasters in the Pacific region have had, and continue to have, significant economic, social and productivity impacts. Consequently, disaster preparation including management of disaster generated waste is one of the most important regional actions for climate change adaptation.[1] However, there are significant challenges in effectively managing disaster wastes due to the adverse social, environmental, economic and health impacts caused by a disaster event.

Guideline Objective

The objectives are to:

- provide a structured framework for the development of National Disaster Waste Management Plans that align with national disaster risk management strategies and environmental policies.
- strengthen national preparedness by ensuring disaster waste considerations are integrated into pre-disaster planning, response, and recovery processes.
- enhance coordination mechanisms among relevant agencies, sectors, and stakeholders involved in disaster waste management.
- support timely and effective response to disaster waste challenges by outlining clear roles, responsibilities, and procedures.
- promote environmentally sound practices for the collection, segregation, recycling, treatment, and disposal of disaster waste.
- minimise risks to public health, safety, and the environment arising from unmanaged or mismanaged disaster waste.
- facilitate capacity building and resource planning for disaster waste management at national and sub-national levels.
- encourage the inclusion of disaster waste data and lessons learned into national information systems for future planning and continuous improvement.

Guideline Purpose

The purpose of the guideline is to:

- Enable Pacific communities to prepare for the management of wastes generated by disasters; and
- Manage the safe, environmentally responsible, efficient and lawful recovery and disposal of disaster waste materials.

What the Guideline Includes

The guidelines focus on the management of hazardous and non-hazardous solid wastes arising from natural disasters. These wastes include:

- Debris generated by damaged and demolished property and infrastructure;
- Materials used during the disaster response stage (e.g. sandbags/barriers);
- Relief waste generated during the response and recovery phases (e.g. unwanted donated goods, healthcare waste); and
- Agricultural waste (including animal carcasses) resulting from the disaster event.

[1]Japan Ministry of Environment (2018). *Disaster Waste Management Guideline for Asia and the Pacific*. 26p.

This Disaster Waste Guideline does not include management of:

- *Human remains*
- *Radioactive waste*
- *Animal carcasses resulting from exotic disease control programs*
- *Reticulated sewage and septic system waste*

This guideline provides a template with drafting instructions for the development of a national disaster waste management plan. The template offers a standard structure for the plan to provide Pacific countries with an opportunity to create a consistent best practice approach to disaster waste management across the region. The Disaster Waste Management Plan is suitable for inclusion in a National Disaster Management Plan or as a stand-alone plan and includes disaster waste reduction actions and post disaster response actions.

A Template for the drafting of a community disaster waste management plan is also include in the Guideline Annexes.

Who should use the Guidelines: The guideline is for stakeholders involved in managing waste generated by a disaster, particularly during the response and early recovery phases. Stakeholders include government, community, humanitarian organisations, waste management companies and emergency services.

Updating the Guidelines: The guideline should be revised every two years or as required. Learnings from the practical management of disaster wastes, new information available, changes in laws and best practice guidance should be considered when updating the guidelines.

PART ONE: THE NATIONAL DISASTER WASTE MANAGEMENT PLAN

1.1 Introduction

A Disaster Waste Management Plan provides disaster waste managers with the necessary information to coordinate disaster waste management responses in the lead up to, during, and after a disaster. The plan also provides guidance on how disaster waste managers can seek additional support from external agencies and stakeholders, work collaboratively, implement greater resource recovery and divert waste material from landfill where possible.

Disaster waste management planning is guided by the principles described in **Section 1.4**. These principles include the use of a foundational waste management hierarchy to guide decision making on disaster waste management responses, and the prioritisation of reuse and recycling of suitable disaster wastes wherever possible. However, local economic, social and environmental conditions must always be considered in all disaster waste management responses.

Specifically, the Disaster Waste Management Plan provides guidance on:

- The institutional and practical arrangements for managing waste generated by natural disasters
- Measures for minimising the quantity of waste generated by a disaster
- Predicting waste volumes generated by a disaster
- Establishing pre-agreements with waste recyclers to collect/receive recyclables from affected communities
- Identification of temporary disaster waste storage sites
- Establishment of administrative guidelines to allow waste facilities to receive disaster waste
- Maximising resource recovery by diverting waste from landfill where practical
- Seeking support and working collaboratively with external agencies and other stakeholders.

The National Disaster Waste Management Plan is a comprehensive document which includes two critical components including :

- Disaster waste management contingency arrangements
- Disaster waste risk reduction actions.

The disaster waste management template provides a step-by-step process to develop a national Disaster Waste Management Plan.

1.2 Completing the Disaster Waste Management Plan Template

A Disaster Waste Management Plan can be generated by filling in the Disaster Waste Management Plan template contained in **Annex 3** of this Guideline, following the instructions provided below and summarised in **Table 3**.

Preamble

To begin, fill in the descriptive details of the Plan. This includes identifying the Plan title, its author, a document control table, abbreviations and definitions, relevant training arrangements and generating a Table of Contents including lists of document Tables and Figures. This section also includes a Forward usually written by a government minister or representative to introduce the Plan and describe its purpose and desired outcomes. Fill in the relevant sections of the template to adequately present this Plan background information.

Introduction (Section 1.1-1.3)

The introduction to the Plan presents a description of the Plan's purpose, its scope and the national policy framework that authorises the Plan. Fill in the Plan template with the names of the appropriate disaster management response agencies and stakeholders and also list the relevant policies and strategies that the Plan is consistent with and authorised by.

Disaster Waste Assumptions (Section 1.4)

A range of assumptions including those derived from a local/national vulnerability assessment dictate appropriate disaster waste management actions. Include this information as a summary of information in Annex 1 (the National Vulnerability Assessment) here.

Disaster Waste Management Assumptions (Section 1.5)

A range of management imperatives also dictate appropriate disaster response. These include the scale of the response and the availability of disaster waste management responders and equipment. Identify these management assumptions and include any other unlisted management assumptions.

Disaster Waste Risk Reduction Actions (Section 2)

The Disaster Risk Reduction section of the Plan identifies immediate and ongoing actions that will reduce potential waste generation rates during a disaster.

- Pre-disaster preventative measures designed to minimise the amount of waste generated during and following a natural disaster including public awareness campaigns, securing waste management equipment and supplies (trucks, bins, bags) to be ready during response, mapping of common construction materials, storage and safeguarding of hazardous substances, establishing waste collection points, reducing vegetation loads and promoting sustainable building practices to reduce the generation of debris.
- Post-disaster measures that include rapid deployment of waste collection responses in affected areas, establishing and utilising temporary storage sites, implementing safe systems for sorting and segregation of waste materials (both on and off the impacted area) to increase disaster waste recovery, recycling and proper disposal to protect public health and the environment. Measures will prioritise the removal of asbestos from buildings, safe collection and storage of hazardous wastes and the management of organic wastes.

Also include any other unlisted disaster waste risk reduction activities being carried out here.

Disaster Early Warning (Section 3)

Early Warning Systems monitor and predict hazards and help reduce the risks associated with them. Identify relevant actors responsible for undertaking disaster early warning actions.

Occupational Health and Safety Considerations (Section 4)

Undertaking disaster waste management potentially exposes workers to a range of hazardous materials and chemicals. Identify any specific materials/chemicals that are known to be present in the potential disaster area, with particular reference to asbestos containing materials if they are known to be present. Clearly identify the types of (personal protective) equipment, and other equipment and supplies that will be necessary to manage the clearance of disaster wastes.

Disaster Waste Management Plan Activation and Coordination (Section 5)

Effective disaster waste management response is coordinated through a pre-existing management framework. Describe the relevant framework in detail here.

Disaster Waste and Environmental Surveys and Monitoring (Section 6)

The management of disaster waste is guided by both rapid (response phase) and detailed (recovery phase) disaster waste assessment surveys following the disaster. The specific procedures used for estimating disaster waste quantities are presented in Annex 6. Contact details for experienced environmental practitioners to assess disaster environmental damage are presented in Annex 7 of the Disaster Waste Management Plan template.

Disaster Waste Removal (Section 7)

The implementation of disaster waste collection as soon as practical after the disaster event is a critical disaster waste management response. Identify actors/first responders responsible for early life-saving actions following a disaster and actors and methods used for later waste collection and removal. Provide a detailed description of authorised procedures for the removal of business property disaster waste if significantly different from that used for private residences.

Hazardous Waste Removal (Section 8)

Hazardous waste may consist of a range of articles including asbestos, common household chemicals, petroleum products, propane tanks, oxygen bottles, batteries, and industrial and agricultural chemicals. Identify any additional hazardous wastes if known. Provide a detailed description of authorised procedures for the removal of hazardous private (and business property) disaster waste if significantly different from private residences. Also provide a detailed description of how hazardous healthcare wastes are to be managed. This should include details on management of staging areas for management of contaminated, hazardous and putrescible wastes.

Damaged Structure Removal (Section 9)

Natural disasters may create health and safety concerns with respect to severely damaged government, commercial and private infrastructure. Identify responsible actors engaged in management of this aspect of disaster waste management.

Disaster Waste Storage Sites (Section 10)

Temporary storage sites provide an interim storage area for piled wastes and a possible location to undertake material recovery activities before a decision is made about where the materials will be sent for disposal or recycling. Potential temporary storage sites should be identified and management procedures developed prior to a disaster (see Annex 10 and 11). Identify operational landfills as well in this section.

Waste Removal Monitoring (Section 11)

Monitoring and recording the quantities of waste being moved and removed is a critical component of the waste management cycle as it provides the required documentation for waste removal tracking and financing. Provide details of pre-existing disaster waste removal contracts, a summary of the data to be collected, as well as details of relevant arrangements to procure and pay for disaster waste removal and disposal operations and services.

Waste Reduction Methods (Section 12)

A variety of waste reduction methods are available to minimise the quantity of disaster waste that has to be permanently disposed of (generally to landfill). Specify relevant and available recycling processes and options that can be utilised following a disaster (Table 5).

Final Disaster Waste Disposal Options (Section 13)

Any non-recyclable (intractable) disaster wastes will have to be finally disposed of. Insert details of how this will be managed.

Public Communications (Section 14)

The goal of a public information system in a disaster management context is to ensure that responders and the community are given accurate and timely information for their own use and individual and organisational planning purposes. Identify main actors, authorised communication protocols (Annex 15) and identify any additional information likely to be communicated during a disaster waste management response.

Eligibility and Reimbursement for Disaster Waste Removal Services (Section 15)

Eligibility for disaster waste removal services must be established prior to a disaster occurring. Identify eligibility criterion and any required financial reimbursement procedures to achieve this.

Disaster Waste Implementation Plan Checklist (Section 16)

A Disaster Waste Management Implementation Plan is developed during the first stage of a disaster response by field assessment teams. A checklist is presented that summarises likely required actions. Insert any additional relevant actions necessary to complete a disaster waste management response.

References (Section 17)

Include any additional relevant references here.

Completing the Disaster Waste Management Plan Annexes

The Disaster Waste Management Plan contains 15 Annexes which contain primary information relevant to implementation of a Disaster Waste Management Plan. The information in each Annex should be collected at the appropriate level (i.e. local/regional/national) for use in disaster waste management planning.

Table 1: Summary of steps to complete the Disaster Waste Management Plan

Section	Section Title	Page	Description of Section to be Completed
Preamble	**Document Cover**		Insert Document Cover with title and appropriate logo and plan date
	Document Control		Insert document control information (Table 1)
	Document Maintenance and Distribution		Identify officers and primary (eg NDMO) and support agencies (eg waste transport companies) who will maintain and distribute the plan
	Training and Exercises		Identify office responsible for training and training cycle. Councils and government departments should consider cross training existing staff in responsibilities related to disaster waste management response and arrange for temporary labour and pre negotiated contracts with suppliers who can supply and operate heavy equipment, undertake debris removal, storage, sorting, recycling, processing, marketing and disposal
	Forward		Insert appropriate forward
	Abbreviations		Insert list of abbreviations used in the plan
	Definitions		Insert list of definitions for terms used in the plan
1	**Introduction**	5	
1.1	Plan Purpose	5	Identify main actors
1.2	Plan Scope	5	Identify main actors
1.3	Policy framework	5	Identify relevant policies, strategies and regulations
1.4	Disaster Waste Assumptions	5	Identify relevant disaster types
1.5	Disaster Waste Management Assumptions	6	Identify anticipated waste management consequences following a disaster event
2	**Disaster Waste Risk Reduction Actions**	7	List all routine and ongoing disaster waste reduction actions being undertaken prior to a disaster event
2.1	Vegetation and Green Waste Management	7	
2.2	Hazardous materials and chemicals	7	
2.3	Rubbish collection	7	
2.4	Waste Management Facilities	7	
2.5	Maintenance of Public Infrastructure	8	
2.6	Bulky and Hazardous Waste Collections	8	
2.7	Mapping of Potential Disaster Wastes	8	

Section	Section Title	Page	Description of Section to be Completed
3	**Disaster Early Warning**	8	Identify all relevant actors, pre-disaster actions and other relevant information that is relevant to a disaster early warning mobilisation
3.1	Convening of the Disaster Waste Working Group	8	
3.2	Waste Management Facilities Preparation	8	
3.3	Public Awareness	8	
3.4	Organisation of the Disaster Waste Response Team	9	
3.5	Stakeholder Briefings	9	
4	**Occupational Health and Safety Considerations**	9	Identify any specific materials or chemicals (including asbestos) that present a threat to disaster waste management teams and the use of appropriate PPE
5	**Disaster Waste Management Plan Activation and Coordination**	10	Describe the relevant disaster management response coordination framework including a diagrammatic representation of the framework(s)
6	**Disaster Waste and Environmental Surveys and Monitoring**	10	
6.1	Rapid Disaster Waste Estimation and Recording	10	Describe rapid assessment techniques for assessing disaster waste quantities
6.2	Environmental Impact Assessment	11	Describe rapid assessment techniques for assessing environmental impacts
7	**Disaster Waste Removal**	11	
7.1	Response operations: Life Saving Disaster Waste Management	11	Identify relevant agencies that carry out life-saving operations and any associated documentation used for describing this activity
7.2	Recovery Phase operations: Disaster Waste Removal	12	Identify relevant agencies that carry out disaster waste removal operations and any associated documentation used for describing this activity
7.2.1	Public Road Waste Removal	12	
7.2.2	Methods of Collection and Removal	12	
7.2.3	Business Property Waste Removal	13	
8	**Hazardous Waste Removal**	13	Insert specific operational details here
8.1	Household Hazardous Waste Removal	13	
8.2	Business Property Hazardous Waste Removal	13	
8.3	Medical Waste Management	13	

Section	Section Title	Page	Description of Section to be Completed
8.4	Temporary Hazardous Waste Staging Areas	13	Identify locations and relevant regulations for siting and management of disaster waste staging centres
9	**Damaged Structure Removal**	14	Complete and refer to Annex 8 and 9 for procedures
9.1	Detailed Assessment of Structures	14	
9.2	Private Property Demolition and Waste Removal	14	
10	**Disaster Waste Storage Sites**	14	Summarise temporary storage site preparatory and management actions derived from Annex 11
10.1	Temporary Storage Site Preparation	14	
10.2	Temporary Storage Site Management	14	
11	**Waste Removal Monitoring**	15	Include any additional monitoring requirements
11.1	Waste Record Keeping	15	
11.2	Monitoring Methods for Waste Removal	15	
11.2.1	Waste Monitor Reports (Field Monitors and disaster waste storage sites monitors)	15	
11.2.2	Truck Certification	15	Identify recognised national transport standard(s) to be complied with
11.2.3	Load Ticket System	15	Elaborate on agreed standardised load ticketing system
12	**Waste Reduction Methods**	16	Identify appropriate recycling processes to be undertaken to manage disaster waste
12.1	Volume Reduction by Burning	16	
12.2	Volume Reduction by Grinding and Chipping	16	
12.3	Volume Reduction by Recycling	16	
13	**Final Disaster Waste Disposal Options**	17	Insert details on agreed process for disposal of intractable disaster wastes
14	**Public Communications**	17	Identify any other disaster waste management information needed to be communication
14.1	Communication Protocol	17	
14.2	Information to be Communicated	17	
15	**Eligibility for Waste Removal**	18	Provide details of agreed documentation to be used for payment for disaster waste management (removal) services
15.1	Funding Eligibility	18	Provide details of agreed eligibility and reimbursement model for disaster waste management

PART TWO: DISASTER WASTE ESTIMATION AND RECORDING

2.1 Types of Disaster Waste

Disasters usually generate large volumes of different categories of solid and liquid wastes which may be non-hazardous or hazardous. Disaster wastes can include:

- Debris generated by damage to property and infrastructure (including landfills)
- Materials deployed during disaster responses (e.g. sandbags used in flood events)
- Relief waste generated during the response and recovery phases (e.g. unwanted donated goods, healthcare waste, single use plastic water bottles, steel food cans; packaging waste)
- Waste from demolished buildings and infrastructure
- Agricultural waste (including animal carcasses and agricultural chemicals)
- Sewage, effluent, healthcare wastes and other hazardous liquids and chemical (including asbestos, industrial chemicals, paints, cleaning products, damaged electronic waste and decomposing food wastes and animal carcasses) which may be released directly or cause leachate to release to the environment.

The type and quantity of wastes generated by an event will depend on the type of disaster that has occurred, its severity and its location. Examples of the typical waste streams that may be generated by each type of disaster and the potential volumes of waste that may be expected in relation to the disaster type are provided in **Table 2**[2]. Also refer to **Annex 4** Disaster Waste Technical Guidance.

[2]Brown *et al*. (2011). Disaster waste management: a review article. *Waste Management* 31 pp. 1085-1098.

Table 2: Typical Pacific Island disaster wastes and their potential impacts [3,4]

Potential source	Waste stream	Waste characteristics	Potential volumes					Potential management issue(s)
			Earthquake	Fire/Volcano	Tsunami	Flood	Cyclone	
Fallen trees/palms and vegetation	Green waste	Fallen trees Leaves, fruits, flowers, branches, stem, and roots	L-M	M-H	M-H	L-M	H	Blockage of access roads Rhinoceros beetle and fire ant breeding sites
Supermarkets, restaurants and households, retail	Kitchen waste	Grease trap and food scraps	L-M	L	M-H	L-M	L-M	Fire ant and mosquito breeding sites Bacteria breeding ground and methane release from rotting organics
	Contaminated and damaged or expired retail supplies	Sacks of rice, sugar, flour, salt, etc. Freezer goods inc. chicken, etc.	L-M	L	M-H	M-H	L-M	Risk to human health, unsafe consumption by people
		Damaged products not worth for selling to customers – toys, electronics, etc	L-M	L	M-H	M-H	L-M	Litter; volume to landfill
Displaced soil and sediments	Soils	Sand, silt, clay, rocks, silts, mud	L-H	L	L-M	M-H	L-H	Blockage of access roads
Volcanic eruption	Ash and volcanic debris	Volcanic ash, boulders	H	-	-	-	-	Dangerous dust, blockage of access roads
Damaged buildings and structures	Construction debris	Timber or wood, wire, iron or aluminium roofing materials, cement blocks, bricks, sewage and water reticulation piping	H	M-H	L-M	L-M	L	Blockage of access roads Physical injury Asbestos exposure

[3]SPREP (2021). *Pacific Island Countries Regional Disaster Waste Management Guideline*. Apia, Samoa. 72p

[4]South Australia (2022), *State Emergency Management Plan, Part 4*. 137p

Potential source	Waste stream	Waste characteristics	Potential volumes					Potential management issue(s)
			Earthquake	Fire/Volcano	Tsunami	Flood	Cyclone	
	Asbestos containing materials	Corrugated roof sheeting, pipe lagging, cement sheeting	M-H	M-H	M-H	L-M	L-M	Risk to human health
Households and businesses	Bulky waste	Furnishings, carpets, textiles, sandbags	M-H	M	L-M	M-H	L-M	Personal injury; volume to landfill
	Hazardous waste	Electronic equipment, pesticides, refrigerants, oil, gas, petroleum products, batteries	L-M	L-M	L-M	L-M	L-M	Leakage of toxic substances, human health impacts and environmental contamination
	Recyclables	Plastic, metal, paper and glass goods, objects and containers	L	L	L-M	L	L	Litter
Agricultural **Other Industrial**	Chemicals and chemical containers	Pesticides, cleaning and laboratory chemicals, CCA posts, petroleum products	L-M	-	M-H	M-H	L-M	Risk to human health and the environment
	Animal carcasses	Dogs, pigs, cats, chickens, etc.	L-M	M-H	L-M	M-H	L-M	Environmental contamination Difficult to manage
	Copper chrome arsenate (CCA)	Treated timbers and poles and burnt ash	L-M	L-M	L-M	L-M	L-M	Risk to human health and the environment
	Fencing wire	Barbed wire, rolled wire – should be considered as metal waste and recyclable	L-M	L-M	L-M	L-M	L-M	Injury to animals Personal injury
Disposal sites	Landfill site losses	Landfilled solid wastes can mobilise in a disaster	L	L	L-M	L-M	L-M	Risk to human health and environment; land and marine based litter
Non-profit organisations and relief centres	Donated goods	Disaster relief goods and packaging	L-M	L-M	L-M	L-M	L-M	Litter, excess volume to landfill

Potential source	Waste stream	Waste characteristics	Potential volumes					Potential management issue(s)
			Earthquake	Fire/Volcano	Tsunami	Flood	Cyclone	
Healthcare facilities and homecare	Healthcare wastes	Human tissues, organs or fluids, body parts, unused blood products, chemicals	L-M	L-M	L-M	L-M	L-M	Infectious, toxic, carcinogen, flammable, corrosive, reactive, explosive or radioactive
Damaged and/or displaced vehicles	End of life vehicles	Family cars, motorbikes, trucks, heavy equipment, etc	L-M	L-M	M-H	M-H	L-M	Personal injury Environmental contamination Difficult to manage
Damaged and/or displaced vessels	Fishing and recreational boats	Domestic and commercial fishing boats (small and big), passenger ferries, yachts, and traditional canoes	-	-	M-H	M-H	L-M	Personal injury Environmental contamination Difficult to manage

L: low waste volume expected; M: medium waste volume expected; H: high waste volume expected

2.2 Introduction to Rapid Disaster Waste Assessment

A rapid disaster waste assessment is an initial evaluation of the waste generated in the areas impacted by a disaster. It is generally conducted between 24 to 72hrs after the disaster event occurs.

Section 5.6 below and Annex 5 should be taken into consideration by the Assessment Team

Rapid waste assessments are conducted to gather data (at a high level) about the waste types and volumes that have been generated, to calculate the number of containers and trucks/vehicles that will be required to clear the wastes, and to predict the size of areas required for temporary storage of collected waste. The rapid assessment is also used to identify any hazardous or acute situations that will require immediate attention and priority clearance (e.g. road blockages, evidence of uncontrolled hazardous materials). Technical expertise may be required to manage hazardous materials.

The information gained from a rapid assessment is used to develop a disaster waste (management) implementation plan and to prioritise waste transfers from disaster sites to temporary storage or final disposal locations.

Rapid disaster waste assessments are usually carried out at multiple locations across the disaster area to record the:

- Number and type (e.g. house, shop, warehouse) of properties that have been damaged
- The extent of damage to buildings (e.g. partial, destroyed)
- Potential waste materials based on the common construction types
- Location of damaged buildings
- Number of vehicles damaged
- Number of deceased animals
- Location of road blockages and piles of debris or vegetation
- Location of hazardous materials and waste situations that are potentially dangerous to the community and the environment

The rapid assessment of buildings, infrastructure and piled rubble and wastes must be done safely and only in circumstances where emergency services have cleared the area for entry

Life threatening situations are prioritised and locations with large populations (depending on the extent of the damage) are usually a priority for management

The location of priority sites are mapped and their waste management response is prioritised using the risk assessment process to enable a coordinated and safe disaster waste management response

The initial rapid disaster waste assessment can be completed using:

- An on-site rapid assessment of property and structure damage and the coinciding piled debris wastes is conducted by rapid response teams[5]. (Each team is allocated an area within the disaster affected zone and, using the prescribed methodology, records the estimated volume and type of disaster waste materials while also identifying potential or apparent hazards in the affected area); or
- In circumstances where information regarding to the disaster affected areas and the extent of damage is not immediately available or when access to undertake site visits for rapid assessments is not possible, the use of aerial (e.g. drone) or satellite imagery may be used to

[5]Rapid Assessment Teams would be usually established by the Disaster Waste Assessment Taskforce of the Disaster Waste Working Group or Cluster

determine a rough order of magnitude assessment of the quantities of disaster waste generated.

The rapid assessment considers the safe handling, transport, storage and disposal requirements for each type of disaster waste; and may also assess whether the materials are suitable for:

- Recovery and reuse *in situ*; or
- Transfer to a temporary waste storage site where recovery for recycling can be safely undertaken; or
- Transfer directly to a disposal site.

Information on potential pathways for disaster waste management is provided in **Annex 5** Disaster Waste Technical Guidance. The management and disposal of disaster waste is determined on a case-by-case basis according to factors such as:

- Safe access to waste materials
- Risks associated with processing mixed debris and waste *in situ*
- Risks associated with mixed debris containing putrescible wastes capable of attracting vectors
- Needs of the community in accessing the debris located on their property for rebuilding purposes
- Location in which the disaster waste is present and any nearby sensitive receiving environments.

Information collected during the rapid waste assessments can be expanded to achieve greater accuracy and a more detailed understanding of waste sources, types, volumes and their ownership during later stages of the disaster response by trained and qualified engineers.

2.3 Safety in conducting a Rapid Disaster Waste Assessment

Maintaining personal and public safety is critical when conducting rapid disaster waste assessments. Rapid assessment teams are provided with individual personal protective equipment (PPE), measurement and hand tools and essential communications equipment. The procurement of basic PPE should be arranged before a disaster occurs, including specialist asbestos PPE. The essential personal protective equipment items to be allocated to rapid assessment personnel are identified in **Figure 1**.

