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

Partner Housing is a signatory to the ACFID Code of Conduct, which is a voluntary, self-regulatory sector code of good practice. As a signatory we are committed and fully adhere to the ACFID Code of Conduct, conducting our work with transparency, accountability and integrity.

Quasar Management Services Pty Limited
ABN 21 003 954 210 Member of Consult Australia
Not-for-profit consulting structural and civil engineer
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

Clean Water Supplies and Hygienic Sanitation

for South Pacific Villages

Water Supply and Reticulation in Ranongga, Solomon Islands

Contents

Partner Housing Australasia (Building) Incorporated

Partner Housing 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.

Preparation of this Document

This document has been prepared by Quasar Management Services Pty Limited for use by Partner Housing Australasia and its partner organisations.

Copyright

Acknowledgements

The following volunteers were engaged in the development of the **VILLAGE AQUA** water supply and sanitation system – Ian Warren, David Kaunitz, Rod Johnston, Graham Vant, Clive Beddoe, Logan English-Smith, Stuart Steinle-Davies, Leonid Bronfentrinker, Peter Wopereis and Fin Adamson.

Partner Housing extends the deepest appreciation for their assistance and expertise, particularly given that their involvement was extensive, in challenging overseas circumstances and on a pro-bono basis.

Partner Housing also recognises the dedication of the Ranongga Community Association and the island communities of Ranongga and Vella Lavella. We extend particular thanks to Herrick Ragoso and Saemon Alepio.

Scope of Manual

VILLAGE AQUA is an efficient and economic system of village water supply and reticulation, developed in Solomon Islands by Partner Housing and the Ranongga Community Association.

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.

Also included are considerations for the specification of village solar energy.

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.

Part 1 – VILLAGE AQUA Manual

Introduction

Part 1 provides the background and brief description of the **VILLAGE AQUA** systems together with guidance on the use of this Manual.

Background

The South Pacific region is home to a diverse range of people, many of whom live in small villages. This **VILLAGE AQUA** manual has been prepared for Partner Housing Australasia to give guidance for this application. VILLAGE AQUA is the system of village water supply, sanitation (including VIP latrines) and the design of solar power systems. These have been developed in the island nations of the South Pacific by Partner Housing and its partner organisations.

Purpose and Structure of This Manual

The purpose of this Manual is to provide a comprehensive reference on the background, design and detailing of **VILLAGE AQUA (**water supply systems and sanitation systems). The intention is to provide a single document in ten parts, from which other simpler or focused documentation can be extracted of developed.

Part 1 – **VILLAGE AQUA** Manual provides the background and brief description of **VILLAGE AQUA**, together with guidance on the use of this Manual.

Part 2 – **VILLAGE AQUA** Design Workbook provides an introduction to the **VILLAGE AQUA** Design Package, consisting of a Microsoft Excel workbook. This may be used to customise the design of the **VILLAGE AQUA** water supply and reticulation systems; **VILLAGE AQUA** pit latrines and septic systems and **VILLAGE AQUA** solar power supply.

Part 3 – **Other Design** Resources provides reference material and links to the UNICEF website, which provides additional useful information for the design of village water supplies and sanitation.

Part 4 – **VILLAGE AQUA** Water Supply Engineering Design gives guidance and a practical example demonstrating the design of a small rural village water supply, including the location of the system, and contours, typical contour map and aerial view, general arrangement water collection and reticulation plumbing, contour plan of catchments, water sheds, large and small catchments, small catchment plan, dam, pipework, break-pressure tank and reticulation pipework.

Part 5 – **VILLAGE AQUA** Water Supply Engineering Detail provides sample drawings for a small rural dam, break-pressure tank, village standpipe plumbing, village standpipe concrete slab and privacy screens for the same sample project.

Part 6 – **VILLAGE AQUA** Water Supply Design Calculations for the same sample project.

Part 7 – **VILLAGE AQUA** Water Supply Bill of Quantities for the same sample project.

Part 8 – **VILLAGE AQUA** Water Supply Construction Guide provides construction guidance.

Part 9 – **VILLAGE AQUA** Rural Sanitation Construction Guide provides construction guidance.

Part 10 – **VILLAGE AQUA** Sample Specifications are for various materials and construction including timber, concrete, and masonry.

Part 2 – VILLAGE AQUA Design Workbook

Introduction

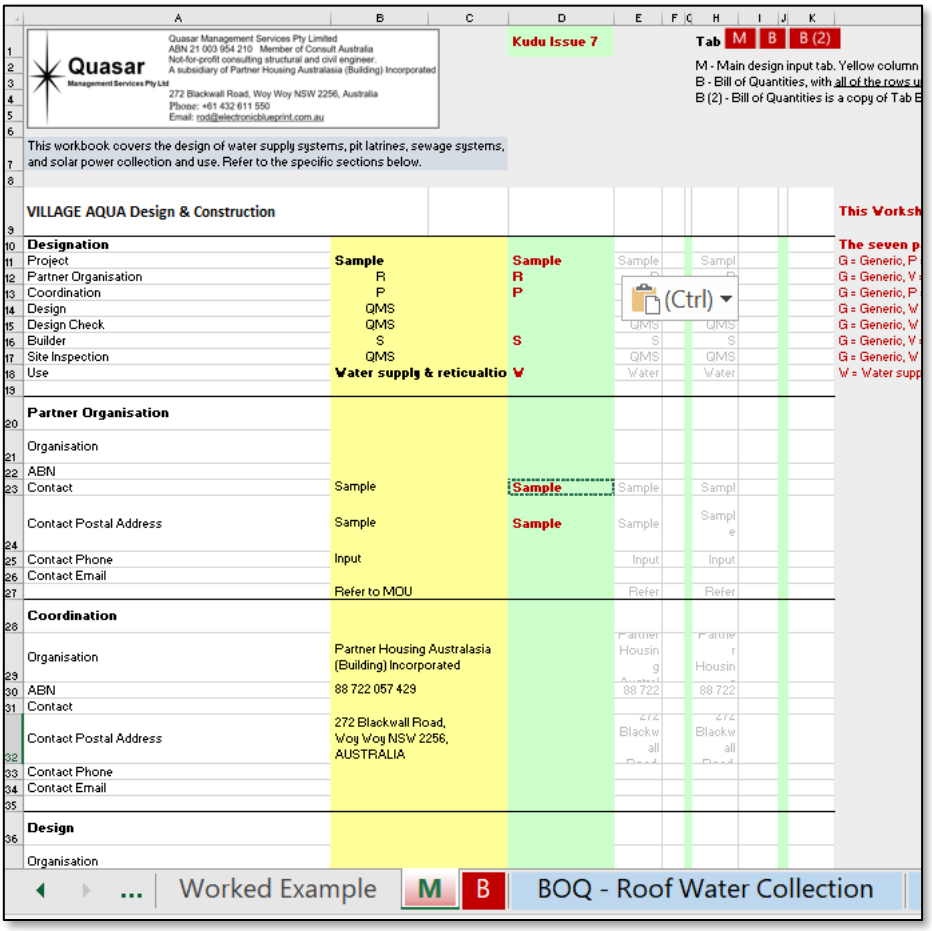
Part 2 provides an introduction to the **VILLAGE AQUA Design Workbook**, consisting of a Microsoft Excel workbook. This may be used to customise the design of –

- **VILLAGE AQUA** water supply and reticulation systems, including water demand calculations, water supply estimation, flow and hydraulic calculations, storage tank sizing, roof water tank sizing, standpipe plumbing and supports, and reticulation pipework.
- **VILLAGE AQUA** sewage disposal via pit latrines and septic systems, sludge disposal, and pit latrine design.
- **VILLAGE AQUA** village solar power systems, including demand calculations, solar access, solar panel capacity, and battery demand.

For a copy of the **VILLAGE AQUA Design Workbook** 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

Screenshot of the Front Page of the VILLAGE AQUA Design Workbook

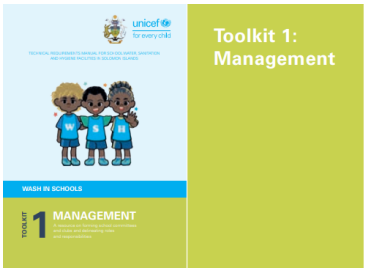


Part 3 - Other Design Resources

UNICEF WASH Design and Promotion Resources

Introduction UNICEF Pacific WASH Solomo

Manual for school water, sanitation and hygiene facilities in Solomon Islands

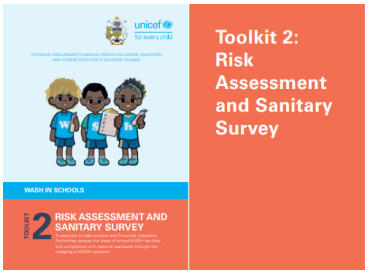


Toolkit 1: Management

Look at:

- Forming a School WASH Committee
- Setting goals
- Assigning roles and responsibilities
- Terms of Reference

Tool Kit 1 Management UNICEF

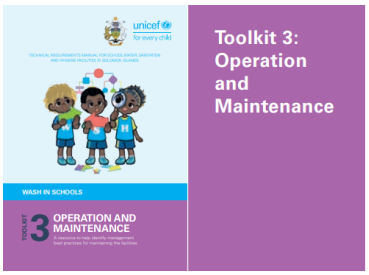


Toolkit 2: Risk Assessment and Sanitary Survey

Look at:

- Mapping the WASH system
- Assessing WASH system current state and risks
- Recognizing good practice
- Assessing annual compliance with *National Standards*
- Assessing progress on implementing the School WASH Plan

Tool Kit 2 Risk Assessment UNICEF P

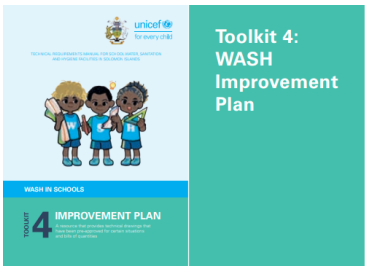


Toolkit 3: Operation and Maintenance

Look at:

- WASH facilities operation and maintenance
- Managing risks:
  - Waste
  - Resilience
  - Emergencies
- Considering appropriate choices for improvements

Tool Kit 3 Operation UNICEF Pacific WASH

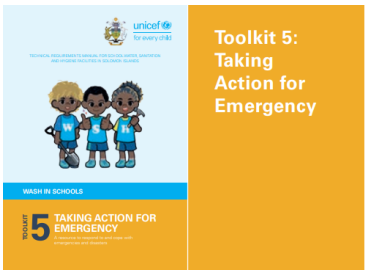


Toolkit 4: WASH Improvement Plan

Look at:

- School WASH Plan template
- Annex A: Technical designs/drawings pre-approved for certain situations, and bills of quantities (BoQs)

Tool Kit 4 Improvement UNICEF



Toolkit 5: Taking Action for Emergency

Look at:

- Knowing what to do when there is a problem
- Keeping and reviewing records of checks, maintenance and improvements
- Knowing what to do when there is an emergency/disaster

Tool Kit 5 Taking Action UNICEF Pacific

Part 4 – VILLAGE AQUA Water Supply Engineering Design

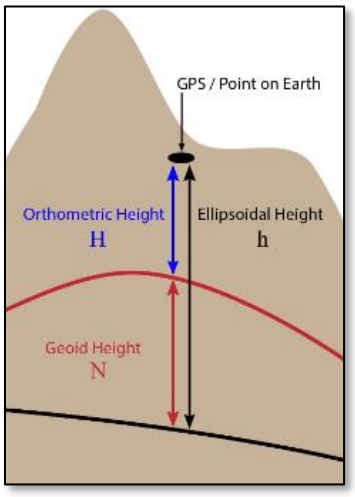
Location and Contours

The first step in the design process is the determination of the location of the village, the water supply and the route which must be traversed by the supply pipework.

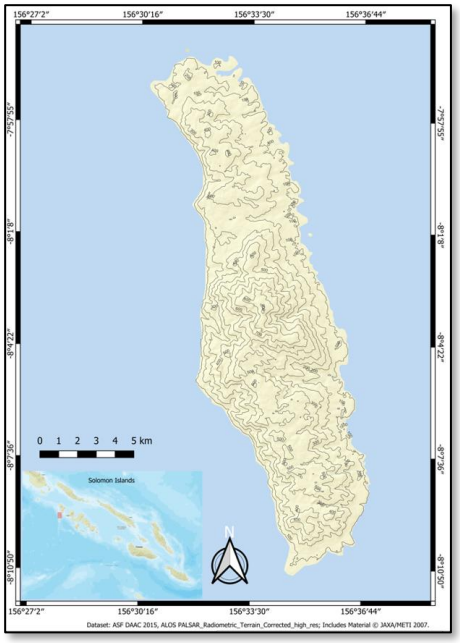
The elevations used for designing water supplies will (most likely) be the Orthometric Height, H, (the height above an idealised Mean Sea Level datum). These are shown on the extracts of OpenStreetMap, and are derived from SRTM data [Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global].

Other maps, extracted using QGIS, may show the Ellipsoidal Height (h), and can give an apparent elevation which is quite different from the Orthometric Height. For example, the Orthometric Height at Kudu school in Ranongga (Solomon Islands) is approximately 50 m, while the Ellipsoidal Height is approximately 120 metres. When using QGIS maps at Kudu, the values shown on the contours will need to be reduced by 70 m (to correspond to Orthometric Height) for purposes of calculating the localised hydraulic grade line (HGL) and the localised energy grade line (EGL).

The Difference Between Ellipsoidal, Geoid, and Orthometric Elevations | Virtual Surveyor : Support Portal (virtual-surveyor.com) The **Ellipsoidal Height** (h) is the difference of the vertical distance between a point on the Earth's Surface and the ellipsoid. The Ellipsoidal height is also known as the geodetic height and should not be confused with geodetic datums. When capturing coordinates with a GPS receiver, the elevation data references the ellipsoid, which means each captured coordinate needs to be calculated to match elevations with the more accurate geoid height. The **Geoid Height** (N) is the difference of the vertical distance between the reference geoid and the ellipsoid. The geoid is a hypothetical shape of the earth that often coincides with the average of the earth's sea level and its imagined extension above or below land areas; the geoid height may sometimes be referred to as the elevation at Mean Sea Level (MSL). The **Orthometric Height** (H)—the height we ultimately want to know—is the difference between the vertical distance from a location on the Earth's Surface and the geoid. Because the geoid coincides with MSL, whenever you see elevation data described as "X" … above or below sea level, it is referring to the orthometric height. H = h – N

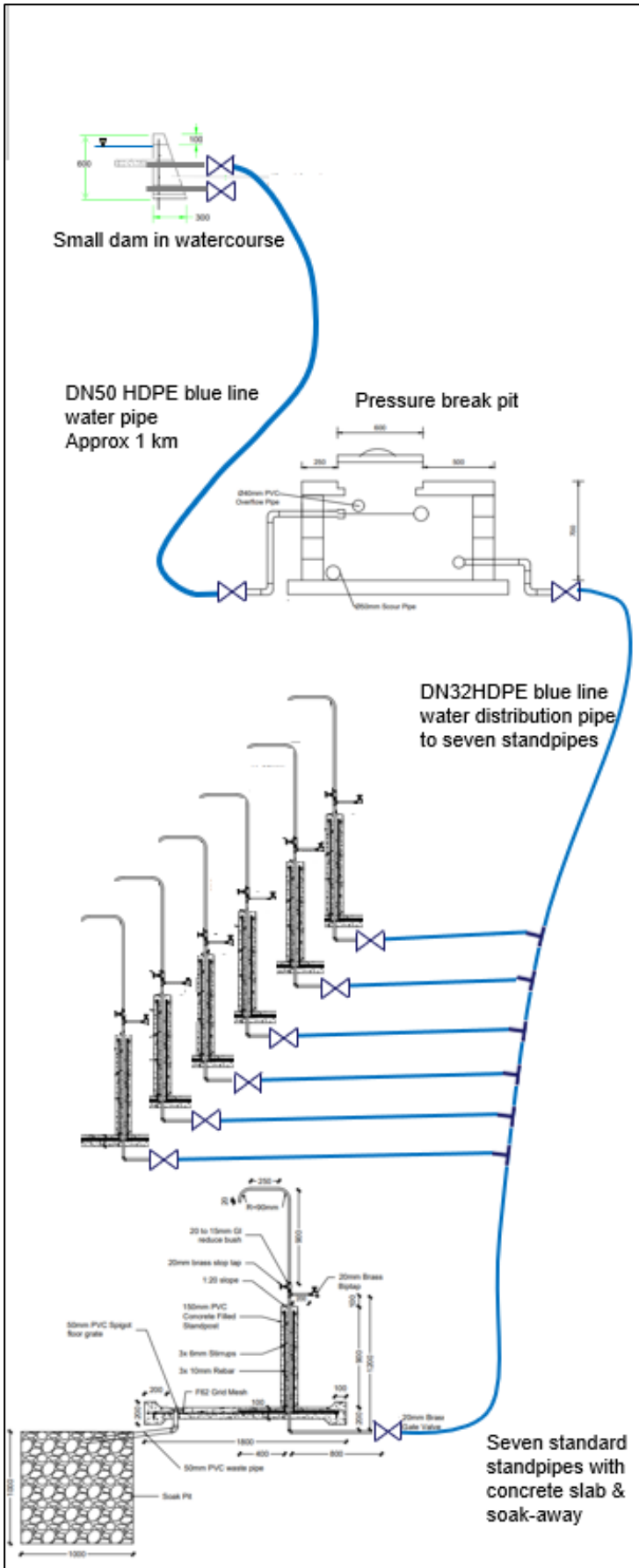


Typical Contour Map and Aerial View



General Arrangement Water Collection and Reticulation Plumbing

Based on a small system providing for under 200 people via seven standpipes



Plumbing Pipes and Fittings

Pipes and fittings are listed in order, progressing from the dam to the standpipes.

Dam

Dam Outlet
DN50 PVC end cap
DN50 x 300 mm PVC pressure pipe with drilled holes
DN50 female BSP faucet socket PVC pressure
DN50 GI pipe x 1.0 m - with both ends threaded
DN50 gate valve brass, F GVB50, Norma
DN50 galvanised hex nipple

Dam Scour
DN50 galvanised pipe x 1.0 m, with both ends threaded
DN50 gate valve brass, 2 inch F GVB50, Norma

Water Main – 1.0 km approximate length

DN50 blue line HDPE pipe, 150 m/coil PN12.5 AS/NZ 4130 (7 Req)
DN50 poly coupling, Plasson (8 Req)

Break Pressure Tank

Break Pressure Tank Inlet
DN50 Poly metric/thread adaptor, Plasson
DN50 galvanised hex nipple
DN50 gate valve brass, FF GVB50, Norma
DN50 x 3 mm galvanised pipe x 100 mm, thread both ends
DN50 x 90 degree galvanised elbow
DN50 x 3 mm galvanised pipe x 500 mm, thread both ends
DN50 x 90 degree galvanised elbow
DN50 x 3 mm galvanised pipe x 500 mm, thread both ends
DN50 ball float valve, tank floater

Break Pressure Tank Outlet
DN50 PVC end cap
DN50 x 300 mm PVC pressure pipe with drilled holes
DN50 female BSP faucet socket PVC pressure
DN50 x 3 mm galvanised pipe x 500 mm, thread both ends
DN50 x 90 degree galvanised elbow
DN50 x 3 mm galvanised pipe x 100 mm, thread both ends
DN50 x 90 degree galvanised elbow
DN50 x 3 mm galvanised pipe x 100 mm, thread both ends
DN50 gate valve brass, FF GVB50, Norma
DN50 galvanised hex nipple
DN50 Poly metric/thread adaptor, Plasson

Break Pressure Tank Scour
DN50 galvanised pipe x 1.0 m, with both ends threaded
DN50 gate valve brass, FF GVB50, Norma

Break Pressure Tank Overflow
DN50 x 88 degree DWV PVC plain bend
DN50 PVC Pipe (DWV) x 2.0 m

Distribution Pipework – 1.4 km approximate length

DN50 poly coupling, Plasson
DN50 x DN32, poly reducing set, Plasson
DN32 poly coupling, Plasson
DN32 x 90 degree poly tee, Plasson
DN32 blue line HDPE pipe x 200 m/coil, PN12.5, AS/NZ 4130

