PACIFIC BUILDING CODES GUIDANCE SERIES

On-Site Waste Management Systems and Rainwater Harvesting Systems

How to apply building code provisions and standards for water, sanitation, and hygiene for households

Pacific Region Infrastructure Facility

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Introduction

Objective

To provide practical guidance on how to apply the Pacific building codes and their referenced standards for water and waste management systems for single and small dwellings (households), considering a variety of contexts and environments encountered in Pacific.

This Guidance Note provides insights into how the key standards referenced in South Pacific Building Codes can be applied in the South Pacific; and how the American-based standards and codes (e.g. International Building Code) can be applied in the North Pacific.

Readers can access awareness material and fact sheets on sustainable water management for Pacific Island countries on the Pacific Community's website[1] or by contacting Pacific Community staff at its various regional and country offices.

Target audience

Homeowners, building practitioners, builders, plumbers, drain layers, and Government building inspectors.

Relevant Pacific building code sections.

The building code requirements for water and sanitation for single and small dwellings (households) can be found in the following building code sections (see Table 1).

Table 1: List of Pacific countries and corresponding Building Code sections

Country	Building Code Section[a]
Cook Islands, Kiribati, Nauru, Niue, Samoa, Vanuatu, Fiji, Solomon Islands, Tonga, Tuvalu	Sections DF
Marshall Islands[b]	Chapters 12 and 29
Samoa	Section G

a National legislation and regulations may have additional requirements;
b The Marshall Islands Building Code also allows the use of the International Residential Code.

Limitation

The technical guide provides general guidance and should not be considered a legal document. Consult national legislation, regulations, standards, and building codes as required.

Format of the Guidance Note

This Guidance Note comprises three parts:

1. How Water, Sanitation, and Hygiene Inform Pacific National Building Codes
2. Septic Tank Designs and Soakaway Systems
3. Rainwater Collection and Storage

1 The Pacific Community website: www.spc.int

PART 1: How Water, Sanitation, and Hygiene Standards (Australian and New-Zealand Standards and the "International Building Code") Inform Pacific National Building Codes

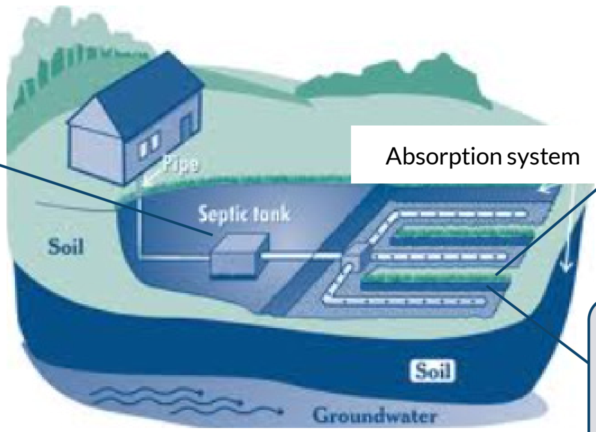
Practitioners will be able to understand the relationship between key Australian and New-Zealand Standards, and International Building Code standards, and how they are influencing the Pacific building codes.

PART 2: Septic Tank Designs and Soakaway Systems

The following flow diagram illustrates how this part of the technical note can be used as a step-by-step guide on how to design and build an on-site wastewater management system (Figure 1).

Figure 1: Overview of a household sewage system

Step 1:
How to size and build a septic tank
Page 7



Step 2:
How to select and size an absorption or soak-away system (trenches or pits)
Page 8

Step 3:
How to **locate** and **build a trench or pit** absorption system
Page 9

Consideration 1:
What can I do if my house is located in high groundwater AND within 15 meters from a drinking water source?
Page 11

Consideration 2:
How is access to a safe toilet taken into consideration if there is no septic tank cleaning service?
Page 11

Consideration 3:
How is access to a safe toilet taken into consideration if there is no reliable access to water?
Page 12

Source: Adapted from https://www.plumbingworldwide.com/how-does-the-sewage-system-work/

PART 3: Rainwater Collection and Storage

Figure 2 illustrates how this part of the technical note can be used as a step-by-step guide for homeowners to design and build rainwater harvesting systems.

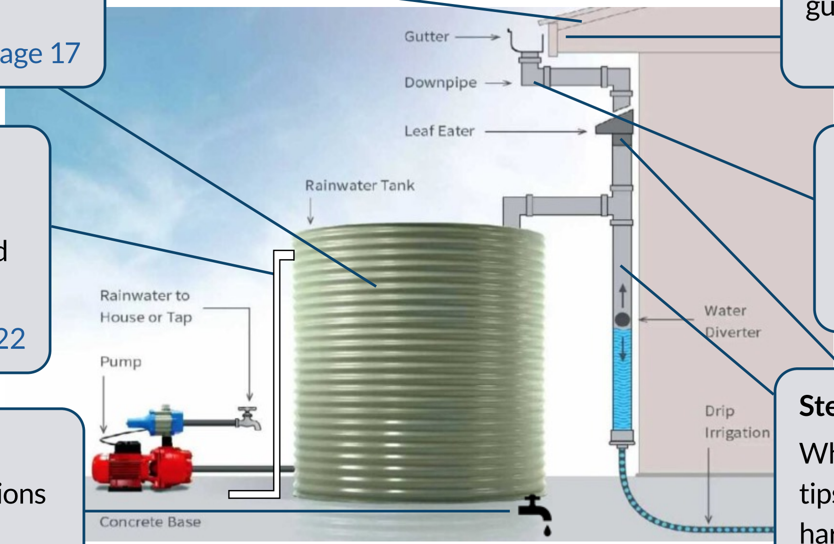
Figure 2: Pacific Water Technology. Rainwater Harvesting and Filtration

Step 1:
How to find the right tank storage
Page 17

Step 2:
How to find the right gutter size
Page 18

Step 5:
How to install an overflow pipe and soak-away
Page 22

Step 3:
How to find the right downpipe size
Page 20



Step 6:
What are the options to access water
Page 23

Step 4:
What are some of the tips to install a rainwater harvesting system
Page 20

Source: Adapted from https://pacificwater.com.au/rainwater-harvesting-filtration/rainwater-harvesting-and-filtration/

PART 1: How Water, Sanitation, and Hygiene Standards (Australian and New-Zealand Standards and International Building Code) Inform Pacific National Building Codes

1.1 Outcome

Practitioners will be able to understand the relationship between key Australian and New-Zealand Standards and International Building Code standards and how they are influencing the Pacific building codes (Table 2).

Table 2: Australian and New-Zealand Standards and their descriptions

Australian & NZ Standards, and International Building Code Reference[a]	Description
AS/NZS 1546.1: On-site domestic wastewater management units (septic tanks)	The objective of this standard is to specify performance requirements and performance criteria for septic tanks, to specify technical means of compliance and to provide test specifications that will enable septic tanks to be manufactured to comply with the performance requirements and performance criteria set out in the Pacific building codes.
AS/NZS 1547:2012: On-site domestic wastewater management	The purpose of this standard is to provide the requirements for treatment units and their land application systems to achieve sustainable and effective on-site domestic wastewater management, to protect public health and the environment.
AS/NZS 2179.1: Specifications for rainwater goods, accessories, and fasteners; Part 1: Metal shape or sheet rainwater goods, and metal accessories and fasteners	Provides manufacturers with requirements for determining the fitness for purpose of metal shape or sheet rainwater goods and metal accessories and fasteners.
AS/NZS 2712: Solar and heat pump water heaters	This standard specifies performance-based requirements for the design and construction of solar and heat pump hot water supply systems and components for household premises and commercial and industrial installations comparable with household installations, intended to deliver drinking water of acceptable quality.
AS/NZS 2845.1: Water supply - Backflow prevention devices; Part 1: Material design and performance requirements	This document specifies requirements for the materials, design, performance, and testing of mechanical backflow prevention devices that are used for the protection of water supplies.
AS/NZS 2904: Damp-proof courses and flashings	This standard specifies requirements for damp-proof course and flashing materials of the sheet membrane, strip, and collar type for use in building construction.
AS/NZS 3500.1: Plumbing and drainage; Part 1: Water services	This document specifies requirements for the design, installation, and commissioning of coldwater services from a point of connection to the points of discharge, and for non-drinking water from a point of connection to the points of discharge.
AS/NZS 3500.2: Plumbing and drainage; Part 2: Sanitary plumbing and drainage	This document specifies requirements for the design and installation of sanitary plumbing and drainage from fixtures to a sewer, common effluent system, or on-site wastewater management system.