During the rapid assessment of disaster waste, tools and equipment will be required to ensure safe assessments can be conducted and that workable communications in place should an emergency arise. The essential equipment to be allocated to each rapid assessment team is provided in **Figure 2**. In addition:

- A Hi viz safety vest should be worn if heavy machinery is operating and/or the need for visibility is important, which is usually the case.
- Is asbestos containing material (ACM) debris is present, then a half face respirator with particulate filters will be needed, as well as disposable overalls and gloves. ACM management procedures should be followed.

Figure 1: Personal Protective Equipment for Rapid Assessors

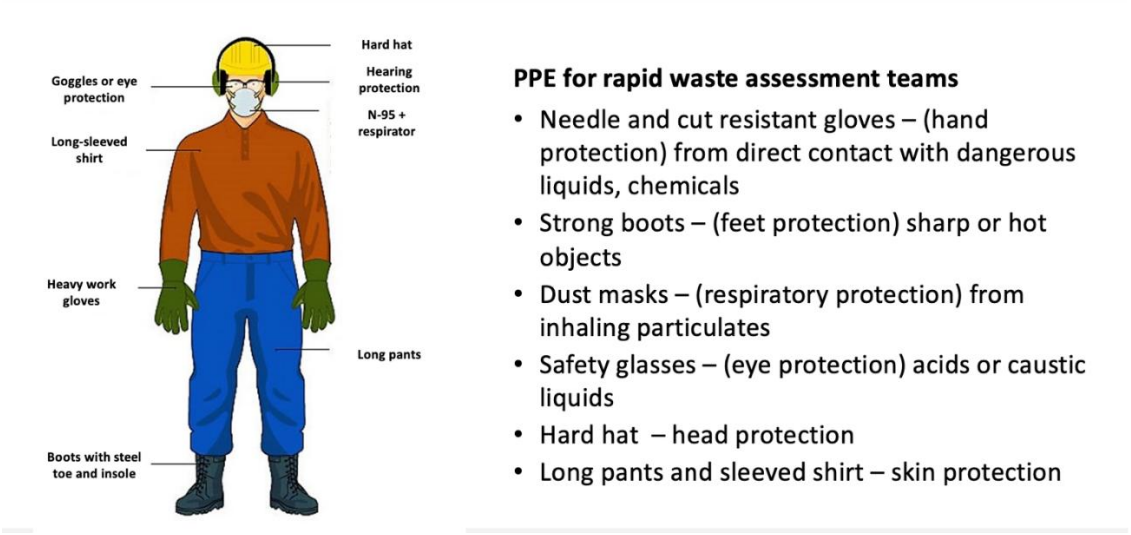


Figure 2. Essential equipment for rapid assessment teams

2.4 Steps in conducting a Rapid Disaster Waste Assessment

Ahead of conducting a rapid disaster waste assessment the following information and resources are prepared:

- Location/street maps of disaster zones for issue to rapid assessment teams;
- Forms (paper and/or ipad) for recording and reporting rapid waste assessment data;
- Public information regarding disaster waste management safety and rapid assessment activities; and
- Safety and communication equipment for each of the rapid assessment individuals and teams.

The rapid assessment teams are then mobilised and:

- Allocated identification badges (or other form of official identification);
- Briefed on safe work methods;
- Allocated individual PPE;
- Allocated communication and other essential equipment

The Disaster Waste Assessment Taskforce leader of the Disaster Waste Working Group will have been briefed on access to disaster waste locations by the national Disaster Management Office and will allocate specific areas to each rapid assessment team in which to complete disaster waste rapid assessments.

2.5 Disaster Waste Quantity Estimation

Estimation of the quantity of disaster waste is based on an approximation of the volume and weight of the disaster waste. This is a common approach used for disaster waste assessment and used throughout this guideline.

Measuring the volume (m^3) of the disaster waste debris that is in dispersed piles or in building sections/infrastructure that remain standing, is essential to estimate the weight and volume of the waste materials to be transported and the land area that will be required to store or dispose of the wastes.

***Note**: Precise measurements are difficult to achieve in a disaster situation*

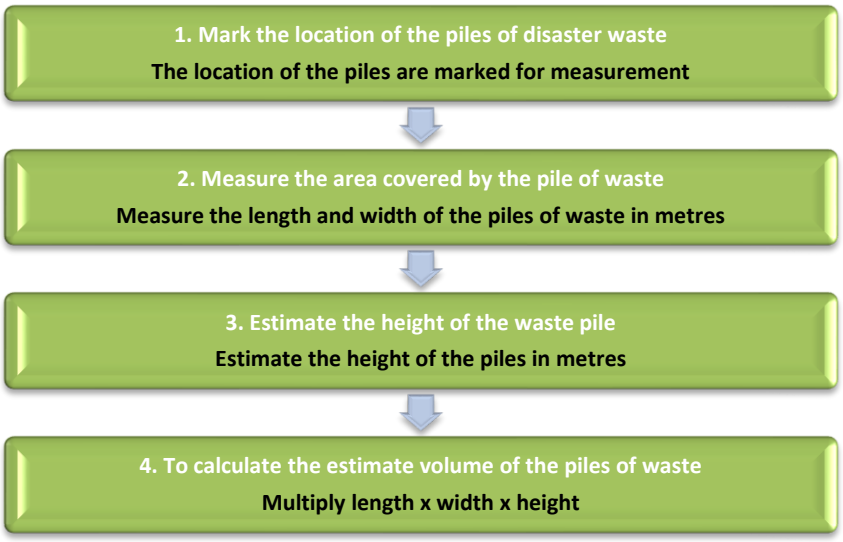
The techniques provided in this guideline illustrate how to estimate the following key disaster waste data:

- Disaster waste volume
- Disaster waste weight
- Land size that will be required for a waste storage facility
- Number of truck loads needed to remove the waste.

The forms used to record the data and information gathered from the rapid assessments are provided in **Annex 4** and as an excel spreadsheets in Attachments 1-3 of this guideline to enable analysis of the overall findings. These techniques may also be used during the more detailed waste assessments by trained engineers in the later recovery stage of the disaster response.

The sequential steps used to estimate the volume of disaster waste are provided in **Figure 3**.

Figure 3: Steps to estimating the volume of disaster waste



In general, all waste estimates are measured in linear metres for calculation to cubic metres (volume) e.g. multiply length (in metres) x width (in metres) x height (in metres) to calculate the waste volume (m^3)

Cubic metres (m^3) can be converted to weight using a density unit for each type of waste material. The density measures the degree of solidness or compactness of a waste material. All weight estimates are measured in tonnes.

2.5.1 Methods for Measuring the Quantity of Disaster Waste

Either visual or physical methods can be used for estimating quantities of disaster waste. Visual measurement methods may include:

- Using the size of a comparison item to estimate the size of the debris pile or area:
  - For smaller areas use of an item of known length e.g. a piece of timber that is 1 metre in length to compare against the length and width and height of the pile and to calculate the m3; or
  - For larger areas and particularly for piled debris over 2 metres in height, using the footprint of a 20' shipping container (i.e. approx. 5.9m long (round off to 6m) and 2.35 metres wide (round off to 3m) and 2.4 metres high (round off to 2.5m) to establish how many containers would fit in the spreading debris area to calculate the m3; or
  - Use a visual estimate such as 20ft shipping container volume of 33m3 and visualise the number of shipping containers that be needed; or
  - Be familiar with the size of a 1m3 cube and imagine how many fit in the spreading debris area.

- Using satellite imagery and the common buildings categories established during the disaster preparation or contingency planning stage (refer **Section 4.5.2** below) to:
    - Estimate the quantity of debris according to the extent of damage that has occurred to the number and type of buildings previously standing in an area that has been impacted by the disaster. Note this method is most valuable when satellite imagery is available for pre- and post-disaster times and where a register of building categories has been prepared, refer **Section 4.5.2**.

Physical methods for estimating quantities of disaster waste may include:

- Stepping out the debris pile or area using a 1 large step = 1 metre measurement
- Using a tape measure (reel) or measuring wheel
- Mobile phone measure apps
- Laser distance measure or GPS.

The type of measuring methodology used will depend on the circumstances and availability of equipment and internet connectivity. The calculations used to estimate disaster waste quantities are explained in the following section and are used to complete the Rapid Disaster Waste Assessment Sheet: PART B - Manual Disaster Waste Estimation. The data collected by the rapid assessments is entered into the Disaster Waste Estimation Database (**Attachment 1)** for analysis purposes.

The University of Newcastle[6] has also developed a set of formula to assist in calculating quantities of disaster waste debris, container loads and temporary storage areas, refer to **Annex 6.**

2.5.2 Estimated the Volume of Debris from Damaged Buildings using Building Category

The pre-disaster planning phase may have prepared a register to categorise buildings by their type, as per the below example:

1. Traditional house;
2. Informal house;
3. Engineered building including house, shops; and
4. Larger structures and infrastructures including warehouses, industrial sites, schools, hospitals.

For each building category, a general material composition is established to include the common building materials used in construction of each category of building. Where the building has several levels – each level is counted as one building. **Table 3** provides an example approach to preparing buildings and material composition estimates but should be relied upon as providing any level of accuracy. The inclusion of this approach in the guideline is for example purposes only.

The building category approach can only provide a rough order estimate of the extent of damage.

[6]University of Newcastle (2022). *Practitioners Guideline and Introduction of Systems to enable Pacific Islands to Effectively Manage Disaster Waste*. Unpublished report to SPREP. 68p.

Table 3: Example register of building category and material composition estimates

Building structure	Material composition (example only)	% composition	Est. average material volume per m²
Traditional house	Wood	30	
	Bamboo	20	
	Palm leaves	15	
	Grass	10	
	Rattan and vines	10	
	Mud and clay	5	
	Furniture and fittings	5	
	Other	5	
Informal house	Corrugated metal	60	
	Wood	20	
	Cloth/fabric	5	
	Mud and clay	5	
	Furniture and fittings	5	
	Other	5	
Engineered building	Concrete, bricks, blocks, stones, footings	80	
	Plasterboard sheeting	1	
	Furniture and fittings	5	
	Timber	5	
	Tiles	1	
	Metals (roofing, walls, fences)	6	
	Other	1	
Larger structures	Metals (roofing, walls, fences)	60	
	Concrete, bricks, blocks, stones, footings	20	
	Timber	5	
	Furniture and fittings	10	
	Other	5	

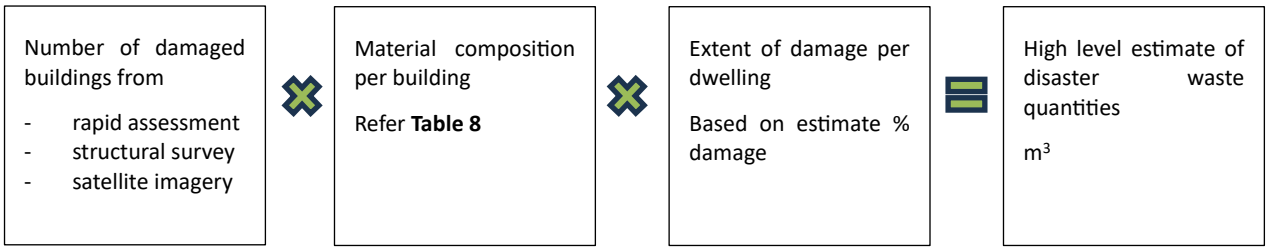
Additional information that may assist in estimating the quantity of debris from damaged buildings, and to understand the number and type of housing and buildings in urban and rural locations may be available through the:

- Local municipality;
- National census; or
- Pre-planning conducted by the National Disaster Management Office.

The housing categories will have been mapped in each municipal area during the Preparation Stage as part of the contingency planning in the National Disaster Waste Management Plan. These maps will broadly identify where and in what numbers these buildings exist prior to a disaster and will be accompanied by aerial or satellite imagery. These images should be updated on a regular basis as part of the overall Preparation Stage to ensure the most current mapping is available for the rapid disaster waste assessments.

The pre- and post-disaster aerial or satellite imagery can be used to compare and estimate the quantity of debris from damaged buildings. This methodology for high level estimation of disaster waste quantities is very useful in circumstances where property level damage assessments cannot be made immediately where situations are not safe for on-site rapid assessment.

This methodology may also be used to support the on-site rapid assessments.



***Note**: the rapid assessment **is not a structural assessment** of damaged buildings. Structural assessments are conducted by qualified and trained engineers to determine whether the buildings are habitable, able to be made habitable or are designated for removal during the recovery phase.*

2.5.3 Estimated the Volume of Debris from Damaged Buildings through On-site Assessment

The following methodology is suitable to use when assessing the potential waste materials that remain in a damaged building i.e. where sections of the building remain standing. An estimation of the debris from damaged buildings that are still partially standing can be made using a visual measurement, tape measure or by stepping out the distance (e.g. 1 long stride = 1 linear metre). The following method can be used to estimate the potential disaster waste volume.

Table 4: On-site assessment of building debris

<table>
<tr><th colspan="2">Methodology for Measuring Building Debris</th></tr>
<tr><td>Figure 4. Disaster waste area
  </td><td>1. Mark out the area for assessment
2. Use visual or physical methods to estimate the:
3. Length of the building or building foundation/slab;
4. Width of the building slab;
5. Height of the partial building;
6. Number of stories or levels the building originally had;
7. Percentage of the original building that remains standing;
8. Record these measurements in the rapid assessment sheet</td></tr>
<tr><td rowspan="2">Example Calculation

For estimating the volume of debris that is dispersed around the property</td><td>Use the car in the driveway in Figure 4 as a guide. The width of the car can be estimated at around 2m, which, when compared to the foundation slab of the building shows the foundation to be approx. 6m in width and 12m in length.
• Length is approximately 12m (L)
• Width is approximately 6m (W)
• Height average is 2.4m (H)
• How many stories x 1
• Factor the original building that remains standing at approximately 10%
• Factor the airspace void within the building at approximately 67% (leaving 33% fittings, furniture etc).</td></tr>
<tr><td>The volume of debris spread around the property can now be measured using:

12mL x 6mW x 2.4mH x 1 level x 90% demolished x 33% non-void = 51.32m^3</td></tr>
<tr><td>Example Calculation

For estimating the amount of building waste remaining in the standing building</td><td>The volume of material remaining in the standing building can now be measured using:

12mL x 6mW x2.4mH x 1 level x 10% standing x 33% non-void = 5.7m^3</td></tr>
</table>

Be aware of the potential for asbestos containing building materials in the debris. This material won't always be immediately identifiable but may be contained in:

- External and internal cement sheeting (cladding)
- Cement corrugated roof sheeting
- Pipe lagging
- Vinyl flooring
- Sewage and water pipes
- Electrical switchboards

Where cement sheeting or corrugated roofing materials are identified, precautionary principles should be applied – and the location mapped as potentially asbestos containing, for immediate response actions (e.g. prevent entry; wetting down or wrapping/containment arrangements).

Note: the rapid assessment should only step out the building size if safe to do so. Otherwise only use visual estimates to measure the original size of the building

2.5.4 Estimated the Volume of Disaster Waste Piles

The volume of each pile can be calculated by multiplying the length of the pile by the width of the pile by the average height. All dimensions should be the same linear metre unit measurement. The volume or cubic metric (m^3) of the waste can then be calculated from the linear metre measurements.

Additional methods include:

- The use of an item of known length e.g. a piece of timber that is 1 metre in length. Once the area of assessment is marked out, use the length of timber to estimate the number of lengths to measure length, width and height of the pile or spreading debris; and/or
    - The use of a visual estimate such as 20ft shipping container volume of 33m3 and visualise the number of shipping containers that be needed by volume.
    - Alternatively, use the footprint of a 20ft shipping container to measure the area e.g. approx. 5.9m long (round off to 6m) and 2.35 metres wide (round off to 3m) and 2.4 metres high (round off to 2.5m).

The following calculations are suitable to use when assessing the potential waste materials that are in piles or spread across an area. The volume of the total waste equals the sum of each pile onsite.

2.5.5 Estimate A: Dispersed debris volume

For this type of debris, a simple estimation of the length, width and height in metres can be made using a stepping out method, a tape measure or wheel. A visual estimation may also be made guided by a 1m length of timber or 20ft shipping container dimensions. The following comparison calculation can also be used to measure dispersed debris or debris that are in piles that are square or rectangle shaped.

Table 5: On-site assessment of dispersed construction debris

<table>
<tr><th colspan="2">Methodology for Measuring Disbursed Construction Debris</th></tr>
<tr><td>Figure 5. Dispersed construction debris
  </td><td>1. Mark out the area for assessment
2. Step out the base length and width of the pile; or
3. Visually estimate these measurements using the blue drum next to the pile which is approx. .5m in diameter and 8m in height;
4. Visually estimate the height of the pile to the length or width to determine how high the pile is; or use the bin height.
5. The pile may be estimated as 1m at its highest point and .5m at its lowest. For this example use a mid-estimate of .75m high.
6. Record these measurements in the rapid assessment sheet</td></tr>
<tr><td rowspan="2">Example Calculation

This estimation methodology uses a comparison object (e.g blue waste drums) .5m diameter and .8m height) the debris can also be seen to be around 8 drums in length, 3 drums in width and ,75m in height</td><td>• Length is 8 x .5m = 4m (L)
• Width is 3 x .5m = 1.5m (W)
• Height is = .75m (H)</td></tr>
<tr><td>A cubic metre can now be measured using:

4m L x 1.5m W x .75m H = 6m^3</td></tr>
</table>

2.5.6 Estimate B: Piled debris volume

Like the previous example, the estimation for this type of debris pile can use a simple estimation of the length, width and height in metres using a stepping out method, a tape measure or wheel. A visual estimation may also be made guided by a 1m length of timber or 20 ft shipping container dimensions.

Measuring a pile that is more cone shaped requires an additional step in the calculation to account for the lost or void space created by the top of the pile that would not need to be accounted for a square or rectangular shaped pile.

Table 6: On-site assessment of disaster waste pile

Methodology for Measuring Disaster Waste Pile	
Figure 6. Disaster waste pile 	1. Mark out the area for assessment 2. Step out the base length and width of the pile; or **3.** Compare the size of the length and width to a known or comparison similar distance 4. Visually compare the top point of the pile to the length or width to estimate the height of the pile. 5. Divide the heigh measurement by a factor of 3 to account for the void space either side of the peak of the pile 6. Record these measurements in the rapid assessment sheet
Example Calculation *This estimation methodology takes account of the void space around the peak of the pile.*	• Length is 2.76m (L) • Width is 2.76m (W) • Height is 1.15m divide by 3 (to account for the peak of pile) (H)
	A cubic metre can now be measured using: 2.76m L x 2.76m W x 1.15m H / 3 = **2.92m^3**

2.6 Estimate the Volume of Vehicle Waste

The volume of the car (or other vehicle) can be calculated by multiplying the length of the car by the width and the average height of the car. However, there remains a significant void space in the car which needs to be accounted for if the volume is to be converted to weight. In this circumstance it can be assumed the car will be compacted prior to transport and the volume can be reduced by up to 50%.

If the vehicle cannot be compressed prior to removal, then the full m^3 is used to calculate the space required on the truck. However, it should not be used to estimate its weight.

Note: In some circumstances it is quicker to record the vehicles by number for later calculation of volume and weight.

Table 7: On-site assessment of damaged vehicles

Methodology for Measuring the Volume of Damaged Vehicles	
Figure 7. Damaged vehicle 	1. Mark out the area for assessment 2. Step out the base length and width of the car; 3. Visually compare the height of the car to the length or width to determine how high the car is; 4. Assume a 50% void space in the vehicle and/or the vehicle will be compacted by 50% prior to transport to reduce the volume; 5. Record these measurements in the rapid assessment sheet
Example Calculation *This estimation methodology uses dimensions for an average size car.*	• Length is 4.2 metres (L) • Width is 1.8 metres (W) • Height is 1.2 metres (H)
	A cubic metre can now be measured using: 4.2m L x 1.8m W x 1.2m H = 9.07m^3 – 50% = **4.53m^3**

2.7 Estimate the Volume of Drums and Containers

Drums and container numbers and volumes are important to record, particularly if they contain, have contained, or are suspected of containing hazardous materials such as chemicals, oils, petroleum etc. Section 5.6 below and Annex 5 should be taken into consideration when carrying out these assessments.

The rapid or detailed site assessments will also record the type of materials that are contained in the drums using the information provided on the labels. If the labels are missing and the contents are unknown, this should be made clear in the assessment report as the handling, loading and transport of these unlabelled drums and containers will need to be undertaken by technically trained personnel.

Important:

- **The assessor must not come into contact with the contents of the drums/containers**. If visible leakage has occurred, the drums must not be handled. **Appropriate PPE is required to undertake these assessments – see also comments in Section 5.6 below and Annex 5.**
- Use photos to record the labels on the containers. Enlarge the photos to identify the contents of the containers for recording purposes and to notify priority clearance.
- In circumstances where drums and containers can be seen to be damaged e.g. rusted, split, the content may be leaking. An assessment will be made on whether spill

containment/bunding will be required and this will be noted as a priority clearance in the assessment documentation.

The volume of full drums or containers can be calculated using three methods:

- Multiply the number of drums by their size e.g. 40 x 205L steel drums and convert the litre volume of the drums to cubic metres (refer calculation A. below), this is recommended for drums of chemical materials;
- Estimate the measurement of the entire pile of drums using length x width x height and convert to cubic metres (refer calculation B. below)
- If the volume of the drums are unknown, estimate the volume of a single drum using diameter x diameter x height x 75% (to account for the space difference between a cube and a cylinder). Multiply this measurement by the number of drums that can be seen and convert to cubic metres.

If the drums are partially empty the calculation methods will need to account for the void space.

When the objective is to measure the contents of the drums, use a percentage to calculate the level of contents inside the drum e.g. 75% for a ¾ full drum. When converting this to weight use a density measure that matches the materials within the drums e.g. example below waste oil is .8t per m^3.

When the objective is to measure the volume of the drums, they should be treated as uncompacted. This is because the volume of the drums (regardless of how full they are) will be needed for transport purposes.

These measures are undertaken to determine transport volumes and to also estimate the volume of potentially hazardous wastes contained in the drums to ensure safe handling and storage.

2.7.1 Example A: Measuring drum volume

This estimation method calculates the volume of the contents of the drums. Using engine oil as an example, the following measurement can be made to estimate the volume/m^3. This estimation methodologies below are useful when considering appropriate storage area for liquid waste that are able to be safely decanted to minimise storage area. This should only be undertaken by trained personnel.

Table 8: On-site assessment of drums and containers content

Methodology for Measuring the Volume of Drums and Containers by their Litre Capacity	
Figure 8. Full and partially full drums 	1. Mark out the area for assessment 2. Estimate the number and size of the drums seen in the pile e.g. 40 x 205L; and 3. Assume the drums are full 4. Record these measurements in the rapid assessment sheet
Example Calculation The estimation methodology can be used to convert total litres contained in the drums to volume (m^3)	A cubic metre can now be measured by converting the total litres to total cubic metres: 40 (drums) x 205L / 1,000 = **8.2m^3**
Example Calculation	A cubic metre can now be measured using 40 (drums) x 205L / 1000 x 75% = **6.15m^3**

The estimation methodology can be used to convert total litres contained in the drums to volume (m^3) – where the drums are assumed/identified as being partially full	

2.7.2 Example B: Pile of empty drums volume

This estimation method calculates the volume (m^3) of drums that will be transported. In this case no compaction factor is to be included. Note: If the drums cannot be compressed prior to transport then the full m^3 can be used to calculate the space required on the truck. However, it should not be used to estimate its weight.

Table 9: On-site assessment of piles of drums and containers

Methodology for Measuring Drums and Containers by the Size of the Pile	
Figure 9. Damaged drums 	1. Mark out the area for assessment 2. Estimate the length x width x height of the pile of drums; and 3. Record these measurements in the rapid assessment sheet
Example Calculation The estimation methodology can be used to convert the size of the drum pile to volume (m^3) and assumes the drums are empty.	A cubic metre can now be measured using: (e.g.) 10m L x 10m W x 3m H = **300m^3**

2.8 Estimate the Weight of Disaster Waste

The following calculations are used when estimating the weight of the disaster waste materials.

The weight of the disaster waste material can only be measured from the m^3 (volume) estimations of the waste.

Note that each estimation method refers to the density of materials which is their weight (tonne) per cubic metre (m^3). Examples of densities are provided in **Table 10** below and a detailed list of waste material densities is provided in **Attachment 2** Density Conversion Sheet.

2.8.1 Example A: Construction debris weight measurement

Table 10: On-site assessment of the weight of construction debris piles

<table>
<tr><th colspan="2">Methodology for Measuring Construction Debris Piles</th></tr>
<tr><td>Figure 10. Construction debris pile
  </td><td>Using the construction debris pile in Section 4.4.1 (Example A) above we can convert the volume to find its estimated weight using the density of concrete slabs in Table 11 below.

Use the density of concrete to estimate weight:
• The density of concrete is 1.5 (tonne per m^3);
• Calculate the m^3 by the density to estimate the weight of the pile</td></tr>
<tr><td rowspan="2">Example Calculation

The estimation methodology can be used to convert the volume (m^3) of the construction debris to weight</td><td>• Volume of pile is = $6m^3$
• Density of the pile is = 1.5 t/m^3</td></tr>
<tr><td>A weight for the concrete and stone pile can now be measured using:

$6m^3$ x 1.5 = 9 tonne</td></tr>
</table>

2.8.2 Example B: Drum and drum content weight measurement

Using the full drum example in **Section 4.7.1** above, the volume can be converted to find the estimated weight by using a waste oil density of 0.8 tonne per cubic metre.

Table 11: Calculating the weight of full drums and containers

<table>
<tr><th colspan="2">Methodology for Measuring the Weight of full Drums and Containers</th></tr>
<tr><td>Figure 11. Drums pile
  </td><td>• Volume of the drums are = 8,200 litres / 1000 = $8.2m^3$
• Density of waste oil is = 0.8 t/m^3</td></tr>
<tr><td>Example Calculation

The estimation methodology can be used to convert the volume (m^3) of the contents of a drum to weight</td><td>A weight for the waste oil drums can now be measured using:

$8.2m^3$ x 0.8 = 6.5 tonne</td></tr>
</table>

2.8.3 Example C: Drum and drum content weight measurement

Using the empty drum example in **Section 4.7.2** above, convert the volume to find the estimated weight by using an empty drum density of 0.08 tonne per cubic metre.