Standpipes – 7 Required

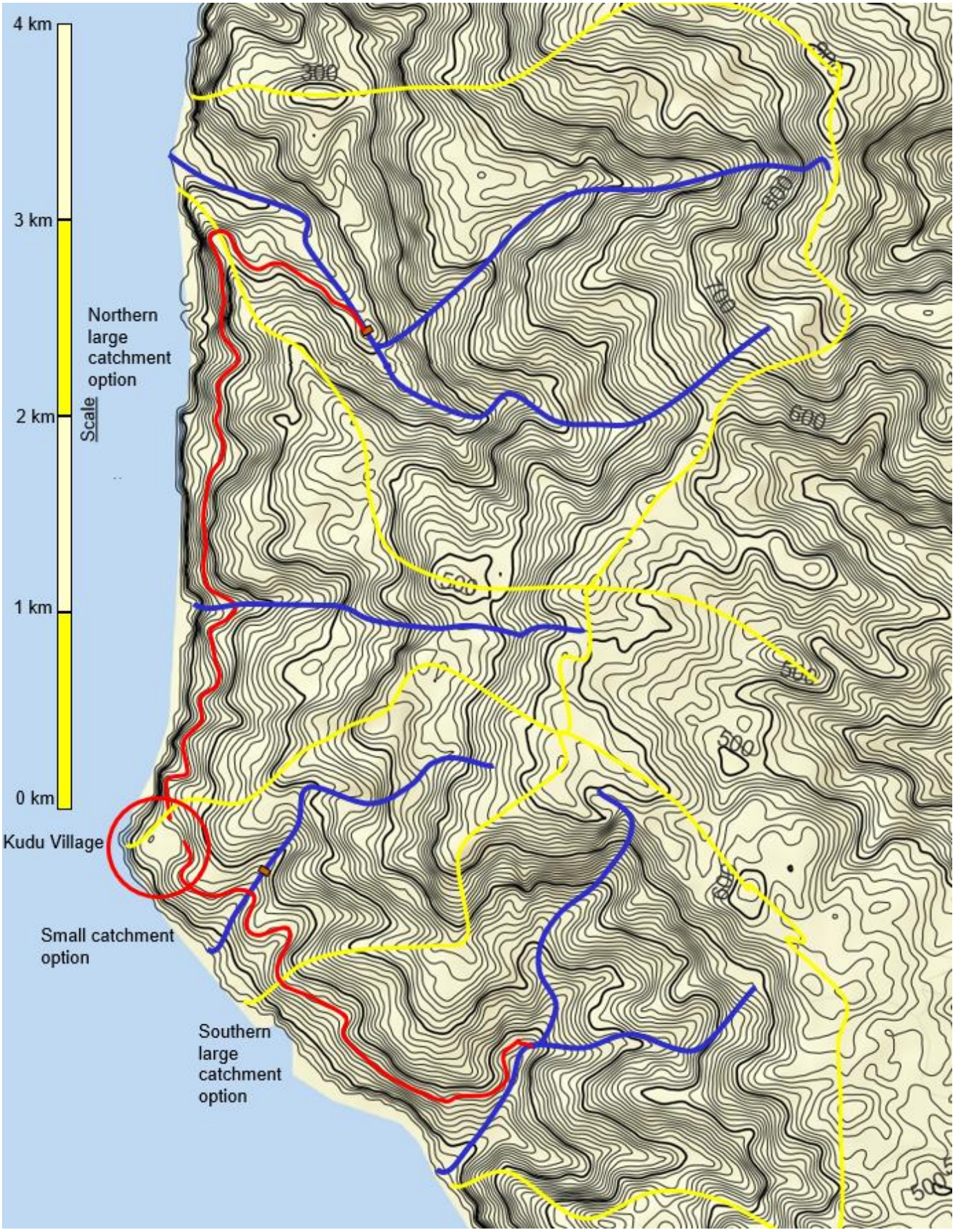
DN32 x DN20 Poly M/Thread Adaptor, Plasson
DN20 brass gate valve, FF, Norma
DN20 x 2.5 mm galvanised pipe x 900 mm, thread both ends
DN20 galvanised elbow x 90 degree
DN20 x 2.5 mm galvanised pipe x 1200 mm, thread both ends
DN20 galvanised female socket
DN20 galvanised tee
DN20 brass stop cock, TH FF
DN20 galvanised hex nipple
DN15 x DN20 galvanised reducing bush
DN15 x 2.8 mm galvanised pipe x 900 mm, thread both ends
DN15 galvanised elbow x 90 degree
DN15 x 2.8 mm galvanised pipe x 600 mm, thread both ends
DN15 galvanised elbow x 90 degree
DN20 x 2.5 mm galvanised pipe x 200 mm, thread both ends
DN20 brass hose cock / R, TH FF

Standpipe Drains – 7 Required

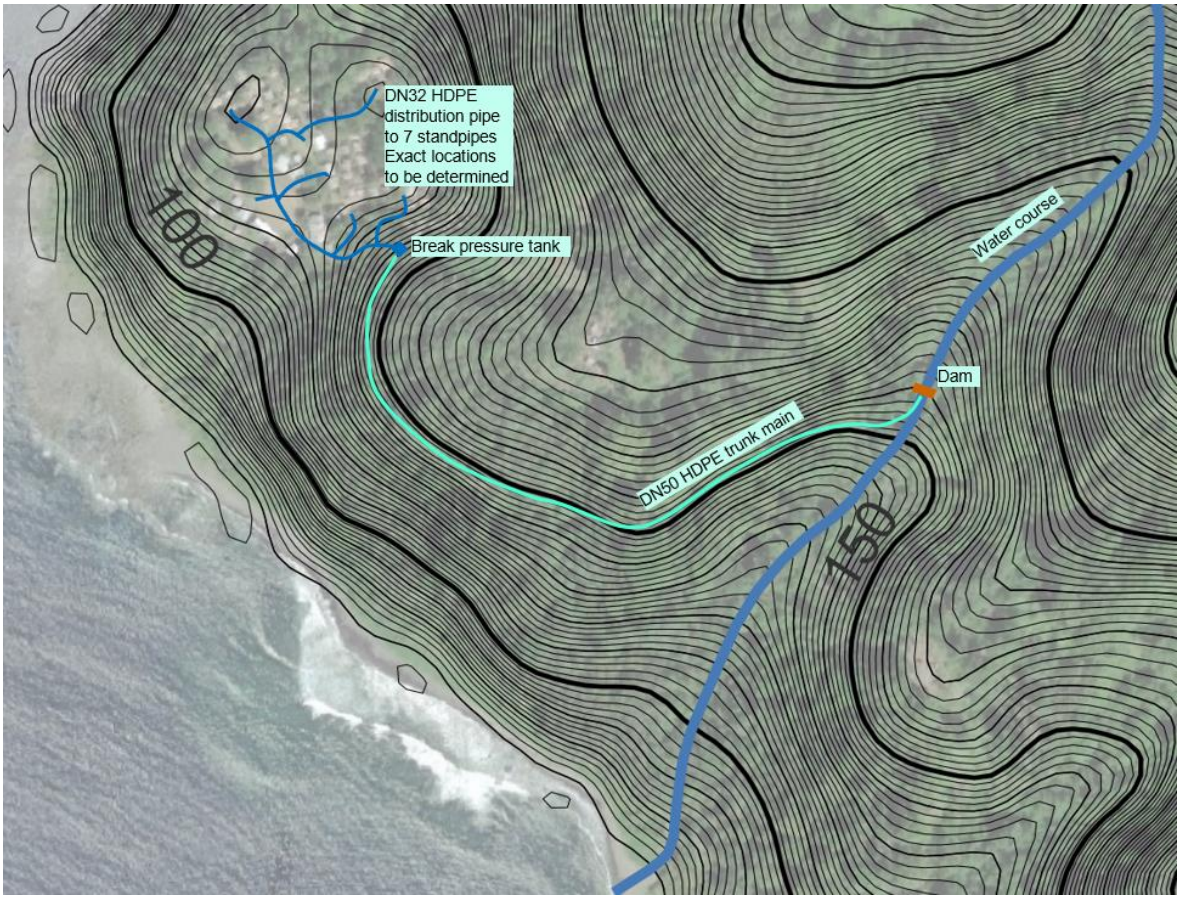
DN50 drop in grate poly round white
DN50 x 88 degree DWV PVC plain bend
DN50 DWV PVC pipe x 2.0 m (cut from 5.8 m length)

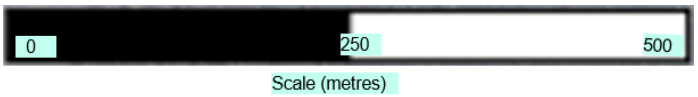
General Arrangement of Water Collection and Reticulation Plumbing for Kudu Village

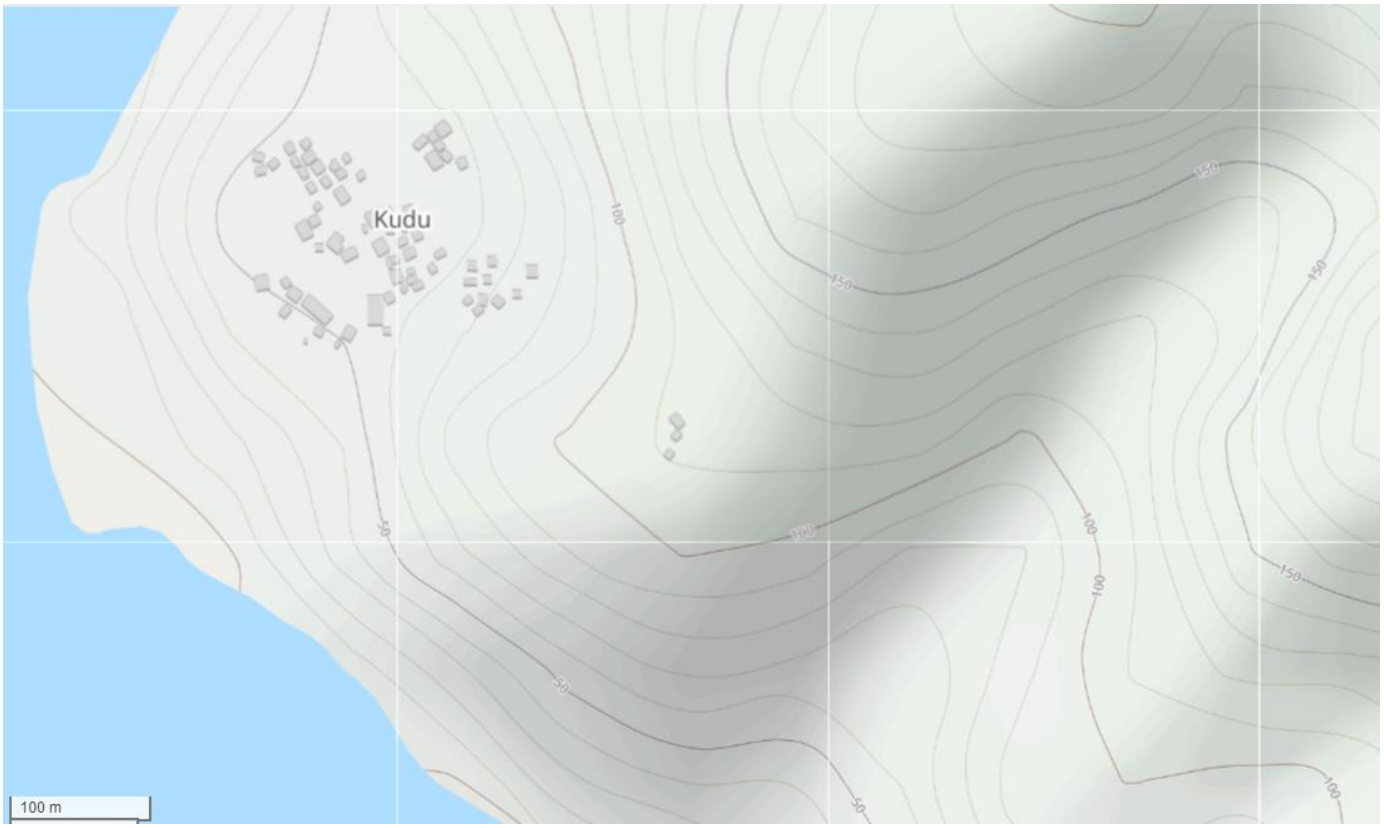
Contour Plan of Catchments, Water Sheds, Large and Small Catchments



Small Catchment Plan - Dam, Pipework, Break-Pressure Tank and Reticulation Pipework







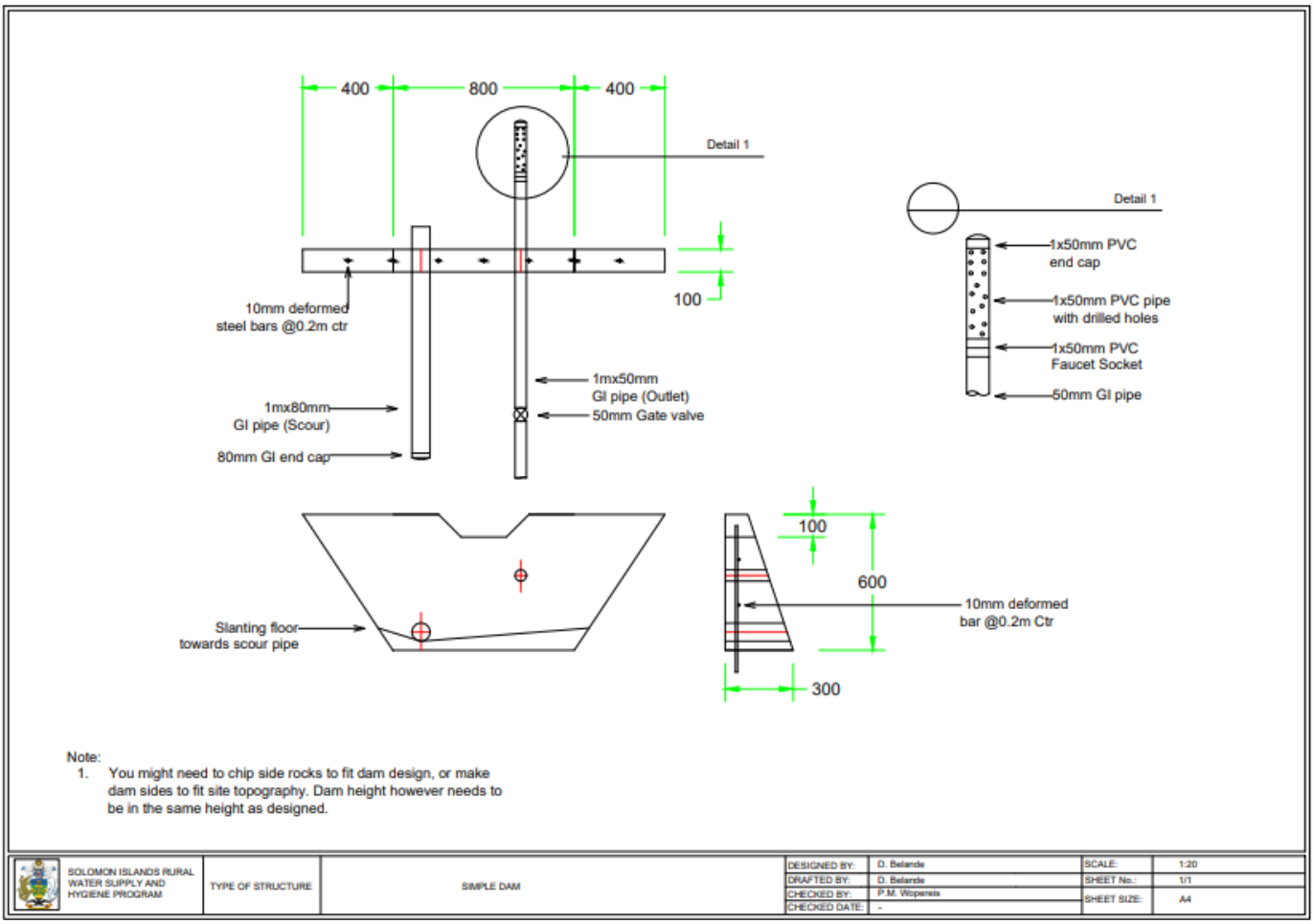
Part 5 – VILLAGE AQUA Water Supply Engineering Detail

Dam Detail

The dam shall comply generally with the standard Solomon Islands RWASH design shown below, except as noted in the Bill of Quantities.

In particular, the scour shall be DN 50 and fitted with a gate valve

Some minor substitution of materials is necessary, depending on availability of certain items.



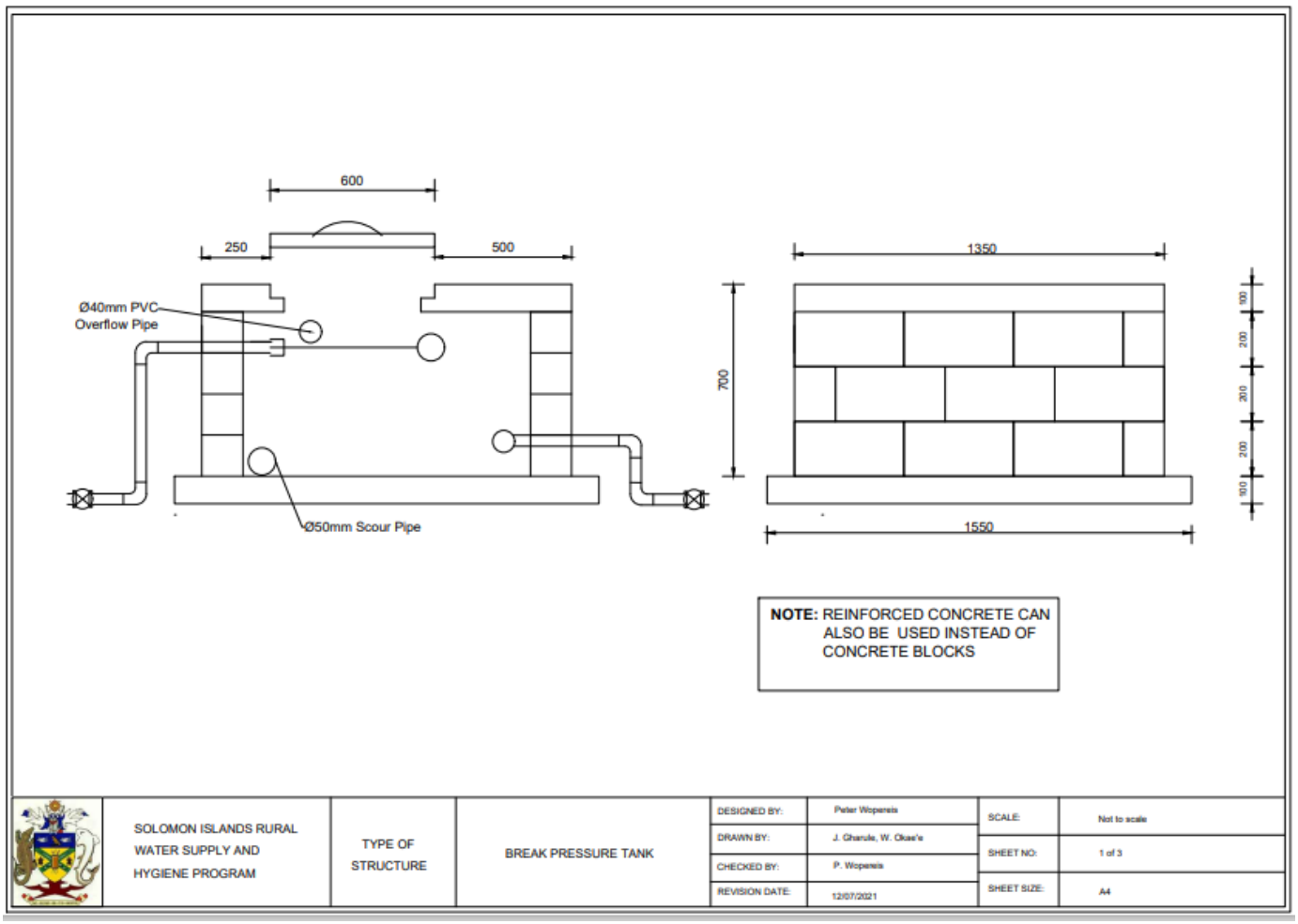
Break-Pressure Tank Detail

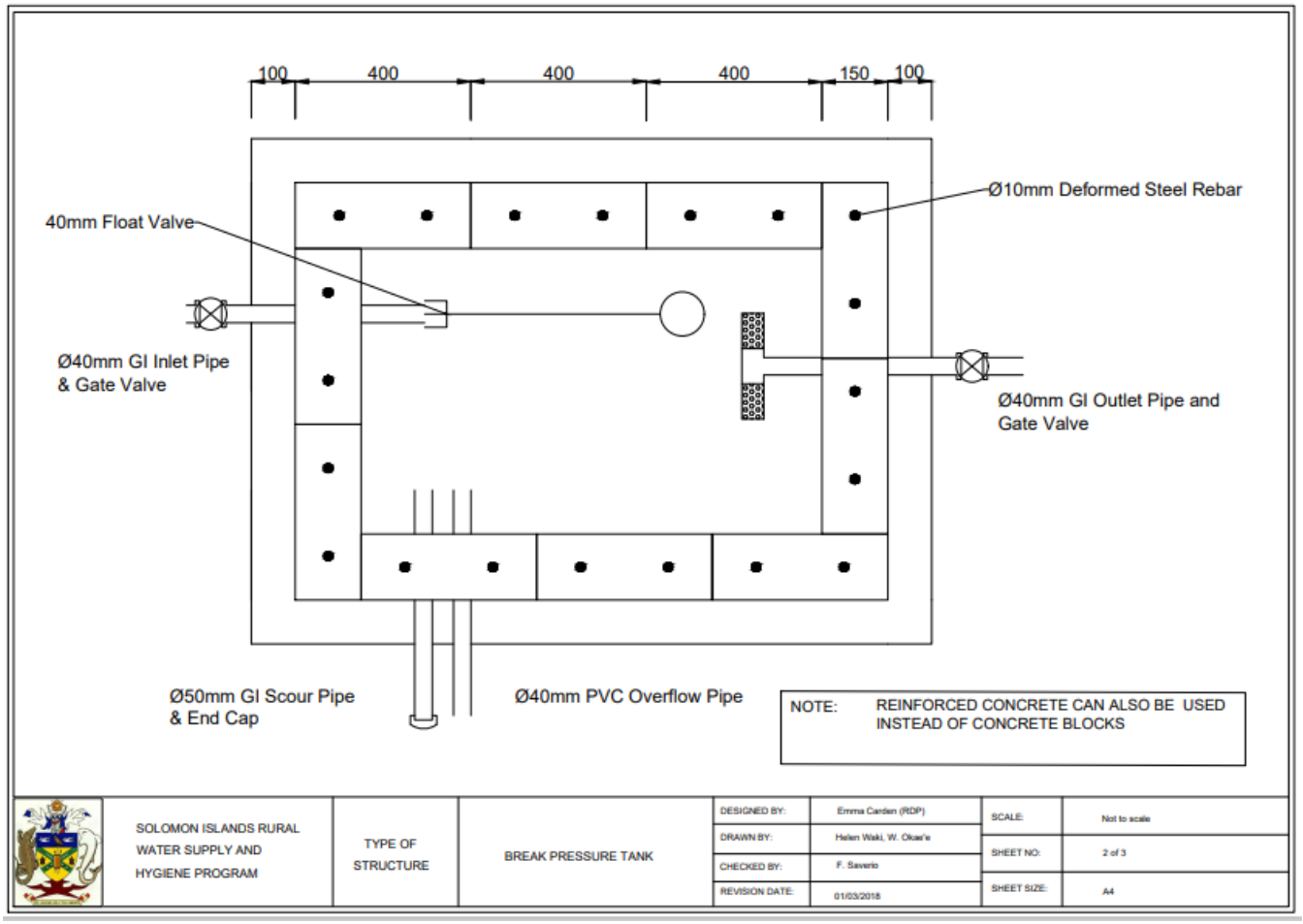
The break-pressure tank shall comply generally with the standard Solomon Islands RWASH design shown below, except as noted in the Bill of Quantities.