Australian & NZ Standards, and International Building Code Reference[a]	Description
AS/NZS 3500.3: Plumbing and drainage; Part 3: Storm water drainage	This document sets out the requirements for materials, design, installation, and testing of roof drainage systems, surface drainage systems, and subsoil drainage systems to a point of connection.
AS/NZS 3500.4: Plumbing and drainage; Part 4: Heated water services	This document sets out the requirements for the design, installation, and commissioning of heated water services using drinking water or rainwater or a combination thereof. It includes aspects of the installation from, and including, the valve(s) on the cold water inlet to any cold water storage tank or water heater and the downstream fixtures and fittings.
International Building Code (IBC) standards, Chapter 29: Plumbing systems	This chapter provides the necessary number of plumbing fixtures, including water closets, lavatories, bathtubs, and showers and the quality and the design of each feature.

a The standards listed here can be accessed by engineers living in the Pacific via their registration with some of the engineers' associations. For example, government engineers in any Pacific countries can make the request to New Zealand Ministry of Foreign Affairs and Trade. and access for free a large number of building standards via the Standards New Zealand website: Standards New Zealand. Home page. https://www.standards.govt.nz/. The Pacific Region Infrastructure Facility also collected a building code biography summarizing some key documents for each of the 13 Pacific countries and different ways to access them.

PART 2:
Septic Tank Designs and Soakaway Systems

2.1 Outcomes

- Practitioners understand the technical options available for on-site wastewater treatment and disposal systems, in particular in areas with challenging environments, including high groundwater tables, areas where there are no septic tank cleaning services, and areas with no reliable water supply.
- Government inspectors are provided with tools to help monitor and inspect the most common anitation systems.
- Practitioners become familiar with the main tasks for operation and maintenance of recommended sanitation systems.
- Practitioners understand more about the safe decommissioning process for redundant assets.

2.2 Scope and Background Information

This part is applicable for household owners but is also applicable for small commercial or institution settings such as schools, while larger buildings or developments need to be designed by certified engineers using relevant codes and standards.

Most of the Pacific Building Codes highlight the two key types of toilet systems: dry' pit latrines and 'wet' toilet types, flushing wastewater to a treatment system.

Section 4 of this part applies to all households where there is sufficient access to a reliable water supply, access to septic tank cleaning services and the sanitary risk is low, for example where the groundwater is lower than 1.5m and there is enough space for adequately designed soakaway systems.

Section 5 provides some alternatives for households located in areas of challenging environment (e.g. high groundwater, lack of reliable water, and lack of sludge cleaning services).

Specific case studies highlight how some of the Pacific building codes have sometimes adapted Australian Standards to distance itself from "the ideal" management of design risks set out in AS/NZS 1546, AS/NZS 1547, and AS/NZS 3500, and to provide a better trade-off representing "the reality" of the complexities in the Pacific context.[2]

2 Other commentary on the Vanuatu National Building Code can be accessed here: the Pacific Building Standards. 1990. *A Partial Commentary on the National Building Code*, Vanuatu. https://www.theprif.org/sites/theprif.org/files/documents/VUT-1990-02-VanuatuNBCPartialCom1990.pdf.

2.3 Definitions

Where households have a 'wet' toilet, the treatment system should include a septic tank and an absorption system.

- The septic tank has two or three chambers that let larger solids sink to the bottom and be retained and let the clarified effluent be discharged to the absorption trench. It also promotes bacterial action to decompose its content effectively and prevent too frequent desludging.
- The effluent absorption system (trench or pit) promotes bacterial action to ensure an efficient percolation into the subsoil, where clarified effluent is absorbed and evaporated.

2.4 Design and Installation in Low-Risk Environments

Step 1: How to size a septic tank?

Several Pacific building codes, such as in Kiribati, Nauru, Solomon Islands, and Vanuatu highlight that separating gray water and black water before entering a septic tank can help minimize the size of septic tanks, which is why guidance is provided for black water only in this section. The Pacific building codes also provide guidance for designs where all wastewater is provided.

Example 1 below illustrates how to design a septic tank using the information provided in the Pacific building codes.

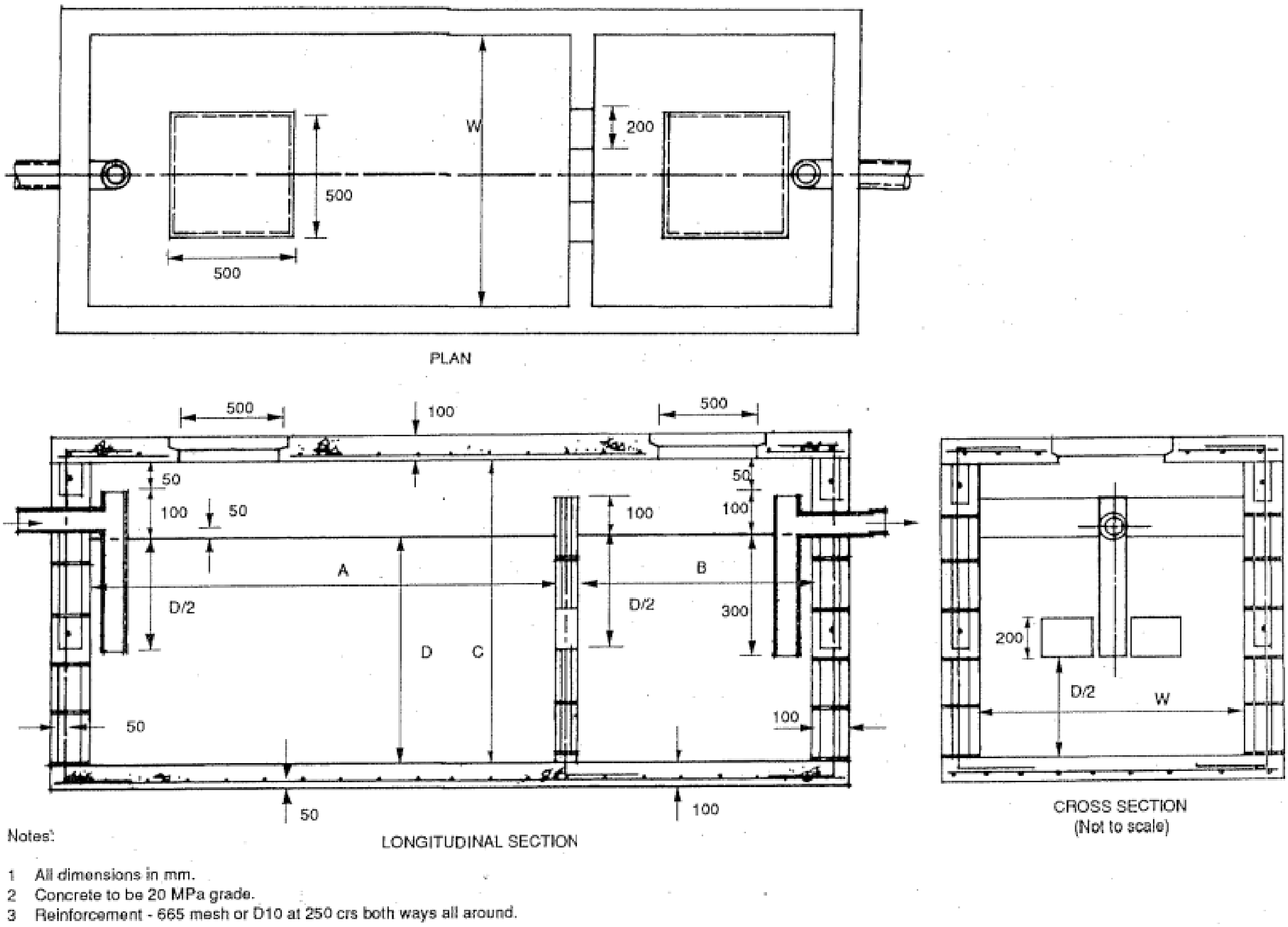
Example 1: Based on the Vanuatu National Building Code (Revision 2025), a family or group of families with 10 total users using one shared toilet system, should have a size of septic tanks of **1.22 cubic meters,** as per on Table 3.