If the drums are intact and not damaged a factor 20kg per 205L drum or 0.08 tonne per cubic metre density can also be used. For 20L steel containers the measure would be approximately 5kg per container or 0.02 tonne per cubic metre.

Table 12: Calculating the weight of a pile of empty drums and containers

Methodology for Measuring the Weight of Empty Drums and Containers	
Figure 12. Drums pile 	• Volume of the drums are = 300m^3 • Density of empty steel drum is = 0.08 t/m^3
Example Calculation The estimation methodology can be used to convert the volume (m^3) of the empty steel drum to weight	A weight for the empty waste oil drums can now be measured using: 300m^3 x 0.08 = **24 tonne**

Table 13: Example of common disaster waste densities

Waste Material	***Density (tonne per m^3)***
Rubble and rock	1.4
Metal heavy gauge	0.9
Metal light gauge e.g. whitegoods, drums, vehicles	0.21
Empty undamaged 205L steel drums	0.08
Concrete slabs, walls (broken)	1.5
Bricks/blocks	1.2
Stone/ gravel	1.5
Sand	1.6
Soil	1.2
Mixed green waste/vegetation uncompacted	0.15
Wood - tree	0.3
Mixed building debris	0.72
Waste oil	0.8
Mixed furniture and fittings	0.1

Refer to **Annex #** Density Conversion Sheet

2.9 Estimate the Number of Disaster Waste Collections Required

The following calculations are used when estimating the number of containers and trucks that will be required to transfer the disaster waste materials to a storage area or to a disposal site. Both the weight (tonne) and the volume (m^3) of the disaster wastes are needed for these estimations.

The transfer of the disaster waste may be restricted by the **gross weight limit** in circumstances where the carrying capacity of the roads and bridges that the waste load will need to travel over have been reduced due to damage. In these circumstances it is better to underestimate allowable load limits when calculating how many trucks and truck movements will be required.

Gross weight is made up of:

- Container weight
- Truck weight
- Load weight.

When it is not possible to measure the load weight then volume capacity must be used.

In either circumstance it is recommended that pre-compaction of disaster waste such as end-of-life vehicles be considered prior to loading. This can be achieved using front end loaders or excavation mobile plant to improve the load efficiency and reduce the number of truck movements required. However, the compaction of materials must not result in a transport vehicle being loaded beyond its legal capacity.

Certain materials may also create void spaces when loaded onto a truck (e.g. steel and timber spars may prevent loads from filling). In this circumstance it is similarly recommended where possible:

a) These types of materials be sorted and pre stacked ready for transport; or
b) Compacted prior to loading (as above)

If pre-compaction is not possible, consider factoring a percentage loss into the calculation. e.g. 20% space lost to air (void) in the load.

The following vehicles may be used during the waste clearance, where available. The suggested vehicle capacities are provided in **Table 14** below and also in **Attachment 1:** Disaster Waste Estimation Database (excel).

Table 14: Vehicle capacities

Vehicle type	***Container/ Vehicle capacity***	
	**Volume (m^3)*	**Load Weight (t)*
20m^3 shipping container (weighs 2.3 tonne)	33	21
40m^3 shipping container (weight 3.7 tonne)	69	26
10m tipper vehicle	8-10	12
Large tipper	7	7
Medium tipper	6	6
Small tipper	4	4

* Consider factoring a 20% load loss to void space

Using the debris pile example, the calculation for measuring the number of truck/container movements is as described in **Table 15** below.

Table 15: Calculating the number of truck loads by weight and volume - small amounts

Methodology for Measuring the Number of Truck Loads (m^3 and t) Required for Small Amounts of Debris	
Figure 13. 10m/12t tipper truck 	1. Use an average of 12 tonne truck weight limit for the container or truck; and 2. Subtract the 9t weight of pile of concrete (**Section 4.7**) from the 12-tonne truck weight limit (as it is less than the truck capacity).
Example Calculation *The estimation methodology can be used to calculate the number of loads that will require transport by weight*	The weight of construction debris pile is less than the capacity of the truck. More waste is needed to fill this load. The number of loads can now be measured using: 12t – 9t = -**3t (remaining weight)** The volume of the load will also be required: • Use an average $9m^3$ volume limit for the container or truck; and • Subtract the volume of materials from the volume capacity of the container or truck (as it is less than the truck capacity).
Example Calculation The estimation methodology can be used to calculate the number of loads that will require transport by volume (m^3)	The volume of the construction debris pile is less than the capacity of the truck. More waste is needed to fill this load. The number of loads can now be measured using: $9m^3 – 6m^3$ = -**$3m^3$ (remaining space)**

If there were 20 similar sized piles of concrete and rock waste to be transferred, the following calculations would be used.

Table 16: Calculating the number of truck loads by weight and volume - large amounts

Methodology for Measuring the Number of Truck Loads (m^3 and t) required for Large Amounts of Debris	
Figure 14. 10m/12t tipper truck 	1. Use an average of 12 tonne transport weight limit for the container or truck; 2. Multiply the weight of the pile by 20; and 3. Divide the 12-tonne load limit by the combined weight of the 20 piles.
Example Calculation *The estimation methodology can be used to calculate the number of loads that will require transport by weight*	The number of loads can now be measured using: 9t x 20 piles / 12t = **15 loads are required** 1. The volume of the load will also be required: 2. Use an average $9m^3$ volume limit for the container or truck; 3. Multiply the volume of the pile by 20; 4. Divide the $9m^3$ volume load limit by the combined volume of the 20 piles.
Example Calculation *The estimation methodology can be used to calculate the number of loads that will require transport by volume (m^3)*	The number of loads can now be measured using: $6m^3$ x 20 piles / $9m^3$ = **13 loads are required**

2.10 Estimation of the Temporary Storage Area Required for the Disaster Waste

The following calculations are used when determining the land area (m^2) that will be needed to create temporary storage sites for stockpiling mixed or separated wastes. The land areas (m^2) can only be estimated once the volume (m^3) of the disaster waste materials is known.

The example below uses the concrete and rock pile in Section 4.5.5above to measure m^2 land space required for temporary storage.

Table 17: Calculating the space required for disaster waste storage

Methodology for Measuring the Area (m^2) Required for Storing Disaster Waste Materials	
Figure 15. Construction debris pile 	• Divide the total volume (m^3) of the disaster waste (requiring storage) by the average height of a temporary storage piles e.g. 3m. • The height will be dependent on the materials to be stored; however, a general rule is to not exceed 3 metre in height • Multiply this by 1.7 to allow for vehicle access to deliver the total area in m^2 required for the temporary storage site
Example Calculation *The estimation methodology can be used to calculate the area (m^2) need to store the disaster waste* Note: 10,000m^2 = 1 hectare	A square metre can now be measured using: 6m^3 x 3m x 1.7 = **3.4m^2** and *3.4m^2 / 10,000 = .00034 hectares*

Note: As a rule of thumb around 4,000m^2 (or 0.04 hectare) of land is needed to process one million m^3 of waste[7].

2.11 Disaster Waste Data Analysis

The data and information collected during the rapid assessment conducted early in Stage 4: Response and the detailed assessments conducted early in Stage 5: Recovery are analysed to assist broader scale decision making to effectively and efficiently:

- Prioritize the management of acute waste issues during the immediate response stage
- Calculate the clearance and collection schedules and the number and type of bins/trucks required
- Determine the location and size of the temporary storage facilities
- Determine the storage and containment facilities required for the range of hazardous wastes generated by the disaster

[7] UNEP Disaster Waste Management Planning, Annex XII

The outcome of the analysis is also used to:

- Update the Implementation Plan with the inclusion of immediate (Response) and longer term (Recovery) actions
- Estimate the costs associated with each of the actions for budget preparation
- Prepare for and implement the planned and budgeted actions in a coordinated and systematic manner
- Monitor and report on the delivery of the actions within the Implementation Plan

Furthermore, the baseline data prepared during the contingency planning phase (Stage 1: Preparation) can be used to understand the household, commercial and industrial wastes that can be expected to resume during the recovery stage of the disaster.

The baseline data together with the disaster waste data can also inform the design of replacement or additional disposal and recycling infrastructure that may be needed during the recovery stage and in to the future.

The analysis stage will therefore require assessors who are responsible for undertaking analysis of the data and information collected to assist planning for recovery, collection and disposal. They will ideally have a technical or working knowledge of:

- Different waste streams and their recovery and recycling capacities
- Recycling and landfill operations
- Mathmatics including density and volume calculation
- Vehicles and equipment used to transport waste materials e.g. tipper trucks, skip bins
- Mobile plant and equipment to clear road access e.g. wheel loaders, excavators, bobcats
- Building and demolition industry including the ability to identify such things as:
    - Asbestos types and condition, treated timbers, hazardous and chemicals wastes
    - Sludges and sediments
    - Building materials e.g. concrete, bricks, timber

The Disaster Waste Estimation Database (refer **Attachment 1**) is used for the analysis function. The data collected manually during the rapid and detailed assessments is entered into the database. The volume and weight are automatically calculated as are the transport requirements and the area needed to store the waste materials.

The database then enables the data to be sorted and filtered using pivot table functions (which are interactive tools for summarizing and analysing large datasets by allowing re-arrangement and filtering of data) to quickly and accurately deliver key calculations.

PART THREE: DISASTER WASTE RISK MANAGEMENT

3.1 Disaster Waste Hazards and Risks

The wastes that can be generated by disaster events may present hazards posing significant risks to impacted communities and the environment.

- A hazard is something that may negatively impact or cause damage or harm to public health, the environment and to public and private assets.
- A risk is defined as the likelihood of damage or harm occurring. Risks may be immediate and/or longer term and have the capacity to cause negative impacts if not managed appropriately and in a timely way.

Hazards associated with disaster wastes commonly include:

- Physical hazard examples:
  - Unstable piles of disaster waste including mud, silts, rock and sand
  - Debris from damaged buildings containing e.g. broken glass, steel sheeting
  - Exposed and damaged asbestos containing materials e.g. cement sheeting, pipe lagging
  - Fire within piles of disaster waste containing batteries, chemicals, ash
  - Fallen power cables
  - Uncontained hazardous waste materials

- Biological hazard examples:
  - Water inundated debris and rotting waste piles resulting in vector-based diseases e.g. malaria,
  - Uncontained health care wastes resulting in the spread of infectious disease due to exposure
  - Raw sewage

- Environmental hazard examples:
  - Uncontained dust generating wastes and release to the air environment
  - Uncontained putrescible wastes in proximity to soil and water environments
  - Uncontained packaging wastes e.g. plastics and litter release to air environment and in proximity to soil and water environments

- Chemical hazard examples:
  - Uncontained chemical liquids, oils and fuels in proximity to soil and water environments
  - Uncontained and/or spreading chemical solids in proximity to soil and water environments
  - Firefighting foam residues in proximity to soil and water environments
  - Unmanaged gas cylinders

3.2 The Objectives of the Disaster Waste Risk Assessment

A disaster waste risk assessment is typically undertaken within 24 hours following the disaster in conjunction with the rapid assessment conducted during this timeframe. The disaster waste risk assessment evaluates any hazardous situations and materials identified during the rapid assessment. The risk assessment process will also be used during the more detailed disaster waste assessment conducted during the Recovery Stage.

Identifying the characteristics of disaster waste (e.g. hazardous) and the status of disaster waste (e.g. unstable piled debris or uncontained hazardous materials) is critical to evaluating the level of risk posed to the community and the environment. Risk assessments undertaken during the rapid

assessment process also prioritise the order in which risk mitigation actions are undertaken and the order in which disaster wastes are collected and cleared following a disaster.

3.3 Risk Assessment[8]

The following sections describe how to categorise and value potential risks to enable planning for priority and non-urgent longer-term actions.

- **A hazard:** A risk assessment commences with identification of the potential hazard. A hazard is something that may negatively impact or cause damage to public health, the environment and to public and private assets.
- **A risk:** The risk is the likelihood of damage or harm occurring. Risks may be immediate and/or longer term and have the capacity to cause negative impacts if not managed appropriately.
- **A risk assessment:** evaluates the hazard and relevant circumstances relating to the hazard, to determine the level and extent of the risk and the mitigating actions required to prevent harm.

3.3.1 Risk Likelihood

The following sections explain how disaster risk exposure is calculated based on the judgement of the rapid assessment team. The likelihood-impact matrix method is used for calculating the level of risk severity, priority, and urgency of action in response to each risk. According to this method, the likelihood and impact of risks are estimated and the exposure of the risk is then determined by multiplying these two scores.

Risk likelihood can be defined as the probability or chance of a threat occurring. The score for risk likelihood ranges from 1 to 5 depending on the probability of the risk occurring. Five levels of risk likelihood can be defined which include:

- Very unlikely (1)
- Unlikely (2)
- Possible (3)
- Likely (4)
- Very likely (5)

3.3.2 Determining the Impact of Disaster Waste

The impact of disaster waste can be defined as the estimate of potential losses associated with a disaster waste risk. It has broad consequences and depends on several factors. The impact score is determined by incorporating the following factors:

(F1) The **scope of impact** refers to the scale of disaster and its consequences. For example, a disaster may occur in a single area, but its economic impacts affect a whole country.

(F2) The **monetary loss** caused by a risk is estimated by considering the physical damages, indirect costs, and associated consequences on the environment.

(F3) The **recovery complexity** also determines the impact of risk due to the number of resources and effort involved in recovery of the associated damages. For example, damages imposed by a disaster that has more severe impacts can take longer to recover from.

[8] Extract: University of Newcastle (2022). *Practitioner's Guideline and Introduction of Systems to enable Pacific Islands to Effectively Manage Disaster Waste.* Unpublished report to SPREP. 68p.

(F4) **Time to recover** (rebuild) has been considered as a factor to estimate the risk impact. Time to recover refers to the amount of time required to arrange disaster waste collection and recovery.

(F5) The **vulnerable population** at risk assesses how many people are directly affected by the disaster. A certain disaster may impact few houses or may have more widespread impacts that involve residents of a region or even a state.

Table 18: Disaster waste risk impact score calculation example

Level (score)	***(F1) Scope of impact***	***(F2) Monetary loss***	***(F3) Recovery Complexity***	***(F4) Time to recover/rebuild***	***(F5) Total vulnerable population at risk***
1	*Local*	*Low*	*Low*	*Immediate*	*Less than 100*
2	Region	*Minor*	*Relative*	*Less than 1 year*	*100 - 1000*
3	Province	*Moderate*	*Moderate*	*1 – 3 years*	*1000 - 10000*
4	Country	*Major*	*Complex*	*3 – 10 years*	*10000 - 100000*
5	Several countries	*Serious*	*Extreme*	*More than 10 years*	*More than 100000*

3.3.3 Disaster Waste Risk Exposure and Threshold

Risk exposure is the measure of potential future loss resulting from a disaster event. It can be calculated by multiplying the likelihood and impact of disaster waste according to the following formula:

$$Disaster\ waste\ risk\ exposure = Risk\ likelihood\ score \times Disaster\ waste\ impact\ score$$

The level of risk exposure determines the management priority for the disaster waste. For example, the higher the level of risk exposure the quicker the response action needs to be.

Table 19: Disaster waste likelihood impact risk matrix

		Disaster Waste Impact Score				
		Negligible [0.2-0.25]	*Minor [0.25-0.4]*	*Moderate [0.4-0.6]*	*Major [0.6-0.75]*	*Severe [0.75-1]*
Risk Likelihood Score	**Very unlikely [0.1-0.2]**	*Low*	*Moderate*	*High*	*High*	*High*
	Unlikely [0.2-0.4]	Low	*Moderate*	*Moderate*	*High*	*High*
	Possible [0.4-0.6]	Low	*Low*	*Moderate*	*Moderate*	*High*
	Likely	Low	*Low*	*Moderate*	*Moderate*	*Moderate*

	[0.6-0.8]					
	Very likely [0.8-1]	Low	*Low*	*Low*	*Moderate*	*Moderate*

3.4 Risk Mitigation

There are a number of general risk mitigation measures that can be used to protect human health and the environment during rapid assessment and disaster waste management activities. These include but are not limited to ensuring:

- Disaster wastes that are assessed as posing a risk to life and the environment are prioritised for immediate response which may include containment, additional on-site management and removal. Noting that:
  - Rapid assessment teams operate in areas cleared for entry by emergency services and first responders within 24hrs
  - Lifesaving operations are led by emergency service trained personnel within 72hrs
  - The immediate containment of hazardous materials within 72hrs
- Services and utilities including gas, electricity and water are disconnected before attempting to assess and clear wastes;
- A structural engineering assessment involves conducting an assessment of damaged buildings to determine if they are safe to enter for the purposes of detailed disaster waste assessment and/or clearance;
- Personnel involved in waste sorting, collection and disposal are equipped with suitable PPE including dust masks (P3 recommended), high visibility clothing, hard hats, gloves and solid boots prior to activities commencing;
- Personnel involved in waste sorting, collection and disposal are vaccinated for tetanus and hepatitis A, B & C;
- The immediate treatment of cuts, abrasions and dust inhalation;
- Interim storage facilities are set up for mixed and segregated wastes if landfill/disposal/recycling facilities are inaccessible or damaged;
- Stockpiled materials:
  - have room for emergency vehicle and collection vehicle access;
  - are less than 3m in height and no more than 4 to 5 metres wide to ensure stability;
  - are clearly marked/signposted to identify recovered materials and residual wastes for collection and to notify of hazardous materials;
  - Critical information is provided to the community in a timely manner in regard to the sorting and removal of disaster wastes.

3.5 Analysis of Risks Associated with Disaster Wastes

The risk analysis register provided as **Attachment 3** is a tool that is suitable for use in disaster waste assessment conducted in both Stage 4 - Response and Stage 5 - Recovery. It is a spreadsheet able to receive data and information regarding the hazards and potential risks identified during the rapid assessments. The formulae within the spreadsheet calculate the priority response level of each risk and allows for broader scale analysis of risk issues and their mitigation response requirements.

The risk analysis tool delivers evaluated information to assist the preparation of the implementation plan for short term response actions. It is also able to be used to evaluate risks identified during the

detailed disaster waste assessment conducted in the Recovery Stage to enable further development of the implementation plan.

Annex 5 sets out in tabular form the management recommendations for the following categories of disaster waste:

1. Vehicles
2. Furniture and Domestic Items
3. Rubble
4. Mixed Waste
5. Metal Waste
6. Soil and Sediment Waste
7. Organic Materials
8. Animal Carcasses
9. Asbestos Containing Materials (ACM)
10. CCA Solids and Ash
11. Chemical Wastes
12. Healthcare / Medical Wastes
13. Bulk Fuels and Oils
14. Relief Aid Wastes

The following should be noted:

- **Asbestos Containing Material (ACM) Wastes** – asbestos wastes normally require management and disposal by trained personnel. In an emergency, however, quick action may be needed to clear debris. In this case:
    - proper PPE should be worn (half face respirator, disposable overalls and gloves, goggles and rubber boots).
    - The respirators and boots must be cleaned. The disposable overalls and gloves, and cleaning materials, should be double bagged and landfilled.
    - The ACM wastes should be double wrapped in plastic and landfilled. It should not be broken unnecessarily.
    - ACM contaminated materials and soil should be transported to the landfill in trucks that are lined or immediately washed, and covered immediately.
    - Trained personnel should be brought to site as soon as possible.
- **Bulk Fuels and Oils** – IF disasters cause bulk fuel and oil tanks to leak then care is needed to keep sources of ignition (e.g. flames, hot items and sparks) well away. Collected spilled liquids can be stored in drums and IBCs for export and disposal, or local incineration if available. Any contaminated soils should be treated with landfarming – i.e. spreading out and turning over regularly.
- **Chemicals, especially spilled chemicals**, should be treated with considerable caution, refer comments below:
    - If time permits and labels exist, Safety Data Sheets (SDSs) can be downloaded from the internet (search for chemical name plus SDS). SDSs are needed to fully understand the hazards and precautions needed for handling.
    - Incompatible chemicals should not be mixed together, especially oxidisers and flammables, or fires and explosions can occur.
    - Sources of ignition should be kept away from flammable chemicals.
    - PPE is needed for chemicals – half-face respirators with organic vapour filters, disposable overalls, chemical gloves, chemical goggles, rubber boots – specific PPE is set out in SDSs.
    - Care is needed with corrosives, especially strong acids and alkalis, and any contact with skin and eyes must be avoided.
    - Containment is needed if possible to avoid environmental contamination.
    - Disposal of chemical wastes will probably need to be by export, but some less hazardous chemical wastes can be landfilled to local managed landfills.

- Specialist advice should be called on as soon as possible.

It is advisable to have spill kits on hand so spills can be contained effectively. The contents of spill kits need to be checked regularly, and some training is needed in spill management.

PART FOUR: ENVIRONMENTAL IMPACT ASSESSMENT

Natural disasters such as cyclones, flooding, heatwaves and bushfires, earthquakes and tsunamis can result in a range of environmental impacts including loss of vegetation, wildlife and wildlife habitat, erosion, siltation, water and ground water contamination, and marine pollution and damage to coral reef and beach ecosystems[9].

Environmental protection and restitution involve the coordinated process of supporting disaster affected communities in both the response and recovery phases, refer **Table 20** below.

Table 20: Environmental management and impact assessment

Stage	Impact Assessment Actions
Response	High level identification of the impacts and risks associated with the disaster event - including air quality, water quality, soil and groundwater, landscapes, ecosystems and wildlife during the rapid assessment process and record these for further analysis
	High level identification of the immediate actions required to mitigate impacts to the environment from the disaster and report these from the rapid assessment process
	Manage first response arrangements for the protection of environmental health, including the containment and management of hazardous wastes, contamination and pollution
Recovery	Undertake a detailed natural environmental damage and biodiversity loss analysis
	Return the site to either the original environmental condition or an agreed level
	Rehabilitate, conserve and supporting the recovery of impacted (or at risk) terrestrial, aquatic, and marine ecosystems, wildlife, landscapes, and natural resources
	Undertake activities to facilitate the restoration and regeneration of biodiversity (species and plants) and ecosystems, natural resources, environmental infrastructure, and amenity/ aesthetics

Identification of the environmental impacts and risks associated with a natural disaster is typically undertaken by specialist teams and agencies, government ministries (Environment, Water, Marine and Coastal Resources, Waste and Sanitation), national and international environment-related NGOs, and local authorities with representation from the affected communities wherever possible.

The assessment is often undertaken in three steps:

- Collation of baseline information on the actual status of the environment immediately before the disaster
- Collection of site information to initially allow a risk mapping exercise to be carried out
- On-the-ground data collection, observation and verification.

[9]UNEP (2008). *Environmental Needs Assessment in Post-Disaster Situations. A Practical Guide for Implementation.* 50p.

PART FIVE: KEY REFERENCES

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PART SIX: ANNEXES AND ATTACHMENTS

ANNEX 1:	National Disaster Waste Management Plan Template
ANNEX 2:	Community Disaster Waste Management Plan Template
ANNEX 3:	Disaster Waste Estimation Manual Recording Tools
ANNEX 4:	Disaster Waste Technical Guidance
ANNEX 5:	University of Newcastle, Disaster Waste Estimation Methodology

ATTACHMENT 1:	Disaster Waste Risk Analysis Database (excel)
ATTACHMENT 2:	Disaster Waste Estimation Database (excel)
ATTACHMENT 3:	Waste Density Conversion Calculator (excel)

ANNEX 1: National Disaster Waste Management Plan Template (V3)

Document Cover

[Insert Document Cover with title and appropriate logo and plan date]

Document Control

Table 1. Document Control Table

Title: [Insert title]					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
[insert date]	[insert version no.]	[insert action]	[insert information]	[insert information]	[insert information]

Document Maintenance and Distribution

The [Co-ordinator or nominee of the National Disaster Waste Working Group] will coordinate the development and maintenance of this plan. The components of this plan will be reviewed on an annual basis, and the review documented on the appropriate page in the plan. The Primary and Support Agencies of this plan

- [add Agency names]
- [add Agency names]

should review the plan annually to ensure that procedures and their implementation remain valid. Copies of this plan will be distributed according to an approved control list. A record of distribution, by copy number, is maintained by the [National Disaster Management Office].

Training and Exercises

The procedures and processes identified in this plan will be incorporated into existing training programs offered by the [National Disaster Management Office]. The Disaster Waste Management Plan and its associated components will be included in an [specify period] exercise cycle. Councils and government departments should consider cross-training existing staff in organisational responsibilities related to disaster waste management. response.

Foreword

[Insert Information here]

Abbreviations

[Insert Information here]

Definitions

[Insert Information here]

Insert Table of Contents

1. Introduction

1.1. Plan Purpose

The purpose of this [national/community] disaster waste management plan is to provide guidance to [insert agencies] tasked with the management and removal of disaster waste resulting from a major disaster in [Insert Country/Municipality]. This plan unifies the efforts of public and private organizations for a comprehensive and effective approach to:

- Provide organizational structure, guidance, and standardized guidelines for clearance, removal, and disposal of disaster waste caused by a national disaster
- Expedite disaster waste removal and disposal efforts
- Establish the most efficient methods to resolve disaster waste removal and disposal issues
- Implement and coordinate private sector disaster waste removal and disposal contracts to maximize cleanup efficiencies
- Coordinate partnering relationships through communications and pre-planning with national agencies [specify Agencies and their role] and local agencies and organisations [specify local Agencies and other relevant local stakeholders and their role] that have waste management responsibilities
- [Add other relevant purposes]

1.2. Plan Scope

[Country/Municipality] is vulnerable to a range of natural disasters, including cyclones, flooding, earthquakes and tsunamis. [Country/Municipality] is able to manage many disaster situations with internal resources, however there are potential disaster waste generating events that may overwhelm these resources and capabilities.