In particular,

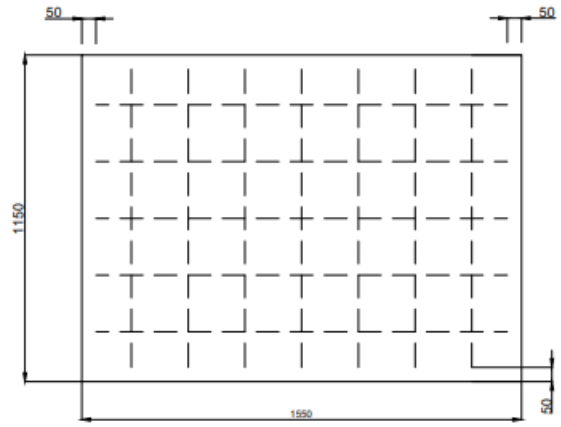
- the outlet and overflow shall be DN50,
- the scour shall be fitted with a gate valve, and
- the inlet strained shall be a straight pipe in lieu of a tee.

Some minor substitution of materials is necessary, depending on availability of certain items.

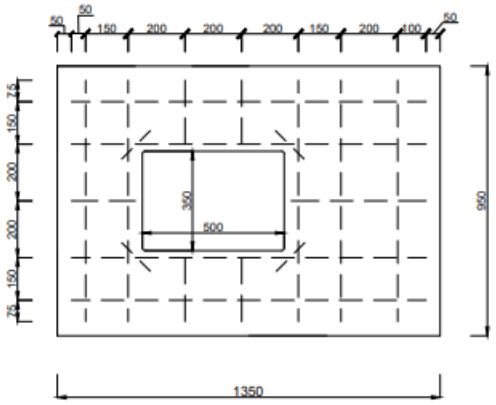




	SOLOMON ISLANDS RURAL WATER SUPPLY AND HYGIENE PROGRAM	TYPE OF STRUCTURE	BREAK PRESSURE TANK	DESIGNED BY:	Emma Carden (RDP)	SCALE:	Not to scale
				DRAWN BY:	Helen Waki, W. Okae'e	SHEET NO:	2 of 3
				CHECKED BY:	F. Saverio		
				REVISION DATE:	01/03/2018	SHEET SIZE:	A4



Base Slab Reinforcement



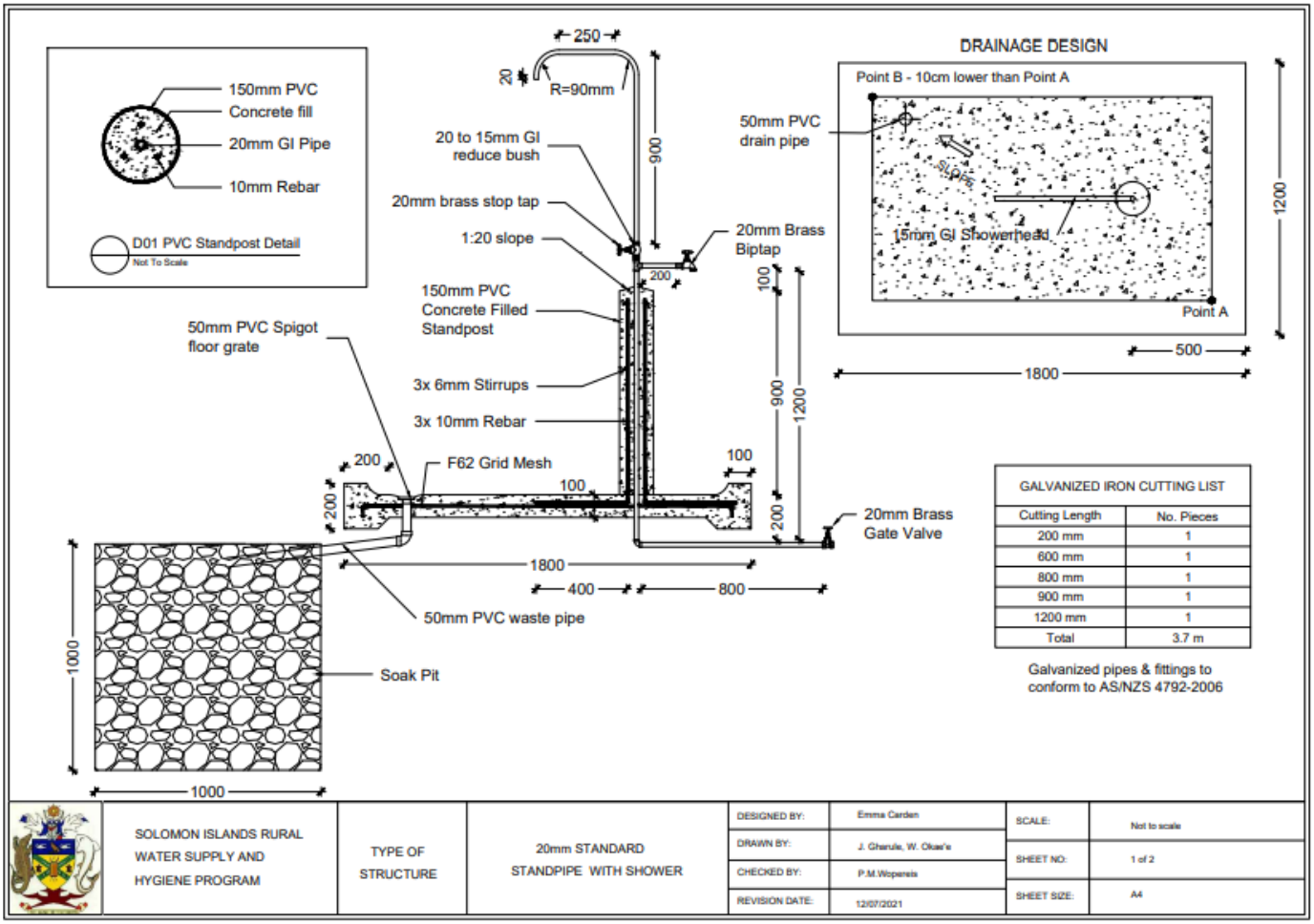
Roof Slab Reinforcement

	SOLOMON ISLANDS RURAL WATER SUPPLY AND HYGIENE PROGRAM	TYPE OF STRUCTURE	BREAK PRESSURE TANK	DESIGNED BY:	Emma Carden (RDP)	SCALE:	Not to scale
				DRAWN BY:	Helen Waki, W. Okae'e	SHEET NO:	3 of 3
				CHECKED BY:	F. Saverio		
				REVISION DATE:	01/03/2018	SHEET SIZE:	A4

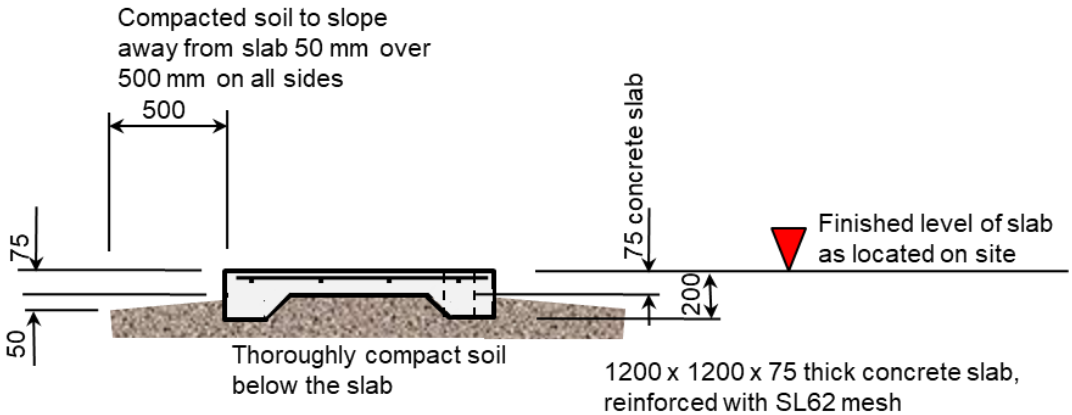
Standpipe Plumbing

The standpipes shall comply generally with the standard Solomon Islands RWASH design shown below, except as noted in the Bill of Quantities. In particular, the top pipework shall consist of elbows in lieu of bent pipes.

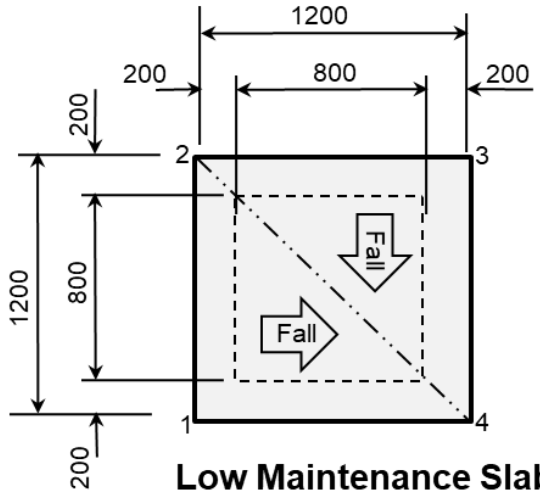
Some minor substitution of materials is necessary, depending on availability of certain items.



Standpipe Concrete Slab



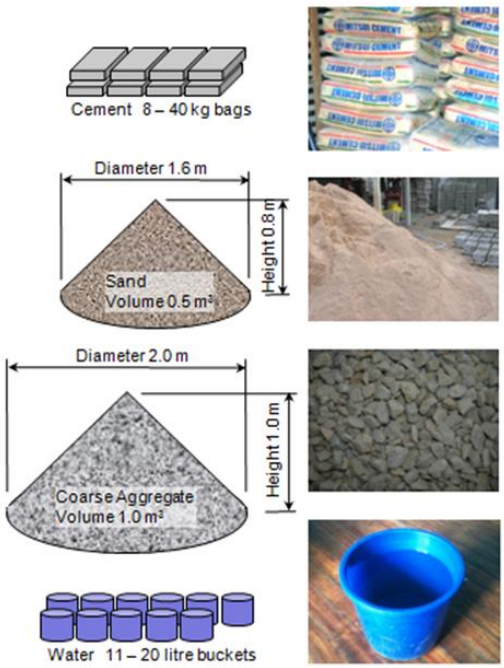
1200 x 1200 x 75 thick concrete slab,
reinforced with SL62 mesh
with 200 x 200 edge thickening



Low Maintenance Slab

For the "Low Maintenance Slab", the top surface is flat, except that there is a 10 mm fall to corner 4. This is achieved by keeping corners 1, 2 and 3 at the same level, and dropping corner 4 by 10 mm. The wet concrete is screeded from the diagonal 2-4 towards corners 1 and 3. The water will drain slowly towards corner 4 and a soak-away can be positioned extending from corner 4.

For 1 cubic metre (1 m^3) of 20 MPa concrete



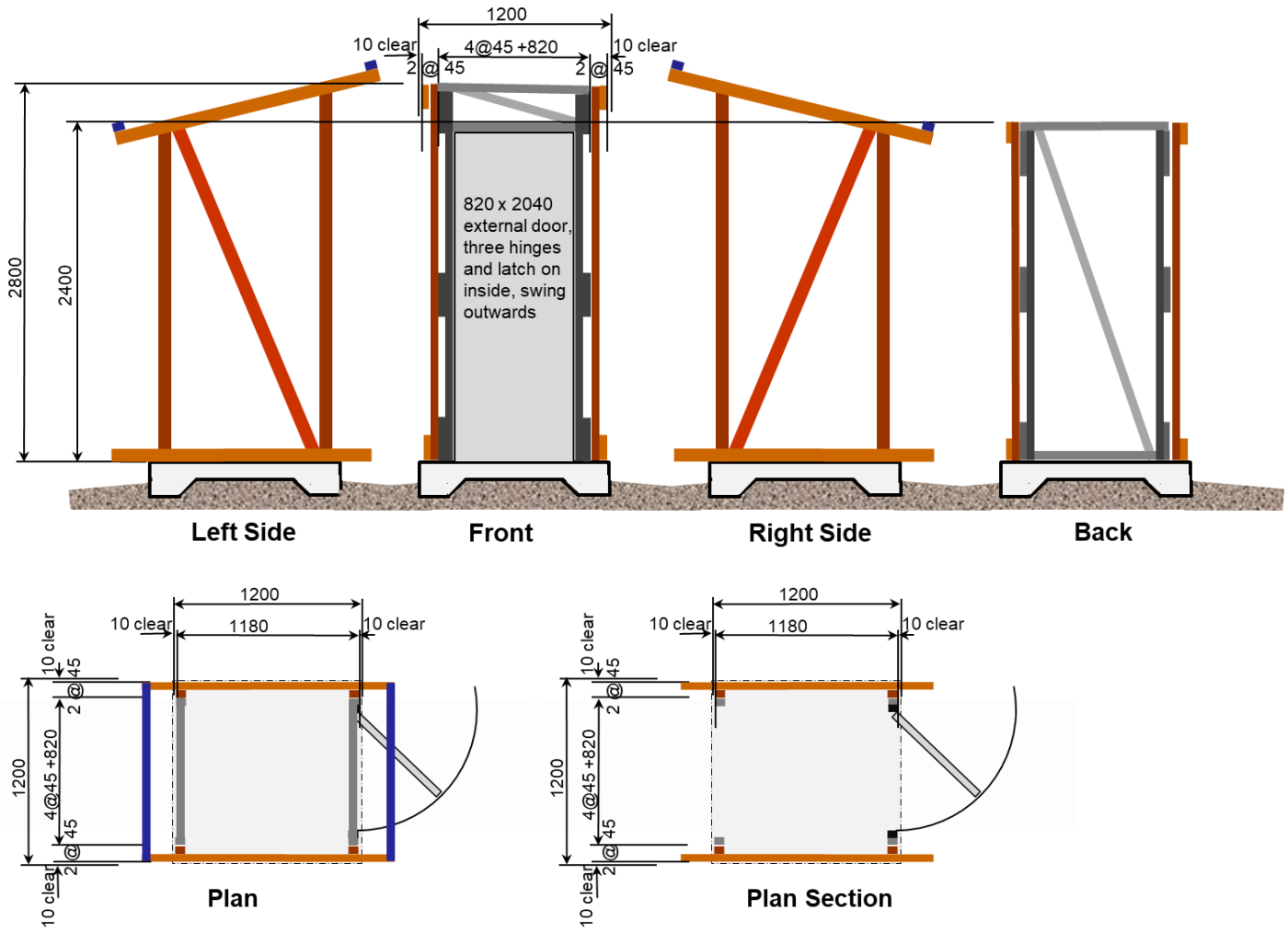
20 MPa Concrete (by volume) 1 : 2 : 4		1 Stand Pipe Base	4 Stand Pipe Bases
Volume of concrete	m^3	0.26	1.00
Wastage included	%	10%	
GP or GB cement	40 kg bags	2	8
Clean sharp sand	m^3	0.1	0.5
20 mm rock aggregate	m^3	0.3	1.0
SL 62 steel mesh	No-mesh m x m	1 - SL62 1.15 x 1.15	4 - SL62 1.15 x 1.15
Timber formwork	m	100 X 50 HW x 4.8 (re-use)	100 X 50 HW x 4.8 (re-use)

Privacy Screens Detail

Privacy screens are an option for village standpipes. They may be retrofitted after the slab and standpipe are constructed. They consist of four prefabricated side frames (the front one with a door fitted). They are erected, and fixed together and normally would not have a roof. An optional roof may be fitted by fixing the two (blue) purlins, and fixing roof sheeting. The wall cladding is not shown or specified in this drawing, and may be selected from suitable local materials. The whole structure must be securely anchored.

All timber shall be 70 x 45 F7 (or equivalent), securely nailed or screwed, with two coats of paint to ensure against deterioration.

Four anchors to 200 x 200 x 200 concrete pads, not shown for clarity.



In this project, there has been no request from the village for privacy screens. Initially supply and instal, one screen to one of the standpipes on a trial basis. If this proves to be popular, further screens may be provided on request.

Part 6 – VILLAGE AQUA Water Supply Design Calculations

The following calculations indicate that there is adequate supply and adequate head for the proposed village water supply and reticulation system.

