Partner Housing Australasia (Building) Incorporated
ABN 88 722 057 429 CFN: 15429
Web: www.partnerhousing.org
PO Box 702, Pennant Hills, NSW, 1715
Pro-bono professional services and funding for South Pacific village infrastructure, housing, water, sanitation and training.

272 Blackwall Road, Woy Woy NSW 2256, Australia
Phone: +61 432 611 550
Email: partner.housingaus@gmail.com

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A subsidiary of Partner Housing Australasia (Building) Incorporated

272 Blackwall Road, Woy Woy NSW 2256, Australia
Phone: +61 432 611 550
Email: rod@electronicblueprint.com.au

Village Aqua Design Manual

Clean Water Supplies and Hygienic Sanitation

for South Pacific Villages

Water supply and reticulation in Ranongga, Solomon Islands

Partner Housing Australasia (Building) Incorporated

Partner Housing Australasia (PHA) is an entirely voluntary organisation, which aims to transform the lives of people living in Asia-Pacific villages by improving the cyclone, earthquake and tsunami resistance of their houses, clinics, schools and community buildings; and by providing clean water supplies and hygienic sanitation.

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A subsidiary of Partner Housing Australasia (Building) Incorporated

272 Blackwall Road, Woy Woy NSW 2256, Australia
Phone: +61 4 0721 8926
Email: rod@electronicblueprint.com.au

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PHA also recognises the dedication of the South Ranongga Community Association and the island communities of Ranongga and Vella Lavella. We extend particular thanks to Herrick Ragoso and Simon Alepio.

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19/02/21	v1	Leonid Bronfentrinker	Ian Warren	
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25/02/22	v1.2	Leonid Bronfentrinker	Rod Johnston	Amendments as per Rod's comments dated 06/12/2021

Table of Contents

1. Purpose of the Village Aqua Manual

The purpose of this manual is to provide a comprehensive reference on the background, design and construction of **Village Aqua** (water supply and sanitation systems). The intention is to provide a single document, from which other focused documentation can be extracted and developed.

1.1. Background

The South Pacific region is home to a diverse range of people, many of whom live in small villages. Partner Housing Australasia (PHA) and its consultants have long considered the practical problems associated with ensuring adequate water supply and sanitation is provided to rural communities. This situation has led us to the development of the **Village Aqua** system.

Village Aqua is the system of village water supply and reticulation developed in the island nations of the South Pacific by PHA and its partner organisations. Also included in this manual are provisions for the design of VIP pit latrines and septic systems, and their siting to preserve the integrity of adjacent water supplies.