This plan establishes the framework within which [Country/Municipality] will respond and coordinate the removal and disposal of disaster waste generated by natural disasters. This plan also identifies the potential role that international agencies and other stakeholder groups will take in a disaster waste management operation.

This plan defines the roles and responsibilities of local emergency managers [specify] with respect to disaster waste management planning prior to a disaster event and actions following a major disaster waste generating emergency.

1.3. Policy framework

This [national/community] disaster management plan is consistent with all relevant national and municipal policies and strategies. These include: [add relevant policies and strategy references here]

-

1.4. Disaster Waste Assumptions

Natural disasters such as cyclones, earthquakes, tsunamis and flooding [add other relevant disaster types] result in a variety of disaster waste that include but are not limited to trees and other vegetative matter, building/construction material, e-waste, personal property (including household furnishings) and motor vehicles, sediment and disaster assistance wastes [add any other relevant disaster wastes]. The quantity and type of waste generated from any disaster will be a function of the location and kind of event experienced, as well as its magnitude, duration, and intensity. Consequently:

- A major natural disaster that requires the removal of disaster waste from public or private lands and waters could occur at any time and potentially without warning.
- A [national/municipality] hazard vulnerability analysis (Appendix 1) has identified [number/or many] specific disaster threats that [Country/Municipality] is vulnerable to and has documented the disaster waste types and quantities that have been generated in the past. Table 2 summarises the **typical types and quantities** of disaster waste that may be generated [nationally/regionally/locally] by these events.
- The quantity of disaster waste resulting from a major natural disaster will exceed [national/local] solid waste removal and disposal capabilities.
- Unattended and long-standing disaster waste may pose safety and health threats.

- Following disasters that result in significant quantities of waste, pre-existing waste disposal sites may not effectively manage disaster waste due to damage, capacity limitations and ongoing routine solid waste management operations.
- Several years of landfill capacity may be consumed during the disaster waste disposal process.
- Waste removal may have environmental consequences including erosion or landslides, falling trees or structures, and the release of asbestos or other contaminants.
- [Add other relevant information]

Table 2. Vulnerability Assessment Summary

[Insert summary vulnerability Table based on Appendix 1 here]

1.5. Disaster Waste Management Assumptions

Upon the declaration of an emergency the [National Disaster Management Office] may issue guidance regarding management of disaster related waste. The [National Disaster Management Office/Disaster Waste Working Group] will coordinate disaster waste management work programmes and the utilisation of personnel; however, the co-opted resources of any work group will never be under the control of an individual not associated with that department or organisation.

- The quantity and type of disaster waste generated, its location, and the size of the area over which it is dispersed will have a direct impact on the type of removal and disposal methods utilized to manage the waste problem, the associated costs incurred, and how quickly the problem can be addressed. Immediately following an emergency there may be heavy demand for waste removal services.
- The extent of damage and the nature of the [local/regional/national] transportation network in a disaster area will influence the management strategy developed by the disaster waste management team.
- Anticipated demand for waste removal services requires a coordinating agency [identify agency] to effectively allocate resources.
- Transportation routes may be damaged or destroyed requiring close coordination between Police and [insert appropriate Agencies].
- Additional resources will be called upon to assist with disaster waste removal, reduction, and disposal process.
- The [local/national/regional] capacity for disaster waste management will be increased by the utilisation of personnel from a range of organisations and stakeholder groups (Appendix 2).
- The [local/national] capacity for disaster waste management is summarised in (Appendix 3) and includes a list of available waste management infrastructure and resources by location.
- Mutual aid resources are under the strategic control of the [National Disaster Management Office] but shall remain under the tactical control of their own supervisors whenever possible.
- [Local/National Governments] are responsible for response and recovery operations up to their capability.
- [Add other relevant information]

2. Disaster Waste Risk Reduction Actions

Routine disaster waste prevention activities undertaken by [specify organisations] prior to a disaster can potentially help reduce the quantity of waste that is required to be managed following a disaster. Important preventative actions can include:

2.1. Vegetation and Green Waste Management

Green waste typically makes up more than 50% of waste accumulated after disasters. Removal of large trees along main roads and strategic choices of smaller replacement species will reduce potential road blockages after a disaster. Routine trimming and maintenance of vegetation in public spaces and along roadways will also reduce quantities of green disaster waste.

2.2. Hazardous materials and chemicals

Hazardous construction materials including asbestos should be removed from all buildings prior to a disaster event occurring. When removal is not possible, warning signs should prominently highlight the presence of asbestos in buildings. Training should be provided to all personnel who will potentially manage asbestos containing materials in a disaster response. Regulations concerning the safe and secure storage of dangerous goods and chemicals including petroleum products and pesticides should be rigorously enforced by [insert relevant authority] to prevent the release of these substances during a disaster.

2.3. Rubbish collection

Domestic and commercial rubbish collection services should operate frequently enough to prevent the build-up of rubbish that could be mobilised during a disaster. Waste management personnel should be trained and equipped for additional roles that they would take on following a disaster.

2.4. Waste Management Facilities

[Municipal/National] landfills should be managed to reduce the quantity of collected waste that is not permanently contained on the site. Dumped waste should be compacted and covered on a daily basis to prevent its movement and mobilisation during a disaster. Equipment used at the landfills should be well maintained and have spare parts on site for repair and adequate stocks of fuel. Ideally, additional equipment should be stored on site to be used during periods of high demand following a disaster. Appropriate legal arrangements [specify legal framework] should be in place (**ie pre-arranged**) to allow rapid acquisition and utilisation of addition waste management machinery and personnel from the private sector (see Appendix 3) following a disaster.

2.5. Maintenance of Public Infrastructure

Building debris represents a large percentage of waste accumulated after disasters. Enforcement of [specify Municipal/National] building codes that maintain structure integrity during a disaster will reduce future disaster waste generation. Existing buildings should be assessed for compliance, and unsafe buildings within the [municipality/country] brought up to standard where possible. Planning schemes should prevent settlement and construction in flood prone areas and areas close to the coast.

2.6. Bulky and Hazardous Waste Collections

Extending municipal rubbish collections to include rural areas, and regular collections of bulky waste will also minimise the quantity of household and business rubbish that could be released during a disaster.

2.7. Mapping of Potential Disaster Wastes

Periodic mapping (including the use of aerial and satellite photography) of critical infrastructure and quantity estimation of commonly used construction materials will provide information that will help prepare first responders and disaster waste managers to preplan disaster response priorities (Appendix 4). Information on the location and storage quantities of bulk hazardous materials such as petroleum products and pesticides will also improve disaster waste management planning.

2.8. [List any other relevant disaster waste reduction actions being undertaken]

3. Disaster Early Warning

Early Warning Systems monitor and predict natural disaster hazards and help reduce the risks associated with them. An effective Early Warning System gives people the knowledge and skills they need to prepare themselves, and potentially vital time to protect themselves when a disaster is forecast. When early warning advice is received about an imminent natural disaster threat, several actions should be implemented by the [National Disaster Management Office] as soon as practical. These include:

3.1. Convening of the Disaster Waste Working Group

Following a disaster warning, the responsible [Disaster Waste Working Group (or Task Force)] may be requested to meet depending on national disaster management arrangements.

3.2. Waste Management Facilities Preparation

The early warning raises the alert level for waste management facility administrators [insert responsible officers/positions] to secure waste collection and disposal facilities [identify facilities] as well as to ensure the facilities readiness to respond after the potential disaster.

3.3. Public Awareness

The disaster warning should be provided to the public on traditional and social media platforms and provide advice about planning management of household wastes after the disaster and where temporary disaster waste collection points will be situated (see also Appendix 15 and Section 14 of this Plan).

3.4. Organisation of the Disaster Waste Response Team

The [disaster waste response teams] should be briefed and ready to mobilise immediately after the disaster. Equipment and resources (vehicles, chainsaws, axes, knives, standby generators, fuel, communication equipment, and personal protection equipment) should be made available and prepared for use (see Section 4 of this Plan and Appendix 3 and Appendix 11).

3.5. Stakeholder Briefings

Before the natural disaster strikes, stakeholder meetings and briefings should be held with representatives of waste management services, road maintenance contractors and [specify other stakeholder representatives] to prepare for the rapid clearance of blocked roads after the disaster strikes. Pre-existing disaster waste removal engagement contracts [specify] should be identified, and potentially interested recycling partners [identify] with capacity to recover scrap metal, firewood and soil and rubble for reclamation and landscaping after the disaster should also be contacted and fully briefed (see Appendix 2 and Appendix 3).

4. Occupational Health and Safety Considerations

Undertaking disaster waste management potentially exposes workers to a range of hazardous materials and chemicals [specify if specific materials/chemicals are known to be present]. It is essential that workers are trained to recognise and avoid exposure to materials in disaster waste that are potentially hazardous, and that all workers are provide with, and always use appropriate Personal Protective Equipment (PPE) while engaged in disaster waste assessment and removal (Appendix 5). An indicative list of essential equipment including OH and S equipment to be issued and/or used by disaster waste management responders is presented in Table 3. Consideration should be given to situations where there may be and extended power outage and/or fuel shortages due to the disaster.

Table 3. Critical equipment for clearance of disaster wastes

Primary for initial response	Secondary for waste processing
PPE including first aid kits, safety vests, leather gloves, protective boots	Mobile incinerator for infectious waste
Torches, notebooks and cameras	Cranes with cables and magnets
Handheld GPS for mapping purposes	Skip bins, hoppers
Two-way radios, mobile phones, satellite phones, drone equipment	Jack hammers
Chainsaws, generators	Pallets and compactors
Fuel	Plastic sheeting
Dump/tipper trucks and roll on roll off or skip trucks	Sealable drums
Debris, earth moving equipment such as skid steer loaders, excavators	Shredders
Road signs, flags, barrier tape to clearly identify working areas	Air quality monitoring equipment

Handling and transport of asbestos or asbestos containing material requires extreme care, and it is important that those involved in the waste management response understand that the definition of asbestos is broad and includes any waste that contains asbestos, including soils. Asbestos can be bonded or friable and poses a high risk to human health. Given the risk to human health, there are specific requirements when managing asbestos

or asbestos containing material. Awareness and training should have been provided previously to personnel who may be involved in the removal, collection and transport of asbestos or asbestos containing material as part of the preparedness stage of disaster planning.

5. Disaster Waste Management Plan Activation and Coordination

When a natural disaster event occurs that has generated disaster waste, the [National Disaster Management Office] will assist in the coordination of the management of the disaster waste removal process by activating this Plan. The [National Disaster Waste Working Group/cluster] will be activated when the disaster is identified to undertake and manage the disaster waste assessment and removal process in cooperation with [specify].

Figure 1. [National] disaster response framework

[Insert summary national disaster response framework here]

6. Disaster Waste and Environmental Surveys and Monitoring

6.1. Rapid Disaster Waste Estimation and Recording

The management of disaster waste is guided by both rapid (response phase) and detailed (recovery phase) disaster waste assessment surveys following the disaster. Specific procedures used for rapid disaster waste quantity estimation are presented in Appendix 6.

The results of the rapid disaster waste assessment are summarised in a disaster waste management cover sheet (Table 4) that identifies the short-term priorities for disaster waste management response.

Table 4. Rapid Disaster Waste Management Cover Sheet

Disaster Waste Management Cover Sheet			
Disaster name			
Date of occurrence			
Location of disaster			
Communities at risk			
Scope of disaster			
Disaster Management Team			
Roles	Responsibilities		
Major Disaster Waste Risks			
Risk Category	Top 10 Risks	Mitigating Actions	Responsible
Chemical			
Biological			
Physical			
Environmental			
Other			
Major Disaster Wastes			
	Action	Total estimated tonnage	Responsible

6.2. Environmental Impact Assessment

Natural disasters such as cyclones, flooding, heatwaves and bushfires, earthquakes and tsunamis can result in a range of environmental impacts including loss of vegetation, wildlife and wildlife habitat, erosion, siltation, water and ground water contamination, and marine pollution and damage to coral reef and beach ecosystems[10]. Identification of environmental impacts and risks associated with a natural disaster is typically undertaken by specialist UN agencies, government line ministries (Environment, Water, Marine and Coastal Resources, Waste and Sanitation; Appendix 7), as well as by national and international environment-related NGOs, local authorities with support from affected communities in three sequential steps:

- Identification of impacts and risks associated with a disaster event on air quality, water quality, soil and groundwater, landscapes, ecosystems and wildlife [specify other];
- Management of environmental impacts by controlling further loss of waste, contamination and pollution, and hazardous materials to the environment; and
- Rehabilitating, conserving and supporting the recovery of impacted (or at risk) terrestrial, aquatic, and marine ecosystems, wildlife, landscapes, and natural resources.

7. Disaster Waste Removal

Natural disasters can generate unprecedented amounts of waste. Emergency roadway clearance, roadside waste removal, private property removal, and household hazardous waste removal are priority disaster waste management responses. The following response and recovery procedures have been developed for planning and operational purposes to facilitate the management and removal of disaster waste:

- **Response Phase operations:** Consists of the clearance of waste that hinders immediate life-saving actions being taken within the disaster area and the clearance of that waste which poses an immediate threat to public health and safety.
- **Recovery Phase operations:** Consists of the removal and disposal of waste which is deemed necessary to ensure the orderly recovery of the community and to eliminate less immediate threats to public and responder health and safety.

7.1. Response operations: Life Saving Disaster Waste Management

There is an immediate need to open emergency access routes into devastated areas following any type of major disaster. [National/Local government/Police/Emergency services] must identify routes within their jurisdiction that are essential to emergency operations. This information is essential for prioritising and directing the efforts of local personnel and for identifying areas where assistance may be needed.

Emergency disaster waste removal involves the opening of roadways by **moving waste to the shoulder of the road**. The wastes may include trees and broken limbs; utility poles, power and telephone lines, transformers and other electrical devices; building waste such as roofing materials, fences, sheds and signs; and personal property such as clothing, furnishings, electrical appliances, boats, and vehicles.

There is no attempt to dispose of the disaster waste at this time, only to clear key access routes to allow:

- Movement of emergency vehicles;
- Resumption of critical services; and
- The assessment of damage to critical infrastructure.

The requirement for [government and municipal] services will be increased drastically after a disaster. After the priority access routes to hospitals, police, fire, and ambulance facilities has been opened, emergency disaster waste management activities should be focused on providing access to other critical infrastructure such as municipal buildings, water and sewage treatment plants, and electrical power generating facilities. All activities which occur and expenses which are incurred during the Response phase of the disaster waste management process should be documented using the [specify appropriate documentation] provided by the [National Disaster Management Office] (see also Sections 11 and 15 of this Plan).

7.2. Recovery Phase operations: Disaster Waste Removal

[10]UNEP (2008). *Environmental Needs Assessment in Post-Disaster Situations. A Practical Guide for Implementation.* 50p.

During the disaster response, disaster waste is simply pushed to the shoulder of the roadways to allow emergency access to the impacted areas. Essentially no sorting of the waste is undertaken at this time. The objective is simply to provide for the safe movement of emergency vehicles and personnel into and out of the disaster area. At the conclusion of immediate disaster response operations, longer term recovery operations are commenced.

7.2.1. Public Road Waste Removal

As removal operations progress, the initial roadside piles of waste become the dumping location for additional household waste and other disaster waste such as construction materials, personal property, general rubbish, white goods (refrigerators, washers, dryers, hot water heaters, etc.), roofing materials, and hazardous waste (household, commercial, and agricultural chemicals). Rapid removal of the waste from the roadside should then become a priority. Waste removal operations will also assist in expediting the replacement or repair of key infrastructure located along public rights-of-ways such as power lines.

7.2.2. Methods of Collection and Removal

The implementation of disaster waste collection as soon as practical after the disaster event assures the public that recovery efforts are in progress. Depending upon the type of disaster, different waste types will have a different priority of collection. For example, putrescible or hazardous waste are usually considered Priority Waste Streams and should be collected as a priority over other waste types. [If known, identify expected priority wastes that would be present after a local/national disaster (see Appendix 1 and Appendix 4). Consideration should also be given to the saturation of the waste, as this can potentially lead to greater health concerns, with wet material being prioritised over dry for removal.

For this [nation/municipal] plan, there are two methods identified for waste collection:

Roadside Collection: Roadside collection parallels an individual's normal rubbish collection. Waste is placed at the side of the road or public rights-of-way by residents and cleanup crews and is collected by the appropriate disaster waste management party [specify]. There are two different methods for roadside collection: mixed waste collection and source-segregated waste collection, with the latter being preferable where possible. Collected disaster waste may be placed in public rights-of-way or public property for the aggregation and temporary storage of disaster waste.

Collection Centres: Collection centres are utilized for residents to enable them to transport disaster waste to a central location for disposal. Separate bins should be designated for specific types of waste and designated individuals assigned to manage the development of the collection centre and oversee its operations.

7.2.3. Business Property Waste Removal

[Insert details here. Provide a detailed description of authorised procedures for the removal of business property disaster waste if significantly different from private residences.]

8. Hazardous Waste Removal

8.1. Household Hazardous Waste Removal

Household hazardous waste may be generated by a natural disaster. This type of waste may consist of asbestos, common household chemicals, petroleum products, propane tanks, oxygen bottles, batteries, and industrial and agricultural chemicals. These items will often be mixed into the waste stream and will require management throughout the waste removal and disposal process. Where possible, hazardous and putrescible materials should be separated from other wastes prior to removal and only be handled and removed by qualified contractors.

8.2. Business Property Hazardous Waste Removal

[Insert details here. Provide a detailed description of authorised procedures for the removal of hazardous business property disaster waste if significantly different from removal from private residences.]

8.3. Medical Waste Management

Most (85%) of healthcare waste consists of general, non-hazardous waste. The remaining 15% is considered hazardous material that may be infectious, toxic, carcinogen, flammable, corrosive, reactive, explosive or

radioactive[11], and requires appropriate specialist management following a disaster if usual management procedures are not available.

[Describe how hazardous healthcare waste will be managed here]

8.4. Temporary Hazardous Waste Staging Areas

A separate staging area for hazardous waste materials, putrescible and contaminated waste should be established in each removal area [provide details]. Removal and disposal of theses wastes will be completed using authorized [specify contractors] in accordance with [(identify which) local and national] regulations. (See also Section 10 of this Plan).

9. Damaged Structure Removal

Natural disasters may create health and safety concerns with respect to severely damaged government, commercial and private infrastructure. Remaining dangerous structures are the responsibility of the owner to demolish to protect the health and safety of adjacent residents. It is possible that unsafe structures will remain due to lack of insurance, absentee landlords, or other circumstances. Consequently, demolition of these structures may become the responsibility of [specify].

9.1. Detailed Assessment of Structures

A key aspect of management of this recovery phase of disaster waste management is the completion of expert detailed engineering assessment of structures to ascertain the volume and type of waste to be created and disposed of, and the demolition and disposal cost (see Appendix 8). This issue will require the cooperation of numerous local officials and may require the resources from any or all of the following: local law and/or municipal agencies, qualified engineers, and qualified contractors [specify] to remove hazardous waste and photographers to document the site before demolition.

9.2. Private Property Demolition and Waste Removal

Procedures for the demolition and waste removal from private property should be identified by [Municipalities/Councils] to minimise impacts to public health and safety, and the economic recovery of the [community](see Appendix 9). If private property owners are not available because they have evacuated, disaster waste management responders may need to enter the property to remove waste considered to be an immediate threat to the lives, health, and safety of its residents.

10. Disaster Waste Storage Sites

A disaster waste storage site is a location to temporarily store, reduce, segregate, and/or process waste before it is transported to its final disposal site. During the response phase, temporary waste storage sites may be needed to efficiently and safely manage the quantities of wastes generated by the disaster. They are frequently used to increase operational flexibility when landfill space is limited or when the landfill is not adjacent to the waste removal area.

After the quantity of disaster waste present has been assessed and estimated (Appendix 6 and Appendix 8), sites for the collection and processing of waste must selected. Consideration should be given first to establishing a site within the damaged area to facilitate the ease of utilization by the affected community. A list of potential temporary disaster waste storage areas is presented in Appendix 10. Several landfills [identify] currently operate in [Country/Municipality] and are also listed in Appendix 10.

10.1. Temporary Storage Site Preparation

After a temporary storage site has been selected, preparatory actions need to be completed to allow safe temporary storage of waste. Preparatory storage site actions include:

[summarise here] and are listed in Appendix 11.

[11]https://www.who.int/news-room/fact-sheets/detail/health-care-waste

10.2. Temporary Storage Site Management

Temporary storage sites need to be managed to allow efficient and safe waste storage. Ongoing temporary storage site management actions are summarised here and listed in Appendix 11. They include:

- Ideally, different types of disaster wastes should be sorted into coloured containers to allow for future quick and accurate identification of waste type
- The maximum height of any stockpile of disaster waste is 4 metres and the maximum length/width is 2 meters due to minimise the risk of stockpile collapse
- Enough space between two piles of waste is at least 2 meters from one side and 5 meters from the other sides to allow space for safe passage of waste managers and the operation of trucks
- The waste with a volume of 25 to 30 cubic metres and maximum weight of up to 26 tons is recommended to be stored in 20ft containers
- The waste with a volume of 55 to 65 cubic metres and maximum weight of up to 27 tons is recommended to be stored in 40ft containers
- Waste materials such as metals and glass are recommended to be stored in smaller containers for safe transport while light materials such as plastic can be stored in larger containers

11. Waste Removal Monitoring

Monitoring and recording the quantities of waste being removed is a critical component of the waste management cycle as it provides the required documentation for waste tracking [describe program], and, if applicable, verifies that the work being completed by a contractor is within the scope of contracted work [describe details]. Full details are presented in Appendix 12.

11.1. Waste Record Keeping

In order to properly document the actions being performed for waste management and removal, waste monitors [insert preferred term] shall be appointed by the [Disaster Waste Management Working Group/Municipality]. Record keeping requirements apply to waste managed throughout a disaster response. These requirements vary depending on the type of waste being transported. In general terms, these requirements include providing:

- waste source information - where the waste came from;
- transporter information, including the identity of the driver, company and vehicle;
- the date(s) the waste was transported;
- tracking systems used and copies of information generated from these systems;
- whether the waste was stored at an interim facility, such as a temporary waste site, and the exact location of the facility;
- Ensure that hazardous waste is not mixed in with loads;
- Ensure that all waste is removed from the trucks at the disaster waste storage site;
- the final waste facility that the waste was recycled or disposed at, including its exact location and company details; and
- receipts from the waste reception facilities
- [add any other relevant requirements]

11.2. Monitoring Methods for Waste Removal

Monitoring the status of waste removal activities is the responsibility of Waste Monitors [use preferred term] located in the field and at waste management storage and disposal sites. Accurate and complete documentation of all waste collection and storage activities is critical to facilitate reimbursement through the pre-existing [identify reimbursement arrangement] arrangement. To facilitate the collection of this information, a range of information must be recorded (see Sections 11.2.1-11.2.3).

11.2.1. Waste Monitor Reports (Field Monitors and disaster waste storage sites monitors)

In order to accurately document waste management and removal activities, a waste monitor report (Appendix 12) should be utilized by the waste monitor or the appropriate designee [identify]. This report will track critical items for [describe program] reimbursement in addition to documenting the logistical requirements of the waste management operations.

11.2.2. Truck Certification

Prior to the utilization of vehicles to remove the waste, each truck must be measured and documented appropriately, or have the appropriate road registration. A truck certification form [specify national standard] allows the monitor to identify the truck itself and its hauling capacity in a standardized manner. It is important to know the truck hauling capacity since waste is often hauled and invoiced by volume.

11.2.3. Load Ticket System

The load ticket system [provide details] tracks the waste from the original collection point to the disaster waste storage site or landfill. By positioning waste monitors at each point of the operations (eg waste collection, temporary storage site, disposal site, [other], the eligible work can be properly documented. An example load ticket can be found in Appendix 13.

12. Waste Reduction Methods

A variety of waste reduction methods are available to minimise the quantity of disaster waste that has to be permanently disposed of (usually by landfilling); therefore, selection of the best waste management option is critical to ensure that waste disposal is completed in the most efficient manner. **Where possible, waste should be treated in accordance with the waste hierarchy, utilising each material for its highest possible use.**

12.1. Volume Reduction by Burning

Controlled Open Burning is a cost-effective method for reducing clean woody tree waste in rural areas where chipping equipment is unavailable (see Section 12.2). This option should be terminated if mixed waste (pressure-treated lumber, poles, aluminium, etc.) enters the waste mix. Incineration of clean, woody tree waste presents little environmental damage and the resulting ash can be used as a soil additive by the local agricultural community.

12.2. Volume Reduction by Grinding and Chipping

Grinding and chipping woody waste is a viable reduction method which is environmentally friendly, and the resulting product can be recycled. This method reduces large quantities of trees and branches and is an efficient method of volume reduction where the resultant mulch can be left in the area where the woody waste was located.

12.3. Volume Reduction by Recycling

Volume reduction by recycling should be considered early in the waste removal and disposal process since it may present an opportunity to reduce the overall cost of the operation (see Appendix 14). The following materials are suitable for recycling (Table 5):

Table 5. Disaster Waste recycling options

Waste Category	Type of waste to be recycled	Recycling process to be utilised
Vehicles	Cars, trucks, vans, boats [insert other]	[insert available appropriate method]
Construction and Demolition Materials	Concrete, lumber and other wood products, asphalt masonry and bricks	[insert available appropriate method]
Electronic waste (E-waste)	Televisions, desktops and laptop computers, stereo equipment and telephones	[insert available appropriate method]
Metal	Ferrous and non-ferrous such as aluminium, steel, sheet metal, copper, tin	[insert available appropriate method]
Putrescible waste	Includes any type of waste that can rot or decay quickly including fruits, vegetables, meats, dairy products, other products from grocery stores and animal carcasses	[insert available appropriate method]

Soil and sediment	Combine with other organic materials that will decompose over time	[insert available appropriate method]
Treated wood	Pressure-treated (CCA) wood, utility poles, and railroad ties	[insert available appropriate method]
Vegetation	Trees, broken tree limbs, stumps, brush and leaves	[insert available appropriate method]
Bulky wastes	Refrigerators, washing machines, dryers, dishwashers, stoves, and hot water heaters	[insert available appropriate method]
Paper and cardboard	All products	[insert available appropriate method]
Plastic	Only certain plastics	[insert available appropriate method]
Household hazardous waste	Cleaners, oils, batteries, pesticides, chemicals, petroleum products and paints	[insert available appropriate method]
Glass	All glass	[insert available appropriate method]
[insert other]	[insert other]	[insert available appropriate method]

13. Final Disaster Waste Disposal Options

Any non-recyclable (intractable) disaster wastes will have to be finally disposed of [Insert details here].