Table 3: Example of Septic Tank Proportions

No. of Persons	ONLY BLACK WATER					
	A (meter)	B (meter)	C (meter)	D (meter)	W (meter)	Volume of Liquids and Solids (cubic meters)
8	1,000	400	1,000	850	800	0.95
10	**1,000**	**600**	**1,000**	**850**	**800**	**1.22**
12	1,000	600	1,000	850	800	1.22
15	1,000	600	1,200	1,050	800	1.34
25	1,200	800	1,200	1,050	1,000	2.10

Source: Vanuatu National Building Code, Table 4.2.3b, Revision 2025.
Notes:
1. Where the letters A, B, C, D, and W can be found in the drawing Figure 3 (referring to Figure 4.2.3a in the Vanuatu National Building Code, Revision 2025 - unpublished).
2. The volume does not include the freeboard volume, the frequency of the desludging is about 3.5 years, a 24-hour minimum retention time is assumed, and the volume calculations are based on an assumption of 35 liters per capita per day (wastewater) and 25 liters per capita per year (sludge) at 96% moisture content.
3. The wastewater effluent and sludge accumulation design criteria are less than that recommended under AS/NZS 1547. The criteria recommended in the Pacific building codes are more appropriate to the Pacific context.

Figure 3: Example of Septic Tank Design



Source: *Vanuatu National Building Code*, Figure 4.2.3a, Revision 2025. Unpublished.

Step 2: How to select and size soakaway systems?

Absorption systems may be designed as soakaway trenches or soakaway pits or may be integrated with the septic tank (Figure 3).

Several Pacific building codes, such as in Kiribati, Nauru, Solomon Islands and Vanuatu, highlight that absorption trenches are better at removing pathogens (i.e., bacteria, viruses, and parasites) in the aerobic condition of trenches, compared with the semi-anaerobic conditions in pits; therefore, practitioners may consider trenches, before considering absorption pits or integrated soakaways (as described in the Pacific building coides) around the septic tanks.

Examples 2, 3, and 4 illustrate how it is possible with recommendations from the building code (in most cases, with care) to design significantly smaller soakage trenches, compared with AS/NZ 1547.

Example 2: From the Vanuatu National Building Code, for a family of 10 people, the length of absorption trench, should be 14 meters.

It is calculated by determining the trench area needed, as follows:

Trench Area = 1,000 x V/E = 1,000 x 1.22 / 45 = 27.1 square meters.

Where:

- V is the volume given in cubic meters in Table 3 and E is the dosage of effluent in liters per area of absorption per day in Table 4 (referring to Table 4.2.4 in the Vanuatu National Building Code, Revision 2025).

Table 4: Determination of dosage of effluents with a percolation test

Time for Water Level in Test to Fall by 25 millimeters (minutes)	Dosage of Effluent, E (Liters per Square Meter of Absorption Area per Day)
1	75
2	60
5	45
10	30
20	18
30	15
60	11

Source: *Vanuatu National Building Code*, Table 4.2.4., Revision 2025.

Then, the length of absorption trench length is calculated as:

Soakaway Trench Length = 27.1 / (2 x 1) = 13.6 meters long.

With the following design criteria (Table 4):

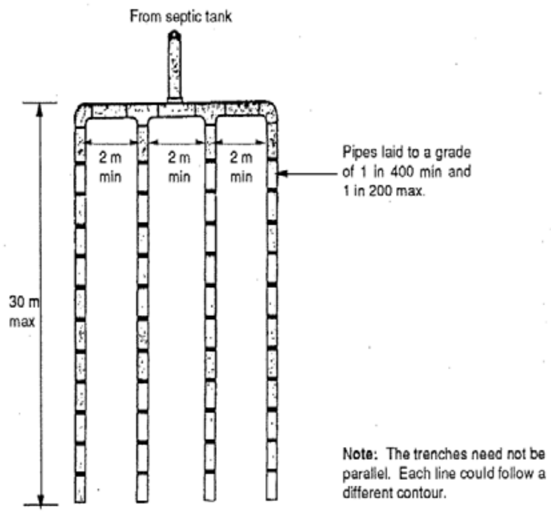
- Dosage of effluent of 45 liters per square meter,
- Effective absorption trench of 1 meter depth, assuming exfiltration on both sides of the trench, which is why the trench length is divided by 2 in the above calculation. The value decreases if one considers that infiltration also takes place.

While percolation tests are helpful to determine optimal sizing of absorption trenches, household owners and small institutional buildings may not be able to obtain the dosage of effluent per area of absorption.[3] Where percolation tests are unavailable AS/NZS 1547 recommends a dosage of effluent (E) of 50 litres/square meter.

Step 3: How to build and locate a trench or pit absorption system?

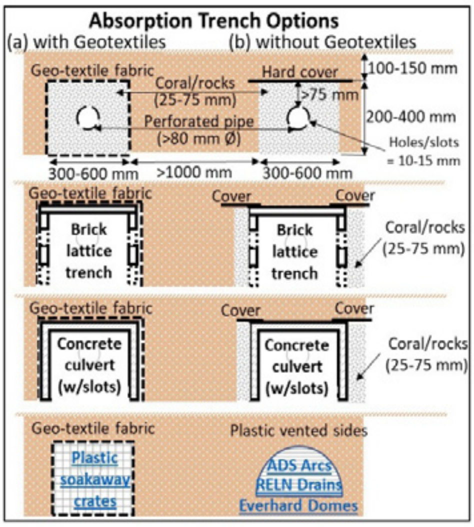
Figures 4 and 5 provide details of absorption trenches, as presented in several Pacific Buildings Codes.

Figure 4: General layout of absorption trench



Source: *Vanuatu National Building Code*, Figure 4.2.5a, Revision 2025. Unpublished

Figure 5: Absorption trench options (cross-sections)



Source: *Nauru National Building Code*, Figure 7.6.1., Revison 2023. Unpublished.

3 The Vanuatu Building Codes only recommends doing a percolation test for the section NF (Public Buildings and group dwellings).

Where sufficient area for absorption trenches is not available, soak pits may be used. Figure 6 illustrates a type of soakaway pit.

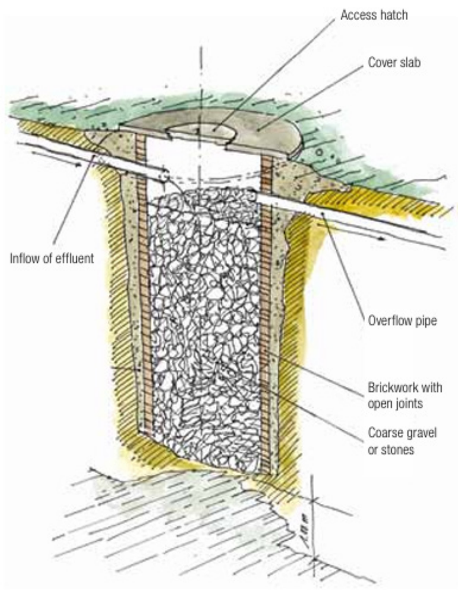
Notes:

1. Bricks with open joints can be replaced with blocks, or a perforated 200L drum based on the context.
2. A geotextile sock can be used instead of bricks, blocks or drums in sandy soils.

Minimum setback distances. Based on the World Health Organization recommendation, minimum safe distances between the soil absorption system and a drinking groundwater source of:

- 1.5 meters vertical separation above the maximum groundwater level, or
- 15 meters horizontal separation where the drinking groundwater source is located upstream (or inland) from the soakaway system, and the wastewater loading rate to the soil absorption system is not greater than 50 millimeters (mm) per day.

Figure 6: Cross section of a soakaway pits



Source: International Committee of the Red Cross. 2023. Website: Water, sanitation, hygiene and habitat in prisons - A Handbook.

These requirements suit the prevailing conditions in the Pacific, i.e.:

(i) Decrease in the anticipated survival time of pathogens due to:

- High ambient temperatures of the soil
- Dry soil with high moisture-holding capacity
- Soil with high exposure to sun, air, and evaporation
- Soil low in soluble organics but rich in microflora)

(ii) Decrease in the likely migration of pathogens due to:

- Saline environment and aerobic state of the groundwater
- Low lateral groundwater velocities
- High groundwater temperature.