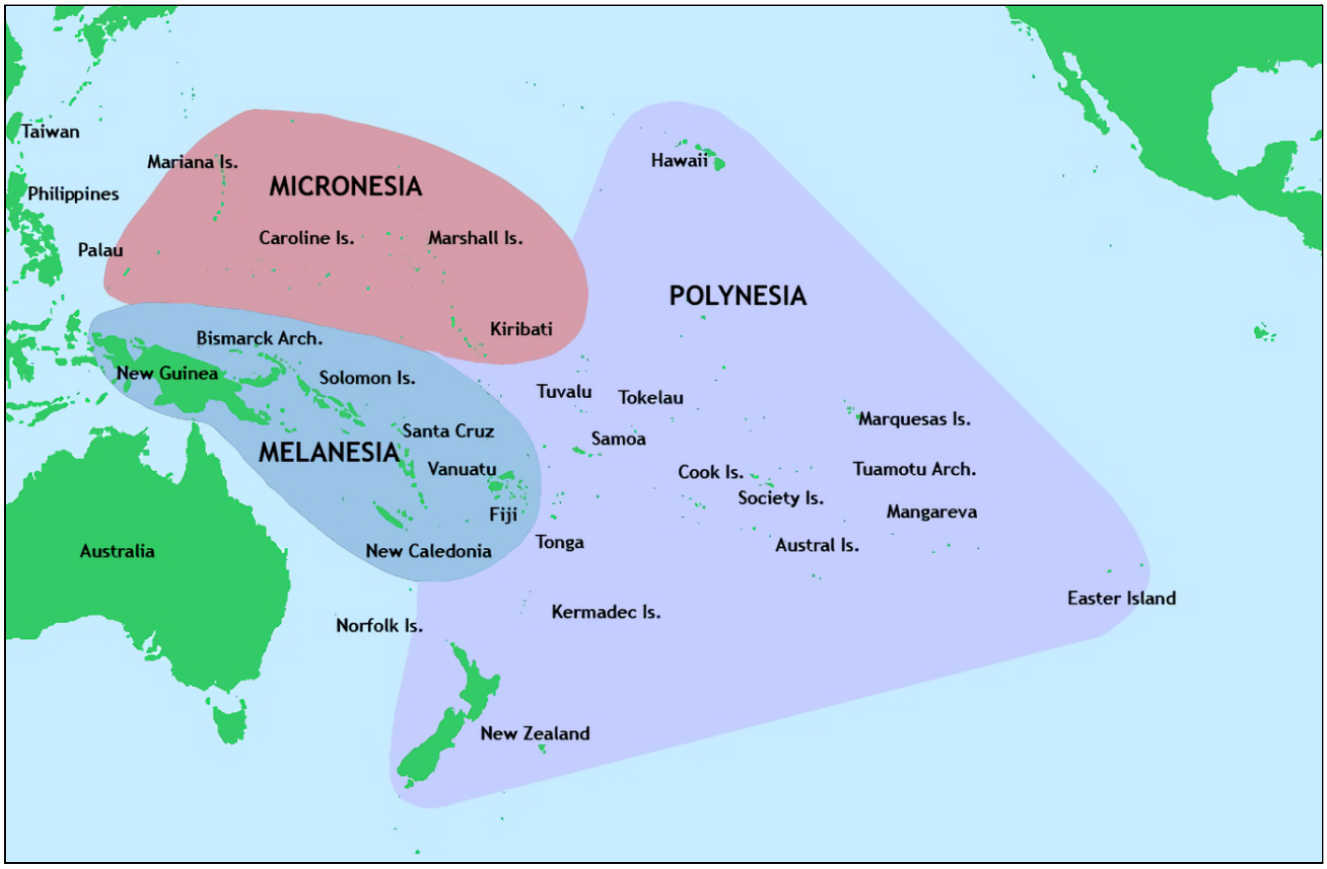


Figure 1: The South Pacific region (source: Vaka Moana: Voyages of the Ancestors - the discovery and settlement of the Pacific, ed K.R. Howe, 2008, p57)

1.2. Scope of Manual

This manual provides details for efficient and economic systems of village water supply and reticulation, developed in Solomon Islands by PHA and the South Ranongga Community Association (SRCA). Also included in this manual are provisions for the design of VIP pit latrines and septic systems, and their siting to preserve the integrity of adjacent water supplies.

The **Village Aqua** Manual continues to be updated on an on-going basis. This Manual is not intended for routine construction, but serves as the source document from which working drawings, material lists, bills of quantities and specifications can be derived for specific projects.

1.3. Structure of This Manual

Part 1 – Purpose and Scope of the **Village Aqua** Manual

Part 1 provides the background and brief description of **Village Aqua**, together with guidance on the use of this Manual.

Part 2 - RWASH Guidelines and Standards

Part 2 provides a list of useful documents and standards relevant to the Rural Water and Sanitation field.

Part 3 – **Village Aqua** Design Package

Part 3 provides an introduction to the **Village Aqua** Design Package, consisting of a Microsoft Excel workbook. This may be used to customise the design of:

- **Village Aqua** water supply and reticulation systems
- **Village Aqua** pit latrines and septic systems.

Part 4 – **Village Aqua** Design Details

Part 4 provides details, material lists and schedules for the principal components of the most common **Village Aqua** systems. These include small dams and weirs, inlets, piping, valves and fittings, rainwater collection gutters and downpipes, tanks, standpipes, associated concrete plinths and supports, latrine bases, toilet buildings, septic tanks, sludge drying beds. This manual may be used to prepare customised details, material lists and schedules for other applications.

Appendix A – **Village Aqua** Fabrication and Construction Guide

Appendix A provides guidelines on the factory prefabrication, including (when appropriate) trial assembly of the systems, and the construction process.

2. RWASH Guidelines and Standards

2.1. Policy/Governance/Stakeholders/Community Training

- The Solomon Islands Rural Water Supply Policy
- Solomon Islands Government Strategic Plan RWASH

2.2. Project Request Process and Forms

- Water Supply System Project Request Form
- Sanitation System Project Request Form

2.3. Design

- Rural Water Supply Training Workbook
- Rural Sanitation Training Workbook
- Solomon Islands RWASH Design and Construction Standards - Technical requirements for rural WASH Projects
- Design report template
- Engineering standard drawings and bill of quantities

3. Village Aqua Design Package

This section provides an introduction to the **Village Aqua** Design Package, consisting of a Microsoft Excel workbook. This may be used to customise the design of:

- **Village Aqua** water supply and reticulation systems
- **Village Aqua** pit latrines and septic systems.