14. Public Communications

The goal of a public information system in a disaster management context is to ensure that the community are given accurate and timely information for their own use and individual planning purposes. If information is not distributed rapidly, rumours and misinformation spread and erode confidence in recovery operations.

14.1. Communication Protocol

All communications related to disaster waste management are the responsibility of [National Disaster Management Office], who will follow established [identify] processes for all public communications (Appendix 15). They will also decide on the most appropriate method/s of communication based on the scale and type of disaster, such as TV, social media and radio, along with the speed at which it needs to be disseminated, as well as other factors that influence the method of communication, including whether electricity is available or not. Where electricity is not available, alternate forms of non-electronic communications such as public meetings [specify other options] should be considered if widespread power/telecommunications outages exist.

14.2. Information to be Communicated

Any information released to the public regarding disaster waste management procedures should include the parameters, rules, and guidelines of waste operations so residents can begin their personal recovery activities. The following is a list of topics that could be included in public information statements:

- Waste collection methods and the impact on normal waste collection services, as applicable;
- Priority wastes to be collected and how to safely prepare for collection;
- Timing of the collection for each affected area;
- Specific requirements for placement of waste at roadside for collection;
- How to source separate wastes prior to collection, for example metals and chemicals;
- Whether residents can drop off materials at designated locations, and if so, advising of drop off locations, when these are available for specific waste streams and any other relevant details; and
- General information on waste collection and disposal costs and/or any waivers in place, insurance and what government assistance may be available to assist with the clean-up of disaster wastes
- [Specify any other information to be communicated]

15. Eligibility for Waste Removal

Eligible waste removal work under the [describe program] must meet the following criteria:

- The waste was generated by the disaster event;
- The waste is located within a designated disaster area on an eligible applicant's property; and
- The waste removal is the legal responsibility of the applicant.

15.1. Funding Eligibility

Eligibility determinations [specify] have been established for the following categories of disaster-generated waste (Table 6). In addition to the criteria listed above, certain requirements must be met of the following waste categories to be eligible for reimbursement [specify].

Table 6. Waste removal eligibility criterion

Waste Category	**Waste types**	**Eligibility for removal criterion**
Vegetative Waste	Whole trees, tree stumps, tree branches, tree trunks and other leafy materials	Within a public right-of-way and collected by an eligible applicant
Construction and Demolition Waste	Damaged components of buildings and structures such as lumber and wood, gypsum wallboard, glass, metal roofing material, tile, carpeting and floor coverings, window coverings, pipe, concrete, asphalt, equipment furnishings, and fixtures	A result of a [nationally] declared disaster
Hazardous Waste	Material that is characterized as having qualities of ignitability, corrosivity, reactivity, or toxicity, and includes household hazardous waste and electronic waste which contains a hazardous material	A result of a [nationally] declared disaster
White good (bulky wastes)	Refrigerators, washing machines, dryers, dishwashers, stoves, and hot water heaters	Within a public right-of-way and collected by an eligible applicant
Soil, Mud, and Sand	Disaster generated material	Within a public right-of-way and collected by an eligible applicant
Vehicles	Cars, trucks, motorbikes, boats	Eligible for removal if • The vehicle presents a hazard or immediate threat that blocks ingress/egress in a public-use area; • The vehicle is abandoned (e.g., the vehicle is not on the owner's property and ownership cannot be determined); or • The applicant can document vehicle ownership
[insert other]		

15.2. Funding Reimbursement

Determination of eligibility and reimbursement [provide details] for disaster waste management operations is available through the [National Disaster Management Office]. Generally, disaster waste located on public property and in public rights-of-way is eligible for reimbursement. This includes such items as vegetative waste including trees, shrubs, stumps, branches, etc., gravel, sand, mud, building waste such as wood, drywall, shingles, etc., vehicles, and white goods which includes refrigerators, water heaters, washers and dryers. Disaster damaged personal property may be moved to the roadside to be picked up by an eligible applicant.

For disaster waste management contractors, eligibility for reimbursement under the [describe arrangements], requires the correct documentation of disaster waste management labour, equipment and contracted services.

Labour - For waste removal work, overtime labour costs (including benefits) are eligible for permanent employees, reassigned employees, and seasonal employees used during the season of anticipated employment. [provide details]

Equipment Hire - Equipment utilised for waste removal work may be reimbursed at an hourly rate. The hourly use rate typically includes the operation, depreciation, maintenance, and fuel for the piece of equipment, but does not include operator labour cost. This reimbursement rate is based on [local] rates. Equipment use must be fully document to be reimbursed. [provide details]

Contracted Services - Reimbursement for contracted services related to waste clearance, removal, disposal, reduction, recycling, and/or monitoring [include other eligible categories] may be available [provide details] given that the scope of work reflects that the necessity to remove the waste is an immediate threat to safety, health, and well-being of the community.

16. Disaster Waste Management Implementation Plan Checklist

A Disaster Waste Management Implementation Plan is developed during the first stage of a disaster response by field assessment teams. **The Plan is essentially a field guide that outlines actions to be undertaken to manage disaster waste, in order of priority (including actions that have been identified by the disaster waste rapid assessment process)**. It is typically finalised after initial rapid disaster waste assessments have been completed and the collected data has been analysed. The Plan facilitates and guides disaster management work crews to undertake a systematic and coordinated approach to prioritising collections and clearances, and the safe segregation of hazardous materials from general debris. The recovery of reusable and recyclable materials is undertaken wherever possible. The Disaster Waste Implementation Plan utilises the arrangements made during the pre-disaster planning wherever possible (e.g. sourcing clearance contractors, temporary labour, and the location and management of temporary storage sites). Subsequent recovery disaster waste management actions will add further detail to the Disaster Waste Implementation Plan as more information is collated about the extent of damage and resultant disaster waste. This recovery phase will likely require a more detailed disaster waste assessment in order to plan longer term waste management activities, including the reinstallation of normal collection services, reprocessing of recovered materials and management of the temporary storage sites.

16.1. Mobilisation of the Disaster Waste Working Group/Clusters

Establish the [Disaster Waste Working Group and its three taskforces] and arrange staff-time rotation schedules. Specify and implement Group line of command including liaison with the [National Disaster Management Office].

16.2. Action Checklist

Prepare a checklist for the following:

- Identification of disaster affected areas to surveyed
- Identification of appropriate regulations and need for any special exemptions to support disaster waste management response
- Identify and prepare operational financial budget(s)
- Operationalise advanced contract agreements with stakeholders and contractors [specify] for emergency disaster waste management response and recovery
- Identification of work crews (including volunteers)
- Mobilise, equip (including PPE) and brief rapid assessment teams
- Complete rapid disaster waste assessment(s)

- Estimate the quantity of disaster waste (including that from evacuation centres) and local treatment capacity
- Prioritise and complete management of hazardous wastes
- Establish hierarchy and management of temporary disaster waste storage sites
- Review capacity and management of permanent landfills for disposal of disaster wastes
- Identify disaster waste transport arrangements
- Consult and discuss proposed disaster waste management operations with stakeholders
- Prepare communication and outreach materials
- Complete detailed disaster waste assessment including estimation of the number of human, technical and financial resources required to manage the disaster waste
- Identify demolition and transport arrangements
- Identify waste recycling and final waste disposal arrangements
- Maintain or recommence routine waste management collection and disposal services
- Complete disaster waste collection and disposal operations
- Closure of temporary sites based on the site management plans
- Complete assessment of environmental impacts and ecosystem damage
- Complete actions to rebuild damaged waste management infrastructure and facilities (including repair or replacement of damaged rubbish trucks and other waste management equipment)
- Complete detailed critical analysis of completed disaster waste management programme
- [insert additional relevant actions]

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[Insert additional references here]

Appendix 1: Disaster waste management capacity and vulnerability assessment

A hazard vulnerability analysis has summarised [Country/Municipality] information relevant to future disaster risk and identified [number/or many] specific disaster threats that [Country/Municipality] is vulnerable to. The analysis has documented the [Local/National] disaster management framework and current waste management practices as well the waste types and quantities that have been generated by past disasters.

	Location 1 [specify]	**Location 2 [specify]**
Population	[insert information]	[insert information]
Government organisation summary	[insert information]	[insert information]
Disaster Management Framework summary	[insert information]	[insert information]
Disaster risk summary	[insert information]	[insert information]
Waste management status summary	[insert information]	[insert information]
Past disaster waste generation quantity summary	[insert information]	[insert information]

Appendix 2: List of Stakeholder Groups

The [local/national/regional] capacity for disaster waste management will be increased by the utilisation of personnel from a range of organisations and stakeholder groups. These groups and their expertise and contact details are presented in Annex 2.

Group Name	**Location**	**Contact details**	**Area of expertise**
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]

Appendix 3: Inventory of available disaster waste management equipment

The [local/national] capacity for disaster waste management is summarised in Annex 3 and includes a list of available waste management infrastructure, equipment and other resources by location.

Location	**Category**	**Details**
Location 1 [Name]	Landfill	[Location and description]
	Temporary Waste Storage Site	[Description]

	Heavy Machinery	[Description]
	Other Machinery	[Description]
	Vehicles	[Description]
	Other Equipment	[Description]
	Contractors	[Description and contact details]
	Expertise and experience summary	[Description]
Location 2 [Name]	Landfill	[Location and description]

Appendix 4: Mapping

Periodic mapping (including the use of aerial and satellite photography) of [local/national] infrastructure will help enable first responders and disaster waste managers to pre-plan disaster response priorities. Mapping should include:

- Population centres
- Industrial sites
- Commercial areas
- Government buildings
- Schools, churches and hospitals
- Waste management infrastructure
- Potential temporary disaster waste storage points

And an estimation of the material composition for categories of buildings compiled:

- Traditional housing
- Informal housing
- Engineered housing
- Large commercial sites
- Large industrial structures
- Stored quantities of bulk hazardous materials such as petroleum products and pesticides

Up-to-date satellite images of urban and rural population centres and key infrastructure areas e.g. government buildings including hospitals, universities, ports etc should be maintained by [National Disaster Management Office]. This information and maps can be used by the [National Disaster Management Office/Disaster Waste Working Group] where access to conduct on site assessments is not possible or is unsafe. Comparison satellite images after the disaster event may also be used to assist this process.

Building category	**Location**	**Owner**	**Type of waste potentially generated**	**Estimated waste quantity (units)**	**Other details**
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]

Appendix 5: Personal Protective Equipment (PPE)

[Insert information]

Appendix 6: Disaster waste estimation method

The management of disaster waste is guided by both rapid (response phase) and detailed (recovery phase) disaster waste assessment surveys following the disaster. Specific procedures used for rapid disaster waste quantity estimation include:

[Insert rapid disaster waste estimation methodology including risk assessment here]

Appendix 7. Environmental Assessment Practitioners

Identification of environmental impacts and risks associated with a natural disaster is typically undertaken by specialist UN agencies, government line ministries (Environment, Water, Marine and Coastal Resources, Waste and Sanitation, as well as by national and international environment-related NGOs. Contact details of relevant [national/local] practitioners are presented below.

Practitioners Name	Company	Address	Phone	Email	Expertise
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]	[Insert information]

Appendix 8. Detailed assessment of private property for demolition and waste removal

Natural disasters may create health and safety concerns with respect to severely damaged government, commercial and private infrastructure. A key aspect of management of this recovery phase of disaster waste management is the completion of expert detailed engineering assessment of structures to ascertain the volume and type of waste to be created and disposed of, and the demolition and disposal cost. The type of information required to be collected by structural engineers and other qualified personnel is listed below.

Data	Description and considerations	Collected information
Waste source	Information on waste sources can be used to identify waste owners, types and volumes. Waste sources may include destroyed or damaged dwellings, sheds, powerlines, roads, fences, trees, livestock, etc. Where possible, more detailed descriptions about the waste source are useful to identify waste streams and estimate volumes. For example, describing the type of damaged building (e.g. wooden home) and the extent of the damage (e.g. partially damaged).	[Insert information]

Location	Information on the location of waste (including street addresses and GPS coordinates) is needed to identify where the waste needs to be collected from and nearby facilities where the waste can be stored, recycled, or disposed.	[Insert information]
Waste owner	Unless otherwise determined, managing the waste generated by an event is the responsibility of the landowner. Where private waste is displaced from private property (e.g. waste moved by a flood) special processes may be needed for public authorities to manage this.	[Insert information]
Historical significance	It is important to identify any damaged or destroyed buildings that are of historical or cultural significance. Care needs to be taken for sites where there is only partial damage to prevent further damage to the buildings.	[Insert information]
Insurance status	Information on the level of insurance (fully insured, partially insured, uninsured) can be used to identify what level of support the community may need to assist with recovery.	[Insert information]
Building age	Information on the age of damaged building/structures can be used to identify the likelihood of asbestos being present. Buildings constructed after the mid-1980s may contain asbestos, but those constructed post-1990 are generally unlikely to have asbestos containing materials.	[Insert information]
Presence of hazardous waste	Information on likely locations of hazardous wastes, particularly in industrial areas should be collected to enable risk assessments, appropriate skilled management, and monitoring. Hazardous wastes include oils, pesticides, refrigerants, etc.	[Insert information]
Presence of Battery Energy Storage Systems	Incorrect disposal of batteries can result in major fires and community safety issues including the generation of toxic smoke plumes. Information should be gathered on the locations of battery energy systems to identify potential volumes of batteries.	[Insert information]
Waste types	Information on waste types is needed to identify appropriate methods for transport, storage, reprocessing and disposal. Waste types include: asbestos and asbestos-containing materials, construction and demolition inert waste, mixed waste, hard waste, green (vegetative) waste, metal waste, vehicle waste, chemical waste drums, food waste, copper chrome arsenate post waste, agricultural waste and more. Waste types can be assessed by waste experts using information collected through damage assessments (e.g. visual observations of the waste).	[Insert information]
Waste nature	Information on the nature of the waste stream is needed to assess the viability of recycling and/or disposal options. For example, waste that is clean, dry, and easy to separate has a higher likelihood of	[Insert information]

	recyclability than waste that is highly mixed or water damaged.	
Estimated waste volume	Information on the volume of waste (both in tonnes and in cubic metres or, in the case of deceased animals, number by species) is needed to identify the level of resources required to manage the waste, such as the number of bins and truck movements to transport the waste from source to waste facilities. This information can also be used to estimate associated costs for waste transport, reprocessing and disposal. Waste volumes can be estimated by waste experts using visual observations of the waste.	[Insert information]
Site **Access**	Events can cause significant damage to infrastructure including roads, bridges/culverts and private access driveways. These may need to be repaired prior to the recovery activity.	[Insert information]

Appendix 9: Procedures for the demolition and waste removal from private property

Procedures for the demolition and waste removal from private property are designed to minimise potential impacts to public health and safety, and the economic recovery of the [community/nation]. If private property owners are not available because they have evacuated, disaster waste management responders may need to enter the property to remove waste considered to be an immediate threat to the lives, health, and safety of its residents.

[Insert property demolition and waste clearance procedures here]

Appendix 10: List of available landfills and temporary waste storage sites

Sites for the collection and processing of waste must selected. Consideration should be given first to establishing a site within the damaged area to facilitate the ease of utilization by the affected community. A list of potential temporary disaster waste storage areas is presented below. Several landfills [identify] currently operate in [Country/Municipality] and are also listed. Contingency planning should clearly establish criteria for the selection of suitable temporary storage sites including:

- Land ownership (public land preferable), zoning (e.g. vacant industrial sites) and approvals
- Buffer distances to housing, community facilities e.g. schools, shops
- Proximity to disaster affected area and road networks
- Land area suitable to meet storage capacity requirements
- Site security / fencing / services
- Having limited access with only certain areas open to the public
- Located close to the disaster area but at a safe distance from housing and businesses

Site name	**Address**	**GPS Coordinates**	**Accepted waste categories**	**Land-owner**	**[Environment Department Approval]**
[Insert Information]	[Insert Information]	[Insert Information]	[Insert Information]	[Insert Information]	[Insert Information]

Appendix 11: Preparation and management of temporary disaster waste storage sites

After a temporary storage site has been selected, preparatory and longer-term management actions need to be undertaken and completed to allow safe temporary storage of waste. Preparatory and ongoing storage site management actions include:

The pre-selection of suitable temporary storage sites should consider:

- Land ownership, zoning (e.g. vacant industrial sites) and approvals
- Buffer distances to housing, community facilities e.g. schools, shops
- Proximity to disaster affected area and road networks
- Land area suitable to meet storage capacity requirements
- Site security / fencing / services
- Require access from main roads
- Require differentiated areas for storage or disposal of different waste types (rubble, topsoil and mud, wood and timber, scrap metal, hazardous waste, general waste) which should be clearly identified.

Safe handling of segregated disaster waste at temporary storage sites is essential. Safe temporary storage of wastes requires that:

- Ideally, different types of disaster wastes should be sorted into coloured containers to allow for future quick and accurate identification of waste type
- The maximum height of any stockpile of disaster waste is 4 metres and the maximum length/width is 2 meters due to minimise the risk of stockpile collapse
- Enough space between two piles of waste is at least 2 meters from one side and 5 meters from the other sides to allow space for safe passage of waste managers and the operation of trucks
- The waste with a volume of 25 to 30 cubic metres and maximum weight of up to 26 tons is recommended to be stored in 20ft containers
- The waste with a volume of 55 to 65 cubic metres and maximum weight of up to 27 tons is recommended to be stored in 40ft containers
- Waste materials such as metals and glass are recommended to be stored in smaller containers for safe transport while light materials such as plastic can be stored in larger containers
- [Insert additional information here]

Appendix 12: Waste monitor report

Monitoring and recording the quantities of waste being removed is a critical component of the waste management cycle as it provides the required documentation for waste tracking [describe program], and, if applicable, verifies that the work being completed by a contractor is within the scope of contracted work.

[Insert reporting framework information here]

Appendix 13: Example Load Ticket

Collected Information	**Ticket Monitor Responsibilities**	
Load Ticket Information	Collection Point	Temporary Storage Site
Ticket Number (If not pre-printed)		
Contract Number	May be identified by a number or name	
Prime contractor's name		
Date		
Truck Number		
Truck driver's name		
Vegetation		

Construction & Demolition		
White Goods		
Household Hazardous Waste		
Other (Required to be described)		
Load Location (GPS or address)		
Loading date/time (departure from collection location)		
Loading site monitor name/signature		
Truck capacity in cubic yards		
Load size (percent of actual cubic yards)		
Unloading location		
Unloading date/time (arrival at DMS)		
Unloading site monitor name/signature		

Appendix 14: Recycling of disaster waste considerations

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
1 Vehicles	• Include motorbikes, cars, trucks and boats • Vehicles may be crushed, inundated with water or damaged by fire	• Roadsides • Communities • Parking areas	• Leakage of fuel, gas and oils to the environment • Potential fire hazard and explosion related to lithium batteries • Attempting to drive or move damaged vehicles may result in accident, personal injury and property damage	• Ensure EOL vehicles are cooled if impacted by fire prior to handling • Removal of oils, fuels and batteries prior to disposal or recycler collection • Ensure vehicle is roadworthy prior to driving • Priority for vehicle to be collected by or sent to car wrecker business (professional)	• Reuse: Repair and reuse as first option • Reuse: Vehicle disassembly for parts • Recycling: Scrap metal waste extracted and recycled • Disposal: Removal of oil, fuels and batteries prior to vehicle compaction and landfill • Disposal: Appropriate disposal of fuels, oils and batteries
2 Furniture and Domestic Items	• Includes damaged furniture, bedding, chairs, tables, mattresses, bikes, storage tins, toys, kitchen items	• Households • Businesses • Public infrastructure	• Needle stick injury and/or from sharp objects e.g. broken glass, metals • Trips and falls • Injury caused by falling debris	• Be aware of uneven terrain, holes and unsafe ground when clearing wastes • Use PPE when handling wastes • Use plant and machinery to move waste • Only separate wastes where safe to do so or send wastes to a waste facility for recovery and recycling • Consolidate and stack/pile remaining materials for collection • Clearly mark/signpost recovered materials and residual wastes for collection	• Reuse/recycling: separate recyclable items on site if safe to do so • Disposal: Separate hazardous items/materials for separate collection • Disposal: Separate residual wastes for collection and transfer sent to interim storage facility or landfill

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options

3 Rubble	• Predominantly inert waste
	• Includes crushed /broken concrete, bricks, blocks, soils
		• Households
		• Businesses
		• Public infrastructure
			• Dense and heavy wastes should not be removed manually and should use appropriate plant and equipment
			• Inhalation of asbestos fibres from asbestos containing building materials
				• Use suitable PPE including asbestos half face respirators with particulate filters (also refer #9 below)	• Reuse: Materials, dependent on quality can be directly reused
					• Recycle: Materials can be crushed and blended for use in reconstruction after the disaster event to make:
					  ○ road bases in
					  ○ construction fill material
					  ○ quarry rehabilitation material

4 Mixed Waste	• Predominantly non inert wastes • Includes green waste, plastics, timber, insulation, hazardous materials, electrical wiring, packaging materials including glass, cardboard, paper, tins, cans, bottles	• Households • Businesses • Office buildings • Supermarkets and shopping centres • Schools • Factories	• Manual handling - dense and heavy wastes should not be removed manually and should use appropriate plant and equipment • Buildings may fall after the disaster event • Unstable stockpiles may fall • Potential fires from combustible materials in the mixed wastes. Can be ignited by sparks from equipment used for cutting and grinding • Needle stick injury and/or from sharp objectives e.g broken glass, metals • This waste may have voids/pockets harbouring rats, insects including mosquitos and contaminated water. There is potential for stings and bites	• Where possible separate waste by material type for stockpiling and collection • Reuse recovered materials on site where suitable • Consolidate and stack/pile remaining materials for collection	• Reuse: Timber and timber items can be recovered for reuse dependent on quality • Recycle: Untreated/unpainted timber that is damaged can be shredded for use as mulch • Recycle: metal may be salvaged and sold to scrap metal industry • Recycle: E-wastes can be sent to recyclers for dismantling/shredding • Disposal: Mixed wastes unsuitable for reuse or recycling are sent to an interim storage facility or landfill

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
5 Metal Waste	• Ferrous (contains iron) and non-ferrous (does not contain iron e.g. aluminium, copper) materials Includes: • machinery, vehicles, including boats, metal and wire fences, roofs, drums • building materials, steel beams, window frames, wire cabling • auto electrical and electrical equipment, and cabling, white goods, batteries	• Households • Businesses • Office buildings • Supermarkets and shopping centres • Schools • Factories	• Manual handling - dense and heavy wastes should not be removed manually and should use appropriate plant and equipment • Metal waste may be mixed with or in close proximity to asbestos containing materials • Metal waste may be contaminated with oil, grease or mixed with other waste with potential to: ○ discharge to the environment ○ cause fires in stockpiles ○ create hazards during transportation	• Metals waste can be heavy and sharp, caution should be taken to avoid manual handling injuries, cuts and abrasions • Use machinery to manage the compaction of materials prior to transport. Ideally transport vehicles will be fully enclosed • Suitable size storage areas will be required and stockpiled materials will require securing until cleared to ensure the steel (particularly light ferrous) materials are stable in high winds • Separate metal waste from other waste and contaminants such as oil. A risk assessment should be conducted to determine hazardous materials/items such as potential asbestos, batteries, gas cylinders • Wire fencing can be bundled or cut into lengths for improved handling • Non-ferrous materials such as copper can be separated for sale to recycling agent • Metals should be combined for sale to recycling agent	• Reuse: Metals such as roofing iron and teel beams may be suitable for use in reconstruction activities • Recycle: ferrous and non-ferrous materials may be salvaged and sold to the scrap metal industry • Disposal: badly corroded steel may not be suitable for recycling and will require disposal

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options

6. Soil and sediment waste	• Soils, sands and sediment
	• May contain contaminants
		• Roads and bridges
		• Agricultural properties
		• Erosion
			• This type of waste may contain contaminants such as heavy metals, asbestos and chemical residues
			• Stockpiling of these materials may cause dust and become a health and environmental hazard
			• Unstable stockpiling may result in collapse and cause injury
				• Push the materials to the side when clearing the site
				• Allow sufficient room for collection vehicles
				• Check for contamination - look for the presence of chemicals, empty or damaged chemical containers
				• Soil may need further assessment if discoloured or has odours.
					• Reuse: spread back on site if is clean fill material
					• Recycling: non contaminated soil and sediment waste for:
					  ○ Road base
					  ○ Batters and bunding
					  ○ Quarry rehabilitation
					  ○ Composting
					  ○ Land reclamation
					• Disposal: Contaminated soil sent to appropriate landfill
					• Disposal: Hazardous soil/sediment may require treatment prior to disposal

7. Organic materials	• Food waste • Green waste / garden waste • Tree/timber waste	• Refrigerators and freezers from households and businesses without power • Damaged commercial freezers or cold stores • Packaged and containerised foods in supermarkets and shopping centres • Food transport vehicles • Farms	• Following a fire disaster, organic material may have blended with molten plastics and other materials unsuitable for composting • Food that has be covered by floodwaters is unsuitable for composting • This waste may harbour rats, insects including mosquitos and contaminated water. There is potential for stings and bites • Poorly managed stockpiling/ storage of these materials can lead to rotting and the spread of dangerous pathogens including fungi, moulds and bacteria • The composting process must be managed	• Stockpile organics separate from contaminants such as packaging wherever possible • Collect and transfer the organic waste materials as soon as possible • Enclose the waste when transporting to prevent leakage or items blowing off loads • Interim storage is not an option for this material without processing • Ensure access to water and sanitation for personnel managing these wastes	• Recycle: Organic wastes that are free of plastics and other contaminants may be suitable for composting • Disposal: Organic materials that are contaminated, decaying or may potentially cause disease are to be landfilled as soon as possible

