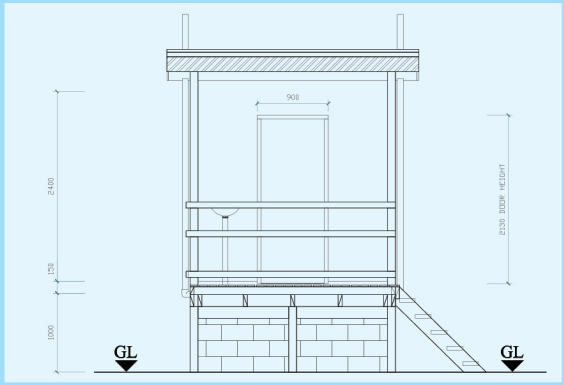
Pacific R2R
Ridge to Reef

Pacific International Waters
Ridge to Reef Project

Composting System
Standard Operating Procedure



Pacific Community
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The **Pacific Ridge to Reef (R2R) Programme** is a multi -country, multi -GEF agency programmatic initiative guiding the coordinated investment of US$90 million in GEF grant funding across multiple focal areas of biodiversity conservation, land degradation, climate change adaptation and mitigation, sustainable land management, sustainable forest management, and international waters in Pacific Small Island Developing States (SIDS).

Operating across 14 Pacific Island countries, the programme aims to deliver tangible and quantifiable local and global environmental benefits by focusing on cross-cutting approaches to water, land and coastal management with linkages across GEF focal areas including: biodiversity, land degradation, international waters, sustainable forest management, climate mitigation and adaptation and capacity development.

The programme is implemented by United Nations Development Programme (UNDP), the United Nations Food & Agriculture Organization (FAO) & the United Nations Environment Programme (UNEP).

Executed regionally by the Pacific Community through the **Regional Ridge to Reef International Waters Project (Regional IW R2R)**, the R2R programme is supported by the Regional Programme Coordination Unit (RPCU) in areas of science-based planning, human capital development, policy and strategic planning, results-based management, and knowledge sharing. The Regional IW R2R Project is one of 15 child projects under the Programme and provides the primary programme coordination vehicle for the 14 other child projects – the national R2R System for Transparent Allocation of Resources (STAR) Projects under the Pacific R2R Programme.

The Regional Project aims to test the mainstreaming of 'ridge-to-reef' (R2R), climate resilient approaches to integrated land, water, forest and coastal management in the Pacific Island countries (PICs) through strategic planning, capacity building and piloted local actions to sustain livelihoods and preserve ecosystem services.

The Regional IW R2R Project has 14 demonstration projects in participating Pacific Islands - Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of the Marshal Islands , Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

Contents

1. General description of site and process

a. (*Insert country* name) International Waters Ridge to Reef Project

b. (*Insert site location, address, and phone number if applicable*)

c. (*Insert name of person with ultimate responsibility over the composting system*)

The site currently composts a mixture of pig waste.

The process is an open-air turned pile process.

2. Types of input materials

The site currently composts the following mixture of waste / material types

Waste description	**Waste Source**	**Waste supplier organisation**
(*E.g., pig waste, dried coconut leaves, mulch, garden waste etc.*)	(*E.g., piggeries, municipal green waste, residential collection etc.*)	(*E.g., local farmer, local utility, or Govt. department etc.*)

3. Composting Activities

3.1. Batch Size and Monitoring

The dimensions of each compost pile are approximately (*insert number*) metres high, (*insert number*) metres wide and (*insert number*) metres long.

The typical batch size is: (*insert* number) metres cubed

Gaps of suitable width to enable turning / monitoring / litter picking shall be left between the piles.

Each formed batch is identified by a marker that displays its pile code/name, in a way and location in the batch that is easily visible to technicians moving materials on site.

If any composted batch is combined with a batch that is only part way through the composting phase, the composting phase for those combined batches shall be restarted.

3.1.1. Monitoring Equipment

The composting monitoring system, including the monitoring equipment, is as follows:

- (*insert name(s) of temperature monitoring equipment*),
- Squeeze Test by hand
- (*insert name(s) of any other equipment used for monitoring composting process parameters other than moisture and temperature*)

The monitoring system (including equipment) shall be maintained in a functional state by the IW R2R Project Manager and suitable staff of the national lead agency.

Calibration checks are carried out on the temperature monitoring equipment once every 12 months by the lead agency of the IW R2R Project and/or the Regional Program Coordinating Unit.

Routine checks on the temperature monitoring system / equipment are carried out by the national IW R2R Project Manager once a month following the procedures based on the brand of equipment procured.

If the check shows significant errors, then remediation efforts shall be made including the servicing or re-purchase of equipment.