Some factors may influence these values, such as:

(i) The direction of groundwater flow (typically from the center of atolls toward the coast)

(ii) The velocity induced by any pumping of the groundwater

(iii) The design of the wastewater soil absorption system.[4]

In most Pacific building codes, the following minimum distances are recommended based on the type of soakaway system, as follows:

(i) 30 meters is required between soak pits and potable water sources

(ii) 15 meters is required in the case of absorption trenches.

4 Nauru National Building Code (unpublished).

2.5 Alternative Designs for a Household in Areas of Challenging Environments

Consideration 1: Where there is a high groundwater table

A septic tank and soakaway trenches may generally be appropriate to use in high groundwater, if the horizontal distance to a drinking source is more than 15 meters, given the critical role of the biofilm in soakaways or pits to remove pathogens.

However, when high groundwater is present AND the horizontal distance to a drinking source is small, other treatment options need to be considered, such as sand filters and mounds, adequate activated sludge systems or alternative Sewerage Treatment Plants. If this is the case, a designer should be consulted, and effluents must be adequate discharged into a soakaway system to limit sanitary risks.

For fiberglass or concrete septic tanks which could flood in high groundwater areas, installation of buoyancy control methods such as anti-flotation ring or use of anchor and straps should be considered.

Consideration 2: Where there are no septic tank cleaning services

Septic tanks are designed to be emptied on a regular basis, generally every 4 to 5 years. When there are no septic tank cleaning services available, an alternative option is to construct a wet toilet with two offset pits (Figure 7). Wet pit latrines are bucket-flushed, water-seal, floor-pan latrines with a soakaway pit in porous soil. Digestion of excreta is by anaerobic bacteria below water level. One pit at a time receives wastewater. When the pit is nearly full, the operator switches an elbow in an inspection diversion chamber (Figure 8), redirecting the wastewater into the other pit. The used pit is left for a few months to compost by anaerobic bacterial action. Contents are then removed and disposed of safely on vacant land where they will turn into soil.

Figure 7: Schematic drawing of a set toilet with two offset pits

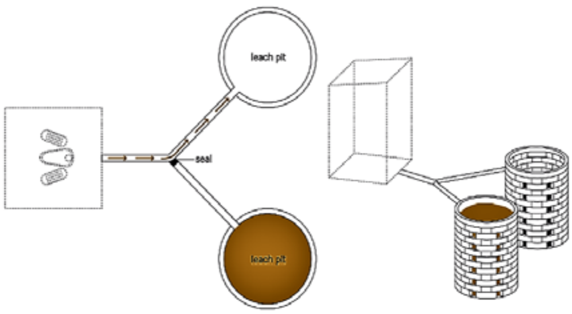


Figure 8: Example of an inspection diversion chamber

Source: Sanitation and Hygiene guidelines, 2nd edition, 2023 (website: Ministry of Health - Environment Unit)

Other advantages of wet toilet with two offset pits (also referred to as “cesspits” in Pacific building codes), are[4]:

(i) they fill about 10 times slower than a septic tank for a given volume (because cesspits operate at sludge moisture content of about 80% compared with septic tanks, which operate at a sludge density of about 98%);

(ii) their modular design enables expansion in series or parallel; in dense soil, the effluent absorption area can be increased by placing rocks around the perimeter of the cesspit;

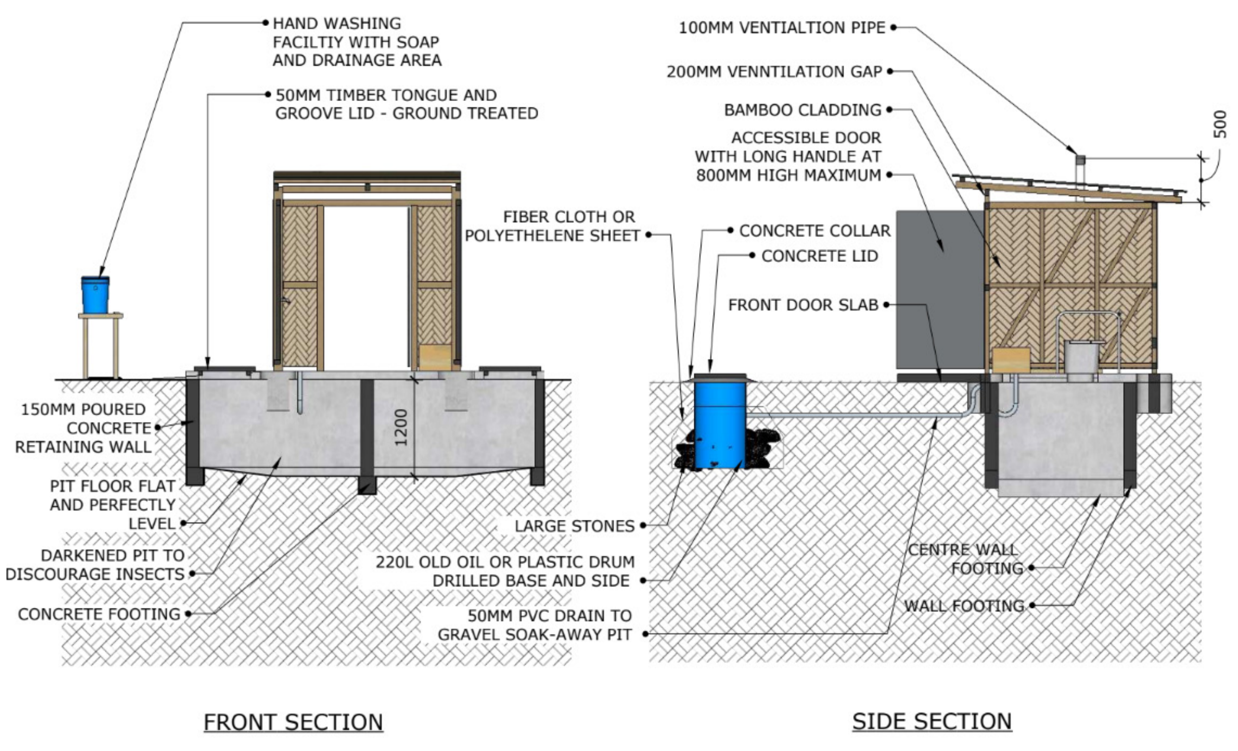
(iii) there are multiple options for resting, switching, or emptying when they fill up; and they do not pose a flotation risk as compared to septic tanks.

Consideration 3: Where water supply is not reliable

Where water supply is unreliable, which is the case of rainwater, it is recommended to build a dry system, with one pit (e.g., a ventilated improved pit toilet) or two pits, creating a composting environment. With composting toilets, one vault at a time receives excreta. Urine is drained away in a separate surface channel. The excreta are covered with loose earth, ashes, or sawdust to reduce odors. When the vault is nearly full, it is sealed with lime mortar and left for a few months to compost by anaerobic bacterial action. Contents are then removed and used for fertilizer. During this time the other vault is used as the latrine.

Important. If a household owner opts to build a wet toilet such as one with a septic tank or twin pits ("cesspits") despite only accessing rainwater, it is recommended to build an alternative dry system such as an improved pit toilet or dry toilet with twin pits such as illustrated in Figure 9, for use when rainwater is unavailable during long dry periods.

Figure 9: Concept drawings for a dry toilet with two pits



Source: *Vanuatu National Building Code*, Revision 2025.

2.6 Monitoring Tools for Government Inspectors or Household Owners

2.6.1 Inspection of Septic Tank Systems

The checklist described in Figure 10 may be used by inspectors to help with their periodical inspection and sign-off for septic tank compliance.

and the wastewater loading rate to the soil absorption system is not greater than 50 millimeters (mm) per day.