Demand			
Population to be serviced	Current population is in the range of 150 to of 240. Limited site area restricts expansion beyond 240.		
Current number of houses	**34**	houses	**34**
Number of people per house	**6.0**	people/house	
Current population	204	people	
Design life	20	years	
Natural increase in population	1.0%		**1.0%**
Simple increase or compounding increase?	Simple		
Design population	240	people	
Design households	40	houses	
Number of people serviced by ….. during the design life			
Community standpipes	240	people	
Number of people serviced by EACH …..			
Community standpipe	30	people	
Number of facilities			
Community standpipes	7	standpipes	**7**
Number of households per standpipe	5.7	households	
Maximum permitted households per standpipe	5.0	households	
Are there sufficient standpipes?	**Problem**		
Water demand (per capita)			
Community standpipes	**100**	l/person/day	
Minimum required water availability	50	standpipes	
Is there sufficient water available?	**OK**	l/person/day	
Average Water Demand			
Average net water demand, Q_{ave}	24,000	l/day	
Factor of safety	1.25		
Maximum net water demand, Q_{max}	**30,000**	l/day	
Maximum net water demand, Q_{max}	**1,250**	l/hour	
Maximum net water demand, Q_{max}	**20.8**	l/minute	
Maximum net water demand, Q_{max}	**0.347**	l/second	
Peak Water Demand			
Peak demand factor	4.0		
Peak net water demand, Q_{peak}	**5,000**	l/hour	
Peak net water demand, Q_{peak}	**83.3**	l/minute	
Peak net water demand, Q_{peak}	**1.389**	l/second	

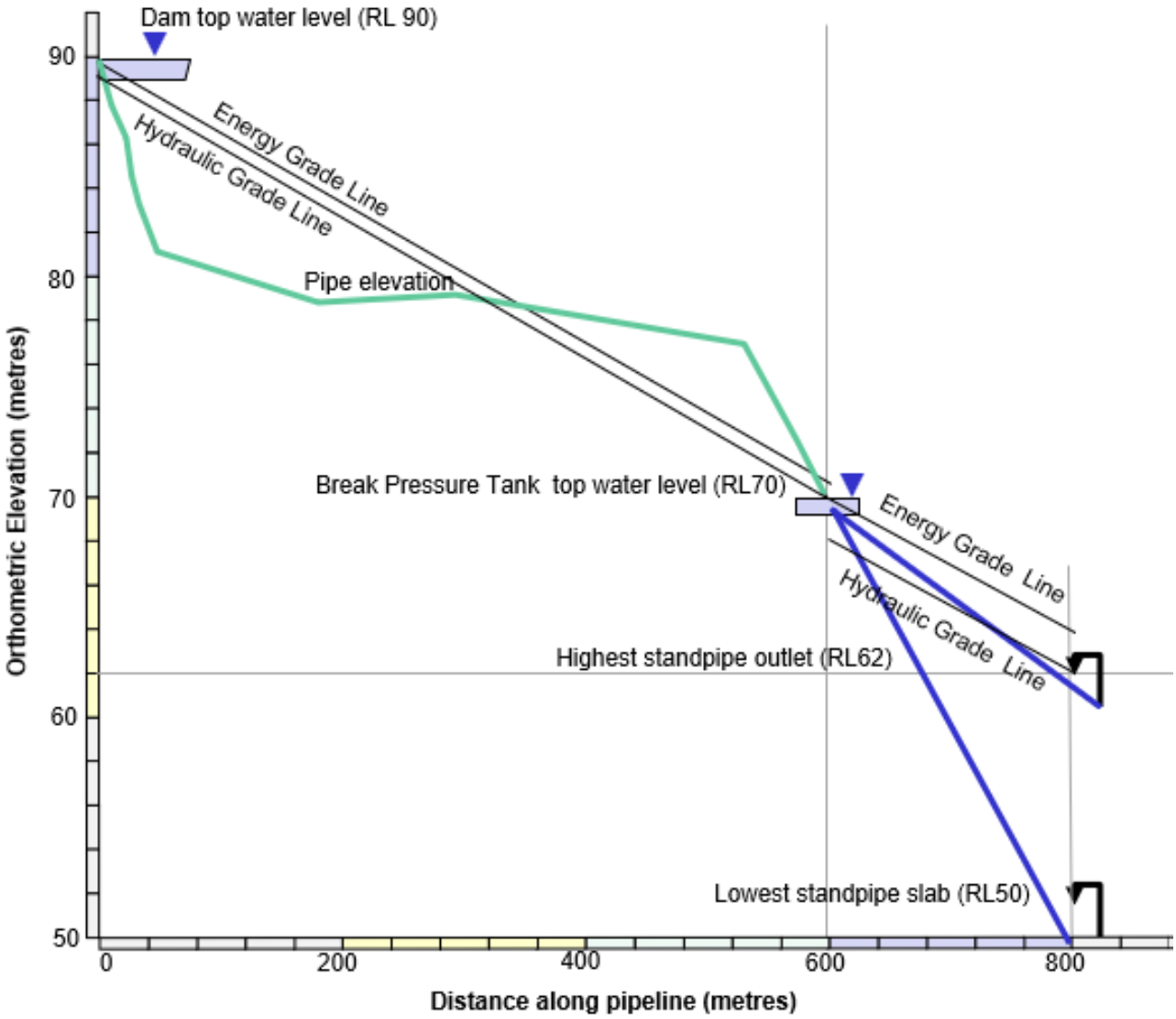
Small Catchment Option

Supply			
Rainfall			
Mean annual rainfall	3,600	mm/year	
Minimum monthly rainfall	210	mm/month	
Minimum daily rainfall	7.00	mm/day	
Minimum rainfall / Mean rainfall	**0.70**		
Catchment			
Mean width of catchment	**0.70**	km	**0.7**
Mean length of catchment	**1.00**	km	**1.0**
Area of catchment	0.70	km^2	
Stream flow			
Precipitation on the catchment	4,900	m^3/day	
Dry weather daily flow / Average daily rainfall	2.6%		
Stream flow supply, $Q_{min.source}$	125	m^3/day	
Stream flow supply, $Q_{min.source}$	125,440	l/day	
Stream flow supply, $Q_{min.source}$	**5,227**	l/hour	
Stream flow supply, $Q_{min.source}$	**87**	l/minute	
Stream flow supply, $Q_{min.source}$	**1.5**	l/second	
Demand / Supply	23.9%		
Does supply exceed demand	**OK**		
Flow Calculations			
Elevations			
Distance lowest standpipe to break pressure tank	100	m	**100**
Distance break pressure tank to source	600	m	**600**
RL of highest standpipe slab	62.00	m	**62**
RL of the highest standpipe shower outlet	64.10	m	
RL of lowest standpipe slab	50.00	m	**50**
RL of the lowest standpipe tap	50.90	m	
RL of break pressure tank or storage tank	**70.00**	m	**70**
TWL of the break pressure tank or storage thank	**72.00**	m	
BWL of the break pressure tank or storage thank	**70.00**	m	
RL of water source, spring or dam	**90.00**	m	**90**
BWL of water source, spring or dam	**90.00**	m	**90**
Static head at highest standpipe outlet	**7.90**	m	
Minimum permissible static head	5.00	m	
	OK		
Static head at storage or break-pressure tank	**18.00**	m	
Maximum permissible static head	50.00	m	
	OK		

These approximate calculations are based on an assumed capture for dry-weather flow of only 2.6% of the rainfall falling within the catchment above the locations of the dam, the remainder being lost to immediate run-off, evaporation and seepage through the soil stratum thus bypassing the dam. They indicate that the supply will be sufficient for the long-term needs of the village, although this should be monitored during prolonged periods of dry weather. If the dry-weather flow is insufficient, capacity can be increased by constructing an auxiliary dam in the larger catchment further to the south, and connecting to the system currently under construction.

Hydraulic calculations for distribution pipelines and standpipes		
Pipe material	HDPE	
Pipe nominal diameter, DN	**32**	mm
Pipe internal diameter, D	0.0261	m
Area of pipe	0.000536	m^2
Pipe length	100	m
Notional increase in pipe length for fittings losses	20.4	m
Total notional pipe length, L	120.4	m
Loss in fittings / loss in pipes	20.4%	
Hazen Williams friction coefficient, C	150	
Static head available	7.90	m
Flow, Q	0.000659	m^3/s
Flow, Q	**0.659**	l/s
Required minimum flow	0.125	l/s
Does flow exceed minimum requirement	**OK**	
Velocity at maximum flow	**1.23**	m/s
Maximum permissible velocity	3.00	m/s
Is velocity less than maximum permissible?	**OK**	
Losses in fittings		
At break pressure tank		
DN50 x 300 mm PVC pressure pipe with drilled holes	0.38	m
50mm female BSP faucet socket PVC pressure	0.06	m
DN50 x 3 mm galvanised pipe x 500 mm, thread both ends	1.60	m
DN50 x 90 degree galvanised elbow	0.22	m
DN50 x 3 mm galvanised pipe x 100 mm, thread both ends	0.06	m
DN50 x 90 degree galvanised elbow	0.06	m
DN50 x 3 mm galvanised pipe x 100 mm, thread both ends	0.06	m
DN50 gate valve brass, FF GVB50, Norma	0.06	m
DN50 galvanised hex nipple	0.22	m
DN50 Poly M/thread adaptor, Plasson	0.96	m
In line		
DN50 poly coupling, Plasson	0.10	m
DN50 x DN32 poly reducing set, Plasson	0.20	m
DN32 poly coupling, Plasson	0.40	m
DN32 x 90 degree poly tee, Plasson	2.60	m
At standpipe		
DN32 x DN20 Poly metric thread aptor, Plasson	0.35	m
DN20 brass gate valve, FF, Norma	0.30	m
DN20 x 2.5mm galvanised pipe x 900 mm, thread both ends	1.35	m
DN20 galvanised elbow x 90 degree	2.00	m
DN20 x 2.5mm galvanised pipe x 1200 mm, thread both ends	1.80	m
DN20 galvanised female socket	0.10	m
DN20 galvanised tee	2.00	m
DN20 brass stop cock, TH FF	0.30	m
DN20 galvanised hex nipple	0.30	m
DN20 x DN15 galvanised reducing bush	0.30	m
DN15 x 2.8 mm galvanised pipe x 900 mm, thread both ends	0.30	m
DN15 galvanised elbow x 90 degree	2.00	m
DN15 x 2.8 mm galvanised pipe x 600 mm, thread both ends	0.30	m
DN15 galvanised elbow x 90 degree	2.00	m

Hydraulic calculations for supply main		
Pipe material	HDPE	
Pipe nominal diameter, DN	**50**	mm
Pipe internal diameter, D	0.0408	m
Area of pipe	0.001307	m^2
Velocity at required flow, V_{req}	**1.059**	m/s
Maximum permissible velocity	3.00	m/s
Is velocity less than maximum permissible?	**OK**	
Minimum permissible velocity	0.70	m/s
Is velocity greater than minium permissible?	**OK**	
DN50 blue line HDPE pipe, 150 m/coil PN12.5 AS/NZ 4130	600.0	m
Notional increase in pipe length for fittings losses	9.0	m
Total notional pipe length, L	609.0	m
Loss in fittings / loss in pipes	1.5%	
Hazen Williams friction coefficient, C	150	
Static head at ground level of tank	18.0	m
Reserve head (safety factor)	3.0	m
Static head available	**18.00**	m
Velocity head (at required flow)	0.057	m
Friction head available	17.94	m
Flow, Q	**0.00138**	m^3/s
Flow, Q	**1.383**	l/s
Required flow, Q_{req}	**0.347**	l/s
Flow Q / Q_{req}	3.98	
Does flow exceed minimum requirement	**OK**	
Check using the alternative method		
Pipe friction coefficent, f	**0.020**	
Sum of minor friction coefficient, K	**20.0**	
Flow, Q_{check} (checked using alternative method)	**1.384**	l/s
Flow Q / Q_{check}	0.999	
Velocity at unrestricted flow	**1.058**	m/s
Maximum permissible velocity	3.00	m/s
Is velocity less than maximum permissible?	**OK**	
Minimum permissible velocity	0.70	m/s
Is velocity greater than minimum permissible?	**OK**	
Head loss at maximum flow (calculation check)	17.94	m
Velocity head at outlet	0.06	m
Total head	18.00	m
Losses in fittings		
At dam		
DN50 x 300 mm PVC pressure pipe with drilled holes	0.60	m
DN50 female BSP faucet socket PVC pressure	0.10	m
DN50 GI pipe x 1.0 m - with both ends threaded	1.60	m
DN50 gate valve brass, F GVB50, Norma	0.35	m
DN50 galvanised hex nipple	0.10	m
In line		
DN50 poly coupling, Plasson	0.60	
At break pressure tank		
DN50 Poly M/thread adaptor, Plasson	0.10	m
DN50 galvanised hex nipple	0.10	m
DN50 gate valve brass, FF GVB50, Norma	0.10	m
DN50 x 3 mm galvanised pipe x 100 mm, thread both ends	0.35	m
DN50 x 90 degree galvanised elbow	1.50	m
DN50 x 3 mm galvanised pipe x 500 mm, thread both ends	0.80	m
DN50 x 90 degree galvanised elbow	1.50	m
DN50 x 3 mm galvanised pipe x 500 mm, thread both ends	0.80	m
DN50 ball float valve, tank floater	0.35	m



Small Catchment – Energy Grade Line and Hydraulic Grade Line

Part 7 – VILLAGE AQUA Water Supply Bill of Quantities

Dam

Dam Wall			1
	150 x 25 mm rough sawn timber formwork x 3.4 m (approx)	lengths	4
SIC002	Paradise cement 40 kg/bag (70 bags per pallet)	40 kg bags	2
Local supply	20 mm gravel (sourced locally)	m^3	0.2
Local supply	5 mm sand (sourced locally)	m^3	0.1
Fabrication	10 mm dia reinforcing bar (10 pieces cut to 700 mm length)	each	10
JHN075kg	75 x 2.35 ϕ mm Bright jolt head nails	kg	2.0
Dam Outlet			1
PVC inlet cap	DN50 PVC end cap	each	1
PVC inlet filter	DN50 x 300 mm PVC pressure pipe with drilled holes	each	1
PVC inlet socket	DN50 female BSP faucet socket PVC pressure	each	1
Fabrication	DN50 GI pipe x 1.0 m - with both ends threaded	each	1
9330553005391	DN50 gate valve brass, F GVB50, Norma	each	1
4897047171628	DN50 galvanised hex nipple	each	1
Dam Scour			1
Fabrication	DN50 galvanised pipe x 1.0 m, with both ends threaded	each	1
9330553005391	DN50 gate valve brass, 2 inch F GVB50, Norma	each	1

Water Main

			1.0
PE24050	DN50 blue line HDPE pipe, 150 m/coil PN12.5 AS/NZ 4130	150 m coil	7
7296173050734	DN50 poly coupling, Plasson	each	8

Break-Pressure Tank

Break-Pressure Tank Structure			1
9310086631427	1.25 mm galvanised tie wire x 50 m, Zenith	roll	2
SIC002	Paradise cement 40 kg/bag (70 bags/pallet)	bag	6
Local supply	20 mm gravel (sourced locally)	m^3	0.6
Local supply	5 mm sand (sourced locally)	m^3	0.5
JHN075kg	75 x 2.35 ϕ mm bright jolt head nails	kg	1
RMF62	F62 welded reinforced concrete mesh (5.8m x 2.2m x 200 x 200 x 6.00 mm, 550MPA, ribbed wire 28 kg/sheet	sheet	1
Fabrication	10 mm steel rod x 700 x 200, cut to length and bend to L shape	each	20
Break-Pressure Tank Inlet			
7296173051755	DN50 Poly M/thread adaptor, Plasson	each	1
4897047171628	DN50 galvanised hex nipple	each	1
9330553005391	DN50 gate valve brass, FF GVB50, Norma	each	1
Fabrication	DN50 x 3 mm galvanised pipe x 100 mm, thread both ends	each	1
4897047172335	DN50 x 90 degree galvanised elbow	each	1
Fabrication	DN50 x 3 mm galvanised pipe x 500 mm, thread both ends	each	1

4897047172335	DN50 x 90 degrees galvanised elbow	each	1
Fabrication	DN50 x 3 mm galvanised pipe x 500 mm, thread both ends	each	1
BFV50	DN50 ball float valve, tank floater	each	1
Break-Pressure Tank Outlet			
PVC inlet cap	50mm PVC end cap	each	1
PVC inlet filter	DN50 x 300 mm PVC pressure pipe with drilled holes	each	1
PVC inlet socket	50mm female BSP faucet socket PVC pressure	each	1
Fabrication	DN50 x 3 mm galvanised pipe x 500 mm, thread both ends	each	1
4897047172335	DN50 x 90 degrees galvanised elbow	each	1
Fabrication	DN50 x 3 mm galvanised pipe x 100 mm, thread both ends	each	1
4897047172335	DN50 x 90 degrees galvanised elbow	each	1
Fabrication	DN50 x 3 mm galvanised pipe x 100 mm, thread both ends	each	1
9330553005391	DN50 gate valve brass, FF GVB50, Norma	each	1
4897047171628	DN50 galvanised hex nipple	each	1
7296173051755	DN50 Poly M/thread adaptor, Plasson	each	1
Break-Pressure Tank Scour			
Fabrication	DN50 galvanised pipe x 1.0 m, with both ends threaded	each	1
9330553005391	DN50 gate valve brass, FF GVB50, Norma	each	1
Break-Pressure Tank Overflow			
9311381150392	DN50 x 88 degree DWV PVC plain bend	each	2
PP05058	DN50 PVC Pipe (DWV) x 2.0 m	each	1

RETICULATION PIPE

			200 m
7296173050734	DN50 poly coupling, Plasson	each	1
7296173347780	DN50 x DN32 poly reducing set, Plasson	each	1
7296173050710	DN32 poly coupling, Plasson	each	6
7296173053001	DN32 x 90 degree poly tee, Plasson	each	6
PE24032	DN32 blue line HDPE pipe x 200 m/coil, PN12.5, AS/NZ 4130	200 m coil	7

SHOWERS/STANDPIPE (7 TOTAL)

Standpipe Plumbing			1
7296173051687	DN32 x DN20 Poly metric thread adaptor, Plasson	each	1
9330553005353	DN20 brass gate valve, FF, Norma	each	1
Fabrication	DN20 x 2.5mm galvanised pipe x 900 mm, thread both ends	each	1
4897047172298	DN20 galvanised elbow x 90 degree	each	1
Fabrication	DN20 x 2.5mm galvanised pipe x 1200 mm, thread both ends	each	1
4897047177439	DN20 galvanised female socket	each	1
4897047169526	DN20 galvanised tee	each	1
9314058550235	DN20 brass stop cock, TH FF	each	1
4897047171581	DN20 galvanised hex nipple	each	1
4897047177354	DN20 x DN15 galvanised reducing bush	each	1
Fabrication	DN15 x 2.8 mm galvanised pipe x 900 mm, thread both ends	each	1
	DN15 galvanised elbow x 90 degree	each	1
Fabrication	DN15 x 2.8 mm galvanised pipe x 600 mm, thread both ends	each	1
	DN15 galvanised elbow x 90 degree	each	1
Fabrication	DN20 x 2.5mm galvanised pipe x 200 mm, thread both ends	each	1

9314058551096	DN20 brass hose cock / R, TH FF	each	1
Standpipe PVC Section			1
PP15058	DN50 PVC Pipe (DWV) x 900 mm, 1 piece (cut from stock length, SBD $ 715 each 5.8 stock length)	900 (ex 5.8 m)	1
Fabrication	10 mm steel rod x 1 900 x 400 mm, cut to length and bend to L shaped, 25 pieces	each	1
SRRS066	6 mm steel rod (smooth) x 6 m long, cut from stock length	each	3.57
Standpipe Drainage			1
9314058510086	DN50 drop in grate poly round white	each	1
9311381150286	DN50 x 88 degree DWV PVC plain bend	each	1
PP05058	DN50 DWV PVC pipe x 2.0 m (cut from 5.8 m length)	each	0.429
Local supply	1.0 x 1.0 x 1.0 m rubble soak pit	m^3	1
Standpipe Slab			1
SIC002	Paradise cement 40kg/bag (70 bags per pallet)	bags	3
Local supply	20 mm gravel (sourced locally)	m^3	0.3
Local supply	5 mm sand (sourced locally)	m^3	0.15
RMF62	F62 welded reinforced concrete mesh (5.8 m x 2.2 m x 200 x 200 x 6.0 mm sheet ,550 MPa Ribbed Wire 28kg/sheet)	5.8 x 2.2 sheets	0.428571429
9310086631427	1.25 mm galvanised tie wire x 50 m, Zenith	roll	0.286
Tools and Equipment			1
9314058800019	Thread seal tape 12 mm x 10 m (white)	roll	10
9310492259970	PVC solvent cement Type N 250 ml (18/ctn) (blue)	each	2
6928073673348	Hacksaw adjustable HD Frame 300 mm HHF3008 INGCO	each	2
6933528730279	Hacksaw blade M2 24T Yellow 300mm(12") 2PK Tolsen	each	15
6928073679623	Combination plier 7 inch 180 mm Insulate INGCO	each	2
6925582103717	Adjustable wrench 300 mm (12 inch) HADW131128 INGCO Handle	each	1
6941640161833	Tape Measure (steel) 8 m X 25 mm HSMT0808 INGCO	each	2
4717302894454	Pipe Wrench 18 inch (4DN50) Sellery	each	1
6933528710363	Pipe Wrench 36 inch (900mm) Heavy duty Y/B Tolsen (Dipped handle)	each	1
9328675003791	Bricklaying trowel 300mm (12 inch), spring steel wooden handle	each	2
9330221000420	Wood float 112 x 380 mm FT4P8002 Flextool (6 pieces/box)	each	2
6925582117349	Bolt cutter 36 inch INGCO HBC0836	each	1
6925582123197	Diagonal cutting plier INGCO HDCP08168 each 1 35.00 35.00	each	1
6941640124678	Lithium-Ion Cordless Drill INGCO CDLI200215 Voltage:20V	each	1
6925582131505	Lithium-Ion Battery Pack 4.0Ah INGCO FBLI2002 Volts:20V	each	1
6925582128390	Fast Intelligent Charger 20V Current 2A FCLI2001S INGCO	each	1
6941640161321	HSS Twist drill bits 8 pieces/set INGCO	set	1
6928073675496	Rabbit plier INGCO HRP02250	each	1
6925582117066	Hand saw 500 mm INGCO HHAS28500	each	2
7891117035558	Drain Spade 1174 x 150 x 65 mm with 74 cm wood handle & plastic D top 77444/404	each	4
7891117011484	Cutter Mattock w/handle 4LB Tramontina	each	2
KHGB6102-12	Bucket Galvanised 12 litre	each	2

6925582112979	Plastering trowel 280 x 130 mm NO TEETH (HPT28138) INGCO	each	2
9330221000574	Trowel bullnose edger 75 x 12 x 5 FT44001S Flextool Each (6 pieces/Box)	each	1
1394	Wire Brush 5 Rows	each	2
4895076540835	Level 900mm (36 inch) Red - Kamly	each	1
6925582113617	Claw hammer (industrial) 20 oz / 560 gram HCH0820 INGCO	each	2
6925582101225	Wood file 8 inch / 200 mm 3 pieces/set HKTFW0308 INGCO	set	2
GTM-FFMON	200 Mill File 200mm (8 inch) Craftek	each	2
6928073713815	Wrecking/Pinch Bar 36 inch (900 mm) length INGCO	each	2
7891114093391	PVC Pipe Cutter 63mm Injected Aluminium Body each 3 998.00 2,994.00	each	3
6933528780021	Tool Box 3 Layers Steel 5100g Y/B Body 495 x 200 x 290mm Tolsen	each	2

REPAIR SPARES 1

9330553005391	DN50 gate valve brass, FF GVB50, Norma	each	2
7296173050734	DN50 poly coupling, Plasson	each	2
7296173347780	DN50 x DN32, poly reducing set, Plasson	each	2
7296173050710	DN32 poly coupling, Plasson	each	2
7296173053001	DN32 x 90 degrees poly tee, Plasson	each	2
9330553005353	DN20 brass gate valve, FF, Norma	each	7
9314058550235	DN20 brass stop cock, TH FF	each	7
9314058551096	DN20 brass hose cock / R, TH FF	each	7
8372590015	Norma nylon tap washer DN15 (A2215NW)	each	20

Privacy Screen

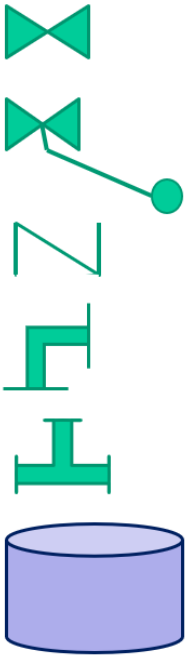
	70 x 45 mm F7 treated formwork x 3.4 m (approx)	lengths	12
JHN075kg	75 x 2.35 ϕ mm Bright jolt head nails	kg	2.0
SIC002	Paradise cement 40kg/bag (70 bags per pallet)	bags	3
Local supply	20 mm gravel (sourced locally)	m^3	0.3
Local supply	5 mm sand (sourced locally)	m^3	0.15
Fabrication	10 mm dia reinforcing bar anchors (4 pieces cut to 700 mm length)	each	4

Part 8 – VILLAGE AQUA Water Supply Construction Guide

Plumbing Symbols

The following symbols are used in this training package to indicate various fittings.