3.1.2. Temperature Monitoring and Response

The temperature of a compost pile is primarily a product of the metabolic heat being generated in the pile from microbial activity. Pile temperatures can also be affected by physical characteristics of the materials being composted (more versus less insulating), as well as chemical reactions (at high temperatures) and external environmental variables. Pile temperatures are an imperfect but useful indication of microbial activity. Newly formed piles commonly reach or exceed 55°C within several days to several weeks of pile construction. If you are trying to ensure pathogen destruction, you will need to obtain 55°C temperatures for several days and obtain these temperatures again following multiple turnings.

The temperature during the composting is monitored as follows:

Pile temperatures will be taken every 1-2 metres along the pile depending on the total length of the pile. Additionally, temperatures will be taken at 0.5m and 1.0m depth below the surface. The temperature detected by the sensor when inserted in the pile shall be allowed to stabilise before a final reading is recorded (Waste and Resource Action Programme, 2012).

Record pile temperatures in the *'Compost Monitoring Log Sheet'* and keep monitoring logs on file.

3.1.3. Moisture Monitoring and Response

Moisture in the pile is a critical factor regarding microbial activity and hence the decomposition process. If you have too much or too little moisture, microbes cannot function effectively. You are targeting a moisture content of roughly 60%. Pile moistures of 50-65% are okay, however, moisture levels approaching the limits of this range should be closely monitored and if moisture moves outside 50-65% it should be addressed. Moisture surrounding the pile can also adversely affect the composting process, as it will inhibit oxygen intake through its sides. Standing water around the piles will result in the saturation of the pile base, creating undesirable, anaerobic conditions.

The moisture content of samples of composting materials from each batch shall be assessed by:

Squeeze test

- Take a small handful of compost in one hand, remove excessively large particles and squeeze the material. Watch for water dripping freely from your hand, observe the space between the fingers and look for signs of excess moisture. Assess moisture content using the guide in Table 1.

Table 1: Moisture assessment index

Index number	Sample moisture behaviour	%	Interpretation
1	Water seeps out	>65%	Too wet
2	More than one droplet appears	>65%	Too wet
3	One droplet appears	60-65%	OK
4	Compost particles remain packed together and no droplets appear	50-60%	OK
5	Compost particles fall away from each other	<50%	Too dry

A visual inspection of the pile and the surrounding site will also provide you with feedback regarding moisture. Site moisture and pile moisture may be connected or not, and therefore clarifying where the moisture is originating, from the pile or the site (including water coming onto the site from the surrounding environment), is important (Waste and Resource Action Programme, 2012).

Record pile moisture content in *'Compost Monitoring Log Sheet'* and keep monitoring logs on file.

3.1.4. Weather Monitoring

The following weather conditions shall be monitored and recorded at each monitoring event:

temperature;
description of weather conditions, including any precipitation (drizzle, rain)

Make note of any other weather conditions that appear to impact on the condition of the pile. Record notes in *'Compost Monitoring Log Sheet'* and keep monitoring logs on file.

3.1.5. Corrective Actions

The temperature will impact your decision to turn or not turn a pile and may indicate that factors in your pile recipe need to be adjusted. There may be a several reasons for depressed temperatures, such as a C:N ratio that is too low or too high, high or low moisture content, compaction in the pile, or excessive pile density. Low temperatures that correlate with a high or low moisture content can be addressed by remediating the moisture issue. If you are experiencing low pile temperatures and moisture is not the issue, your C:N ratio or the pile density are the next issues to explore. If everything in your pile recipe seems fine, try turning the pile once to mix and aerate it (Department of Environmental Conservation, 2015).

If your moisture content (MC) is high (above 65%) you need to dry out your mix. If the mix is not significantly above 65% MC, simply turning the pile may achieve the desired drying effect. Turning, as well as general exposure to dry climatic conditions, can reduce pile moisture over time. In many cases, multiple turnings over several dry days may be sufficient. If the mix is significantly moister than 65% or in very wet times of year, the addition of dry matter is required. This can be done by opening the top of the pile with the bucket, forming a trough, adding some dry matter, and then rolling or otherwise turning the pile to incorporate the material.

If your pile moisture is below 50%, the addition of moisture is required. In some cases, impending rain may sufficiently wet the pile. When you are adjusting pile moisture up or down you need to be careful not to adversely impact the pile recipe in other ways. This can be a good use for leachate or dirty stormwater collected from the site if the pile is still actively achieving thermophilic temperatures (to ensure pathogen destruction).

3.2. Sanitisation and Stabilisation

The sanitization step in a composting process serves as the critical control point for minimization of risks associated with human, animal and plant pathogens (British Standards Institute, 2005). The stabilisation step in a composting process after which elevated temperatures no longer occur, pathogens have been destroyed to acceptable limits and the compost is said to be stable for use.

For each pile, the sanitisation and stabilisation phase will occur during the 12 weeks actively managed composting phase.

It is recognised that compliance to Composting Standards is not the objective of the R2R Project, and the critical limits proposed in Table 2 and 3 are to be used as a guide only for the indication of the sanitary and stable state of the compost pile.