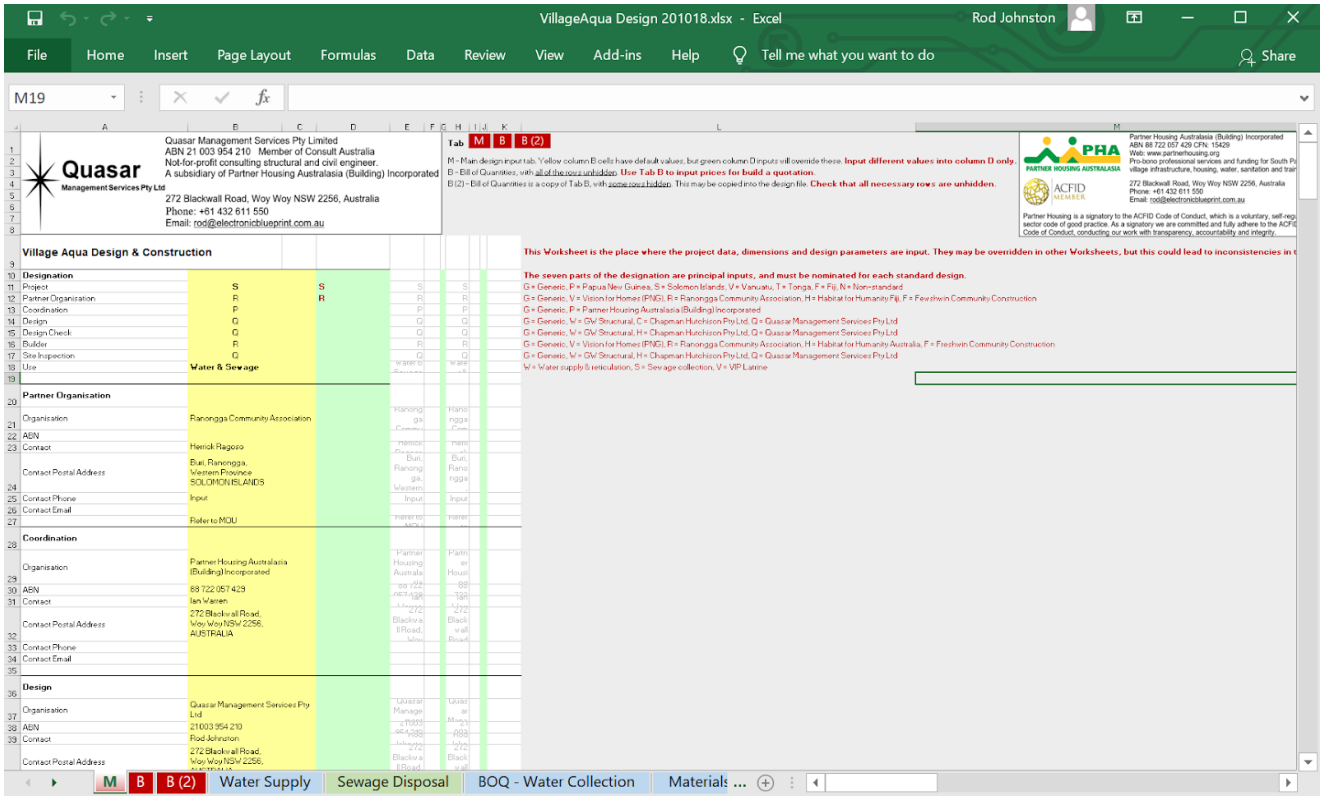


Figure 1: Screenshot of the first page of the **Village Aqua** Design Workbook

For a copy of the **Village Aqua** Design Package and information regarding its conditions of use, please contact:

Quasar Management services Pty Ltd
272 Blackwall Road, Woy Woy, NSW
Attention: Rod Johnston rod@electronicblueprint.com.au

3.1. Village Aqua Design Package Details

The following items explain some of the key elements of the workbook. For further details please refer to the workbook itself.

Tab M – Main Input
This is the main input tab for design information.

Tab B – Bill of Quantities
This is the Bill of Quantities, with all of the rows visible. Use Tab B to input prices to build a quotation.

Tab W – Water Supply Calculations
This tab is used to carry our detailed analyses for various village populations, rainfall data and geographical scenarios.

- Since data is read directly from Tab M, it is unnecessary to input data into this tab.
- Green cells can be used temporarily to test other options.

Tab S – Sanitation Calculations
This tab is used to carry our detailed analyses for various village populations, water supplies and geographical scenarios.

- Since data is read directly from Tab M, it is unnecessary to input data into this tab.
- Green cells can be used temporarily to test other options.

4. Village Aqua Design Details

This section provides details, links, material lists and schedules for the principal components of the most common Village Aqua systems. These include small dams and weirs, inlets, piping, valves and fittings, rainwater collection gutters and downpipes, tanks, standpipes, associated concrete plinths and supports, latrine bases, toilet buildings, septic tanks, sludge drying beds. This manual may be used to prepare customised details, material lists and schedules for other applications.