Other fittings are defined in International Standards.
https://www.bing.com/images/search?q=plumbing+symbols+australia&id=2A908889A796F73881A8CE96A85D81C5DF491B75&FORM=IQFRBA



Gate valve. Other types of valves such as ball valves may be appropriate.

Float valve, set to close when the water level reaches a set level.

Check valve (non-return valve)

Elbow

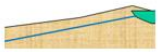
Tee

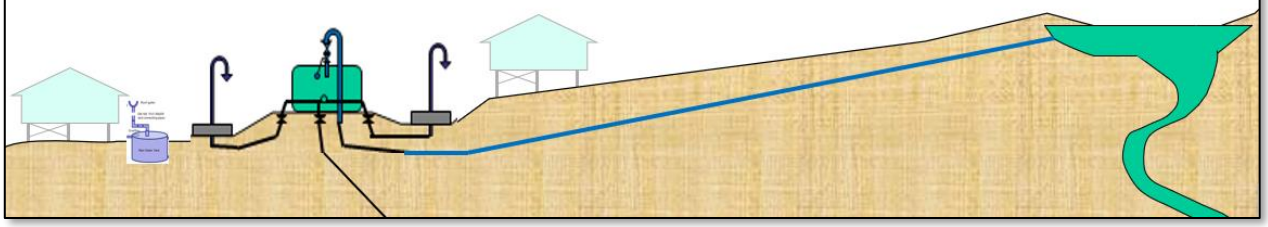
Tank

Tools

Water Supply Arrangements

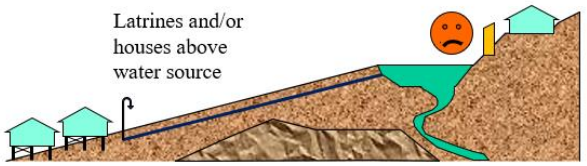
The main components of a rural water gravity supply system are :

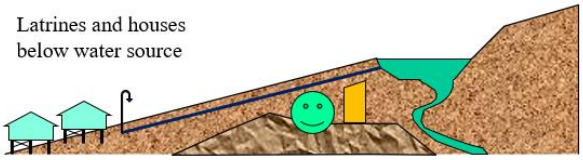
- A dam or a spring box, to collect the water 
- A pipe from the dam (gravity main) is large enough to for the required flow 
- Standpipes to deliver the water 
- Roof gutters and domestic storage tanks 
- If necessary, holding tanks with control valve to distribute water equitably. 



Water Supply Location

Water sources should be above houses and above latrines.

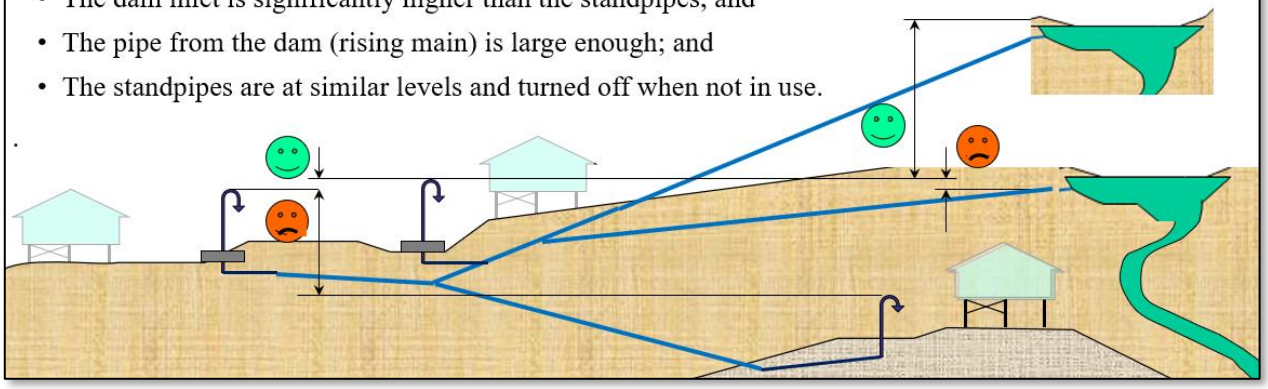




The flow of water to the standpipes will be equitable provided:

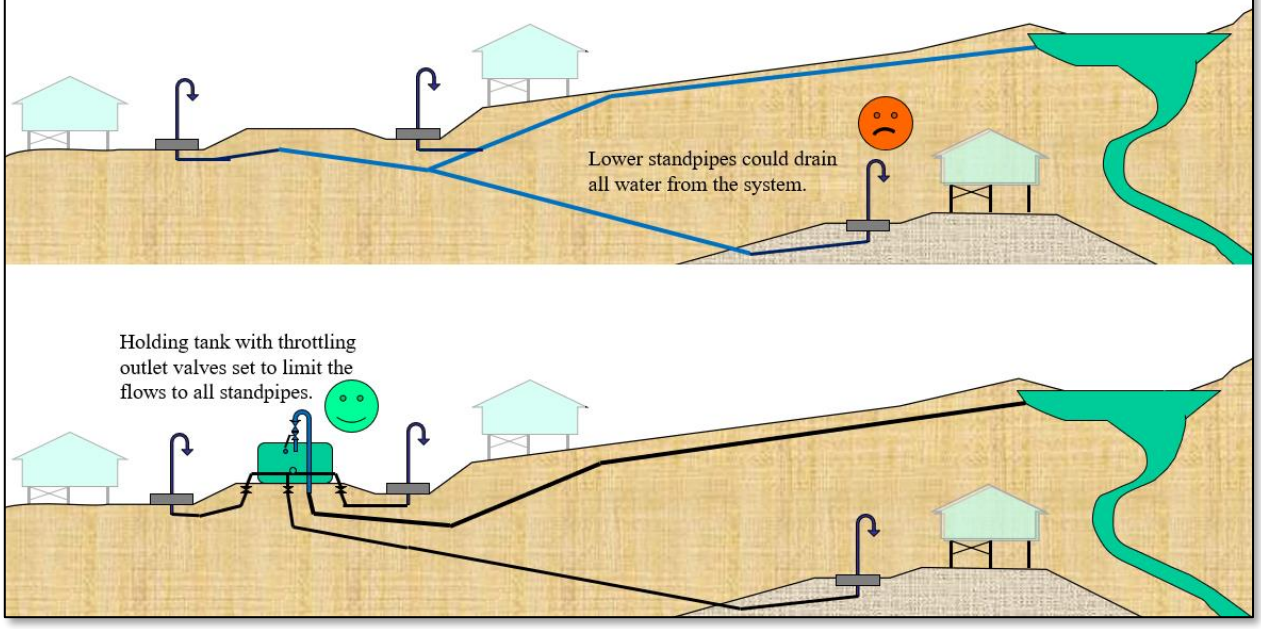
- The dam inlet is significantly higher than the standpipes, and
- The pipe from the dam (rising main) is large enough; and
- The standpipes are at similar levels and turned off when not in use.

.



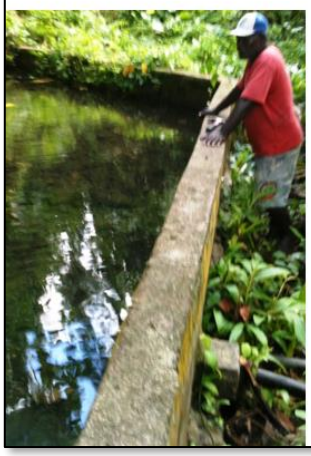
Water Supply Arrangements

If one or more of the standpipes are located below the others, they could drain the system. To avoid this problem, consider installing a holding tank with throttling outlet valves set to limit the flows to all standpipes. These valves must be managed by a person with the authority to control the flow to each standpipe.

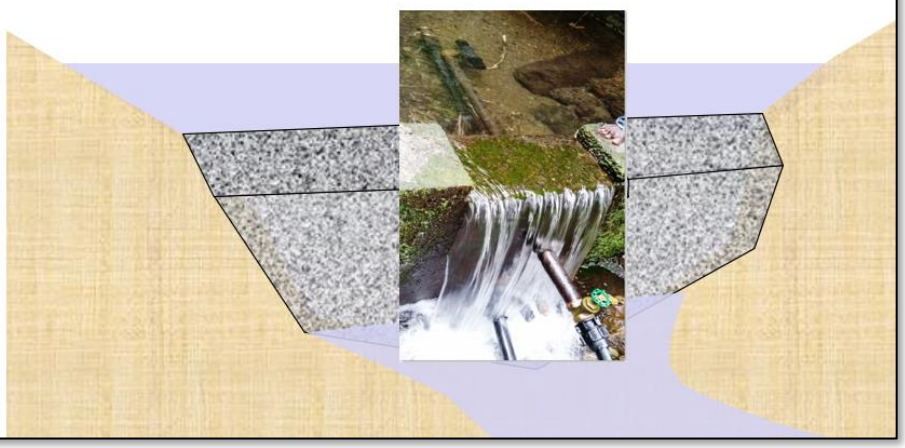


Dams

Dams are walls constructed in a creek bed to collect creek water.

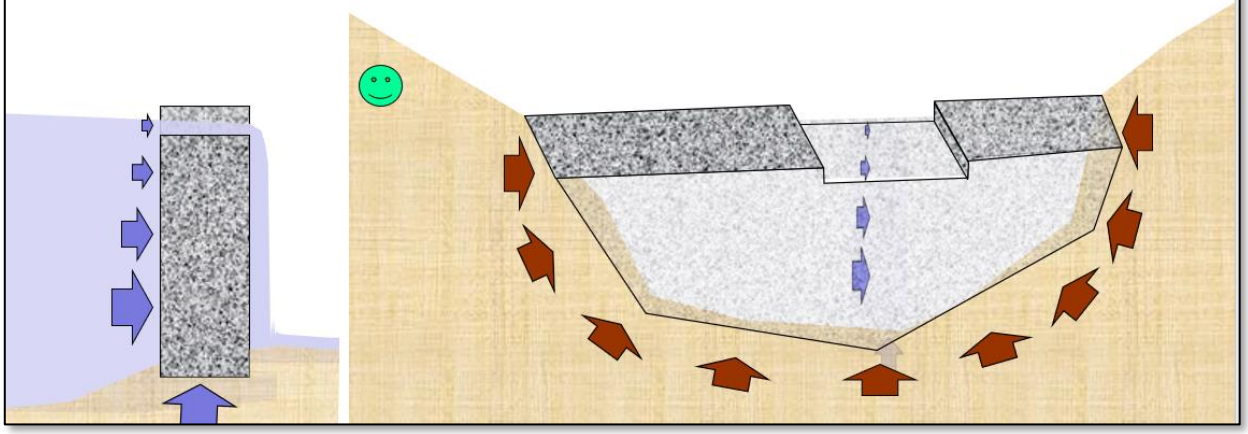


Dams



Dams – Keyed into Abutting Rock Outcrops

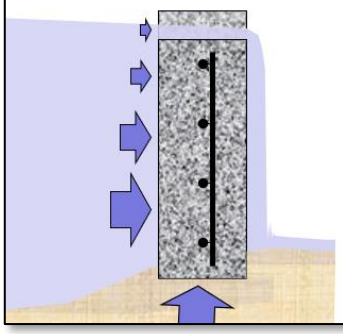
Water pressure behind and under dams will push them over unless they are firmly wedged between rock outcrops (or a rock-bolted to rock shelf below.)

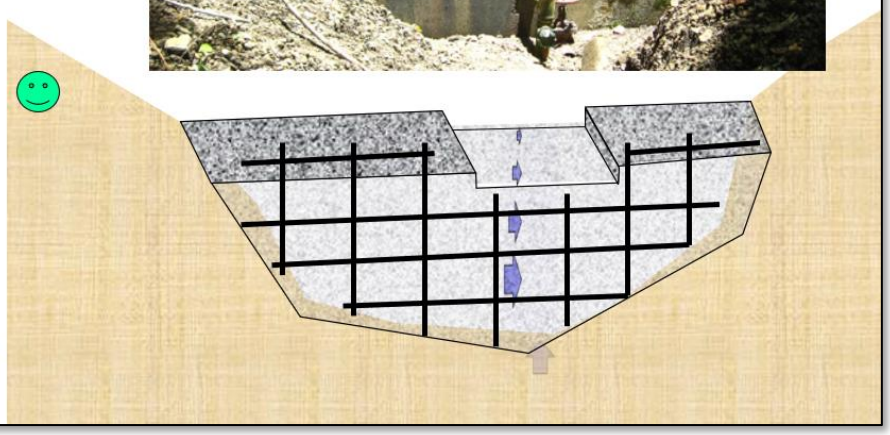


Dams – Reinforced Concrete Walls

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

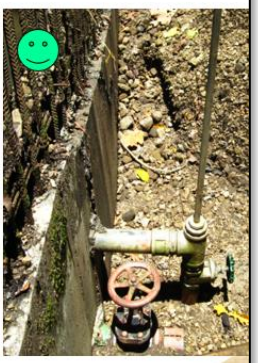
Vertical reinforcement for future extension

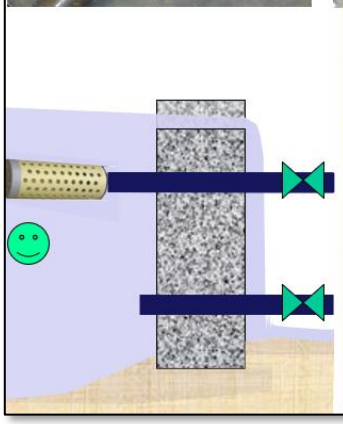


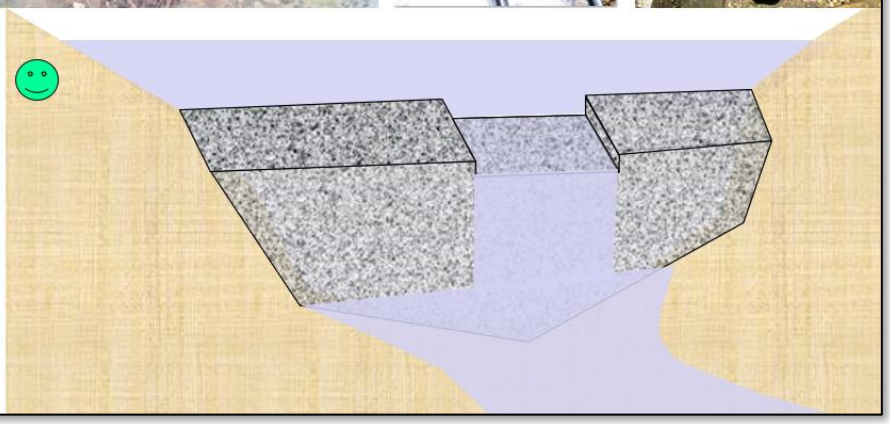


Dams – Water Intake and Flushing Arrangement

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.







Spring Box

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.

Spring Box Concrete

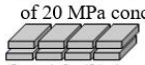
20 MPa Concrete (by volume) 1 : 2 : 4		1 Spring Box
Volume of concrete	m^3	1.00
Wastage included	%	11%
GP or GB cement	40 kg bags	8
Clean sharp sand	m^3	0.5
20 mm rock aggregate	m^3	1.0
Steel reinforcement	N10 S Bend on site	96 @ 1100 64 @ 600
Timber formwork	mm x mm No @ m	100 X 50 HW 44 @ 1.5 (re-use)
Plywood formwork	No @ m x m	6 plywood 5 @ 1.2 x 1.2 (re-use)

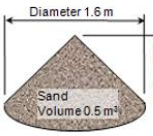
Notes:

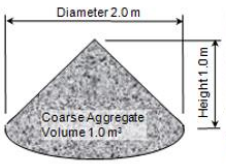
Height may be varied to suit the site conditions, including the fall in the creek bed and resulting heights of inlet and outlet. This design and the quantities tabulated are for a maximum height of 1.2 metres (overall external dimensions).

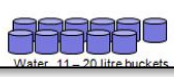
Concrete shall be poured in each wall such that the differential height of concrete is no more than 300 mm.

For 1 cubic metre (1 m^3) of 20 MPa concrete









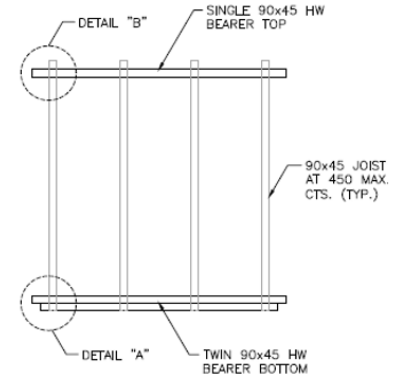
Spring Box Plan and Formwork

Notes:

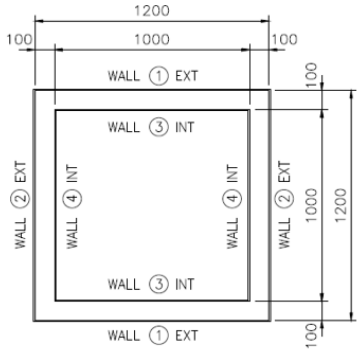
Height may be varied to suit the site conditions, including the fall in the creek bed and resulting heights of inlet and outlet. This design and the quantities tabulated are for a maximum height of 1.2 metres (overall external dimensions).

Concrete shall be poured in each wall such that the differential height of concrete is no more than 300 mm.

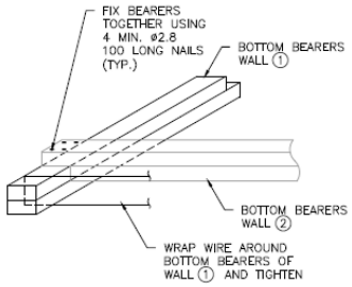
Detail "B" is the same as Detail "A" except use one bearer per wall.