Table 2: critical limits of sanitisation phase critical control points

Parameter	**Sanitisation phase critical limits**
Temperature	65 - 80 C
Moisture content	51 - 65 % m/m
Minimum duration	7 consecutive days* when temperatures and moisture are within the above ranges OR 7 not necessarily consecutive days* when temperatures and moisture are within the above ranges
Minimum number of turns	2 turns during the minimum duration above OR state 'Not applicable' if turning not utilised during this phase**

*these critical limits may be subject to change depending on the initial trials of the composting of pig waste.
** number or applicability of turnings will be investigated during initial trials of the composting of pig waste.

Table 3:critical limits of stabilisation phase critical control points

Parameter	**Stabilisation phase critical limits**
Temperature	45 - 80 C
Moisture content	40 - 65 % m/m
Minimum duration	6 weeks when temperatures and moisture are within the above ranges (except during and up to 24 hours after each turn, if composting batches are turned during this phase)
Minimum number of turns	4 turns during the minimum duration above OR state 'Not applicable' if turning not utilised during this phase**

*these critical limits may be subject to change depending on the initial trials of the composting of pig waste.
** number or applicability of turnings will be investigated during initial trials of the composting of pig waste

When each batch has completed the sanitisation and stabilisation period, this shall be recorded on the *'Compost Monitoring Log Sheet'*.

Monitoring locations and frequencies of monitoring composting conditions within each batch shall be carried out as stated in table 5a when the batch is undergoing sanitisation and then as stated in table 5b when the batch is undergoing stabilisation (see SOPs section 4.4.2).

References

British Standards Institute. (2005). *PAS 100:2011 Specification for composted materials.* BSI.

Department of Environmental Conservation. (2015). *Compost Site Management.* Vermont: Department of Conservation, Vermont.

Waste and Resource Action Programme. (2012). *Compost Quality Protocol.* Northern Island Environment Agency, .

Annex 1: Compost Monitoring Log (Bins/Piles)

Pile name:	Pile start date:
Pile contents:	Sanitisation end date:
	Stabilisation end date:

Date	Pile Temperature				Moisture	Height	Notes (turning, weather, odour, visual, vectors…)
	Front		Back				
	50cm depth	1m depth	50cm depth	1m depth			

Annex 2: Glossary of terms

Aerobic - Occurring in the presence of oxygen. For successful composting, sufficient oxygen should be provided to keep the system aerobic. This ensures that the composting proceeds rapidly and with minimal odour.

Anaerobic - occurring in the absence of oxygen. Anaerobic composting proceeds slowly and produces excess odours.

Batch – a mixture of waste and plant material that is left to compost for a period of time without any new material being added, until the mixture becomes compost.

Compost - Solid particulate material that is the result of composting, that has been sanitised (see definition of sanitisation) and stabilised (see definition of stabilisation), and which confers beneficial effects when added to soil, is used as a component of a growing medium, or is used in another way in conjunction with plants.

Composting - Process of controlled biological decomposition of biodegradable materials under managed conditions that are predominantly aerobic, and which allow the development of thermophilic temperatures as a result of biologically produced heat.

Maturation - Period of lower rate biodegradation than in the preceding steps of composting (sanitisation and stabilisation). This step occurs after the actively managed period, either before or after any compost screening.

Microbial activity – Process whereby microorganisms break down organic matter and produce carbon dioxide, water, heat, and humus, the relatively stable organic end product.

Mulch - Material spread and allowed to remain on the soil surface to conserve soil moisture, suppress weeds and shield soil particles from the erosive forces of raindrops and runoff

Sanitisation - biological processes that together with conditions in the composting batch eradicate human and animal pathogens or reduce them to acceptably low, sanitary levels

Stabilisation - Biological processes that together with conditions in the composting mass give rise to compost that is nominally stable.

Stable, stabilised - Degree of processing and biodegradation at which the rate of biological activity has slowed to an acceptably low and consistent level and will not significantly increase under favourable, altered conditions

Thermophilic micro-organisms - micro-organism species for which optimum growth temperatures are within the range 45 °C to 80 °C

The GEF unites 182 countries in partnership with international institutions, non-governmental organizations (NGOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives.

The GEF Pacific R2R programme was developed to provide an opportunity for Pacific small island developing states (SIDS) to develop and implement integrated approaches for the sustainable development of island economies and communities. Partnerships are key to realizing benefits at the local, regional, and global levels.

GEF Implementing Agencies

UNDP is on the ground in 177 countries and territories and partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of live for everyone.

FAO has 194 member nations working to achieve food security for all, to make sure people have a regular access to enough high-quality food to lead active and healthy lives.

UNEP is the leading global environmental authority that sets the environmental agenda and promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system.

Executing Agency

The **Pacific Community** is an international development organization with 26 member countries and territories. It is the principal scientific and technical agency proudly supporting development in the Pacific regional since 1947.

GEF Pacific Regional International Waters Ridge to Reef Project & Programme Coordination Unit

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