Figure 10: Example of a sanitation inspection sheet

Sanitation Inspection Checklist

Flush toilet with septic tank

Toilet Owners Name: ________________ **Inspection Date:** ________________

FRONT PERSPECTIVE BACK PERSPECTIVE

#	INSPECTION CHECK	CIRCLE ONE	
	MINIMUM (ESSENTIAL) CRITERIA – IMPROVED SANITATION SERVICE		
1.	The toilet is used by one household only	Y	N
2.	There is sufficient water supply available for flushing throughout the year (25-40L/d/user)	Y	N
3.	Access path is cleared between the house and the toilet	Y	N
4.	Toilet is located between 3m and 30m from house served	Y	N
5.	Toilet is located down gradient of water sources (well, river, spring), and at a minimum horizontal distance of 15m (if not sure of flow direction, min. is 30m)	Y	N
6.	There is either a mount or dug channel to prevent flood to enter the septic tank	Y	N
7.	The septic tank is sealed to prevent insects from entering the pit	Y	N
8.	The septic tanks is 3 metres away from any dwelling within or outside the allotment	Y	N
9.	The septic tank has a total length of at least 3 times the width	Y	N
10.	There is a vent pipe on the pipe going to the septic tank and the opening is covered with insect netting	Y	N
11.	The vent pipe is a minimum of 32 mm in diameter	Y	N
12.	The septic tank has an access hatch / lid	Y	N
13.	The access hatch is installed where pumping out of the septic tank is practical	Y	N
14.	There is a minimum of 2 years between calls for emptying out the pit with a suction truck	Y	N
15.	There is no ponding of waste water (from both handwashing and septic tank)	Y	N
16.	There is a handwashing facility with soap within 3m between the toilet and the house	Y	N
17.	Toilet and handwashing are easy to use for everyone in the house (children, elderly, people with disability)	Y	N
18.	Toilet has an appropriate door with internal lock and external locks to keep it secure	Y	N
19.	Toilet floor is clean and there is no strong smell	Y	N
20.	There is a bin with lid	Y	N

Overall, this toilet should be: ☐ **UNCHANGED** ☐ **UPGRADED** ☐ **REPLACED** (if question #1, 2, 4, 5,8, 13, 14, are 'no')

Source: Government of Vanuatu, Ministry of Health, Environment Unit. 2023. *Sanitation and Hygiene Guidelines*, 2nd Edition website: Ministry of Health - Environment Unit.

Important. There should be an inspection point provided at the beginning and end of any soakaway trench, with an end cap, in order to facilitate inspections.

2.6.2 Inspection of Dry Toilet with Two Pits

Table 5 shows an example of an inspection checklist used to inspect dry toilets with two pits (for example a composting toilet [Figures 11a, 11b, and 11c]).

Figures 11a, 11b, and 11c: Composting toilets at Natawa school Sanma Vanuatu

Source: *Engineers Without Borders Australia*. 2025.

Table 5: Example of inspection checklist for composting toilets

Item	Yes (=OK)	No (=RISK)	Further action recommended
1. ACCESS TO THE STRUCTURE AND OVERALL TOILET MAINTENANCE			
Is there a clear path to the toilet?			
Is the concrete floor strong and does it HAVE NO cracks?			
If there is an accessible toilet, is there an appropriate ramp to the toilet?			
Are the walkway and railings in good condition with NO loose or weak parts?			
Is the toilet house (door, walls, roof) in good condition with NO loose or missing parts?			
Is the inside of the toilet clean and dust free?			
Is the handwashing station working properly and is there soap?			
2. DRAINAGE			
Is there NO infiltration of water into the compost chambers?			
Does the urine diversion system drain into an appropriate soakaway system (i.e., no wet ground is observed)?			
VENTILATION			
Are the vent pipes properly installed (i.e., do they finish 50 centimeters above the roof, with mesh to avoid flies and a cap to stop water entering the pipe, mesh, and support brackets)?			
PLUMBING			
Is there an ABSENCE OF leaks with the plumbing systems?			
Is the guttering system clean and maintained?			
Are there good cyclone-proof straps installed for the roof and the water tank?			
COMPOST MANAGEMENT			
Is there a sufficient amount of sawdust or alternative carbon source material in the toilet?			
Is one pit kept closed safely while the other one is being used?			

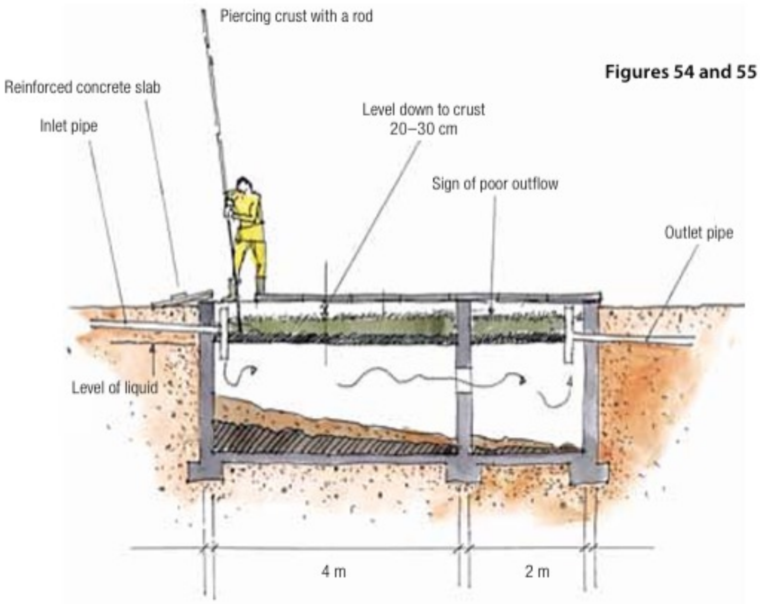
Item	Yes (=OK)	No (=RISK)	Further action recommended
Is the access trap to the compost chamber outside securely fastened to the blockwork with NO gaps?			
WASTE AND INSECT MANAGEMENT			
Are the rubbish bin and women's menstrual hygiene bin managed well?			
Is there a mesh lid on the seat riser (used to prevent flies from entering the toilet)?			
SECURITY			
Are there locks that work correctly?			
Is there solar lighting present? Is it working?			
PRIVACY			
Are there any screening materials (vegetation or other) installed to ensure privacy of the users?			

Source: Adapted from *Engineers Without Borders Australia* by the author. (2024). Unpublished.
Note: Many of these checks can easily be adapted for other types of toilets.

2.7 Desludging of a Septic Tank

Figure 12 illustrates how to inspect a septic tank every 4-5 years and confirm if it is necessary to empty it.

Figure 12: Inspection of a Septic Tank



Source: International Committee of the Red Cross. 2023.
Website: Water, sanitation, hygiene and habitat in prisons - A Handbook.

The general rule is that a septic tank must be desludged when the sludge level reaches one-third of the total depth. This should happen on average every 4 to 5 years.

The tank should never be completely emptied; some deposit should be left to maintain the digestion process.

2.8 Decommissioning of a Septic Tank

When a tank is no longer in use, it needs to be decommissioned. The following list contains recommendations to decommission a septic tank to ensure that the decommissioning process is handled safely and effectively:

(i) **Hire a professional.** Decommissioning should only be done by reputable sewer service providers to ensure safety and compliance with local regulations.

(ii) **Remove the tank.** Safely remove the unused or abandoned septic tank, soak pits, and drain fields.

(iii) **Fill and Seal the tank.** If the tank is to be left in place, fill the tank with soil or other materials to prevent collapse and properly sealed the to prevent contamination.

(iv) **Document the process.** The asset owner to keep records of the decommissioning process for future reference and compliance.

Figure 13 illustrates what could happen if a decommissioned septic tank is not filled with soil or other material, and the process is not documented.

Figure 13: Truck falling in a decommissioned septic tank at the Tata School in Santo, Vanuatu

Photo source: Butterfly Trust.

PART 3:
Rainwater Collection and Storage

3.1 Outcomes

- Practitioners will become familiar with examples and best practices of designing and building rainwater storage systems in the Pacific for drinking water purpose.
- Household owners are provided with tools to help maintain their rainwater tanks.
- Government inspectors will have tools to help monitor and inspect rainwater harvesting systems.
- Practitioners become familiar with main tasks for Operations and Maintenance of rainwater harvesting systems, to ensure safe water.

3.2 Design and Installation

Step 1: How to size a rainwater harvesting tank?

The calculation for tank size requirements is based on estimations of daily consumption, roof size, annual rainfall and its variability and the desired reliability of the supply. Example 5 gives an example of calculations in the Nauru Building Code (footnote 4).

Example 5. In areas where most (i.e. 75%) of the annual rainfall occurs in 3 or 4 months it is necessary to size the tank to hold 100 to 120 days of consumption. Taking an average family size of 5 members, each consuming no more than 30 litres of the stored water per day, then the storage tank volume required = 100 x 30 x 5 = 15,000 litres.