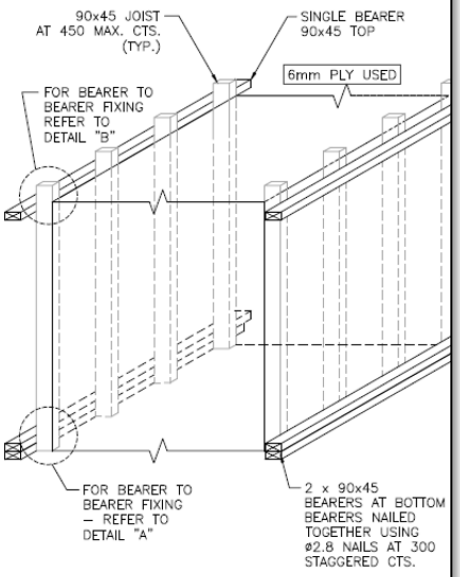
FORMWORK - WALL ELEVATION



FORMWORK - WALL PLAN



DETAIL A

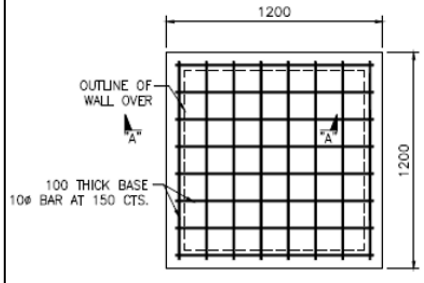


EXTERIOR FORMWORK DETAILS

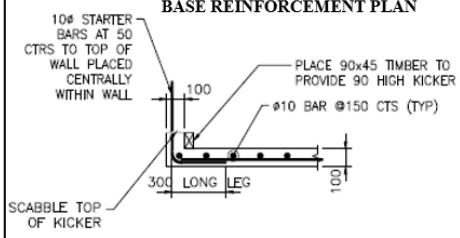
Spring Box Reinforcement

Acknowledgements: D Kaunitz, C Bennett, I Warren

NOTES:
1. WHEN POURING BASE, TIE HORIZONTAL REO TO THE TOP OF THE VERTICAL STARTER BARS TO PREVENT STARTER BARS FROM MOVING.
2. PROVIDE 40mm COVER TO ALL REINFORCEMENT.

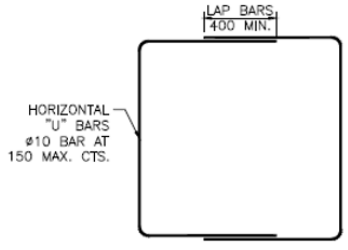


BASE REINFORCEMENT PLAN

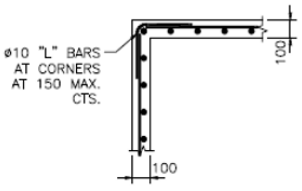


SECTION A

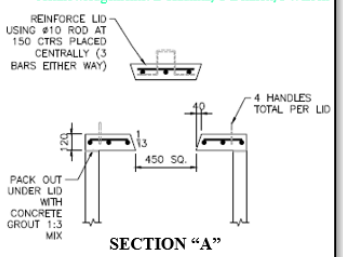
NOTES:
1. WALLS 100mm IN THICKNESS, PROVIDE ø10 BAR AT 150 CTS. PLACED CENTRALLY BOTH WAYS (WALLS 1000mm HIGH).



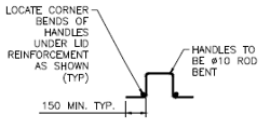
BAR LAPPING PLAN – OPTION 1



BAR LAPPING PLAN – OPTION 2

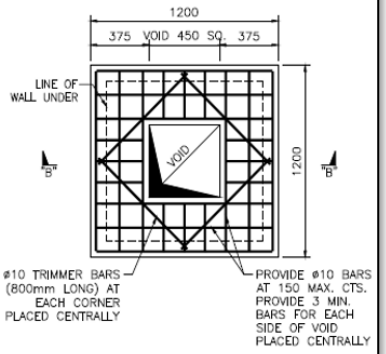


SECTION "A"



HANDLE DETAIL

NOTES:
1. LID 120mm THICK



LID REINFORCEMENT

Spring Box Construction Checklist

Construction Checklist

Builder:
Site:
Activity: Water Supply Spring Boxes

Item or Product	Inspection Required	Accept Criteria	Hold Witness	Date	Inspector	Comment
Drawings & specifications	Inspect controlled docs	Latest issue on site	Hold			
Location and set out	Level	+,- 50 mm	Hold			
Divert water & construct bund	Visual inspection	Water diverted	Hold			
Excavate and dispose excess soil	Level	+,- 50 mm	Hold			
Construct base forms	Spot check dimensions	+,- 5 mm	Hold			
Place base reo	Spot check dimensions	+,- 5 mm	Hold			
Place base concrete & cure	Monitor mix	20 MPa concrete	Witness			
Construct wall forms	Spot check dimensions	+,- 5 mm	Hold			
Construct wall plumbing	Visual inspection	In position	Hold			
Place wall reo	Spot check dimensions	+,- 5 mm	Hold			
Place wall concrete & cure	Monitor mix	20 MPa concrete	Witness			
Construct roof & lid forms	Spot check dimensions	+,- 5 mm	Hold			
Place roof & lid reo	Spot check dimensions	+,- 5 mm	Hold			
Place roof & lid concrete & cure	Monitor mix	20 MPa concrete	Witness			
Clean up	Visual inspection	Clean & tidy	Witness			

Pipes and Fittings

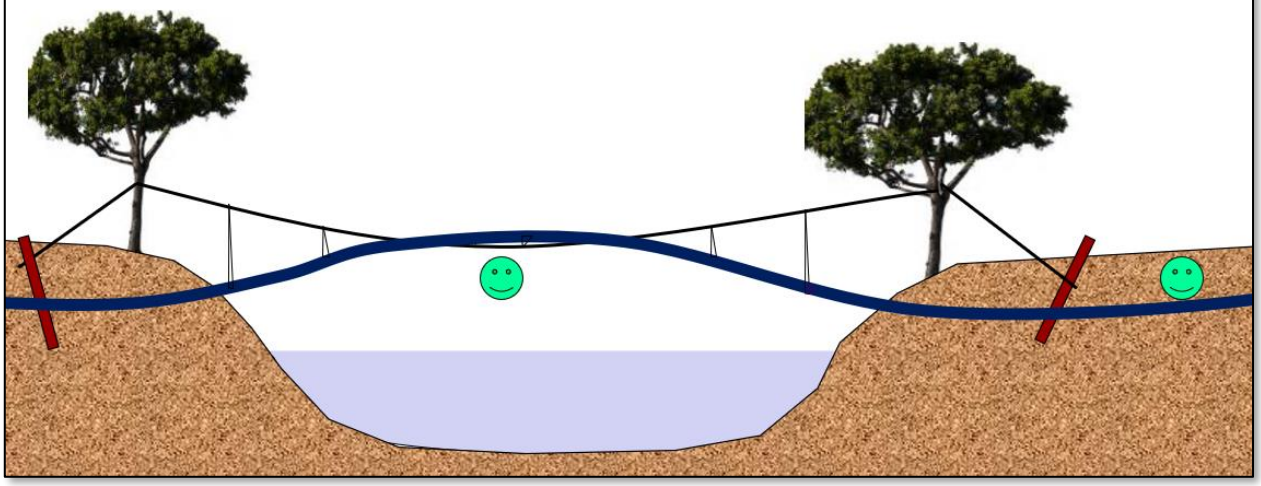
Pipes and Fittings – Importance of Protecting Pipes

Flash floods may damage pipes.

- Bury pipes deeply;

  OR

- Suspend pipes from stainless steel wires pulled tightly between strong trees, tied back into soil anchors. For crossings under 10 metres long, use two length of galvanised pipe to protect the polythene water pipe.



Standpipes

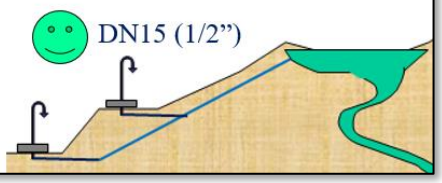
Standpipes provide water for communal use, usually close to the houses that they service. The main components are:

1. Reinforced concrete slab, either dished (with a drain hole and drainage pipe) or flat with a slight slope draining away from assessable areas.
2. Concrete filled **DN80** PVC pipe, containing the riser.
3. **DN20** or **DN15** plumbing, consisting two taps, one controlling an overhead shower and the other delivering water at waist height for filling buckets and washing.

Solomon Islands Rural Water Supply and Sanitation (Clause 5.3.4) recommends the use of DN20 (¾") plumbing for village standpipes.

In some circumstances DN15 (1/2") plumbing may be appropriate.

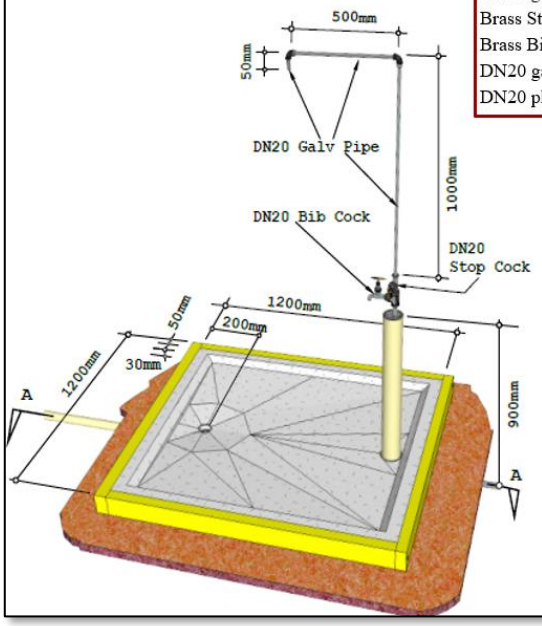
- If there is low availability of water, or if there is a difference in standpipe heights, DN15 plumbing will throttle the flow to the lowest pipes, ensuring a more even flow to all standpipes.
- On site in villages, it is easier to cut or clear the thread of screwed DN 15 galvanized steel pipe than for larger sizes.

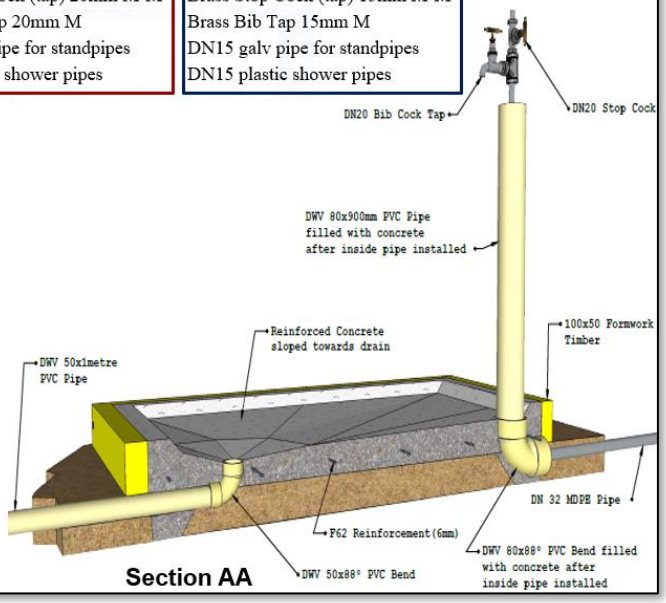


Standpipe Plumbing

DN20 Standpipe
DN80 PVC Pipe "Iplex"
DN80 PVC Elbow "Iplex"
DN20 galv elbow
DN20 galv M-M nipple
DC25>DN20 galv F-F reducer
DN20 galv socket F-F
PE 25 mm x 25 mm BSP M connector "Plasson"
DN20 galv tee M-M-M
Brass Stop Cock (tap) 20mm M-M
Brass Bib Tap 20mm M
DN20 galv pipe for standpipes
DN20 plastic shower pipes

DN15 Standpipe
DN80 PVC Pipe "Iplex"
DN80 PVC Elbow "Iplex"
DN15 galv elbow
DN15 galv M-M nipple
DC25>DN15 galv F-F reducer
DN15 galv socket F-F
PE 25 mm x 25 mm BSP M connector "Plasson"
DN15 galv tee M-M-M
Brass Stop Cock (tap) 15mm M-M
Brass Bib Tap 15mm M
DN15 galv pipe for standpipes
DN15 plastic shower pipes

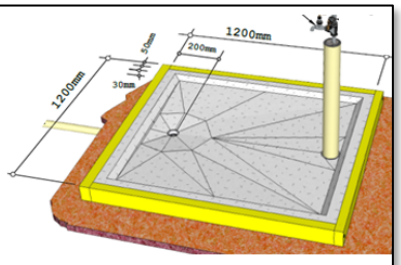




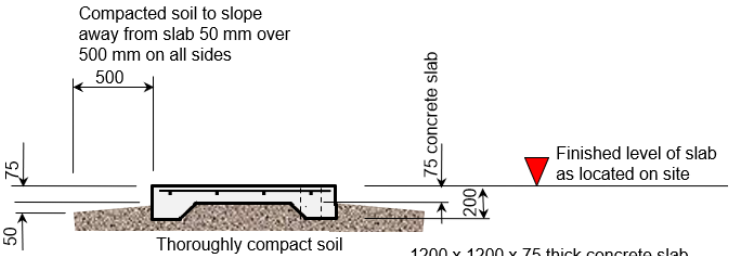
Section AA

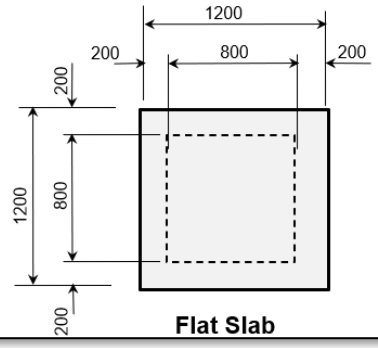
Standpipe Concrete Pads

After the standpipe plumbing is installed, a reinforced concrete pad shall be constructed to provide a non-slip surface where people can stand to wash or obtain water.



Dished Slab





Flat Slab

Option 1 – Dished Slab

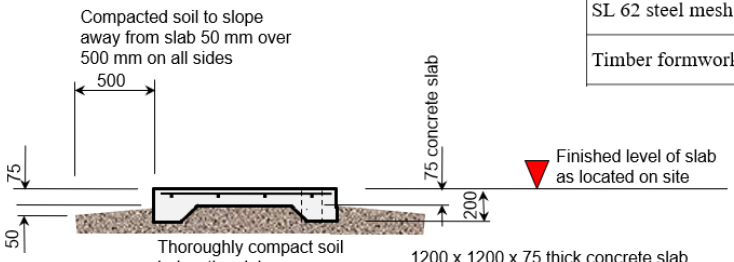
If the surrounding ground is relatively flat with poor drainage, the concrete pad should be dished with a drain hole and drainage pipe to remove the waste water a convenient distance . This is more difficult to construct and may become slippery if the drain is not kept clear.

Option 2 – 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.

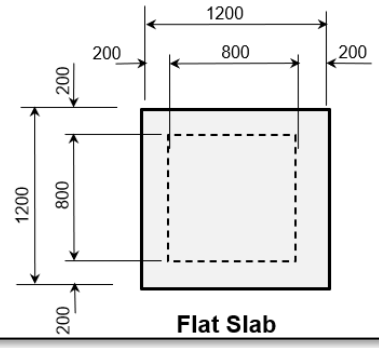
Standpipe Concrete Pads

20 MPa Concrete (by volume) 1 : 2 : 4		1 Stand Pipe Base	4 Stand Pipe Bases
Volume of concrete	m^3	0.26	1.00
Wastage included	%	10%	
GP or GB cement	40 kg bags	2	8
Clean sharp sand	m^3	0.1	0.5
20 mm rock aggregate	m^3	0.3	1.0
SL 62 steel mesh	No-mesh m x m	1 - SL62 1.15 x 1.15	4 - SL62 1.15 x 1.15
Timber formwork	m	100 X 50 HW x 4.8 (re-use)	100 X 50 HW x 4.8 (re-use)

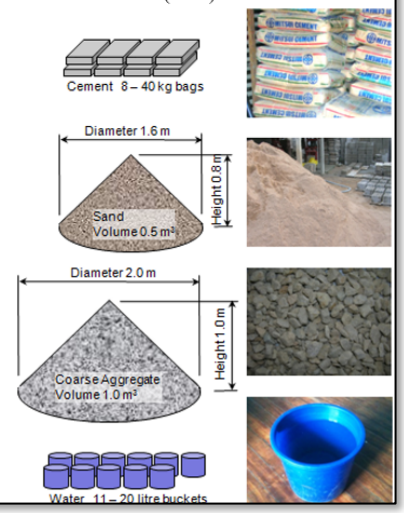


1200 x 1200 x 75 thick concrete slab, reinforced with SL62 mesh with 200 x 200 edge thickening

Top surface of slab should be rebated to channel water towards a drain



For 1 cubic metre ($1 m^3$) of 20 MPa concrete

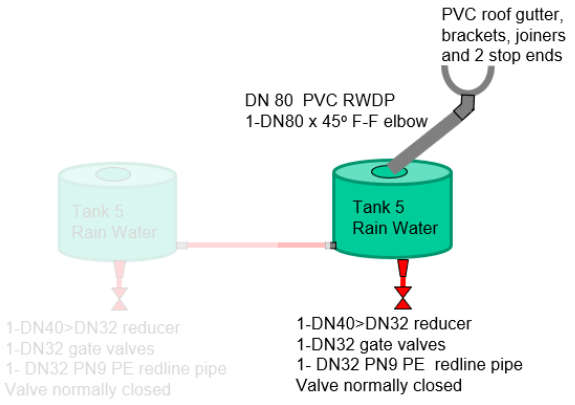


Roof Gutters, Rainwater Downpipes and Tanks

Roof Gutters, Rainwater Downpipes and 3,000 litre Tanks

These materials are required to connect **one** cottage to **one** 3,000 litre storage tank.

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



Materials for One Gutter, Downpipe, 3000 litre Tank

5 metres PVC "Marley" Rainwater Guttering

1 x PVC "Marley" Guttering Connector/Junction

8 x PVC "Marley" Rainwater Guttering Support Brackets

2 x PVC "Marley" Guttering Ends (1 left-hand, 1 right-hand)

1 x PVC "Marley" Guttering 80mm Spout Junction

4 metres 80mm PVC "Marley" Pipe

2 x 80mm 45º PVC "Marley" Bends

2 x Metal 80mm downpipe support Brackets

1 x DN15 Brass Bib Cock (male)

1 x DN20(male) x DN15(female) Galv Reducing Socket

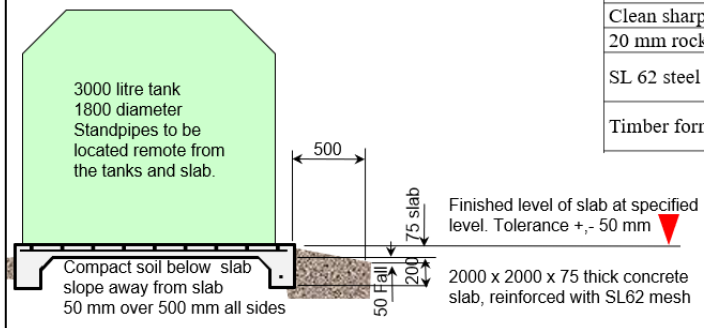
1 x 250ml PVC Cement Glue (sufficient for 6 cottages)

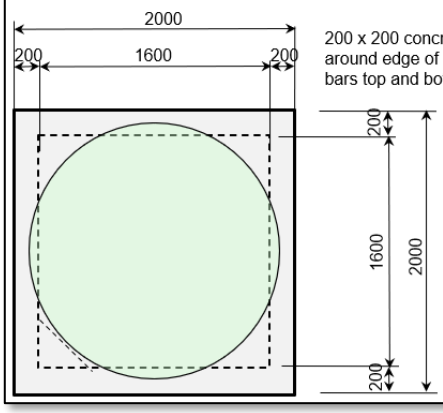
1 kg Flathead Galv 50mm Clout Nails (this is sufficient for 6 cottages)

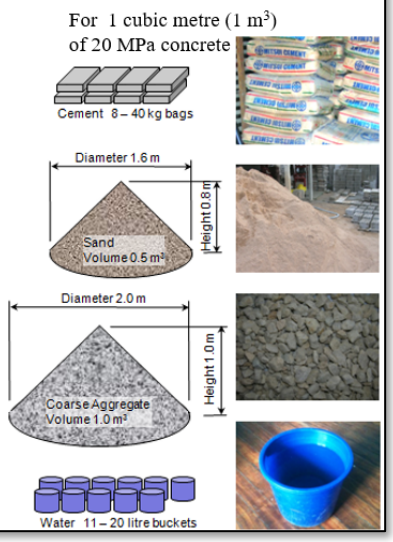
1 x 30m heavy duty Teflon Tape (for sealing threads on taps & socket reducers) (this is sufficient for 12 cottages)

Concrete Tank Stand for One 3,000 litre Tank

20 MPa Concrete (by volume) 1 : 2 : 4		1 Single Tank Pad	2 Single Tank Pads
Volume of concrete	m^3	0.58	1.00
Wastage included	%	10%	
GP or GB cement	40 kg bags	5	8
Clean sharp sand	m^3	0.3	0.5
20 mm rock aggregate	m^3	0.6	1.0
SL 62 steel mesh	No-mesh m x m	1 - SL62 1.95 x 1.95	2 - SL62 1.95 x 1.95
Timber formwork	m	100 X 50 HW x 8.0 (re-use)	100 X 50 HW x 8.0 (re-use)







Latrine Design

General Considerations and Regulatory Compliance

Partner Housing Latrines (as described in this Training Workbook) are based on the standard designs in the regulation documents of several South Pacific countries, with particular emphasis on the Solomon Islands guidelines. These designs reflect national attitudes age, disability, gender and other relevant regulatory issues. Partner Housing reflects and adheres to these national regulations where they are applicable.