4.1. Water Supply

4.1.1. Rainwater Harvesting Systems

- Rainwater Harvesting and tank standard drawings and Bill of Quantities

4.1.2. Tanks

- 2000g Cement tank standard drawings and Bill of Quantities
- 3000g Cement tank standard drawings and Bill of Quantities
- 4000g Cement tank standard drawings and Bill of Quantities
- 5000g Cement tank standard drawings and Bill of Quantities

4.1.3. Wells

- Buried Well standard drawings and Bill of Quantities

4.1.4. Standpipes

- Standpipe and Shower standard drawings and Bill of Quantities
- Handwashing station standard drawings and Bill of Quantities
- Tapstand standard drawings and Bill of Quantities
- Handpump standard drawings and Bill of Quantities
- SOL Mark 5 Handpump Installation Manual

4.1.5. Reticulation

- Break pressure tank standard drawings and Bill of Quantities

4.2. Sanitation

- Dry pit latrine standard drawings and Bill of Quantities - Option A
- Dry pit latrine standard drawings and Bill of Quantities - Option B
- Ventilated improved pit latrine standard drawings and Bill of Quantities - Option A
- Ventilated improved pit latrine standard drawings and Bill of Quantities - Option B
- Pour flush latrine standard drawings and Bill of Quantities - Option A1
- Pour flush latrine standard drawings and Bill of Quantities - Option A2
- Pour flush latrine standard drawings and Bill of Quantities - Option B
- Twin pit flush offset latrine standard drawings and Bill of Quantities
- Compost toilet for single household standard drawings and Bill of Quantities
- Compost toilet suitable for 20 people standard drawings and Bill of Quantities

5. Appendix A – Village Aqua Design Summaries

This section provides a summary of various water supply and sanitation measures to provide a better understanding of each system.

For details of planning, designing and constructing the following infrastructure, please refer also to the details in Part 4 and the following two training workbooks in Part 2.

- Rural Water Supply Training Workbook
- Rural Water Supply Training Workbook

5.1. Village Aqua Dams

Dams are walls constructed in a creek bed to collect creek water. Water pressure behind and under dams will push them over unless they are firmly wedged between rock outcrops (or a rock-bolted to rock shelf below.)

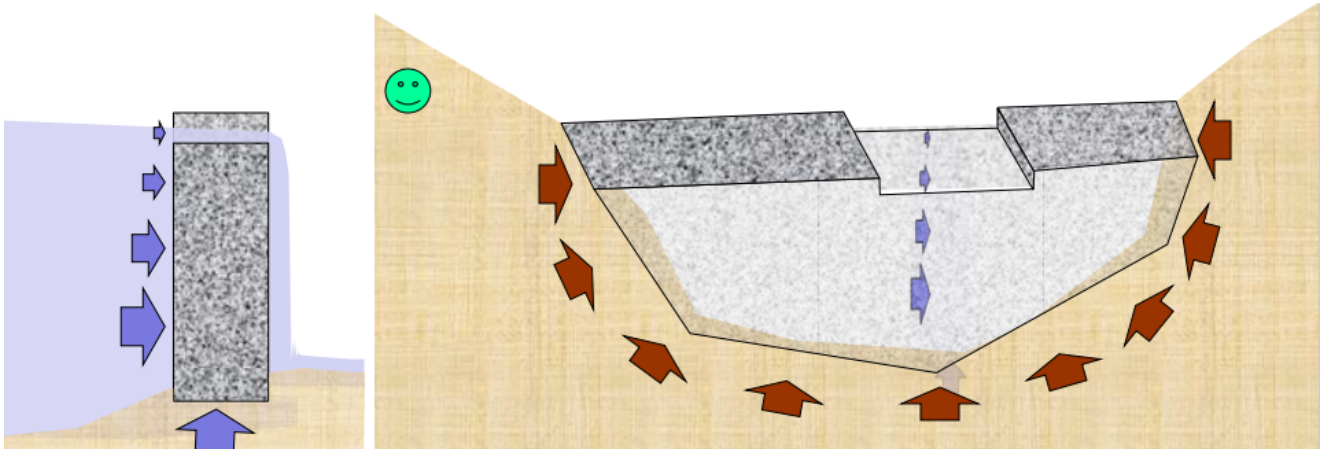


Figure A1: Water pressure acting on the dam wall.

To resist water pressure, all dams should be made from steel-reinforced concrete, with horizontal and vertical reinforcement designed by an engineer.