The sizing of the roof area can be expressed as:

A = 365 x C/R, where:

- A is the roof area acting as the catchment in square metres,
- C is the daily average consumption of water by the household in litres, and
- R is the average annual rainfall in millimeters. The value is available online for each country or accessible with the respective Departments of Meteorology.

To allow for variation in actual rainfall from monthly averages, it is advisable to assume that the available roof area is twice the theoretical area:

A = 2 x 365 x C/R = 730 C/R

Therefore, assuming an annual rainfall of 2000 mm in Nauru, the minimum roof area required to feed the storage tanks = 730 x 150/2000 = **55-meter square**.

Most national building codes have calculated the average minimum roof area and tank capacity for different islands as a function of their respective rainfall intensity. This is the case in Vanuatu, where values have been separated in dry and wet areas.[5] Departments of meteorology in respective countries will help adapt these figures for different scenarios based on the latest climate modeling.

Example 6. Based on the Vanuatu National Building Code, if a family in Tanna is seven members and the daily consumption per head is 20 liters, the required roof catchment is 75 square meters and the required tank size is 11.2 kiloliters.

5 Vanuatu design and construction standards for rural water supply in Vanuatu. Government of Vanuatu, Department of Water Resources. Unpublished. Most of Northern Provinces' islands in Torba and Penama are considered as wet, while other central and southern Provinces' islands were split between dry and wet areas.

This was calculated using figures in table 7.

Table 7: Minimum Roof Area and Tank Capacity for Rainwater Collection

Total tank capacity of 7.5 kiloliters		Total tank capacity of 12 kiloliters
Minimum roof catchment to drain into storage (square meters)		
50	30	80
Efate Espiritu Santo Malekula Aneityum	Vanua Lava	Tanna

Note: This table is based on a family size of five members, each consuming no more than 30 liters per day of the stored water. The minimum roof area and storage capacity required in representative regions in Vanuatu have been calculated for the average rainfall in those regions.
Source: *Vanuatu National Building Code*, Table 3. Revision 2025.

Required roof catchment = Minimum roof catchment to drain into storage in Tanna x Consumption of the family of 7 / Consumption of the family of 5 = 80x(20x7)/(30 x 5) = **75 square meters**.

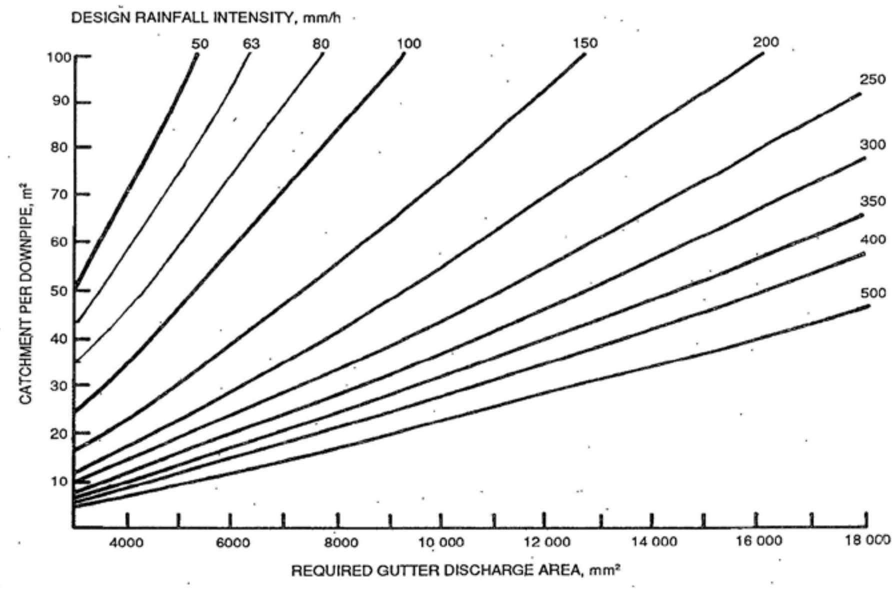
Required tank size = 12 x 20 x 7 / (30 x 5) = **11.2 kiloliters.**

Note: If a risk of failure of supply once a year is acceptable, the tank size can be reduced by 30%.

Step 2: How to size rainwater harvesting gutters?

Roof gutters must be sized on the basis of the rainfall intensity using rainfall intensity data. Figure 13 is used in the Vanuatu Building Code, to give values of the net area of cross-section of the gutter for different roof catchment areas and different rainfall intensities. Eaves gutters must be sized for a rainfall intensity corresponding to a 20-year return period whereas internal box and valley gutters must be sized for a 100-year return period intensity, which should be available either online or from the departments of meteorology.

Figure 13: Eave Gutter size and rainfall intensity



Source: *Vanuatu National Building Code*, Figure NF3.1., Revision 2025.
Notes:
1. The roof catchment area is the area of the roof drained by one downpipe. It is taken as the area of the roof from ridge to gutter between two adjacent downpipes.
2. Values can be interpolated for catchment areas falling between the given figures.
3. The gutter sizes do not include any allowance for freeboard. A freeboard of 25 mm for eaves gutters and 35 mm for internal box gutters must be added to the cross-sections derived from the table.

Example 3. From Figure 13, using a roof catchment area of 50 square meters and rainfall intensity 60 millimeters (mm) per hour, the gutter size needs to be 65 x 500 = 32,500 square millimeters. For a 200 mm width of gutter, the depth of the gutter is 32,500 / 200 = 162 mm + freeboard of 25 mm = 187 mm.

Example 4. Table 8 presents another way to calculate required cross-sectional area of gutter as per the Nauru Building Code.

Table 8: Gutter sizes

Item	Roof Catchment Area (square meters)			
	10	20	50	100
Type of gutter	Required cross sectional area of gutter (square millimeters)			
Eaves gutter	1,400	2,500	5,180	9,100
Internal box valley or gutter	2,800	5,000	10,360	18,200

Source: *Nauru National Building Code*, Table DF 8.1, 2023.
Notes:
1. The roof catchment area is the area of the roof drained by one downpipe. It is taken as the area of the roof from ridge to gutter between two adjacent downpipes.
2. Values can be interpolated for catchment areas falling between the given figures.
3. The gutter sizes do not include any allowance for freeboard. A freeboard of 25 millimeters for eaves gutters and 35 millimeters for internal box gutters must be added to the cross-sections derived from the table.
4. Eaves gutters have been sized for a rainfall intensity corresponding to a 20-year return period whereas internal box and valley gutters have been sized to a 100-year return period intensity.

Examples of gutters commonly used in the Pacific are shown in Figures 14a to 14d.

Figure 14a: Small PVC gutter

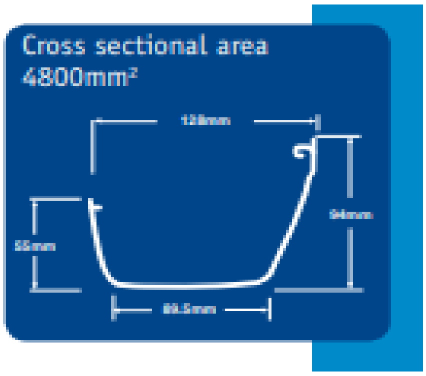


Figure 14b: Small PVC gutter

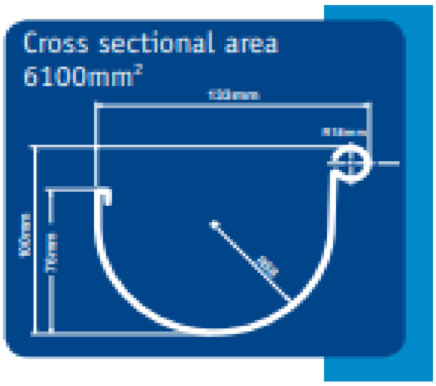


Figure 14c: Large PVC gutter

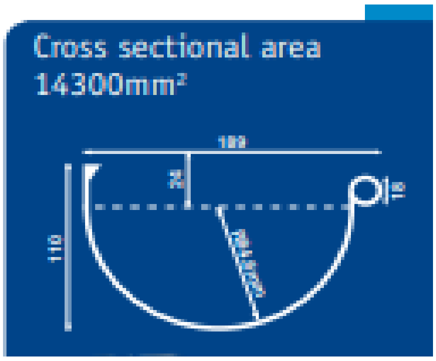
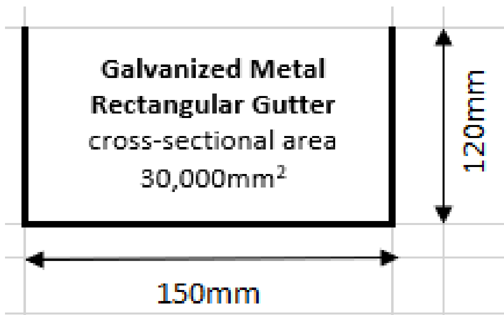


Figure 14d: Large, galvanized metal gutter



Source: *Solomon Islands Building Manual.* Unpublished.