Age Considerations

Partner Housing VIP Latrines are designed as "squat" toilets, because this is the most hygienic design for the remote villages for which they are intended. When specifically requested, a pedestal may be included for the elderly.

Disability Considerations

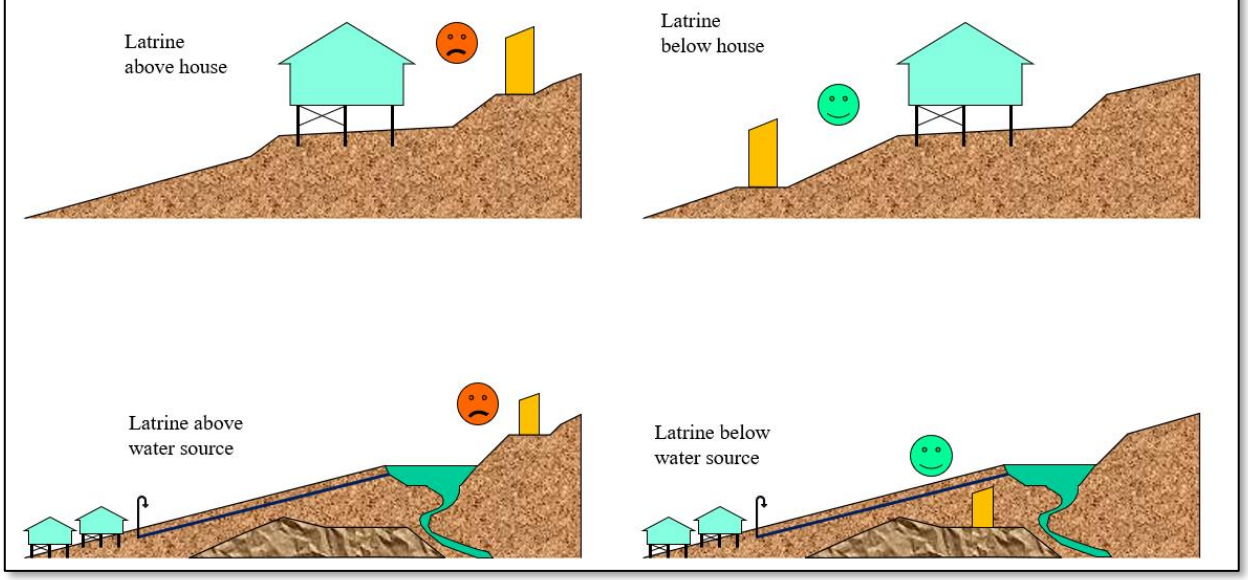
Partner Housing VIP Latrines are intended for use in remote villages, generally accessed through the jungle via (at best) rough footpaths. A person with disabilities would require assistance to access the latrine. The latrine itself is designed to provide sufficient room to enable both the disabled person and their assistant to move about freely inside.

Gender Considerations

Partner Housing VIP Latrines are designed within a weatherproof out-house, with a self-closing lockable door; thus providing maximum privacy for women, men and children. The inside surface is timber, to allow for the mounting of any other toilet fitting as may be required, including those specific to women.

Latrine Location

Latrines should be located below houses and below water sources.



Ventilated Improved Pit (VIP) Latrine

VIP Latrines may vary in design. The following VIP Latrine consists of :

1. 900 mm diameter x 1-2 metres deep pit. Safety during excavation is of utmost importance, and will limit depth / diameter. A pit liner may be required to prevent collapse. If a larger hole is required, slab must be modified to suit.
2. Reinforced concrete slab with:
   - A large key-hole opening for the squat hole; and
   - 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 may be used 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 are 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.

VIP Latrine Enhancements

In cyclonic areas, the superstructure should be strengthened, so as to resist high winds. Refer to separate detailing.

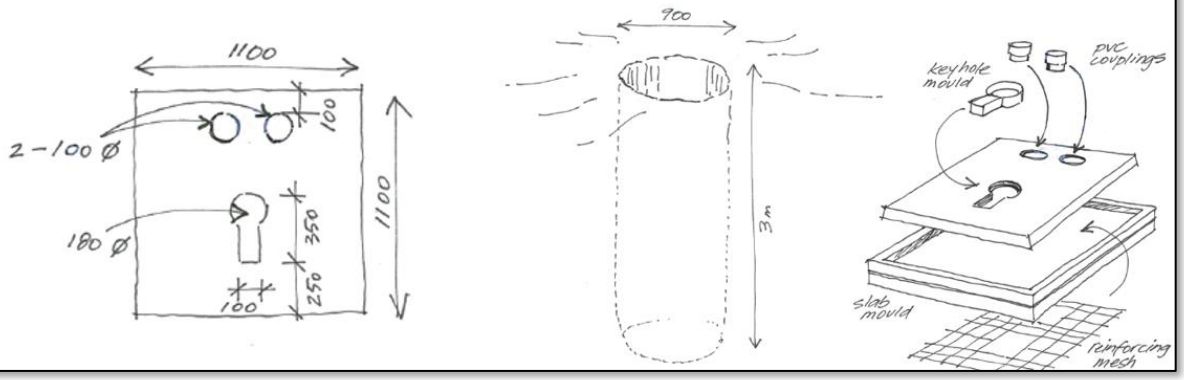
The slab should be used as is, but could be fitted with pedestal, seat and cover as an option; BUT it must include cement mortar benching inside the pedestal that directs the excreta down the hole, and does not permit it to collect on the slab. This arrangement must be regularly cleaned.

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; and
- the rate at which the pit will fill and overflow.

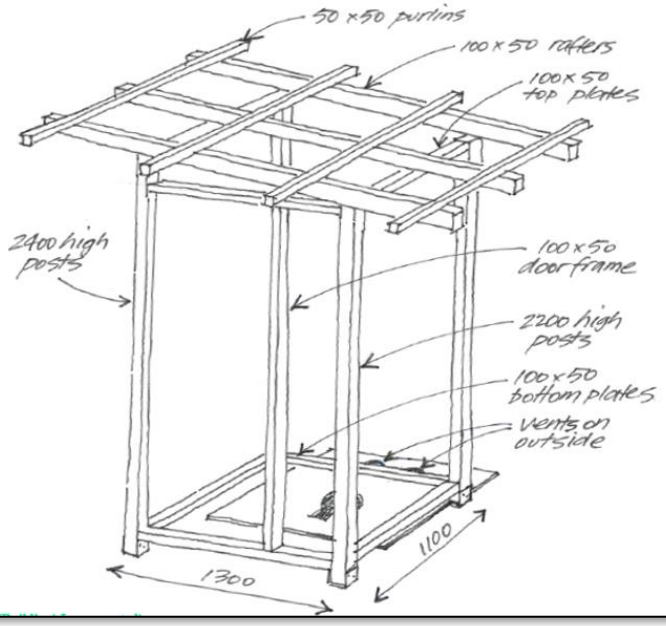
VIP Latrine Construction

- Dig a 900 mm diameter pit, 3 to 4 metres deep.
- Locate the pit on high ground, to avoid rainwater flooding pit.
- Locate the concrete slab over the pit. Allow adequate room at edges of the pit for the concrete footings.
- Cast the concrete slab using a timber mould, reinforcing mesh, keyhole mould for squat and coupling for a vent.
- Oil the mould and keyhole before pouring the concrete, to ease removal from slab.
- Remove the keyhole before the concrete hardens.



VIP Latrine Construction

- Build the frame.
- Position the frame ensuring that the vent hole is on the outside.
- Attach the post anchors and concrete in the footings.
- Strap the rafters to the frame

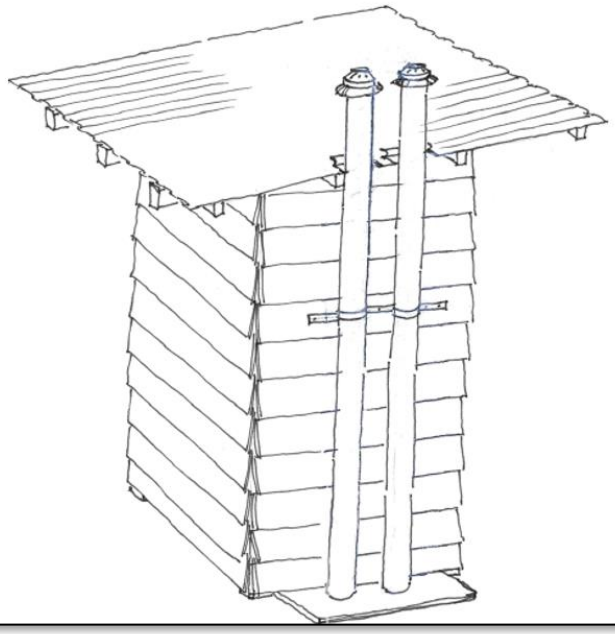


VIP Latrine Construction

- Fix two sheets of corrugated roofing.
- Bend up the corners of the sheeting if hazardous.
- Fix the weatherboard cladding and corner beads.
- Allow sufficient overlap to ensure a completely dark internal space.
- Seal any internal gaps at floor level with cladding to suit.

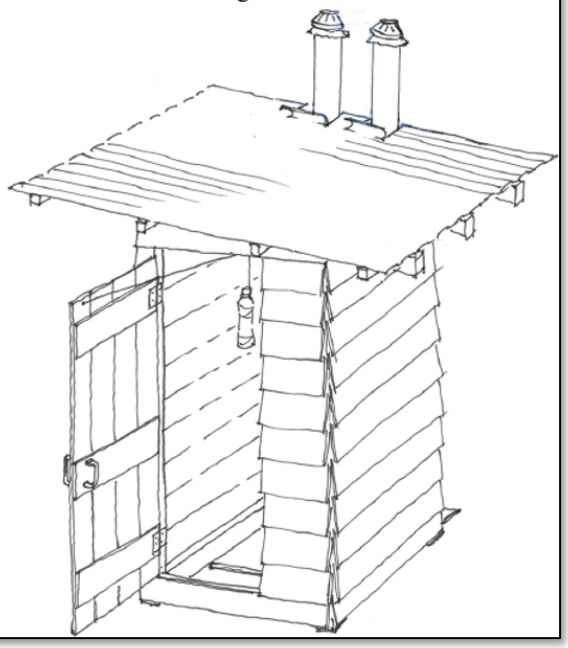
VIP Latrine Construction

- Cut back the roof sheeting and peel back to allow clearance for the vent pipe.
- Cover the vent pipe with flyscreen mesh and vent cap.
- Before inserting the vent pipe, notch the bottom of the coupling to allow built-up gas to escape up vent.
- Strap the vent pipe to the wall.



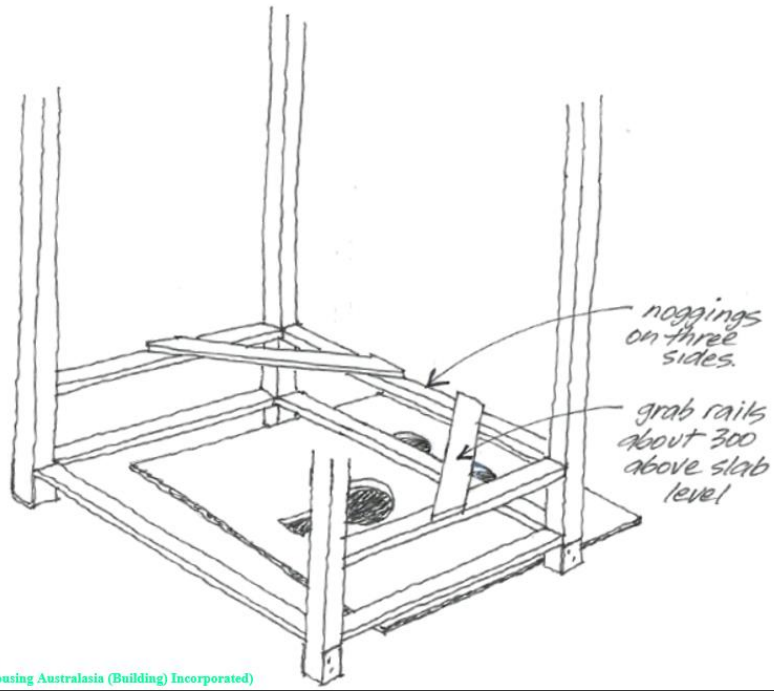
VIP Latrine Construction

- Make the door using cladding, ensuring minimal gaps between the boards.
- Fix the hinges, handles and lock if required. Door should swing out.
- Make the door closer with a water-filled 600ml plastic drink bottle and fishing line.
- Paint the shed.



VIP Latrine Grab Rails

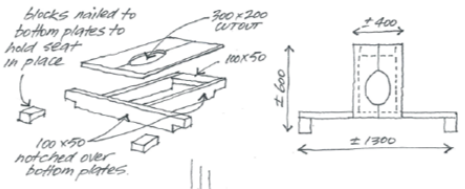
Grab rails are to assist the disabled and elderly in returning to an upright position.



Acknowledgement: Design and artwork - David Kaunitz and Partner Housing Australasia (Building) Incorporated)

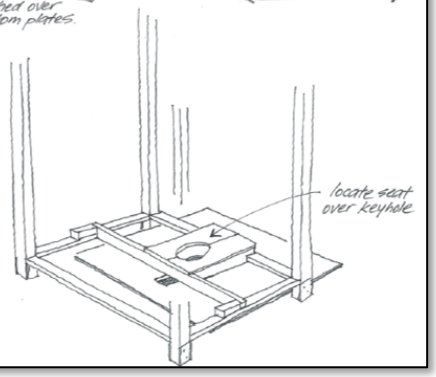
VIP Latrine Seat

The VIP Latrine seat is a simple addition to latrines for people who have difficulty in assuming or maintaining the squat position. By using materials readily available within the village the seat can either be made at the time of latrine construction or retro-fitted when required. As the seat does not touch the slab, this allows the entire area of the slab to be cleaned. This can be done by either leaving the seat in place or lifting the seat out completely. The seat is designed to correspond to the standard latrine keyhole –no enlargement is necessary thus avoiding any child safety issues. The seat is sufficiently elevated to minimise spillage onto the slab yet gives adequate support. The seat can also provide assistance when returning to an upright position. It is suitable for use by children.



Materials

1 -100 x 50 x 3m length of timber
1 -200 x 20 x 1.2m length of timber as used for weatherboard
Cladding nails

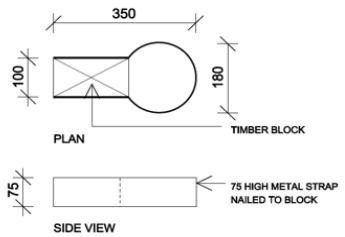


Acknowledgement: Design and artwork - David Kaunitz and Partner Housing Australasia (Building) Incorporated

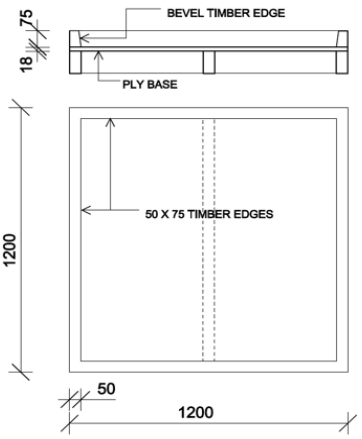
Concrete VIP Latrine Base

Approximate mix (by volume) 1 : 2 : 4		1 VIP Latrine Slab	10 VIP Latrine Slabs
Volume of concrete	m^3	0.10	1.00
Wastage included	%	10%	10%
GP or GB cement	40 kg bags	1	8
Clean sharp sand	m^3	0.05	0.5
20 mm rock aggregate	m^3	0.10	1.0
SL 62 steel mesh	No-mesh m x m	1 - SL62 1.15 x 1.15	8 - SL62 1.15 x 1.15
Timber formwork	m	75 X 50 HW x 8.4 (re-use)	75 X 50 HW x 8.4 (re-use)
Plywood formwork		18 plywood 1.2 x 1.2 (re-use)	18 plywood 1.2 x 1.2 (re-use)

SL 62 steel mesh OR
4 / N10 x 1150 steel reinforcement each way

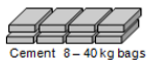


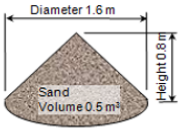
KEYHOLE MOULD

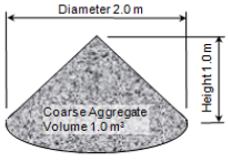


TIMBER SLAB MOULD

For 1 cubic metre (1 m^3) of 20 MPa concrete







Acknowledgement: David Kaunitz and Partner Housing Australasia (Building) Incorporated

Water Sealed Toilets

Photo: D Parsons

Water Sealed Toilets Construction

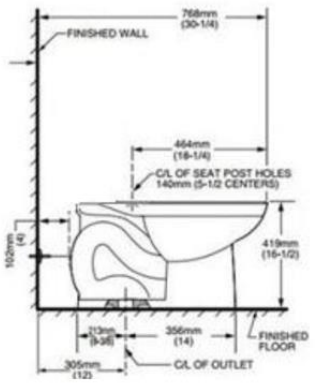
This specification is additional to the requirements for VIP Latrines.

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:

1. Have a drain pipe with a minimum diameter of 100 mm, laid in a straight line, less than a 45° 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 vents(s) to prevent air locks;
4. Have inspection ports at pipe junctions etc.



Siphon-type toilet pan with small diameter outlet pipe

Source: Solomon Islands *Rural Water Supply, Sanitation & Hygiene – Design and Construction Standards* Version 2, November 2015
Photo: D Parsons

Water Sealed Toilets Further Considerations

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.

The pit must not drain into drinking water

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

Photos: D Parsons

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.

Acknowledgements regarding design and artwork: Emergency Architects Australia and Partner Housing Australasia (Building) Incorporated)

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.

Materials

3 litre plastic container for water

2 x 1.8m forked sticks

2 x 1m sticks

1 x 500mm length cord

1 x 1m length cord

A piece of soap

Tools

1 x 100mm (4") nail

Pliers

Candle or lighter

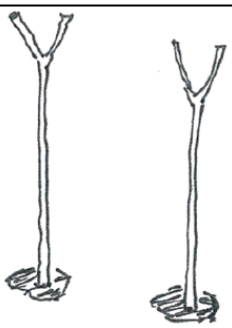
Handsaw

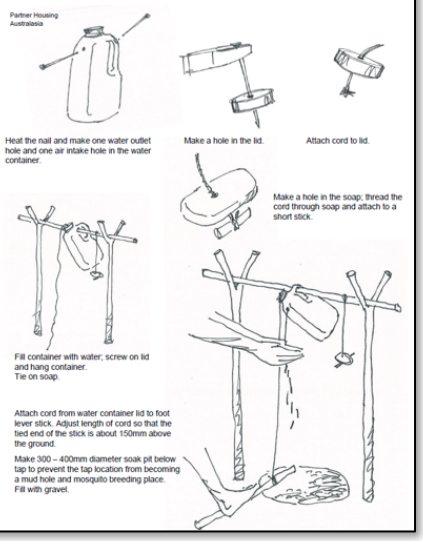
Spade or shovel

A large bucket of gravel

Hand Washing Device Construction

- Dig two holes about 600mm deep and about 600mm apart.
- Place the sticks into holes ensuring that forks are level.
- To protect the sticks from termites paint lower part of sticks with used car oil or ‘carbonise’ over a fire.
- Fill the holes with soil and rocks and pack tightly.
- Heat the nail and make one water outlet hole and one air intake hole in the water container.
- Make a hole in the lid.
- Attach the cord to the lid.
- Make a hole in the soap; thread the cord through soap and attach to a short stick.
- Fill the container with water; screw on lid and hang container.
- Tie on the soap.
- Attach a cord from water container lid to foot lever stick. Adjust the length of cord so that the tied end of the stick is about 150mm above the ground.
- Make a 300 to 400mm diameter soak pit below tap to prevent the tap location from becoming a mud hole and mosquito breeding place.
- Fill with gravel