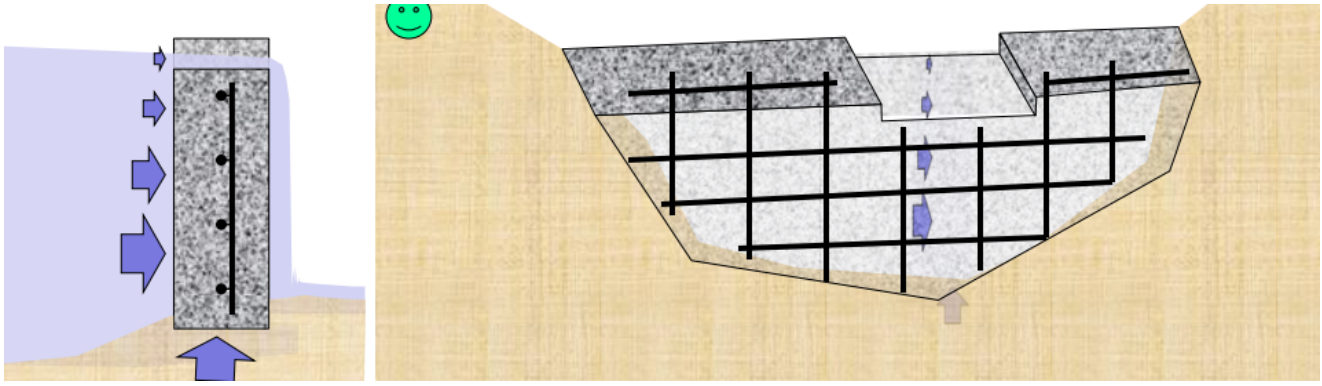


Figure A2: Steel reinforcement inside the dam wall.

5.1.1. Water Intake and Flushing

Suspended solids will eventually drop to the bottom of the dam, which should be flushed regularly through a flushing pipe and valve. Relatively clear water should be drawn from near the top of the dam, through a large leaf strainer, pipe and valve.

Figure A3: Examples of good and bad water intake practices.

5.2. Village Aqua Spring Boxes

Spring boxes are concrete boxes constructed in a creek bed to collect water, allowing the suspended solids to drop to the bottom and relatively clear water to be drawn from the top.

Figure A4: A spring box being constructed.

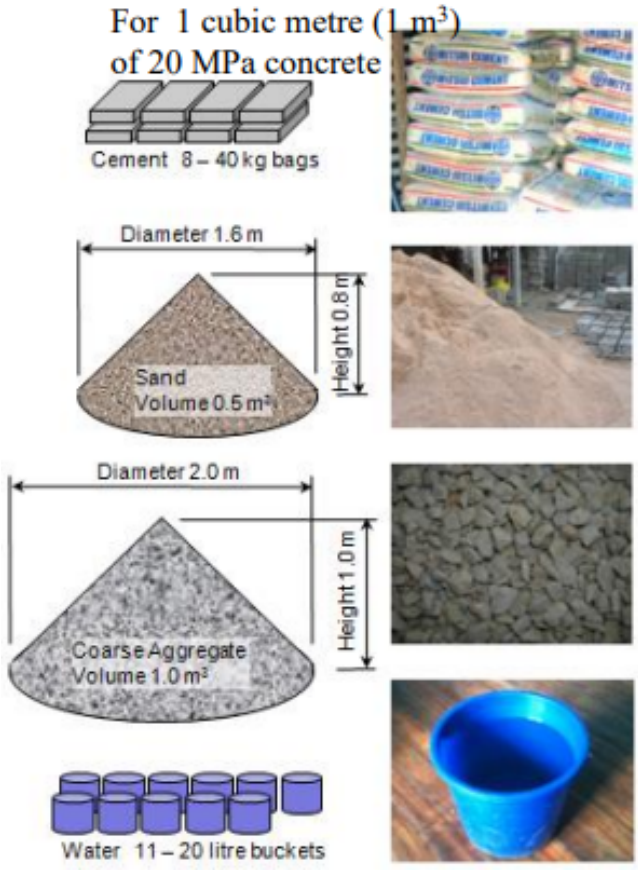


Figure A5: Concrete ingredients.

5.3. Village Aqua Standpipes

Standpipes provide water for communal use, usually close to the houses that they service.