Step 3: How to size downpipes?

The downpipes are sized as follows: the minimum area of cross-section of a downpipe must be the greater of:

(i) half the area of cross-section of the gutter it serves; or

(ii) the area calculated for each 10 square meters of the roof area drained by it at the rate of:

- 650 square millimeters (mm^2) for eaves gutters and
- 930 mm^2 for internal box gutters.

Example 5. For a medium-sized house (e.g. 10 meters long by 6 meters wide with a 0.6-meter overhang and a conventional gable roof), the roof area on one side will be 11.2 meters by 3.6 meters = 40.3 square meters requiring a downpipe cross-sectional area of 4 x 650 square millimeters ($mm^{2)}$ or 2,600 mm^2. The cross-sectional area of an 80-millimeter PVC downpipe is about 5,020 mm^2, so one downpipe is adequate for each side and will meet the design requirement.

Step 4: How to install rainwater harvesting systems

Recommendations for installing rainwater harvesting systems were separated into "essential" and "desirable" elements, providing households with ways to increase their water management standards based on their ability to carry out the various elements, following advice from the Guide to Safe Rainwater Harvesting in Tonga[6] and the Solomon Islands Building Manual.[7]

Essential elements

(i) Always make sure there is enough height difference between the eaves and the top of the water tank. Avoid u-shaped downpipe profiles where the downpipe runs down through the ground then back up to the tank, as dirt will accumulate in the low section.

(ii) Make sure the downpipes are adequately supported using a PVC downpipe clip or a galvanized strap.

(iii) Always tie down the tanks with cables to avoid damage during cyclones or earthquakes. Alternative designs such as restraining blocks around the tanks should be considered, in particular in coastal areas where tie-down cables may rust within one year.

(iv) Prevent contamination by sealing entry points to the tank with a lid and vent pipes with screen mesh.

Desirable elements

(v) Where possible, locate the rainwater tank closest to the building to avoid a long section of downpipe that may need vertical supports.

(vi) Some building manuals recommend the use of the following guttering accessories that can be considered to improve water quality:

First flush diverters. The main function of a first flush diverter is to prevent the first flow of water from the roof from entering the water storage tank.

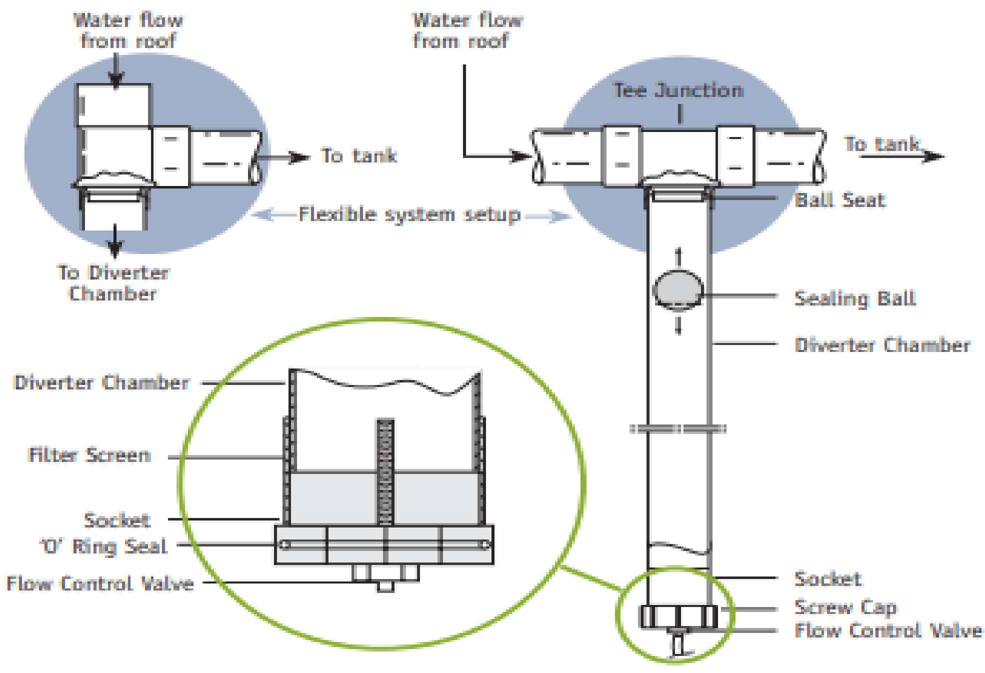
When it begins to rain, the first flow of contaminated water is diverted into a diverter chamber. Once the chamber is full, fresh water automatically flows into the storage tank.

The Type of first flush diverter chosen should be selected based on the quantity of water to be diverted. The flush diverter shown in Figure 15 is suitable for small roof catchments such as residences.

6 Government of Tonga. 2023. *A Guide to Safe Rainwater Harvesting in Tonga*. https://climatechange.gov.to/wp-content/uploads/2023/12/ESR-1056-Tonga-rainwater-harvesting-updated-logos-2023-English-3.50.pdf.

7 *Solomon Islands Building Manual*. Annexure. Unpublished.

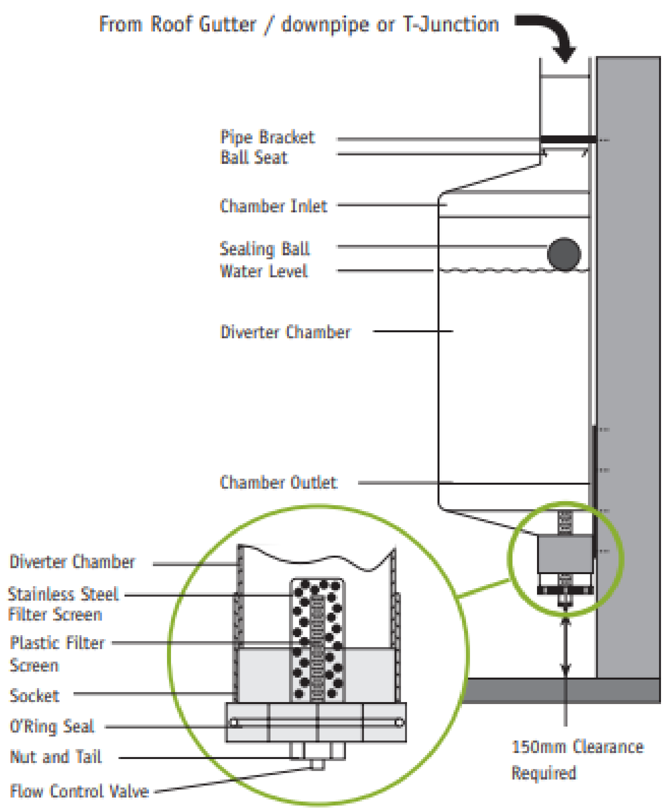
Figure 15: PVC first flush diverter (90-millimeter diameter chamber)



Source: *Solomon Islands Building Manual*. Unpublished.

Larger roof catchments will require a larger diversion chamber to be effective, such as the first flush diverter illustrated which has a 300mm diameter chamber (Figure 16). The product specifications should provide advice to help select the correctly sized first flush device and how to install it.

Figure 16: PVC first flush diverter (300-millimeter diameter chamber)



Source: *Solomon Islands Building Manual*. Unpublished.

Leaf diverters. Leaf diverters such as the one indicated in Figure 17 help to prevent debris from entering the rainwater harvesting system, which improves water quality and reduces the need to flush debris out of the water tank.

The screen should be easy to slide out so that it can be washed and replaced whenever dirt accumulates on the screen

The leaf diverter should be located below the gutter outlet and mounted below the roof eaves with the downpipe positioned just above the screen.