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
s8. Animal carcass	• Arises from the whole or any part of a dead animal Includes: • Livestock • Family pets • Assistance animals • Animals used for work, sport etc. • Animals from the wild • Aquatic species (farmed or wild) Does not include animals destroyed by biosecurity management post disaster	• Farms • Abattoirs • Veterinary clinics • Private homes • Businesses • Fish deaths • Wild animals	• Manual handling injuries including cuts and abrasions from moving waste • Emotional/psychological trauma • Potential leachate leakage to surface and ground waters from leaving animal carcasses in situ and in burying • Potential dusts and odours from rotting carcasses • Potential pathogens from rotting carcasses including bacteria, viruses, parasites, (e.g. salmonella, botulism)	• Manage appropriate and immediate disposal of these materials wherever possible • Determine the risk of spread of disease asap • If interim storage is required, ensure the carcasses are covered and do not store for extended periods • Ensure decontamination of vehicles used to move and transport the waste carcasses to ensure biosecurity conditions are met and prevent/minimise the spread of disease • Ensure access to water and sanitation for personnel managing these wastes	• Recycling: Composting • Disposal: Buried in situ, mass burial or landfilling. Use appropriate disposal methodologies e.g. liners

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
9. Asbestos containing materials (ACM)	• Asbestos includes varieties of mineral silicates harmful to human health • Asbestos can be present in asbestos cement roofing and sheeting, vinyl flooring, pipe insulation and other building materials • Asbestos can be in: friable form (powder form or can be crumbled, pulverised or reduced to power by hand pressure when dry • Non-friable form that is reinforced with a bonding compound and in solid form – but which may become friable through deterioration or removal activities	• Damaged buildings including dwellings, offices, factories, supermarkets and shopping centres, schools and hospitals	• Inhalation of asbestos fibres can cause serious long term health risks including: lung cancer, mesothelioma and asbestosis	• The removal of asbestos in any form should only be done by fully trained and licensed personnel using approved equipment and removal and air monitoring methodologies but emergency removal may need to be carried out, in which case suitable PPE must be worn and careful precautions observed. • Materials are wetted down and wrapped in heavy duty plastic sheeting to prevent escape of fibres • Warning signage should be placed at the entry points to sites where asbestos containing materials are found	• Disposal: at a suitable managed landfill landfill which has the correct procedures for managing asbestos wastes

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
10. CCA solid and ash waste	• CCA (Copper Chrome Arsenate) – solid and ash waste • Used for the treatment of softwood timber usually greenish in color • Agricultural fence posts and structures • Outdoor furniture and decking • Pallets and skids	• Farms and orchards • Houses and buildings	• CCA in solid or ash form is toxic to human health and the environment • CCA timbers have the potential to release toxic leachate to the environment particularly when wet • CCA waste releases toxic gases and generates toxic residual ash (containing heavy metals) to the environment when burnt • CCA ash may release toxic dusts/particulates to the environment when disturbed, airborne or mobile	• This material must not be burned, shredded or chipped • Material must be kept as dry as possible to avoid leaching • Pack the CCA wastes onto pallets or dedicated waste bins and cover immediately for transport and storage • Seal CCA ash in containers for transport and storage under cover and within bunded area • Ensure storage is separate to other materials • Keep the materials elevated above ground level during storage •	• Disposal: at a suitable managed landfill
11. Chemical wastes	• Chemical (hazardous) wastes are defined within the Basel Convention and have the following characteristics that are harmful to environmental and public health: • Ignitable, corrosive, reactive, toxic, explosive, flammable and infectious • May be solid, liquid or gas	• Farms and other agricultural activities • Transport vehicles • Chemical storage facilities • Processing facilities • Factories • Household chemicals • Laboratory Chemicals – Schools, Universities, Hospitals	• Injury from inhalation, skin exposure, spills or ingestion of hazardous chemicals • Hazards include fire and explosion, human toxicity (acute and chronic including cancers), skin and eye corrosion and environmental toxicity. • Environmental damage caused by spills and discharges to air, soil and water environments • Biodiversity loss through discharge of chemical (hazardous) wastes to flora and fauna habitat and the environment	• Emergency responders will ensure sites are safe and able to be entered • Manage sites where chemicals wastes are identified by cordoning off and securing the area to the public and ensuring adequate bunding and containment is in place to prevent discharge to the environment • Application of appropriate chemical waste signage • Packaging, labelling and transport according to dangerous goods code • Refer to MSDS	• Disposal: via export to sustainable and environmentally sound treatment and disposal facilities (require transboundary approvals, import and export approvals) • Disposal: (contained and approved) interim storage while awaiting treatment and disposal

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
12. Healthcare/ medical wastes	• Needles, syringes, surgical instruments discarded as part of medical, dental or veterinary practices or research • Human tissue, bone, organ and body parts • Swabs, bags or tubes containing liquid body substances including bloods, body fluids and infectious material • Specimen or culture discarded during medical, dental or veterinary practice or research • Drugs and medicines	• Healthcare facilities • Medical centres • Hospitals • Veterinary clinics	• Punctures and injuries from sharps, needlestick and surgical instruments have the potential to transmit disease including but not limited to: ○ Tetanus ○ AIDS ○ Hepatitis • Exposure to infectious materials	• Use appropriate sharps containers for the storage of used needles • Use sealable, tamper proof and appropriate containers for the storage and transfer of medical wastes • Ensure appropriate labelling of wastes; and wastes are contained during transport • Ensure appropriate disposal methodologies	• Disposal: treatment and autoclaving, incineration by authorised, certified and appropriately trained personnel • Medicines and drugs can usually be landfilled to a suitable managed landfill with immediate cover.
13. Bulk Fuels and Oils	• Petrol and Diesel Storage Tanks • Used Oil Storage Tanks	• Bulk Fuel Storage • Power Stations	• Fire and Explosion • Soil Contamination	• Keep sources of ignition well away from spilt fuels and oils • Contain spillage as much as possible with Spill kits and temporary bunds • Do not pump with electric pumps	• Store any recovered fuels and oils in drums or IBCs • Stockpile contaminated soils – can be treated by spreading out and turning regularly • Disposal may need to be by export if no suitable managed landfill is available
14, Relief Aid Wastes	• Plastic water bottles • Food cans • Packaging waste • Unused and/or inappropriate aid materials	• Relief Aid	• Mostly inert but quantities can be substantial in volume • Food cans with residual food can encourage rats and other disease vectors	• This waste may overload local landfills. Reduce in size by crushing and shredding if possible	• Disposal to local landfill

Appendix 15. Public Communication Protocol

The goal of a public information system in a disaster management context is to ensure that the community are given accurate and timely information for their own use and individual planning purposes. If information is not distributed rapidly, rumours and misinformation spread and erode confidence in recovery operations.

[Insert communication protocol here]

ANNEX 2: Community Disaster Waste Management Plan Template (V3)

Document Cover

[Insert Document Cover with title and appropriate logo and plan date]

Document Control

Table 1. Document Control Table

Title: [Insert title]					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
[insert date]	[insert version no.]	[insert action]			

Document Maintenance and Distribution

[Insert] will coordinate the development and maintenance of this plan. The components of this plan will be reviewed on an annual basis, and the review documented on the appropriate page in the plan.

The Primary and Support Agencies of this plan [add Agency names] should review the plan annually to ensure that procedures and their implementation remain valid. Copies of this plan will be distributed according to an approved control list. A record of distribution, by copy number, is maintained by [insert].

Training and Exercises

The procedures and processes identified in this plan will be incorporated into existing training programs offered by the [National Disaster Management Office]. The Disaster Waste Management Plan and its associated components will be included in an [specify period] exercise cycle.

Foreword

[Insert Information here]

Abbreviations

[Insert Information here]

Definitions

[Insert Information here]

Insert Table of Contents

1. Introduction

1.1. Plan Purpose

The purpose of this community disaster waste management plan is to provide guidance to [insert agencies] tasked with the management and removal of disaster waste resulting from a major disaster in [Insert Municipality or Council Area]. This plan unifies the efforts of public and private organizations for a comprehensive and effective approach to:

- Provide organizational structure, guidance, and standardized guidelines for clearance, removal, and disposal of disaster waste caused by a national disaster
- Expedite disaster waste removal and disposal efforts
- Establish the most efficient methods to resolve disaster waste removal and disposal issues
- Implement and coordinate private sector disaster waste removal and disposal contracts to maximize cleanup efficiencies
- Coordinate partnering relationships through communications and pre-planning with local [specify local Agencies and other relevant local stakeholders] and national agencies [specify Agencies] that have waste management responsibilities
- [Add other relevant purposes]

1.2. Plan Scope

[Specify the Municipality/Council Area] is vulnerable to a range of natural disasters, including cyclones, flooding, earthquakes and tsunamis. The [specify the Municipality/Council Area] is able to manage many disaster situations with internal resources, however there are potential disaster waste generating events that may overwhelm these resources and capabilities.

This plan establishes the framework within which [specify the Municipality/Council Area] will respond and coordinate the removal and disposal of disaster waste generated by natural disasters. This plan also identifies the potential role that international agencies [specify] and other stakeholder groups [specify] will take in a disaster waste management operation.

This plan defines the roles and responsibilities of local emergency managers [specify] with respect to waste management planning prior to a disaster event and actions following a major disaster waste generating emergency.

1.3. Policy framework

This community disaster management plan is consistent with all relevant national and municipal policies and strategies. These include: [add relevant policies and strategy references here]

-
-
-

1.4. Disaster Waste Assumptions

Natural disasters such as cyclones, earthquakes, tsunamis and flooding [add other relevant disaster types] result in a variety of disaster waste that include but are not limited to trees and other vegetative matter, building/construction material, e-waste, personal property (including household furnishings) and motor vehicles and sediment [add any other relevant disaster wastes]. The quantity and type of waste generated from any disaster will be a function of the location and kind of event experienced, as well as its magnitude, duration, and intensity. Consequently:

- A major natural disaster that requires the removal of disaster waste from public or private lands and waters could occur at any time and potentially without warning.
- A local hazard vulnerability analysis (Appendix 1) has identified [number/or many] specific disaster threats that [the Municipality/Council Area] is vulnerable to and has documented the disaster waste types and quantities that have been generated in the past. Table 2 summarises the **typical types and quantities** of disaster waste that may be generated locally by these events.
- The quantity of disaster waste resulting from a major natural disaster will exceed local solid waste removal and disposal capabilities

- Unattended and long-standing disaster waste may pose safety and health threats.
- Following disasters that result in significant quantities of waste, pre-existing waste disposal sites may not effectively manage disaster waste due to damage, capacity limitations and ongoing routine solid waste management operations.
- Several years of landfill capacity may be consumed during the disaster waste disposal process.
- Waste removal may have environmental consequences including erosion or landslides, falling trees or structures, and the release of asbestos or other contaminants.
- [Add other relevant information]

Table 2. Vulnerability Assessment Summary

[Insert summary vulnerability Table based on Appendix 1 here]

1.5. Disaster Waste Management Assumptions

Upon the declaration of an emergency the [National Disaster Management Office] may issue guidance regarding management of disaster related waste. The [National Disaster Management Office/Disaster Waste Working Group] will coordinate disaster waste management work programmes and the utilisation of personnel; however, the co-opted resources of any work group will never be under the control of an individual not associated with that department or organisation.

- The quantity and type of disaster waste generated, its location, and the size of the area over which it is dispersed will have a direct impact on the type of removal and disposal methods utilized to manage the waste problem, the associated costs incurred, and how quickly the problem can be addressed. Immediately following an emergency there may be heavy demand for waste removal services.
- The extent of damage and the nature of the local transportation network in a disaster area will influence the management strategy developed by the disaster waste management team.
- Anticipated demand for waste removal services requires a coordinating agency [identify agency] to effectively allocate resources.
- Transportation routes may be damaged or destroyed requiring close coordination between Police and [insert appropriate Agencies].
- Additional resources will be called upon to assist with disaster waste removal, reduction, and disposal process.
- The local capacity for disaster waste management will be increased by the utilisation of personnel from a range of organisations and stakeholder groups (Appendix 2).
- The local capacity for disaster waste management is summarised in (Appendix 3) and includes a list of available waste management infrastructure and resources by location.
- Mutual aid resources are under the strategic control of the [National Disaster Management Office] but shall remain under the tactical control of their own supervisors whenever possible.
- Local Governments are responsible for response and recovery operations up to their capability.
- [Add other relevant information]

2. Disaster Waste Risk Reduction Activities

Routine disaster waste prevention activities undertaken by [specify] prior to a disaster can potentially help reduce the quantity of waste that is required to be managed following a disaster. Important preventative actions can include:

2.1. Vegetation and Green Waste Management

Green waste typically makes up more than 50% of waste accumulated after disasters. Removal of large trees along main roads and strategic choices of smaller replacement species will reduce potential road blockages after a disaster. Routine trimming and maintenance of vegetation in public spaces and along roadways will also reduce quantities of green disaster waste.

2.2. Hazardous materials and chemicals

Hazardous construction materials including asbestos should be removed from all buildings prior to a disaster event occurring. When removal is not possible, warning signs should prominently highlight the presence of asbestos in buildings. Training should be provided to all personnel who will potentially manage asbestos containing materials in a disaster response. Regulations concerning the safe and secure storage of dangerous goods and chemicals including petroleum products and pesticides should be rigorously enforced by [insert relevant authority] to prevent the release of these substances during a disaster.

2.3. Rubbish collection

Domestic and commercial rubbish collection services should operate frequently enough to prevent the build-up of rubbish that could be mobilised during a disaster. Waste management personnel should be trained and equipped for additional roles that they would take on following a disaster.

2.4. Waste Management Facilities

Local landfills should be managed to reduce the quantity of collected waste that is not permanently contained on the site. Dumped waste should be compacted and covered on a daily basis to prevent its movement and mobilisation during a disaster. Equipment used at the landfills should be well maintained and have spare parts on site for repair and adequate stocks of fuel. Ideally, additional equipment should be stored on site to be used during periods of high demand following a disaster. Appropriate legal arrangements should be in place to allow rapid acquisition and utilisation of addition waste management machinery and personnel from the private sector (see Appendix 3) following a disaster.

2.5. Maintenance of Public Infrastructure

Building debris represents a large percentage of waste accumulated after disasters. Enforcement of local building codes that maintain structure integrity during a disaster will reduce future disaster waste generation. Existing buildings should be assessed for compliance, and unsafe buildings within the [the Municipality/Council Area] brought up to standard where possible. Planning schemes should prevent settlement and construction in flood prone areas and areas close to the coast.

2.6. Bulky and Hazardous Waste Collections

Extending municipal rubbish collections to include rural areas, and regular collections of bulky waste will also minimise the quantity of household and business rubbish that could be released during a disaster.

2.7. [List any other relevant disaster waste reduction actions being undertaken]

3. Disaster Early Warning

Early Warning Systems monitor and predict natural disaster hazards and help reduce the risks associated with them. An effective Early Warning System gives people the knowledge and skills they need to prepare themselves, and potentially vital time to protect themselves when a disaster is forecast. When early warning advice is received about an imminent disaster threat, several actions should be implemented by [specify the Municipality/Council] as soon as practical. These include:

3.1. Waste Management Facilities Preparation

The early warning raises the alert level for waste management facility administrators [insert responsible officers/positions] to secure waste collection and disposal facilities as well as to ensure the facilities readiness to respond after the potential disaster.

3.2. Public Awareness

The disaster warning should be provided to the public on traditional and social media and provide advice about management of household wastes after the disaster and where temporary emergency waste collection points will be situated (Section 13 of this Plan).

3.3. Organisation of the Disaster Waste Response Team

The [disaster waste response teams] should be organised and ready to mobilise after the disaster. Equipment and resources (vehicles, chainsaws, axes, knives, standby generators, fuel, communication equipment, and personal protection equipment) should be prepared for use (see Appendix 3).

3.4. Stakeholder Briefings

Before the natural disaster strikes, stakeholder meetings and briefings should be held with representatives of waste management services, road maintenance contractors and [specify other stakeholder representatives] to prepare for the rapid clearance of blocked roads after the disaster strikes. Potentially interested recycling partners to recover scrap metal, firewood and soil and rubble for reclamation and landscaping after the disaster should also be contacted and briefed (see Appendix 2 and Appendix 3).

4. Occupational Health and Safety Considerations

Undertaking disaster waste management potentially exposes workers to a range of hazardous materials and chemicals [specify if specific materials/chemicals are known to be present]. It is essential that workers are trained to recognise and avoid exposure to materials in disaster waste that are potentially hazardous, and that all workers are provide with, and always use appropriate Personal Protective Equipment (PPE) while engaged in disaster waste assessment and removal (Appendix 5). An indicative list of essential equipment including OH and S equipment to be issued and/or used by disaster waste management responders is presented in Table 3. Consideration should be given to situations where there may be and extended power outage and/or fuel shortages due to the disaster.

Table 3. Critical equipment for clearance of disaster wastes

Primary for initial response	Secondary for waste processing
PPE including first aid kits, safety vests, leather gloves, protective boots	Mobile incinerator for infectious waste
Torches, notebooks and cameras	Cranes with cables and magnets
Handheld GPS for mapping purposes	Skip bins, hoppers
Two-way radios, mobile phones, satellite phones, drone equipment	Jack hammers
Chainsaws, generators	Pallets and compactors
Fuel	Plastic sheeting
Dump/tipper trucks and roll on roll off or skip trucks	Sealable drums
Debris, earth moving equipment such as skid steer loaders, excavators	Shredders
Road signs, flags, barrier tape to clearly identify working areas	Air quality monitoring equipment

Handling and transport of asbestos or asbestos containing material requires extreme care, and it is important that those involved in the waste management response understand that the definition of asbestos is broad and includes any waste that contains asbestos, including soils. Asbestos can be bonded or friable and poses a high risk to human health. Given the risk to human health, there are specific requirements when managing asbestos or asbestos containing material. Awareness and training should have been provided previously to personnel who may be involved in the removal, collection and transport of asbestos or asbestos containing material as part of the preparedness stage of disaster planning.

5. Disaster Waste Management Plan Activation and Coordination

When a natural disaster event occurs that has generated disaster waste, the [specify the Municipality/Council] will assist in the coordination of the management of the disaster waste removal process by activating this Plan.

Figure 2. Local disaster response framework

[Insert summary community disaster response framework here]

6. Disaster Waste Estimation and Recording

The management of disaster waste is guided by both rapid and detailed disaster waste surveys following the disaster. Specific procedures used for disaster waste estimation are presented in Appendix 4. The results of the rapid disaster waste assessment are summarised in a disaster waste management cover sheet (Table 4) that identifies the short-term priorities for disaster waste management response.

Table 4. Rapid disaster waste assessment cover (summary) sheet

Disaster Waste Management Cover Sheet			
Disaster name			
Date of occurrence			
Location of disaster			
Communities at risk			
Scope of disaster			
Disaster Management Team			
Roles	Responsibilities		
Major Disaster Waste Risks			
Risk Category	Top 10 Risks	Mitigating Actions	Responsible
Chemical			
Biological			
Physical			
Environmental			
Other			
Major Disaster Wastes			

	Action	Total estimated tonnage	Responsible

7. Disaster Waste Removal

Natural disasters can generate unprecedented amounts of waste. Emergency roadway clearance, roadside waste removal, private property removal, and household hazardous waste removal are priority disaster waste management responses. The following response and recovery procedures have been developed for planning and operational purposes to facilitate the management and removal of disaster waste:

- **Response operations:** Consists of the clearance of waste that hinders immediate life-saving actions being taken within the disaster area and the clearance of that waste which poses an immediate threat to public health and safety.
- **Recovery operations:** Consists of the removal and disposal of waste which is deemed necessary to ensure the orderly recovery of the community and to eliminate less immediate threats to public and responder health and safety.

7.1. Response operations: Life Saving Disaster Waste Management

There is an immediate need to open emergency access routes into devastated areas following any type of major disaster. Local emergency services must identify routes within their jurisdiction that are essential to emergency operations. This information is essential for prioritising and directing the efforts of local personnel and for identifying areas where assistance may be needed.

Emergency disaster waste removal involves the opening of roadways by **moving waste to the shoulder of the road**. The wastes may include trees and broken limbs; utility poles, power and telephone lines, transformers and other electrical devices; building waste such as roofing materials, fences, sheds and signs; and personal property such as clothing, furnishings, electrical appliances, boats, and vehicles.

There is no attempt to dispose of the disaster waste at this time, only to clear key access routes to allow:

- Movement of emergency vehicles;
- Resumption of critical services; and
- The assessment of damage to critical infrastructure.

The requirement for [government and municipal] services will be increased drastically after a disaster. After the priority access routes to hospitals, police, fire, and ambulance facilities has been opened, emergency disaster waste management activities should be focused on providing access to other critical infrastructure such as municipal buildings, water and sewage treatment plants, and electrical power generating facilities [include other here]. All activities which occur and expenses which are incurred during the Response phase of the disaster waste management process should be documented.

7.2. 7.2 Recovery operations: Disaster Waste Removal

During the disaster response, disaster waste is simply pushed to the shoulder of the roadways to allow emergency access to the impacted areas. Essentially no sorting of the waste is undertaken at this time. The objective is simply to provide for the safe movement of emergency vehicles and personnel into and out of the disaster area. At the conclusion of immediate disaster response operations, longer term recovery operations are commenced.

7.2.1. Public Road Waste Removal

As removal operations progress, the initial roadside piles of waste become the dumping location for additional household waste and other disaster waste such as construction materials, personal property, general rubbish,

white goods (refrigerators, washers, dryers, hot water heaters, etc.), roofing materials, and hazardous waste (household, commercial, and agricultural chemicals). Rapid removal of the waste from the roadside should then become a priority. Waste removal operations will also assist in expediting the replacement or repair of key infrastructure located along public rights-of-ways such as power lines.

7.2.2. Methods of Collection and Removal

The implementation of disaster waste collection as soon as practical after the disaster event assures the public that recovery efforts are in progress. Depending upon the type of disaster, different waste types will have a different priority of collection. For example, putrescible or hazardous waste are usually considered Priority Waste Streams and should be collected as a priority over other waste types. [If known, identify expected priority wastes that would be present after a local disaster (see Appendix 1). Consideration should also be given to the saturation of the waste, as this can potentially lead to greater health concerns, with wet material being prioritised over dry for removal.

For this community plan, there are two methods identified for waste collection:

Roadside Collection: Roadside collection parallels an individual's normal rubbish collection. Waste is placed at the side of the road or public rights-of-way by residents and cleanup crews and is collected by the appropriate disaster waste management party [specify]. There are two different methods for roadside collection: mixed waste collection and source-segregated waste collection, with the latter being preferable where possible. Collected disaster waste may be placed in public rights-of-way or public property for the aggregation and temporary storage of disaster waste.

Collection Centres: Collection centres are utilized for residents to enable them to transport disaster waste to a central location for disposal. Separate bins should be designated for specific types of waste.

7.2.3. Business Property Waste Removal

[Insert details here. Provide a detailed description of authorised procedures for the removal of business property disaster waste if significantly different from private residences.]

8. Hazardous Waste Removal

8.1. Household Hazardous Waste Removal

Household hazardous waste may be generated by a natural disaster. This type of waste may consist of asbestos, common household chemicals, petroleum products, propane tanks, oxygen bottles, batteries, and industrial and agricultural chemicals. These items will often be mixed into the waste stream and will require management throughout the waste removal and disposal process. Where possible, hazardous and putrescible materials should be separated from other wastes prior to removal and only be handled and removed by qualified contractors.

8.2. Business Property Hazardous Waste Removal

[Insert details here. Provide a detailed description of authorised procedures for the removal of hazardous business property disaster waste if significantly different from removal from private residences.]

8.3. Medical Waste Management

Most (85%) of healthcare waste consists of general, non-hazardous waste. The remaining 15% is considered hazardous material that may be infectious, toxic, carcinogen, flammable, corrosive, reactive, explosive or radioactive[12], and requires appropriate specialist management following a disaster.

[Describe how hazardous healthcare waste will be managed here]

9. Temporary Hazardous Waste Staging

[12]https://www.who.int/news-room/fact-sheets/detail/health-care-waste

A separate staging area for hazardous waste materials, putrescible and contaminated waste should be established in the Municipality/Council Area]. Removal and disposal of theses wastes will be completed using authorized contractors in accordance with local and national regulations.

10. Disaster Waste Storage Sites

A disaster waste storage site is a location to temporarily store, reduce, segregate, and/or process waste before it is transported to its final disposal site. It is frequently used to increase operational flexibility when landfill space is limited or when the landfill is not adjacent to the waste removal area.

After the quantity of disaster waste present has been assessed and estimated [Appendix 4], sites for the collection and processing of waste must selected. Consideration should be given first to establishing a site within the damaged area to facilitate the ease of utilization by the affected community. A list of potential temporary disaster waste storage areas is presented in [Appendix 6]. [State number] of landfills currently operate in [Municipality/Council Area] and are also listed in [Appendix 6].

10.1. Temporary Storage Site Preparation

After a temporary storage site has been selected, preparatory actions need to be completed to allow safe temporary storage of waste. Preparatory storage site actions include: [summarise here] and are listed in (see Appendix 7).