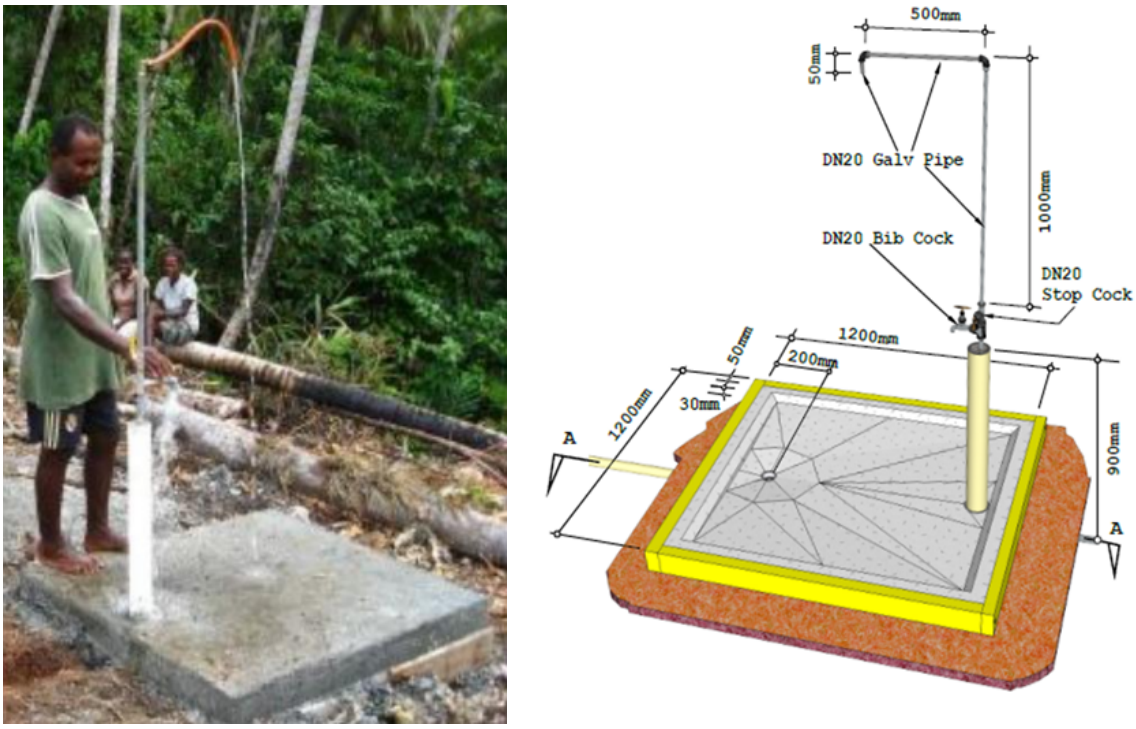


Figure A6: A constructed standpipe in the Solomon Islands (left) and a schematic of a typical standpipe arrangement (right).

The main components of standpipes are:

1. Reinforced concrete slab
2. Concrete filled DN80 PVC pipe, containing the riser.
3. DN20 or DN15 plumbing, consisting of two taps, one controlling an overhead shower and the other delivering water at waist height for filling buckets and washing.

Standpipe Slab Options

Option 1 – Dished Slab

If the surrounding ground is relatively flat with poor drainage, the concrete pad should be dished with a drain hole and drainage pipe sloping uniformly downwards to remove the wastewater to a convenient distance. This is more difficult to construct and may become slippery if the drain is not kept clear.

Option 2 – Low Maintenance Flat Slab

If the surrounding ground is sloping and well drained, the concrete pad may be constructed flat, with a very slight slope. This is easier to construct and easier to maintain.

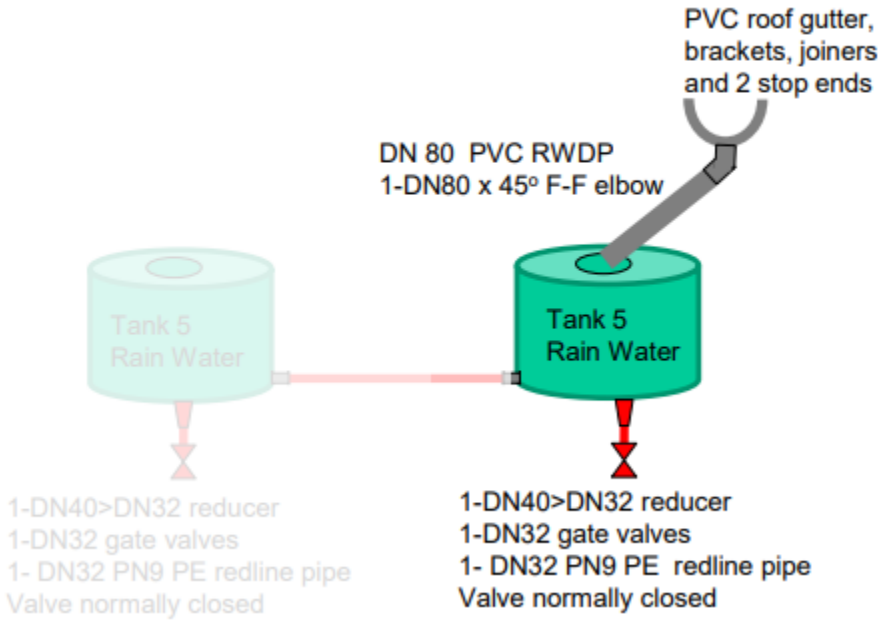
The galvanised steel upright and showerhead components of the standpipes may be prefabricated. Special attention should be given to ensure that the die nut used is compatible with the fittings. In the case of the SIRWASH Guidelines, this is a British Standard Pipe (BSP) right-handed thread.