The leaf diverter can most easily be mounted on the external wall adjacent to the guttering outlet. Alternatively, it can be mounted directly below the PVC gutter outlet on vertical wooden post positioned against the back of the fascia board.

Figure 17 : PVC leaf diverter

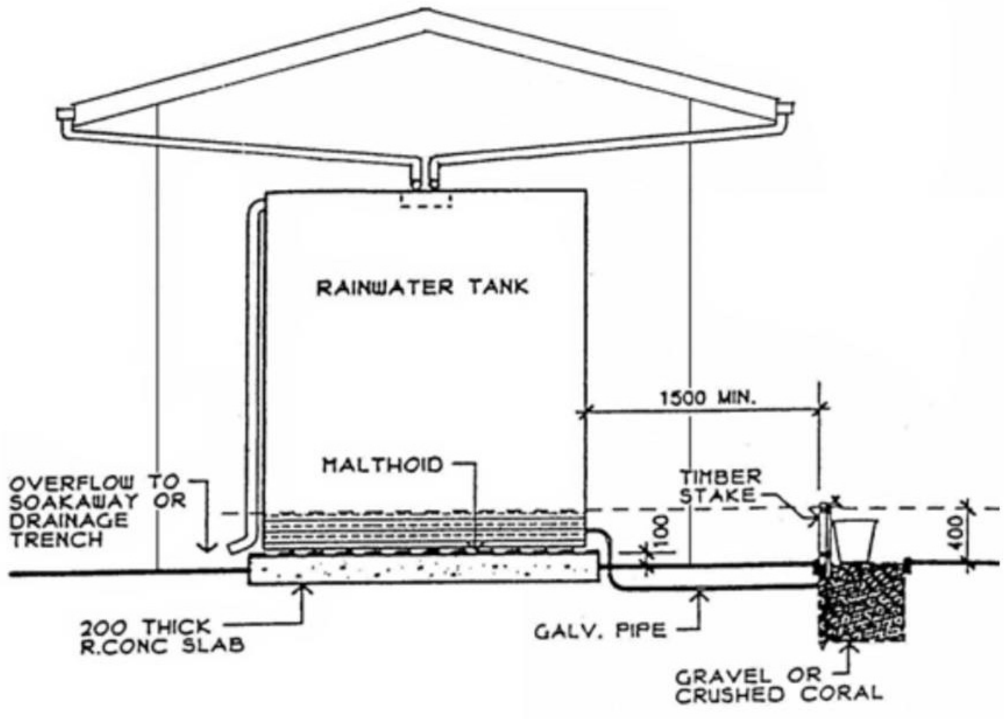
Source: Solomon Islands Building Manual. Unpublished.

Step 5: How to install an overflow pipe and soakaway?

Rainwater tanks must be fitted with overflow pipes for the disposal of excess rainwater inflow. The overflow pipes fitted to tanks must be adequate to prevent uncontrolled overflow. Overflow pipes should not terminate near the rainwater tank support structure (Figure 18).

Overflows, as well as leaf diverters and first flush systems, should be routed to specifically designed soakaways or nearby wells. If the pipe connecting the tank overflow into the soakaway pit is buried it should have an 'air gap' installed on the outside of the tank before it enters the pit, in case the soakage pit becomes totally clogged (and so backs up into the tank). The air gap obviously should be protected with mesh to prevent insects/vermin entering the tank.

Figure 18: Example of rainwater tank illustrating overflow pipe and access to water with a tap and bucket system



Source: Alexander and Lloyd Group for the PNG Department of Education. Unpublished.

Step 6: What are the options to access water?

There are two recommended ways to extract the water from a rainwater tank, without contaminating it: (i) one or two taps located at the bottom of the tank, or (ii) a pump bringing it inside the house.

3.3 Monitoring Tool for Government Inspectors or Rainwater Harvesting Tank Owners

The following tool is available for government inspectors or rainwater harvesting tank owners to identify frequent issues and undertake preemptive maintenance tasks. It is a sanitary inspection form (Figure 19) provided in the *Vanuatu Rural Water Supply and Sanitation Standards Manual, Version 2* (unpublished), which includes reminders of the essential elements for safe rainwater supply system.

Figure 19: Example of a Sanitary Inspection Form

SANITARY INSPECTION FORM

GENERAL INFORMATION				
Name of water scheme/community:				
Name local contact:	Phone number:			
Type of system:	....	Rainwater	....	Gravity Fed
	....	Dug well	....	Indirect Gravity Fed
	....	Hand pump		
Local Geology:	....	Limestone	....	Volcanic
	....	Sand	....	Unknown
Date of construction:	Population served by the system:			
Describe recent maintenance to the system/comments:				

ROOF RAINWATER HARVESTING	No	Yes	Recommended action
Is the roof area dirty?			
Are the gutters dirty?			
Is a first flush system absent?			
Are any openings of the tank not properly covered?			
Are there cracks in the wall of the tank?			
Is the inside of the tank dirty?			
Is the tap leaking?			
Is the drainage in bad condition or absent?			
Is the tank cover absent?			
Is there any source of pollution around the tank or roof area?			

Source: DoWR. Sanitary Inspection Form, from the *Vanuatu Rural Water Supply and Sanitation Standards Manual, Version 2.* Unpublished.

3.4 Rainwater Tanks Maintenance for Safe Water Supply

3.4.1 Preemptive Maintenance

Preemptive maintenance is the most important task that household owners are recommended to undertake to avoid any water contamination. It means keeping the system clean and in good condition, including the roof, gutters and the tank. It helps prevent contamination from vermin; vegetation falling on the roof; bird excreta; poor condition of or inappropriate roof materials; or other environmental contaminants from the atmosphere, such as sea spray, ash from fire (or from a volcano), or agricultural chemicals spray drift.[8]

The following advice can be followed when cleaning the tank on an annual basis:

(i) Clean and flush the tank from outside as much as possible.

(ii) If one must enter the tank, he/she can do so with an observer on top of the tank and without using cleaning products when in the tank, just wiping down and cleaning/flushing with water.

(iii) Once the tank is cleaned, use chlorine to disinfect from outside the tank and when it refills. The use of chlorine to disinfect is explained in section 4.2.

3.4.2 Rainwater Tank Disinfection

If there are any risks identified from any elements in the sanitary inspection form, or if water testing confirms contamination, households are recommended to disinfect their rainwater tanks by following the recommendations in Fact Sheet 8 (Figure 20) in *Harvesting the Heavens.*[8]

8 South Pacific Applied Geoscience Commission. 2004. *Harvesting the Heavens: Guidelines for Rainwater Harvesting in Pacific Island Countries.*

Figure 20: Fact Sheet – Disinfecting your rainwater tank

FACT SHEET 8
DISINFECTING YOUR RAINWATER TANK

You should disinfect your tank only when one or more of the following situations are present:

- People are getting sick from drinking the water with sore stomachs and diarrhoea;
- Animal or human waste, including bird droppings have entered the tank;
- After tank repairs or maintenance where people have entered the tank;
- The water has been tested and there is a known bacterial contamination.

1. Calculate the volume of water in your tank (see Fact Sheet 7).
2. Add $\frac{1}{2}$ bottle (125 ml) of plain household grade unscented and uncoloured bleach (with 4% active chlorine) to every 1,000 litres of water currently in your tank.

Amount of water in the tank	Amount of bleach
1,000 litres	125 ml
2,000 litres	250 ml
3,000 litres	375 ml
Etc.	Etc.

3. Wait 24 hours after putting in the chlorine to allow enough time to disinfect the water before you drink it. Any chlorine smell and taste in the water will go away after a short time. If you find the taste of chlorine unacceptable boil the water for at least 5 minutes before drinking it.

Remember to wear proper hand and eye protection when preparing and handling chlorine solutions to avoid burning skin and damaging eyes.

Source: South Pacific Applied Geoscience Commission. 2004.
Harvesting the Heavens: Guidelines for Rainwater Harvesting in Pacific Island Countries.
https://www.pacificwater.org/userfiles/file/Harvesting%20the%20Heavens%20-%20Guideline%28JC0178%29.pdf.

3.4.3 Other Household Treatment Methods

If rainwater tanks are not properly maintained poor water quality can become an issue, To address poor water quality different countries have adopted different strategies, depending on their local contexts. Boiling water is an effective strategy. Other strategies include solar water disinfection or Sawyer water filters and buckets.

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