10.2. Temporary Storage Site Management

Temporary storage sites need to be managed to allow efficient and safe waste storage. Temporary storage site management actions are summarised here and listed in Appendix 7. They include:

- Ideally, different types of disaster wastes should be sorted into coloured containers to allow for future quick and accurate identification of waste type
- The maximum height of any stockpile of disaster waste is 4 metres and the maximum length/width is 2 meters due to minimise the risk of stockpile collapse
- Enough space between two piles of waste is at least 2 meters from one side and 5 meters from the other sides to allow space for safe passage of waste managers and the operation of trucks
- The waste with a volume of 25 to 30 cubic metres and maximum weight of up to 26 tons is recommended to be stored in 20ft containers
- The waste with a volume of 55 to 65 cubic metres and maximum weight of up to 27 tons is recommended to be stored in 40ft containers
- Waste materials such as metals and glass are recommended to be stored in smaller containers for safe transport while light materials such as plastic can be stored in larger containers

11. Waste Reduction Methods (see Appendix 8)

A variety of waste reduction methods are available to minimise the quantity of disaster waste that has to be permanently disposed of (usually by landfilling); therefore, selection of the best waste management option is critical to ensure that waste disposal is completed in the most efficient manner. **Where possible, waste should be treated in accordance with the waste hierarchy, utilising each material for its highest possible use.**

11.1. Volume Reduction by Burning

Controlled Open Burning is a cost-effective method for reducing clean woody tree waste in rural areas where chipping equipment is unavailable (see Appendix 3). This option should be terminated if mixed waste (pressure-treated lumber, poles, aluminium, etc.) enters the waste mix. Incineration of clean, woody tree waste presents little environmental damage and the resulting ash can be used as a soil additive by the local agricultural community.

11.2. Volume Reduction by Grinding and Chipping

Grinding and chipping woody waste is a viable reduction method which is environmentally friendly, and the resulting product can be recycled. This method reduces large quantities of trees and branches and is an efficient method of volume reduction where the resultant mulch can be left in the area where the woody waste was located.

11.3. Volume Reduction by Recycling

Volume reduction by recycling should be considered early in the waste removal and disposal process since it may present an opportunity to reduce the overall cost of the operation. The following materials are suitable for recycling:

Waste Category	Type of waste to be recycled	Recycling process to be utilised
Vehicles	Cars, trucks, vans, boats [insert other]	[insert available appropriate method]
Construction and Demolition Materials	Concrete, lumber and other wood products, asphalt masonry and bricks	[insert available appropriate method]
Electronic waste (E-waste)	Televisions, desktops and laptop computers, stereo equipment and telephones	[insert available appropriate method]
Metal	Ferrous and non-ferrous such as aluminium, steel, sheet metal, copper, tin	[insert available appropriate method]
Putrescible waste	Includes any type of waste that can rot or decay quickly including fruits, vegetables, meats, dairy products, other products from grocery stores and animal carcasses	[insert available appropriate method]
Soil and sediment	Combine with other organic materials that will decompose over time	[insert available appropriate method]
Treated wood	Pressure-treated (CCA) wood, utility poles, and railroad ties	[insert available appropriate method]
Vegetation	Trees, broken tree limbs, stumps, brush and leaves	[insert available appropriate method]
Bulky wastes	Refrigerators, washing machines, dryers, dishwashers, stoves, and hot water heaters	[insert available appropriate method]
Paper and cardboard	All products	[insert available appropriate method]
Plastic	Only certain plastics	[insert available appropriate method]
Household hazardous waste	Cleaners, oils, batteries, pesticides, chemicals, petroleum products and paints	[insert available appropriate method]
Glass	All glass	[insert available appropriate method]
[insert other]	[insert other]	[insert available appropriate method]

12. Final Disaster Waste Disposal

Non-recyclable disaster wastes will have to be finally disposed of. [Insert details here]

13. Public Information System

The goal of a public information system in a disaster management context is to ensure that the community are given accurate and timely information for their own use and individual planning purposes. If information is not distributed rapidly, rumours and misinformation spread and erode confidence in recovery operations.

13.1. Communication Protocol

All communications related to disaster waste management are the responsibility of [National Disaster Management Office/identify], who will follow established [identify] processes for all public communications. They will also decide on the most appropriate method/s of communication based on the scale and type of disaster, such as TV, social media and radio, along with the speed at which it needs to be disseminated, as well as other factors that influence the method of communication, including whether electricity is available or not. Where electricity is not available, alternate forms of non-electronic communications such as public meetings [specify other options] should be considered if widespread power/telecommunications outages exist.

13.2. Information to be Communicated

Any information released to the public regarding disaster waste management procedures should include the parameters, rules, and guidelines of waste operations so residents can begin their personal recovery activities. The following is a list of topics that could be included in public information statements:

- Waste collection methods and the impact on normal waste collection services, as applicable;
- Priority wastes to be collected and how to safely prepare for collection;
- Timing of the collection for each affected area;
- Specific requirements for placement of waste at roadside for collection;
- How to source separate wastes prior to collection, for example metals and chemicals;
- Whether residents can drop off materials at designated locations, and if so, advising of drop off locations, when these are available for specific waste streams and any other relevant details; and
- General information on waste collection and disposal costs and/or any waivers in place, insurance and what government assistance may be available to assist with the clean-up of disaster wastes
- [Specify any other information to be communicated]

14. Eligibility for Waste Removal

Eligible waste removal work under the [describe program] must meet the following criteria:

- The waste was generated by the disaster event;
- The waste is located within a designated disaster area on an eligible applicant's property; and
- The waste removal is the legal responsibility of the applicant.

15. Key References

Anon (2024). *Lautoka City Council Disaster Waste Management Contingency Plan. Lautoka City Council. 41p.*

Anon. (2024). *Debris Management Plan for Campbell County, Kentucky.* Cambell County Emergency Operations Plan. 29pp.

SPREP (2021). *Pacific Island Countries Regional Disaster Waste Management Guideline*. Apia, Samoa. 72p.

Tonkin and Taylor (2018). *Disaster Waste Management Plan Template*. Bay of Plenty Regional Council, New Zealand. 68p.

UNEP (2013). *Disaster Waste Management Guidelines*. United Nations Office for the Coordination of Humanitarian Affairs. Emergency Preparedness Section, joint UNEP/OCHA Environment Unit. 46p.

[Insert additional references here]

Appendix 1: Disaster waste management capacity and vulnerability assessment

A hazard vulnerability analysis has summarised local information relevant to future disaster risk and identified [number/or many] specific disaster threats that the local area is vulnerable to. The analysis has documented the local disaster management framework and current waste management practices as well the waste types and quantities that have been generated by past disasters.

	Location [Specify]
Population	[insert information]
Government organisation summary	[insert information]
Disaster Management Framework summary	[insert information]
Disaster risk summary	[insert information]
Waste management status summary	[insert information]
Past disaster waste generation quantity summary	[insert information]

Appendix 2: Stakeholder Groups

The local capacity for disaster waste management will be increased by the utilisation of personnel from a range of organisations and stakeholder groups. These groups and their expertise and contact details are presented in Annex 2.

Group Name	**Location**	**Contact details**	**Area of expertise**
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]
[Insert information]	[Insert information]	[Insert information]	[Insert information]

Appendix 3: Inventory of available disaster waste management equipment

The local capacity for disaster waste management is summarised in Annex 3 and includes a list of available waste management infrastructure, equipment and other resources by location.

Location	**Category**	**Details**
Location 1 [Name]	Landfill	[Location and description]
	Temporary Waste Storage Site	[Description]
	Heavy Machinery	[Description]

	Other Machinery	[Description]
	Vehicles	[Description]
	Other Equipment	[Description]
	Contractors	[Description and contact details]
	Expertise and experience summary	[Description]
Location 2 [Name]	Landfill	[Location and description]

Appendix 4: Disaster waste estimation method

[Insert Disaster waste estimation methodology here]

Appendix 5: Personal Protective Equipment (PPE)

[Insert information here]

Appendix 6: List of available landfills and temporary waste storage sites

Sites for the collection and processing of waste must selected. Consideration should be given first to establishing a site within the damaged area to facilitate the ease of utilization by the affected community. A list of potential temporary disaster waste storage areas is presented below. Several landfills [identify] currently operate in the local area and are also listed. Contingency planning should clearly establish criteria for the selection of suitable temporary storage sites including:

- Land ownership (public land preferable), zoning (e.g. vacant industrial sites) and approvals
- Buffer distances to housing, community facilities e.g. schools, shops
- Proximity to disaster affected area and road networks
- Land area suitable to meet storage capacity requirements
- Site security / fencing / services
- Having limited access with only certain areas open to the public
- Located close to the disaster area but at a safe distance from housing and businesses

Site name	**Address**	**GPS Coordinates**	**Accepted waste categories**	**Land-owner**	**[Environment Department Approval]**
[Insert Information]	[Insert Information]	[Insert Information]	[Insert Information]	[Insert Information]	[Insert Information]

Appendix 7: Preparation and management of temporary disaster waste storage sites

After a temporary storage site has been selected, preparatory and longer-term management actions need to actions need to be undertaken and completed to allow safe temporary storage of waste. Preparatory and ongoing storage site management actions include:

The pre-selection of suitable temporary storage sites should consider:

- Land ownership, zoning (e.g. vacant industrial sites) and approvals

- Buffer distances to housing, community facilities e.g. schools, shops
- Proximity to disaster affected area and road networks
- Land area suitable to meet storage capacity requirements
- Site security / fencing / services
- Require access from main roads
- Require differentiated areas for storage or disposal of different waste types (rubble, topsoil and mud, wood and timber, scrap metal, hazardous waste, general waste) which should be clearly identified.

Safe handling of segregated disaster waste at temporary storage sites is essential. Safe temporary storage of wastes requires that:

- Ideally, different types of disaster wastes should be sorted into coloured containers to allow for future quick and accurate identification of waste type
- The maximum height of any stockpile of disaster waste is 4 metres and the maximum length/width is 2 meters due to minimise the risk of stockpile collapse
- Enough space between two piles of waste is at least 2 meters from one side and 5 meters from the other sides to allow space for safe passage of waste managers and the operation of trucks
- The waste with a volume of 25 to 30 cubic metres and maximum weight of up to 26 tons is recommended to be stored in 20ft containers
- The waste with a volume of 55 to 65 cubic metres and maximum weight of up to 27 tons is recommended to be stored in 40ft containers
- Waste materials such as metals and glass are recommended to be stored in smaller containers for safe transport while light materials such as plastic can be stored in larger containers
- [Insert additional information here]

Appendix 8: Recycling of disaster waste considerations

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
1 Vehicles	• Include motorbikes, cars, trucks and boats • Vehicles may be crushed, inundated with water or damaged by fire	• Roadsides • Communities • Parking areas	• Leakage of fuel, gas and oils to the environment • Potential fire hazard and explosion related to lithium batteries • Attempting to drive or move damaged vehicles may result in accident, personal injury and property damage	• Ensure EOL vehicles are cooled if impacted by fire prior to handling • Removal of oils, fuels and batteries prior to disposal or recycler collection • Ensure vehicle is roadworthy prior to driving • Priority for vehicle to be collected by or sent to car wrecker business (professional)	• Reuse: Repair and reuse as first option • Reuse: Vehicle disassembly for parts • Recycling: Scrap metal waste extracted and recycled • Disposal: Removal of oil, fuels and batteries prior to vehicle compaction and landfill • Disposal: Appropriate disposal of fuels, oils and batteries
2 Furniture and Domestic Items	• Includes damaged furniture, bedding, chairs, tables, mattresses, bikes, storage tins, toys, kitchen items	• Households • Businesses • Public infrastructure	• Needle stick injury and/or from sharp objects e.g. broken glass, metals • Trips and falls • Injury caused by falling debris	• Be aware of uneven terrain, holes and unsafe ground when clearing wastes • Use PPE when handling wastes • Use plant and machinery to move waste • Only separate wastes where safe to do so or send wastes to a waste facility for recovery and recycling • Consolidate and stack/pile remaining materials for collection • Clearly mark/signpost recovered materials and residual wastes for collection	• Reuse/recycling: separate recyclable items on site if safe to do so • Disposal: Separate hazardous items/materials for separate collection • Disposal: Separate residual wastes for collection and transfer sent to interim storage facility or landfill

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options

3 Rubble	• Predominantly inert waste
	• Includes crushed /broken concrete, bricks, blocks, soils
		• Households
		• Businesses
		• Public infrastructure
			• Dense and heavy wastes should not be removed manually and should use appropriate plant and equipment
			• Inhalation of asbestos fibres from asbestos containing building materials
				• Use suitable PPE including asbestos half face respirators with particulate filters (also refer #9 below)	• Reuse: Materials, dependent on quality can be directly reused
					• Recycle: Materials can be crushed and blended for use in reconstruction after the disaster event to make:
					  ○ road bases in
					  ○ construction fill material
					  ○ quarry rehabilitation material

4 Mixed Waste	• Predominantly non inert wastes • Includes green waste, plastics, timber, insulation, hazardous materials, electrical wiring, packaging materials including glass, cardboard, paper, tins, cans, bottles	• Households • Businesses • Office buildings • Supermarkets and shopping centres • Schools • Factories	• Manual handling - dense and heavy wastes should not be removed manually and should use appropriate plant and equipment • Buildings may fall after the disaster event • Unstable stockpiles may fall • Potential fires from combustible materials in the mixed wastes. Can be ignited by sparks from equipment used for cutting and grinding • Needle stick injury and/or from sharp objectives e.g broken glass, metals • This waste may have voids/pockets harbouring rats, insects including mosquitos and contaminated water. There is potential for stings and bites	• Where possible separate waste by material type for stockpiling and collection • Reuse recovered materials on site where suitable • Consolidate and stack/pile remaining materials for collection	• Reuse: Timber and timber items can be recovered for reuse dependent on quality • Recycle: Untreated/unpainted timber that is damaged can be shredded for use as mulch • Recycle: metal may be salvaged and sold to scrap metal industry • Recycle: E-wastes can be sent to recyclers for dismantling/shredding • Disposal: Mixed wastes unsuitable for reuse or recycling are sent to an interim storage facility or landfill

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
5 Metal Waste	• Ferrous (contains iron) and non-ferrous (does not contain iron e.g. aluminium, copper) materials Includes: • machinery, vehicles, including boats, metal and wire fences, roofs, drums • building materials, steel beams, window frames, wire cabling • auto electrical and electrical equipment, and cabling, white goods, batteries	• Households • Businesses • Office buildings • Supermarkets and shopping centres • Schools • Factories	• Manual handling - dense and heavy wastes should not be removed manually and should use appropriate plant and equipment • Metal waste may be mixed with or in close proximity to asbestos containing materials • Metal waste may be contaminated with oil, grease or mixed with other waste with potential to: ○ discharge to the environment ○ cause fires in stockpiles ○ create hazards during transportation	• Metals waste can be heavy and sharp, caution should be taken to avoid manual handling injuries, cuts and abrasions • Use machinery to manage the compaction of materials prior to transport. Ideally transport vehicles will be fully enclosed • Suitable size storage areas will be required and stockpiled materials will require securing until cleared to ensure the steel (particularly light ferrous) materials are stable in high winds • Separate metal waste from other waste and contaminants such as oil. A risk assessment should be conducted to determine hazardous materials/items such as potential asbestos, batteries, gas cylinders • Wire fencing can be bundled or cut into lengths for improved handling • Non-ferrous materials such as copper can be separated for sale to recycling agent • Metals should be combined for sale to recycling agent	• Reuse: Metals such as roofing iron and teel beams may be suitable for use in reconstruction activities • Recycle: ferrous and non-ferrous materials may be salvaged and sold to the scrap metal industry • Disposal: badly corroded steel may not be suitable for recycling and will require disposal

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options

6. Soil and sediment waste	• Soils, sands and sediment
	• May contain contaminants
		• Roads and bridges
		• Agricultural properties
		• Erosion
			• This type of waste may contain contaminants such as heavy metals, asbestos and chemical residues
			• Stockpiling of these materials may cause dust and become a health and environmental hazard
			• Unstable stockpiling may result in collapse and cause injury
				• Push the materials to the side when clearing the site
				• Allow sufficient room for collection vehicles
				• Check for contamination - look for the presence of chemicals, empty or damaged chemical containers
				• Soil may need further assessment if discoloured or has odours.
					• Reuse: spread back on site if is clean fill material
					• Recycling: non contaminated soil and sediment waste for:
					  ○ Road base
					  ○ Batters and bunding
					  ○ Quarry rehabilitation
					  ○ Composting
					  ○ Land reclamation
					• Disposal: Contaminated soil sent to appropriate landfill
					• Disposal: Hazardous soil/sediment may require treatment prior to disposal

7. Organic materials	• Food waste • Green waste / garden waste • Tree/timber waste	• Refrigerators and freezers from households and businesses without power • Damaged commercial freezers or cold stores • Packaged and containerised foods in supermarkets and shopping centres • Food transport vehicles • Farms	• Following a fire disaster, organic material may have blended with molten plastics and other materials unsuitable for composting • Food that has be covered by floodwaters is unsuitable for composting • This waste may harbour rats, insects including mosquitos and contaminated water. There is potential for stings and bites • Poorly managed stockpiling/ storage of these materials can lead to rotting and the spread of dangerous pathogens including fungi, moulds and bacteria • The composting process must be managed	• Stockpile organics separate from contaminants such as packaging wherever possible • Collect and transfer the organic waste materials as soon as possible • Enclose the waste when transporting to prevent leakage or items blowing off loads • Interim storage is not an option for this material without processing • Ensure access to water and sanitation for personnel managing these wastes	• Recycle: Organic wastes that are free of plastics and other contaminants may be suitable for composting • Disposal: Organic materials that are contaminated, decaying or may potentially cause disease are to be landfilled as soon as possible

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
s8. Animal carcass	• Arises from the whole or any part of a dead animal Includes: • Livestock • Family pets • Assistance animals • Animals used for work, sport etc. • Animals from the wild • Aquatic species (farmed or wild) Does not include animals destroyed by biosecurity management post disaster	• Farms • Abattoirs • Veterinary clinics • Private homes • Businesses • Fish deaths • Wild animals	• Manual handling injuries including cuts and abrasions from moving waste • Emotional/psychological trauma • Potential leachate leakage to surface and ground waters from leaving animal carcasses in situ and in burying • Potential dusts and odours from rotting carcasses • Potential pathogens from rotting carcasses including bacteria, viruses, parasites, (e.g. salmonella, botulism)	• Manage appropriate and immediate disposal of these materials wherever possible • Determine the risk of spread of disease asap • If interim storage is required, ensure the carcasses are covered and do not store for extended periods • Ensure decontamination of vehicles used to move and transport the waste carcasses to ensure biosecurity conditions are met and prevent/minimise the spread of disease • Ensure access to water and sanitation for personnel managing these wastes	• Recycling: Composting • Disposal: Buried in situ, mass burial or landfilling. Use appropriate disposal methodologies e.g. liners

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
9. Asbestos containing materials (ACM)	• Asbestos includes varieties of mineral silicates harmful to human health • Asbestos can be present in asbestos cement roofing and sheeting, vinyl flooring, pipe insulation and other building materials • Asbestos can be in: friable form (powder form or can be crumbled, pulverised or reduced to power by hand pressure when dry • Non-friable form that is reinforced with a bonding compound and in solid form – but which may become friable through deterioration or removal activities	• Damaged buildings including dwellings, offices, factories, supermarkets and shopping centres, schools and hospitals	• Inhalation of asbestos fibres can cause serious long term health risks including: lung cancer, mesothelioma and asbestosis	• The removal of asbestos in any form should only be done by fully trained and licensed personnel using approved equipment and removal and air monitoring methodologies but emergency removal may need to be carried out, in which case suitable PPE must be worn and careful precautions observed. • Materials are wetted down and wrapped in heavy duty plastic sheeting to prevent escape of fibres • Warning signage should be placed at the entry points to sites where asbestos containing materials are found	• Disposal: at a suitable managed landfill landfill which has the correct procedures for managing asbestos wastes

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
10. CCA solid and ash waste	• CCA (Copper Chrome Arsenate) – solid and ash waste • Used for the treatment of softwood timber usually greenish in color • Agricultural fence posts and structures • Outdoor furniture and decking • Pallets and skids	• Farms and orchards • Houses and buildings	• CCA in solid or ash form is toxic to human health and the environment • CCA timbers have the potential to release toxic leachate to the environment particularly when wet • CCA waste releases toxic gases and generates toxic residual ash (containing heavy metals) to the environment when burnt • CCA ash may release toxic dusts/particulates to the environment when disturbed, airborne or mobile	• This material must not be burned, shredded or chipped • Material must be kept as dry as possible to avoid leaching • Pack the CCA wastes onto pallets or dedicated waste bins and cover immediately for transport and storage • Seal CCA ash in containers for transport and storage under cover and within bunded area • Ensure storage is separate to other materials • Keep the materials elevated above ground level during storage •	• Disposal: at a suitable managed landfill
11. Chemical wastes	• Chemical (hazardous) wastes are defined within the Basel Convention and have the following characteristics that are harmful to environmental and public health: • Ignitable, corrosive, reactive, toxic, explosive, flammable and infectious • May be solid, liquid or gas	• Farms and other agricultural activities • Transport vehicles • Chemical storage facilities • Processing facilities • Factories • Household chemicals • Laboratory Chemicals – Schools, Universities, Hospitals	• Injury from inhalation, skin exposure, spills or ingestion of hazardous chemicals • Hazards include fire and explosion, human toxicity (acute and chronic including cancers), skin and eye corrosion and environmental toxicity. • Environmental damage caused by spills and discharges to air, soil and water environments • Biodiversity loss through discharge of chemical (hazardous) wastes to flora and fauna habitat and the environment	• Emergency responders will ensure sites are safe and able to be entered • Manage sites where chemicals wastes are identified by cordoning off and securing the area to the public and ensuring adequate bunding and containment is in place to prevent discharge to the environment • Application of appropriate chemical waste signage • Packaging, labelling and transport according to dangerous goods code • Refer to MSDS	• Disposal: via export to sustainable and environmentally sound treatment and disposal facilities (require transboundary approvals, import and export approvals) • Disposal: (contained and approved) interim storage while awaiting treatment and disposal

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
12. Healthcare/ medical wastes	• Needles, syringes, surgical instruments discarded as part of medical, dental or veterinary practices or research • Human tissue, bone, organ and body parts • Swabs, bags or tubes containing liquid body substances including bloods, body fluids and infectious material • Specimen or culture discarded during medical, dental or veterinary practice or research • Drugs and medicines	• Healthcare facilities • Medical centres • Hospitals • Veterinary clinics	• Punctures and injuries from sharps, needlestick and surgical instruments have the potential to transmit disease including but not limited to: ○ Tetanus ○ AIDS ○ Hepatitis • Exposure to infectious materials	• Use appropriate sharps containers for the storage of used needles • Use sealable, tamper proof and appropriate containers for the storage and transfer of medical wastes • Ensure appropriate labelling of wastes; and wastes are contained during transport • Ensure appropriate disposal methodologies	• Disposal: treatment and autoclaving, incineration by authorised, certified and appropriately trained personnel • Medicines and drugs can usually be landfilled to a suitable managed landfill with immediate cover.
13. Bulk Fuels and Oils	• Petrol and Diesel Storage Tanks • Used Oil Storage Tanks	• Bulk Fuel Storage • Power Stations	• Fire and Explosion • Soil Contamination	• Keep sources of ignition well away from spilt fuels and oils • Contain spillage as much as possible with Spill kits and temporary bunds • Do not pump with electric pumps	• Store any recovered fuels and oils in drums or IBCs • Stockpile contaminated soils – can be treated by spreading out and turning regularly • Disposal may need to be by export if no suitable managed landfill is available
14, Relief Aid Wastes	• Plastic water bottles • Food cans • Packaging waste • Unused and/or inappropriate aid materials	• Relief Aid	• Mostly inert but quantities can be substantial in volume • Food cans with residual food can encourage rats and other disease vectors	• This waste may overload local landfills. Reduce in size by crushing and shredding if possible	• Disposal to local landfill

ANNEX 3. Disaster Waste Estimation Manual Recording Tools

The information sheets below are used to report and analyse the findings of the rapid assessment team when the use of electronic equipment is not available:

- Sheet 1: Rapid Disaster Waste Assessment Cover Sheet (for Disaster Waste Working Group reporting purposes**)**
- Sheet 2: Disaster Waste Risk Assessment Recording Sheet for use during a Rapid Assessment
- Sheet 3: Disaster Waste Recording Sheet for use during the Rapid Assessment; and the
- Sheet 4: Disaster Waste Data Analysis Sheet for use in the event of power outage

Sheet 1: Rapid Disaster Waste Assessment Cover Sheet (for Disaster Waste Working Group reporting purposes)

	Rapid Disaster Waste Assessment Cover Sheet (for DWWG reporting purposes)	
Rapid Assessment ID:	**Lead Assessor Name:** **Signature:**	**Approval authority name:** **Designation:** **Signature:**
Disaster name	[Insert name of disaster]	
Type of disaster event	[Insert type of disaster]	
Date of disaster event	[Insert date the disaster occurred]	
Date of rapid assessment	[Insert the date this rapid assessment was completed]	
Location of assessment	[Insert name of street/area that was assessed – Note: this should correlate with those areas that were allocated to the team	
Communities at risk	[Insert the name of the communities that are located at, near to and downstream of the assessment area	
Scope of disaster assessment	[Insert how the data was collection, and the type of assessment conducted e.g. road networks, informal or urban housing, commercial area]	
Comment/recommendation		
Rapid Disaster Waste Assessment Team		

Name	Role	Responsibilities	Signature of Assessor

Major Disaster Waste Risks Relating to the Rapid Assessment Area (Use the manual risk assessment sheet for rapid assessment work and transfer the key information to the section below)			
Risk Category	Risk	Mitigating Actions	Priority
Chemical			
Biological			
Physical			
Environmental			
Other			

Disaster Waste Information (Use the manual estimation sheet for rapid assessment work and transfer the calculated data and information to the section below)

Location (GPS)	[Insert waste type]	Total est. m^3	Total est. tonnes	Action required [insert] • Priority waste clearance • Requires expert handling • Potentially recyclable	Handling method [insert] • Sort in situ • Temporary storage • Disposal site • Haz waste containment and storage	Storage site area [Insert # m^2]	Containers or trucks [insert #]

Sheet 2: Disaster Waste Risk Assessment Recording Sheet for use during a Rapid Assessment

Disaster Waste Risks in the Rapid Assessment Area					
ID	Location (and GPS)	Risk Category [Insert] • Physical • Chemical • Biological • Environmental • Other	Risk - Describe	Mitigating Actions - Describe	Priority [Insert] • Non urgent • Plan Action • Immediate