5.4 Village Aqua Roof Plumbing

Roof plumbing and rainwater collection are vital to capture rain that hits the roof area instead of letting it spill over and soak into the ground.

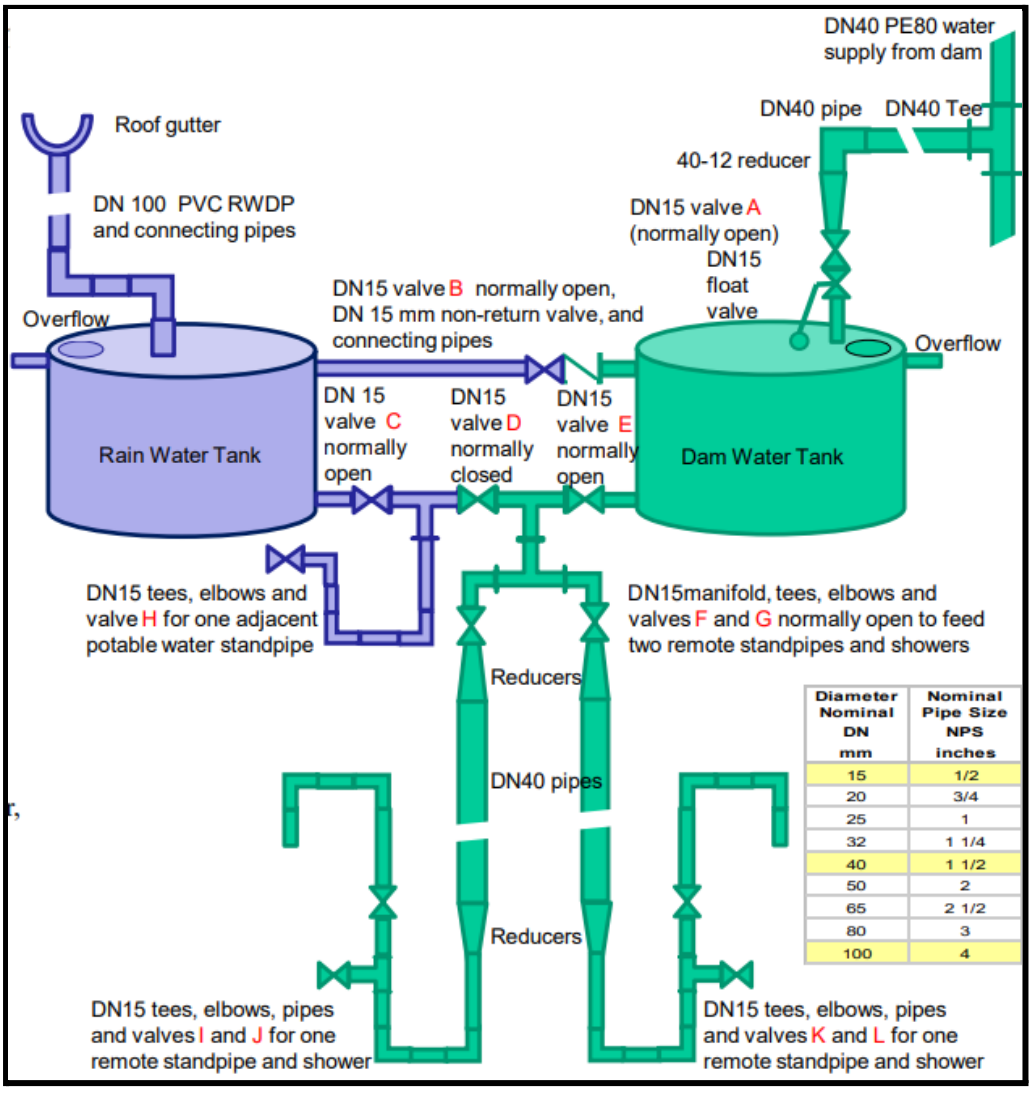
Figure A7: A typical roof drainage and rainwater tank collection system arrangement.

It is important that all fittings are compatible and should all be sourced from one supplier only. Do not mix and match products/fittings from more than one source.



5.5 Village Aqua Tanks

Below is a typical arrangement where a local potable roof supply (blue) is used to supply a potable water standpipe (blue) and to augment a normally non-potable supply (green) from a remote dam and associated standpipes (green).



Diameter Nominal DN mm	Nominal Pipe Size NPS inches
15	1/2
20	3/4
25	1
32	1 1/4
40	1 1/2
50	2
65	2 1/2
80	3
100	4

Normal Operation

1. Access rain water from valve H.
2. Access dam water from Valves I, J, K & L.
3. When the rain water tank is full, the float valve will close and water will flow to tanks higher in the system.
4. When the Rain Water Tank is full, water will flow to the Dam Water Tank.