Sheet 3: Disaster Waste Recording Sheet for use during the Rapid Assessment

Assessment ID	Assessor Name:							Date:	
Location (GPS)	**Waste Material**	**Length**	**x**	**Width**	**x**	**Height**	**Number**	**Description of hazards identified**	**Recommended priority and actions**
	e.g. Mixed rubble	14	x	6	x	2			
	e.g. Mixed organics	14	x	6	x	2			
	Oil drums 44 gallon		x		x		20	Damaged drums potential leakage	
	20L drums		x		x		30	Labels no intact / unknown substance	
			x		x				
			x		x				
			x		x				
			x		x				
			x		x				
			x		x				
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			x		x				
			x		x				

Sheet 4: Disaster Waste Data Analysis Sheet for use in the event of power outage

Location (GPS)	Waste Material	Length LM	x	Width LM	x	Height LM	=	Volume m^3	x	*Density	=	Weight (tonne)	÷	14 t loads weight/14t	Temporary storage area = m^3/3*1.7
	e.g. Mixed rubble	14	x	6	x	2	=	168	x	1.36	=	228.48	÷	16.3	168/3x1.7 = 95.2m^2
	e.g. Mixed organics	14	x	6	x	2	=	168	x	.38	=	63.84	÷	4.56	168/3x1.7 = 95.2m^2
			x		x		=		x		=		÷		
			x		x		=		x		=		÷		
			x		x		=		x		=		÷		
			x		x		=		x		=		÷		
			x		x		=		x		=		÷		
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			x		x		=		x		=		÷		
			x		x		=		x		=		÷		

Abbreviations: LM = linear metres; m^3 = cubic metres; m^2 = square metres; t = tonne

*Refer to Density Conversion Calculator

ANNEX 4. Disaster Waste Technical Guidance

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
1 Vehicles	• Include motorbikes, cars, trucks and boats • Vehicles may be crushed, inundated with water or damaged by fire	• Roadsides • Communities • Parking areas	• Leakage of fuel, gas and oils to the environment • Potential fire hazard and explosion related to lithium batteries • Attempting to drive or move damaged vehicles may result in accident, personal injury and property damage	• Ensure EOL vehicles are cooled if impacted by fire prior to handling • Removal of oils, fuels and batteries prior to disposal or recycler collection • Ensure vehicle is roadworthy prior to driving • Priority for vehicle to be collected by or sent to car wrecker business (professional)	• Reuse: Repair and reuse as first option • Reuse: Vehicle disassembly for parts • Recycling: Scrap metal waste extracted and recycled • Disposal: Removal of oil, fuels and batteries prior to vehicle compaction and landfill • Disposal: Appropriate disposal of fuels, oils and batteries
2 Furniture and Domestic Items	• Includes damaged furniture, bedding, chairs, tables, mattresses, bikes, storage tins, toys, kitchen items	• Households • Businesses • Public infrastructure	• Needle stick injury and/or from sharp objects e.g. broken glass, metals • Trips and falls • Injury caused by falling debris	• Be aware of uneven terrain, holes and unsafe ground when clearing wastes • Use PPE when handling wastes • Use plant and machinery to move waste • Only separate wastes where safe to do so or send wastes to a waste facility for recovery and recycling • Consolidate and stack/pile remaining materials for collection • Clearly mark/signpost recovered materials and residual wastes for collection	• Reuse/recycling: separate recyclable items on site if safe to do so • Disposal: Separate hazardous items/materials for separate collection • Disposal: Separate residual wastes for collection and transfer sent to interim storage facility or landfill

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options

3 Rubble	• Predominantly inert waste
	• Includes crushed /broken concrete, bricks, blocks, soils
		• Households
		• Businesses
		• Public infrastructure
			• Dense and heavy wastes should not be removed manually and should use appropriate plant and equipment
			• Inhalation of asbestos fibres from asbestos containing building materials
				• Use suitable PPE including asbestos half face respirators with particulate filters (also refer #9 below)	• Reuse: Materials, dependent on quality can be directly reused
					• Recycle: Materials can be crushed and blended for use in reconstruction after the disaster event to make:
					  ○ road bases in
					  ○ construction fill material
					  ○ quarry rehabilitation material

4 Mixed Waste	• Predominantly non inert wastes • Includes green waste, plastics, timber, insulation, hazardous materials, electrical wiring, packaging materials including glass, cardboard, paper, tins, cans, bottles	• Households • Businesses • Office buildings • Supermarkets and shopping centres • Schools • Factories	• Manual handling - dense and heavy wastes should not be removed manually and should use appropriate plant and equipment • Buildings may fall after the disaster event • Unstable stockpiles may fall • Potential fires from combustible materials in the mixed wastes. Can be ignited by sparks from equipment used for cutting and grinding • Needle stick injury and/or from sharp objectives e.g broken glass, metals • This waste may have voids/pockets harbouring rats, insects including mosquitos and contaminated water. There is potential for stings and bites	• Where possible separate waste by material type for stockpiling and collection • Reuse recovered materials on site where suitable • Consolidate and stack/pile remaining materials for collection	• Reuse: Timber and timber items can be recovered for reuse dependent on quality • Recycle: Untreated/unpainted timber that is damaged can be shredded for use as mulch • Recycle: metal may be salvaged and sold to scrap metal industry • Recycle: E-wastes can be sent to recyclers for dismantling/shredding • Disposal: Mixed wastes unsuitable for reuse or recycling are sent to an interim storage facility or landfill

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
5 Metal Waste	• Ferrous (contains iron) and non-ferrous (does not contain iron e.g. aluminium, copper) materials Includes: • machinery, vehicles, including boats, metal and wire fences, roofs, drums • building materials, steel beams, window frames, wire cabling • auto electrical and electrical equipment, and cabling, white goods, batteries	• Households • Businesses • Office buildings • Supermarkets and shopping centres • Schools • Factories	• Manual handling - dense and heavy wastes should not be removed manually and should use appropriate plant and equipment • Metal waste may be mixed with or in close proximity to asbestos containing materials • Metal waste may be contaminated with oil, grease or mixed with other waste with potential to: ○ discharge to the environment ○ cause fires in stockpiles ○ create hazards during transportation	• Metals waste can be heavy and sharp, caution should be taken to avoid manual handling injuries, cuts and abrasions • Use machinery to manage the compaction of materials prior to transport. Ideally transport vehicles will be fully enclosed • Suitable size storage areas will be required and stockpiled materials will require securing until cleared to ensure the steel (particularly light ferrous) materials are stable in high winds • Separate metal waste from other waste and contaminants such as oil. A risk assessment should be conducted to determine hazardous materials/items such as potential asbestos, batteries, gas cylinders • Wire fencing can be bundled or cut into lengths for improved handling • Non-ferrous materials such as copper can be separated for sale to recycling agent • Metals should be combined for sale to recycling agent	• Reuse: Metals such as roofing iron and teel beams may be suitable for use in reconstruction activities • Recycle: ferrous and non-ferrous materials may be salvaged and sold to the scrap metal industry • Disposal: badly corroded steel may not be suitable for recycling and will require disposal

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options

6. Soil and sediment waste	• Soils, sands and sediment
	• May contain contaminants
		• Roads and bridges
		• Agricultural properties
		• Erosion
			• This type of waste may contain contaminants such as heavy metals, asbestos and chemical residues
			• Stockpiling of these materials may cause dust and become a health and environmental hazard
			• Unstable stockpiling may result in collapse and cause injury
				• Push the materials to the side when clearing the site
				• Allow sufficient room for collection vehicles
				• Check for contamination - look for the presence of chemicals, empty or damaged chemical containers
				• Soil may need further assessment if discoloured or has odours.
					• Reuse: spread back on site if is clean fill material
					• Recycling: non contaminated soil and sediment waste for:
					  ○ Road base
					  ○ Batters and bunding
					  ○ Quarry rehabilitation
					  ○ Composting
					  ○ Land reclamation
					• Disposal: Contaminated soil sent to appropriate landfill
					• Disposal: Hazardous soil/sediment may require treatment prior to disposal

7. Organic materials	• Food waste • Green waste / garden waste • Tree/timber waste	• Refrigerators and freezers from households and businesses without power • Damaged commercial freezers or cold stores • Packaged and containerised foods in supermarkets and shopping centres • Food transport vehicles • Farms	• Following a fire disaster, organic material may have blended with molten plastics and other materials unsuitable for composting • Food that has be covered by floodwaters is unsuitable for composting • This waste may harbour rats, insects including mosquitos and contaminated water. There is potential for stings and bites • Poorly managed stockpiling/ storage of these materials can lead to rotting and the spread of dangerous pathogens including fungi, moulds and bacteria • The composting process must be managed	• Stockpile organics separate from contaminants such as packaging wherever possible • Collect and transfer the organic waste materials as soon as possible • Enclose the waste when transporting to prevent leakage or items blowing off loads • Interim storage is not an option for this material without processing • Ensure access to water and sanitation for personnel managing these wastes	• Recycle: Organic wastes that are free of plastics and other contaminants may be suitable for composting • Disposal: Organic materials that are contaminated, decaying or may potentially cause disease are to be landfilled as soon as possible

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
s8. Animal carcass	• Arises from the whole or any part of a dead animal Includes: • Livestock • Family pets • Assistance animals • Animals used for work, sport etc. • Animals from the wild • Aquatic species (farmed or wild) Does not include animals destroyed by biosecurity management post disaster	• Farms • Abattoirs • Veterinary clinics • Private homes • Businesses • Fish deaths • Wild animals	• Manual handling injuries including cuts and abrasions from moving waste • Emotional/psychological trauma • Potential leachate leakage to surface and ground waters from leaving animal carcasses in situ and in burying • Potential dusts and odours from rotting carcasses • Potential pathogens from rotting carcasses including bacteria, viruses, parasites, (e.g. salmonella, botulism)	• Manage appropriate and immediate disposal of these materials wherever possible • Determine the risk of spread of disease asap • If interim storage is required, ensure the carcasses are covered and do not store for extended periods • Ensure decontamination of vehicles used to move and transport the waste carcasses to ensure biosecurity conditions are met and prevent/minimise the spread of disease • Ensure access to water and sanitation for personnel managing these wastes	• Recycling: Composting • Disposal: Buried in situ, mass burial or landfilling. Use appropriate disposal methodologies e.g. liners

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
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DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
10. CCA solid and ash waste	• CCA (Copper Chrome Arsenate) – solid and ash waste • Used for the treatment of softwood timber usually greenish in color • Agricultural fence posts and structures • Outdoor furniture and decking • Pallets and skids	• Farms and orchards • Houses and buildings	• CCA in solid or ash form is toxic to human health and the environment • CCA timbers have the potential to release toxic leachate to the environment particularly when wet • CCA waste releases toxic gases and generates toxic residual ash (containing heavy metals) to the environment when burnt • CCA ash may release toxic dusts/particulates to the environment when disturbed, airborne or mobile	• This material must not be burned, shredded or chipped • Material must be kept as dry as possible to avoid leaching • Pack the CCA wastes onto pallets or dedicated waste bins and cover immediately for transport and storage • Seal CCA ash in containers for transport and storage under cover and within bunded area • Ensure storage is separate to other materials • Keep the materials elevated above ground level during storage •	• Disposal: at a suitable managed landfill
11. Chemical wastes	• Chemical (hazardous) wastes are defined within the Basel Convention and have the following characteristics that are harmful to environmental and public health: • Ignitable, corrosive, reactive, toxic, explosive, flammable and infectious • May be solid, liquid or gas	• Farms and other agricultural activities • Transport vehicles • Chemical storage facilities • Processing facilities • Factories • Household chemicals • Laboratory Chemicals – Schools, Universities, Hospitals	• Injury from inhalation, skin exposure, spills or ingestion of hazardous chemicals • Hazards include fire and explosion, human toxicity (acute and chronic including cancers), skin and eye corrosion and environmental toxicity. • Environmental damage caused by spills and discharges to air, soil and water environments • Biodiversity loss through discharge of chemical (hazardous) wastes to flora and fauna habitat and the environment	• Emergency responders will ensure sites are safe and able to be entered • Manage sites where chemicals wastes are identified by cordoning off and securing the area to the public and ensuring adequate bunding and containment is in place to prevent discharge to the environment • Application of appropriate chemical waste signage • Packaging, labelling and transport according to dangerous goods code • Refer to MSDS	• Disposal: via export to sustainable and environmentally sound treatment and disposal facilities (require transboundary approvals, import and export approvals) • Disposal: (contained and approved) interim storage while awaiting treatment and disposal

DW Type	Description	Sources	Potential hazards	Management Recommendations	Reuse, recycling and disposal options
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13. Bulk Fuels and Oils	• Petrol and Diesel Storage Tanks • Used Oil Storage Tanks	• Bulk Fuel Storage • Power Stations	• Fire and Explosion • Soil Contamination	• Keep sources of ignition well away from spilt fuels and oils • Contain spillage as much as possible with Spill kits and temporary bunds • Do not pump with electric pumps	• Store any recovered fuels and oils in drums or IBCs • Stockpile contaminated soils – can be treated by spreading out and turning regularly • Disposal may need to be by export if no suitable managed landfill is available
14, Relief Aid Wastes	• Plastic water bottles • Food cans • Packaging waste • Unused and/or inappropriate aid materials	• Relief Aid	• Mostly inert but quantities can be substantial in volume • Food cans with residual food can encourage rats and other disease vectors	• This waste may overload local landfills. Reduce in size by crushing and shredding if possible	• Disposal to local landfill

ANNEX 5: University of Newcastle Disaster Waste Estimation Methodology13

Reference: Practitioner's Guideline and Introduction of Systems to Enable Pacific Islands to Effectively Manage Disaster Waste, Section 6 Disaster waste estimation methodology, pgs 42-45

Calculate the estimated volume of debris from damaged buildings

After a disaster, the amount of debris waste from affected houses can be estimated using the following equation:

$$WD = \sum_{i=i}^{k} \mathrm{C}_i \times N_i \times F_i$$

Where:

***K**: Total number of buildings from same size (for example category 1: warehouses, category 2: high rise buildings, category 3: houses, category 4: shops, etc)*

***WD** stands for the total estimated quantity of disaster waste (m^3)*

***Ci** is the amount of disaster debris from the unit generation of debris (each building / house) (m^3)*

***Fi** is the coefficient factor for each type of building (in terms of size) that takes into account the size of each building that is proportionate to the amount of waste. If the size of the houses and buildings are quite different. Such as multi-story buildings. A coefficient will be considered as 1 for the smallest units and will be multiple for larger units. For example, a 10-story building should be counted as 10 houses.*

***Ni**: Number of damaged buildings in each building size category*

Calculate the estimated volume of the piles of waste

The volume of the total waste equals the sum of each pile onsite. The volume of each pile can simply be calculated by multiplying the length of each pile, width of the pile, and the average height. All dimensions should be the same. For example, if metre is used for measurement. Then the volume of waste is calculated by cubic metric (m^3)

$$V = \sum_{i=1}^{k} (L_i \times W_i \times AV_i)$$

Where:

***V**: Total volume of the waste onsite which is composed of several piles (K = number of piles)*

***Li**: length of each pile*

[13] *University of Newcastle (2022). Practitioner's Guideline and Introduction of Systems to enable Pacific Islands to Effectively Manage Disaster Waste. Unpublished report to SPREP. 68p.*

***Wi**: Width of each pile*

***AV$_i$**: Average Height of each pile (i = 1 to k) that will be calculated as follows (H_k: heights measurements from 4 corners and the middle of each pile):*

$$AV_i = \left(\sum_{k=1}^{5} H_k\right)/5$$

In other words, Average Height (HV) equals sum of the 5 heights measurements (4 corners and the middle) divided by five.

Estimation of the area for the temporary DW storage sites

The land area as the temporary storage sites required for piling up the waste can be calculated using the formula inspired by Japan's ministry of the environment. According to this method, the land area required for temporary storage sites is calculated as follows.

$$A = \frac{W}{d \times H} \times \frac{1}{r}$$

Where:

A: land area of the temporary storage site [m^2],

w: collected disaster waste [kg],

d: density of the disaster waste [kg/m^3]

H: height for stacking the disaster waste [m],

r: ratio of waste storage to total storage area which equals to (60%)

The estimation of the number of containers for collecting waste

The most common size of containers is 20ft and 40ft. The volume of a 20ft container is approximately 33 cubic metres while that of 40ft container is 69 cubic metres. To calculate the total number of containers required for the storage and transport of the disaster waste, the total volume of the waste is calculated by the methods discussed above.

$$N = \frac{V}{C}$$

Where:

N is the total number of containers required for the collection of DW (number)

V represents the total volume of waste (m^3)

C is the capacity of each container (m^3)

ATTACHMENT 1: Disaster Waste Estimation Database

Disaster Waste Estimation Sheet

Disaster event:
Date:
Location:

ID	Record date	Location	GPS coordinates	Shape	Length	Width	Height	Height	Apparent amount of devastation	Number of piles/buildings	Volume of DW	Type of DW	*Density of DW	Tonnes of DW		Temporary DW storage area	Type of truck / container	Truck / container capacity m3	Total number of truck/continers needed	Truck/container capacity in tonnes	Total number of trucks/containers needed
Enter the ID number of this DW	Enter the Record date	Enter the DW location	Enter the DW GPS coordinates	Shape of DW pile	Length of each DW pile /building (m)	Width of each DW pile/building (m)	How many stories or levels the building had	Height of each DW pile/story or level of the building (m)	% of building left standing	Total number of DW piles/buildings in this cluster	Total volume of DW piles in m3	Select material	Insert density for the material type (tonne/m3)	Total tonnage of DW piles	Average height of stacked material in temporary storage (m)	Land area required for temporary storage (m2)	Type of truck / container	The capacity of container/ truck available in volume (m3)	Number of containers required for collection of DW	The capacity of container/ truck in weight (t)	Total number of containers needed for DW removal
				DEBRIS	10.0	100.0		20.0		5	100,000	building - fittings, fixtures			3	55,556	20m3 container	14	7,142.9	12	
				DEBRIS				10.0		3	0	building - electrical			3	0	Large 10m truck & trail	30	0.0	33	
				RECOVERED MAT.	1.0	1.0		8.0		7	19	building - metal light gauge			3	10	Small tipper	4	4.7	4	
				DEBRIS	1.0	1.0		4.0		1	4	building - glass			3	2	Large tipper	7	0.6	7	
				DAMAGED BUILDING	1.0	1.0	1	2.4	30%	1	1	Structure - Engineered	0.73	1	3	0	Large tipper	7	0.1	7	0.1
				DAMAGED BUILDING	1.0	1.0	1	2.4	10%	1	0	Structure - Informal	1.14	0	3	0	Large tipper	7	0.0	7	0.0
				DEBRIS	1.0	1.0		1.0			0	Mixed building waste	0.72	0							
				DEBRIS							0	Waste chemicals	0.90	0							

ATTACHMENT 2: Waste Density Conversion Calculator

Density Calculator: volume (per m3) to weight (kg and tonne)

Mixed materials	Density	A *enter litres*	equals kilograms	B *enter m3*	equals tonnes	C *enter tonnes*	equals kilograms
General waste compacted	0.44		0.00		0.00		0.00
General waste uncompacted	0.15		0.00		0.00		0.00
Industrial and transport packaging including film	0.01		0.00		0.00		0.00
Mixed batteries	1.12		0.00		0.00		0.00
Mixed building waste	0.72		0.00		0.00		0.00
Mixed C&D waste (concrete, soil, timber, steel)	1.23		0.00		0.00		0.00
Mixed computers & IT peripherals	0.24		0.00		0.00		0.00
Mixed consumer packaging (commingled stream)	0.06		0.00		0.00		0.00
Mixed disaster waste	0.72		0.00		0.00		0.00
Mixed household hardwaste e.g furniture, household	0.1		0.00		0.00		0.00
Mixed ferrous	0.5		0.00		0.00		0.00
Mixed non ferrous	0.16		0.00		0.00		0.00
Mixed organics inc. food/kitchen, garden/vegetation	0.38		0.00		0.00		0.00
Mixed soil, sand, rubble <150mm	1.4		0.00		0.00		0.00
Mixed textiles	0.15		0.00		0.00		0.00
Quarantine waste	0.3		0.00		0.00		0.00
Street cleaning waste	0.7		0.00		0.00		0.00
Wood mix inc. fencing, , furniture, pallets, timber	0.3		0.00		0.00		0.00

Single type materials	Density	*enter litres*	equals kilograms	*enter m3*	equals tonnes	*enter tonnes*	equals kilograms
Aluminium cans - baled	0.15		0.00		0.00		0.00
Aluminium cans - flattened	0.08		0.00		0.00		0.00
Aluminium cans - whole	0.02		0.00		0.00		0.00
Asbestos	0.22		0.00		0.00		0.00
Asphalt/Bitumen	0.8		0.00		0.00		0.00
Biosolids - dry	0.56		0.00		0.00		0.00
Biosolids - wet	0.72		0.00		0.00		0.00
Bricks	1.2		0.00		0.00		0.00
Car Batteries	1.12		0.00		0.00		0.00
Cardboard	0.09		0.00		0.00		0.00
Carpets	0.3		0.00		0.00		0.00
Cement Sheet	0.5		0.00		0.00		0.00
Ceramics	0.75		0.00		0.00		0.00
Clay	1.15		0.00		0.00		0.00
Clinical Waste	0.22		0.00		0.00		0.00
Concrete	1.5		0.00		0.00		0.00
Contaminated soil (low level)	0.92		0.00		0.00		0.00
Fencing wooden	0.17		0.00		0.00		0.00
Fluorescent light tubes	0.24		0.00		0.00		0.00
Food/Kitchen	0.34		0.00		0.00		0.00
Furniture wooden	0.24		0.00		0.00		0.00
Garden /Vegetation	0.15		0.00		0.00		0.00
General electrical Inc. whitegoods/e-waste	0.11		0.00		0.00		0.00
Glass bottles - semi-crushed	0.34		0.00		0.00		0.00
Glass bottles - whole	0.17		0.00		0.00		0.00
Grass	0.25		0.00		0.00		0.00
Hazardous Wastes	0.2		0.00		0.00		0.00
Hospital General Waste	0.2		0.00		0.00		0.00
Insulation	0.05		0.00		0.00		0.00
Kitchen grease trap	0.9		0.00		0.00		0.00
Leather	0.18		0.00		0.00		0.00
Linoleum	0.2		0.00		0.00		0.00
Litter trap	0.75		0.00		0.00		0.00
Mattresses	0.05		0.00		0.00		0.00
Mercury containing lamps including fluoros	0.2		0.00		0.00		0.00
Metals - ferrous (solid)	7.5		0.00		0.00		0.00
Metals - non ferrous	0.9		0.00		0.00		0.00
Office paper	0.1		0.00		0.00		0.00
Paint	0.8		0.00		0.00		0.00
Paper / Cardboard	0.1		0.00		0.00		0.00
Plasterboard	0.2		0.00		0.00		0.00
Plastic bags	0.07		0.00		0.00		0.00
Plastic containers - baled	0.13		0.00		0.00		0.00
Plastic containers - whole	0.01		0.00		0.00		0.00
Plastic containers - whole, some flattened	0.01		0.00		0.00		0.00
Plywood sheets	0.46		0.00		0.00		0.00
Polystyrene	0.02		0.00		0.00		0.00
Rock and stone	1.58		0.00		0.00		0.00
Rubber exc. tyres	0.36		0.00		0.00		0.00
Rubble	1.36		0.00		0.00		0.00
Sand	1.6		0.00		0.00		0.00
Sawdust	0.3		0.00		0.00		0.00
Soil - clean	1.11		0.00		0.00		0.00
Steel cans - baled	0.22		0.00		0.00		0.00
Steel cans - flattened	0.13		0.00		0.00		0.00
Steel cans - whole	0.05		0.00		0.00		0.00
Textiles	0.1		0.00		0.00		
Tiles	0.47		0.00		0.00		0.00
Timber	0.18		0.00		0.00		0.00
Timber pallets/MDF	0.15		0.00		0.00		0.00
Trees	0.5		0.00		0.00		0.00
Tyres	0.26		0.00		0.00		0.00
Waste chemicals	0.9		0.00		0.00		
Waste Oil	0.8		0.00		0.00		0.00
Wooden posts	1		0.00		0.00		0.00
Wood / Timber	0.3		0.00		0.00		0.00

ATTACHMENT 3: Disaster Waste Risk Analysis Database

Disaster Waste Risk Register

Disaster:

Date:

Reference:

Risk ID: [Inser rapid assessment ID]	Record Date [Insert date rapid assessment was conducted]	Location of rapid assessment: insert location details	Risk Category: Select from dropdown box	Description of Risk: Insert the potential adviser impacts to human health and the environment	DW material: Select from dropdown box	DW Source: Select from dropdown box	Scope of Impact (1. Local; 2. Province; 3. Country; 4. Region; 5. Several Countries): Select from dropdown box	Monetary Loss (1. Low; 2. Minor; 3. Moderate; 4. Major; 5. Serious):	Recovery Complexity (1. Low; 2. Relative; 3. Moderate; 4. Complex; 5. Extreme)	Time to Recover/Rebuild (1. Immediate; 2. Less than 1 year; 3. 1 to 3 years; 4. 3 to 10 years; 5. More than 10 years)	Total Vulnerable Population (1. Less than 100; 2. 100 to 1,000; 3. 1,000 to 10,000; 4. 10,000 to 100,000; 5. More than 100,000)	Overall Impact Score	Probability of Threat Occurring (0.20 Very unlikely; 0.40 Unlikely; 0.60 Possible; 0.80 Likely; 1.00 Very likely)	Risk Exposure Score	Tolerance / Priority
							2	3	3	4	5	0.68	0.6	0.408	Immediate Action
							2	3	3	4	5	0.68	0.2	0.136	Plan Action
												0		0	No Immediate Action
												0		0	No Immediate Action
												0		0	No Immediate Action
												0		0	No Immediate Action
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