Maintenance

1. If rainwater is not available, the tank can be used as extra storage of dam water, by closing Valve H and opening Valve D.
2. To isolate the rain water tank (for maintenance), close Valves B and C and open Valve D.
3. To isolate the dam water tank (for maintenance), close Valves B and E and open Valve D.

5.7 Village Aqua Hand Pump

This video provides instructions on how to prepare and install a Hand Pumped Well.

Figure A8: Sol Mk 5 hand pump installation, components and procedure (source: Ranongga video, hand pump designed by Peter Wopereis).

5.8 Village Aqua Ventilated Improved Pit (VIP) Latrines

A Ventilated Improved Pit (VIP) latrine is a toilet that collects feces in the ground. A drop hole is created in the floor of the latrine for collection of urine and feces. Pit latrines can decrease the spread of disease by limiting contact between feces, flies and food.

VIP Latrines consist of:

1. 900 mm diameter x 3-4 metres deep pit.
2. Reinforced concrete slab with:
   2.1. A large key-hole opening for the squat hole
   2.2. Two holes for the ventilation pipes.
3. Vent pipes sealed into the concrete slab suck out foul air as fresh air is drawn down through the squat hole. Double vent pipes are used in this design to achieve the equivalence of a single 150 mm diameter pipe. The top of the vent pipes should extend 500 mm above the roof and be painted black to encourage air flow.
4. A weatherproof timber out-house, painted black inside and outside, to foster air flow, with a self-closing door.

Flies are attracted but cannot pass the fly screen to enter the pipes. Any flies entering the latrine are attracted to the light coming from the vent pipe but will be unable to escape once they have gone up the vent pipe and hit the screen. Flies avoid dark spaces. A dark interior and self closing door are critical.

Figure A9: An example of a VIP latrine.

In cyclonic areas, the superstructure should be strengthened, so as to resist high winds. The slab can be used as is, but could be fitted with a pedestal, seat and cover as an option, however, it must include cement mortar benching inside the pedestal that directs the excreta down the hole, and does not permit it to collect on the slab. This arrangement must be regularly cleaned.

In all cases, there must be close consideration of:

- the sighting of the latrine to prevent contamination of drinking water, living areas or crops by seepage or overflow.
- the availability of flushing and cleaning water
- the rate at which the pit will fill and overflow.

5.9 Village Aqua Water Sealed Toilets

The specifications for this type of toilet is in addition to the specification for the VIP latrine. Water-sealed toilets shall:

1. Only be used where a sufficient quantity of water for flushing is available throughout the year, rainwater is not considered as a sufficient source for flushing
2. Have a toilet slab made of reinforced concrete (or fibreglass, plastic or other technically sound material).
3. When discharging into a pit below, have an easily removable slab and superstructure for easy relocation.

Additional requirements for off-set pits, water-sealed toilets shall be:

1. Have a drain pipe with a minimum diameter of 100 mm, laid in a straight line, less than a 45 degree bend and a minimum of 5% slope for the drain pipe.
2. Have drain pipes between 3 and 6 m length from permanent housing or toilets constructed inside a building.
3. Have drain pipes fitted with air vent(s) to prevent air locks.
4. Have inspection ports at pipe junctions etc.

Figure A10: Examples of water sealed toilets.

The pit must be of sufficient dimensions to cater for the excreta and flushing water. Porous sandy soil, loose rock and rock fissures will help drain the pit, however, the pit must not drain into drinking water supplies.

Provide a large container or mandi to store a reserve of flushing water and a bucket large enough to hold sufficient water to flush the pedestal.

5.10 Village Aqua Hand Washing

Hand-washing with soap helps prevent diarrheal diseases and pneumonia, which together are responsible for the majority of child deaths estimated at more than 3.5 million each year. Washing with water alone is significantly less effective than washing hands with soap. Using soap and a small amount of water breaks down the grease and dirt which carries most germs.

The critical times when hands should be washed with soap are after using the latrine or cleaning a child's bottom and before handling food. By making hand-washing with soap normal practice at these times would make a significant contribution to meeting one of the UN's Millennium Development Goals of reducing deaths among children under the age of five by two-thirds by 2015.

Figure A11:The Tippy Tap. (Acknowledgements regarding design and artwork: Emergency Architects Australia)

The Tippy Tap consists of a container hanging in a timber frame and a rope fixed to a stick. By treading on the stick the container tips over and a small trickle of water comes out of the hole in the container. When the stick is released the container comes back to the neutral position which cuts off the water supply. As hands are not required to operate the tap contamination of the water is thus prevented.