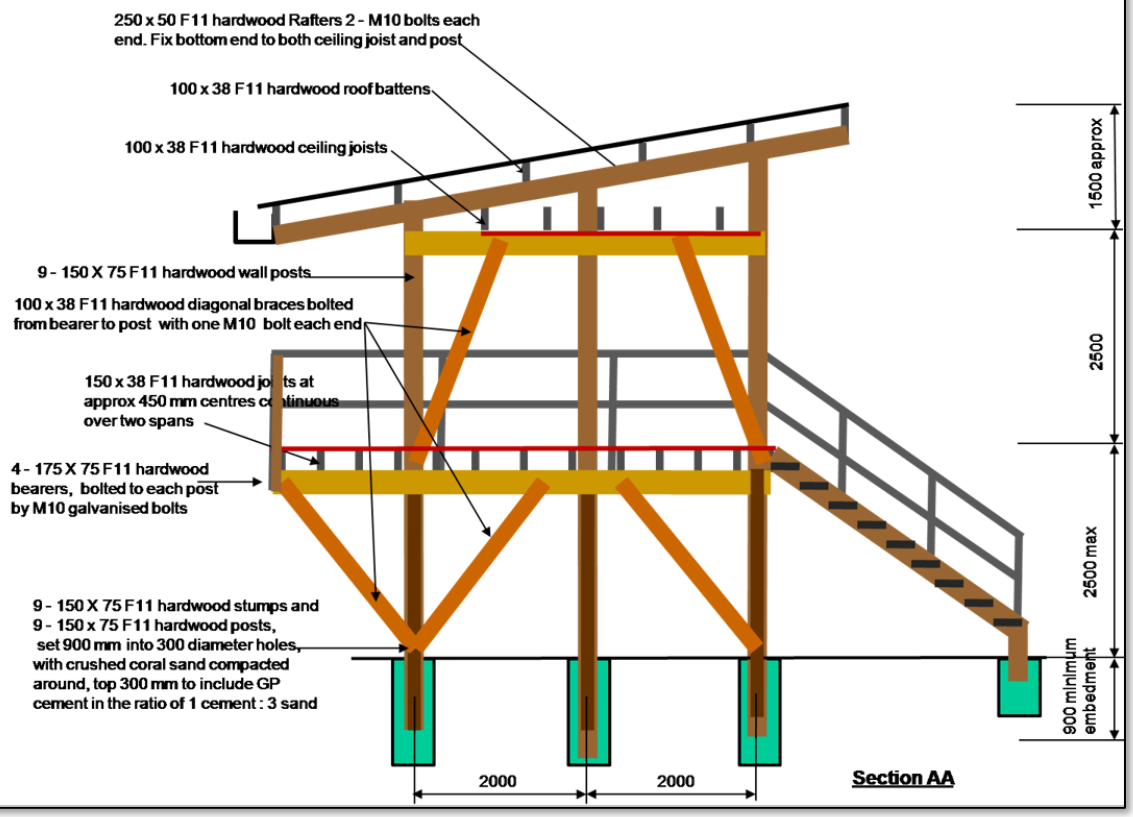




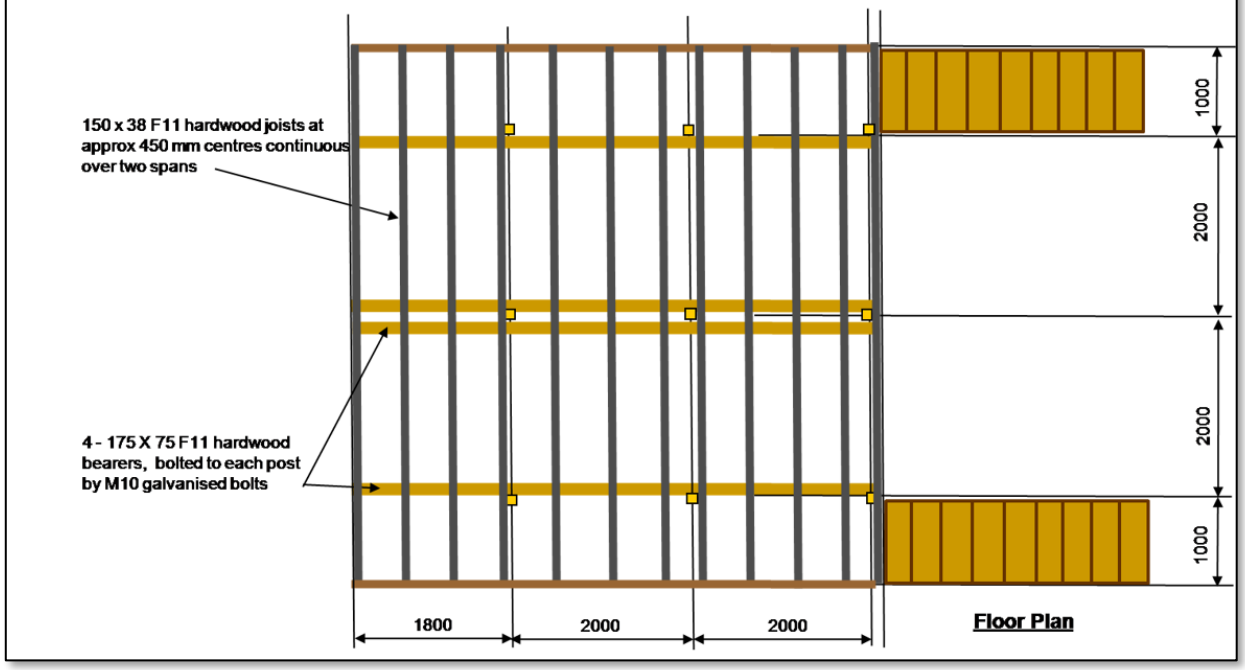
Acknowledgements regarding design and artwork: Emergency Architects Australia and Partner Housing Australasia (Building) Incorporated)

Rural Septic Toilets

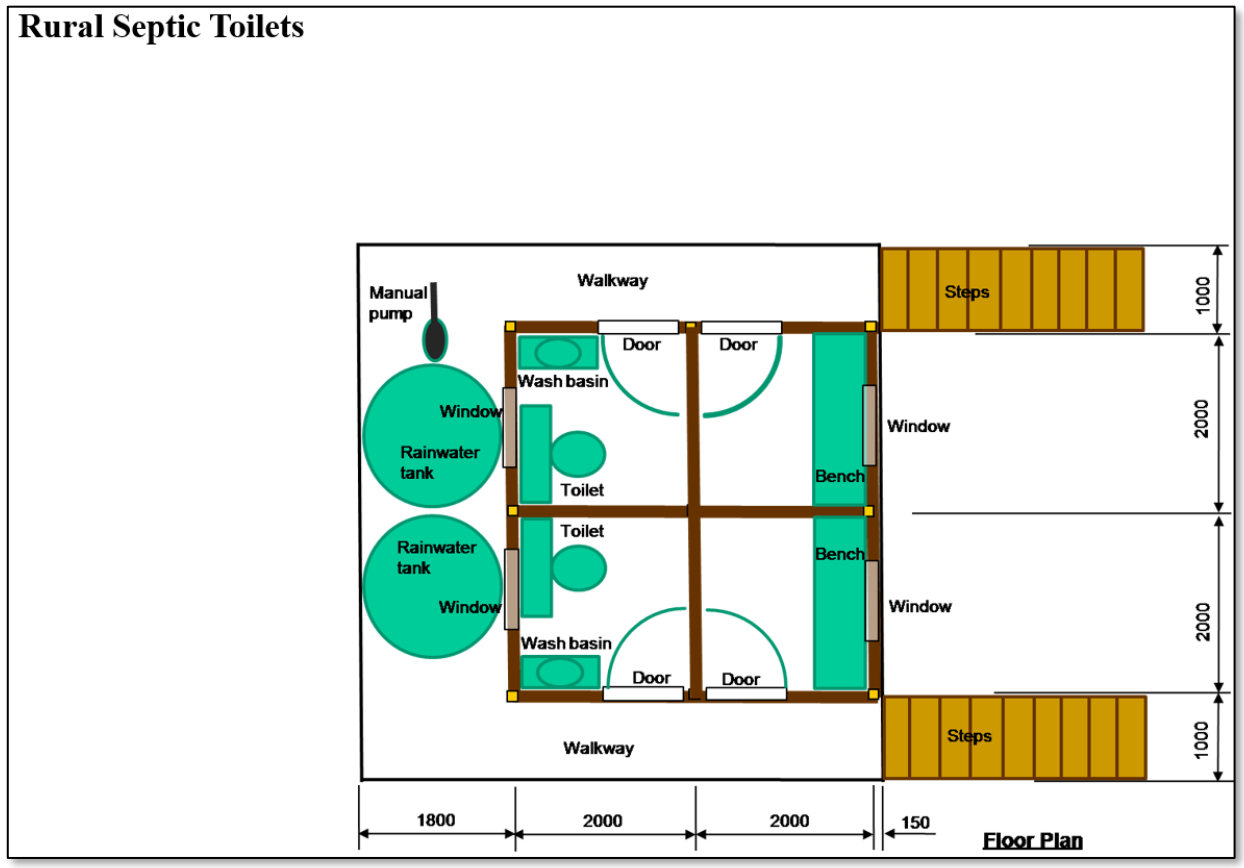
Rural Septic Toilets



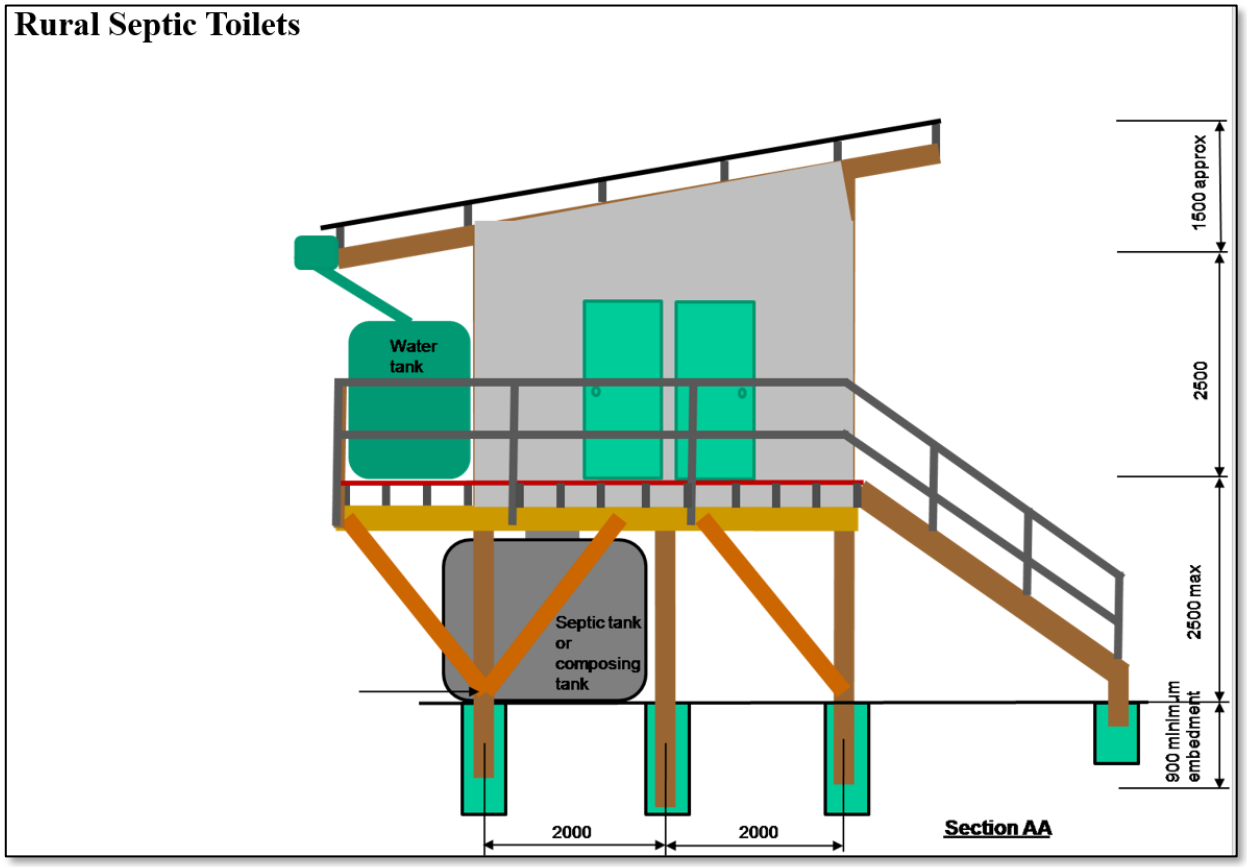
Rural Septic Toilets



Rural Septic Toilets



Rural Septic Toilets



Design and Construction Checklist				
Site				
Activity	Pit Latrines			
Item or Product	Inspection Required	Accept Criteria	Hold or Witness	Date & Inspector
Installation procedures	Inspect latest copy of the documents	Latest issue of documents with the relevant information in file	Hold	
Location	Visual inspection	Away from water table & buildings	W	
Diameter & depth of pit	Visual inspection	900 x 300 mm	Hold	
Framing	Visual inspection	As per drawing	W	
Cladding and roof	Visual inspection	Fixed in position	W	
Door	Operate door	Swing freely & close	W	
Concrete base	Visual inspection	As per drawing	W	
Vent	Visual inspection	Fixed & connected	W	
Grab rails	Visual inspection	In position	W	
Hand washing device	Operate device	Operates correctly	W	

Part 10 – VILLAGE AQUA Sample Specifications

Introduction

Part 5 provides generic specifications for the principal components of **VILLAGE AQUA** systems.

Timber

Scope

This section covers timber framing, such as columns, posts, beams, battens, rafters, trusses and the like, consisting of sawn timber and plywood.

Relevant Standards

AS 1720.1 Timber structures - Part 1 Design methods

AS 1720.2 Timber structures - Part 2 Timber properties

AS 1604 Timber – Preservative treated – Sawn and round

AS 2082 Visually stress-graded hardwood for structural purposes

AS 2858 Visually stress-graded softwood for structural purposes

AS 2878 Timbers – Classification into strength groups

AS 3519 Timber – Machine proof grading

Levels, Dimensions, Square and Setting Out

The structure upon which the framing is to be constructed shall be within the specified tolerances, with particular attention given to levels, dimensions, square and setting out.

Bracing

All buildings shall be adequately supported against lateral wind loads, as specified in the relevant Standard (AS 1170.2 or AS 4055). In some cases, lateral earthquake loads may be a design criterion. The bracing requirements shall be determined for the appropriate Region, Terrain Category, Topography and Shielding and recorded on the drawings by the design engineer.

Tie Down

All buildings shall be adequately tied down to resist overturning due to wind loads, as specified in the relevant Standard (AS 1170.2 or AS 4055). The tie-down requirements should be determined for the appropriate Region, Terrain Category, Topography and Shielding and recorded on the drawings by the design engineer. Ensure that all tie-down systems are continuous to the footings or to the specified location on the structure.

Timber Shrinkage

Provision shall be made for timber shrinkage. Gaps that result from timber splitting shall be repaired, filled with wood filler and sanded smooth before completion.

Preservatives

Timber in exposed applications shall be treated with pyrethroid-and metal-based light organic solvent preservatives (LOSPs) to minimize fungal decay and attack by insects.

Health Warnings and Precautions

Precautions shall be in accordance with the requirements of the relevant Regulations and, where applicable, the recommendations of the following reference *RIC Good Wood Project & the Good Wood Advisory Centre, Victoria, Preservatives.*

Light Organic Solvent Preservative (LOSP)

- LOSP is a solvent-based treatment, which inhibits fungal invasion of timber. It contains copper naphthenate, zinc naphthenate, tri-butyl tin oxide (TBTO) or pentachlorophenol (PCP), with resin or wax to improve its retention and to increase its ability to repel water.
- LOSP will release, to the atmosphere, 30-40 litres of hydrocarbon solvent per cubic metre of treated timber.
- LOSP is suitable for above-ground applications where dimensional-stability is important, is used principally in external applications (e.g. fences, decks, and outdoor furniture).
- LOSP is not suitable for in-ground applications because it does not chemically fix in the wood and will leach into the soil.
- LOSP must not be used for food storage, except where LOSP formulation is of very low toxicity.
- Where LOSP treated timber is exposed, cut, or drilled, the exposed surface should be coated with a post-protection treatment.

Although previously in use, the following timber preservatives shall not be used.

Creosote: Creosote gives off a vapour that irritates the eyes and skin; and is therefore not recommended.

Pigment Emulsified Creosote (PEC): PEC is a combination of coal tar, with a heavy metal pigment used to stabilize it. PEC is not suitable for normal building applications.

Pentachlorophenol (PCP): PCP (derived from sodium pentachlorophenate) is an organochlorine family, of the same chemical group as DDT and Agent Orange. PCP can cause fatigue, fever, weight loss and nausea. PCP dioxins can also cause birth defects, allergies or cancer. PCPs can be passed on to successive generations through sperm and breast milk. PCP must be disposed of without special technology and facilities. It is recommended that PCPs should not be used.

Copper Chrome Arsenate (CCA): CCA consists of heavy metals, copper, chromium and arsenic, which may leach from the timber and pose a health risk. CCA shall not be used. If CCA-treated timber is already in use, the following precautions should be taken:

- Wear protective equipment when handling CCA treated timber.
- Wash hands thoroughly after handling CCA treated timber.
- Do not allow food to come into contact with CCA treated timber.
- Do not burn CCA treated timber in open fires, stoves, fireplaces, or the like.
- Ammoniacal copper quaternary (ACQ)
- Copper azole
- Boron

Design and Construction

Timber structures shall comply with the Drawings, Building Regulations and relevant Standard (AS 1684 [residential applications], AS 1720 [general applications]).

Minimum Strength Grade

Timber used for structural framing purposes shall have a strength grade not less than F11 or MGP10 as applicable.

Timber Type, Properties, Preservation and Application

Timber and timber products shall comply with the Drawings, Building Regulations and relevant Standard (AS 1684 [residential applications], AS 1720 [non-residential applications]), and shall be of the nominated stress grade (or strength group), durability class, and (where appropriate) lyctid susceptibility, shrinkage and ignitability.

The following tables are based on AS 1684.2 & 3 Table H1. For additional properties and definitions refer to source document.

Preservative requirement: P = Should be preservative treated, S = Should be seasoned ,O = Commonly used untreated

Availability: R = Readily available, L = Limited Availability

Durability Class: 1 = Highest natural durability to 4 = Lowest natural durability.

Where required to achieve particular resistance to termite and/or borer attack, the species listed herein shall be treated to achieve the hazard levels listed in AS 1684.2 & 3 Table C1.

Lyctid Susceptible: S = Susceptible, N = Not susceptible, R = Rarely susceptible

Timber and Timber Products for Use Below Found Level

Timber and timber products shall not be used in direct contact with the ground.

If timber is required to be embedded below ground level, it shall be painted with high-build latex paint to a height 100 mm above the concrete surface and fully encased in Grade N20 concrete (20 MPa) of sufficient thickness to provide not less than 50 mm cover to all parts of the timber.

Timber and Timber Products for Above-ground External Exposed Framing

Standard Trade Name	Preservative Requirement	Available	Strength Group Seasoned	Durability Class	Lyctid Susceptible	Tangential Shrinkage %	Early Fire Hazard Ignitability
Group (Mixed Queensland & North NSW Hardwoods)	O	R	SD3	3	S		
Jarrah	O	R	SD4	2	S	7.4	13
Hoop Pine	P	R	SD5	4	N	3.8	14
Slash Pine	P	R	SD5	4	N	4.2	
Radiata Pine	P	R	SD6	4	N	5.1	14
Kwila (Merbau)	O	L	SD3	2	S	2.5	
Red Mahogany	O	L	SD3	2	N	6.3	
Keruing	P	L	SD3	4	S	9.5	

Timber and Timber Products for Above-ground Internal Protected Framing

Standard Trade Name	Preservative Requirement	Available	Strength Group Seasoned	Durability Class	Lyctid Susceptible	Tangential Shrinkage %	Early Fire Hazard Ignitability
Group (Mixed Queensland & North NSW Hardwoods)	O	R	SD3	3	S		
Douglas Fir (Oregon)	O	R	SD5	4	N	4.0	14
Hoop Pine	S	R	SD5	4	N	3.8	14
Slash Pine	S	R	SD5	4	N	4.2	
Radiata Pine	S	R	SD6	4	N	5.1	14
Group (Hemfir)	O	R	SD7	4	N		
Group (Australian mixed softwoods)	O	R	SD7	4	N		
Group (Spruce Pine Fir [SPF])	O	R	SD7	4	N		
Group (Unidentified imported softwoods)	O	R	SD8	4	N		
Kwila (Merbau)	O	L	SD3	2	S	2.5	
Keruing	O	L	SD3	4	S	9.5	

Concrete

Scope

This section covers the construction of the following concrete members for small to medium sized buildings:

- Concrete footings
- Concrete ground beams
- Concrete slab-on-ground
- Concrete piers.

Building Regulations and Standards

All materials and construction shall comply with the most recent version of:

- the relevant parts of the Building Regulations;
- the Standards referred to therein;
- other Standards nominated in this specification; and
- other relevant Regulations.

Relevant Standards

AS 3600 Concrete Structures

AS 3610 Formwork for concrete

AS 3660.1 Termite management – New Building work

AS 3660.2 Termite management – In and around existing buildings and structures – Guidelines

AS 3660.3 Termite management – Assessment criteria for termite management systems

AS 1379 Specification and supply of concrete

AS 1478.2 Chemical admixtures for concrete, mortar and grout

AS 2870 Residential slabs and footings - Construction

AS 3799 Liquid membrane-forming curing compounds for concrete

AS 4200.1 Pliable building membranes and underlays - Materials

AS/NZS 4671 Steel reinforcing materials

Definitions

Site Classifications (based on AS 2870)

Class A – Most sand and rock sites with little or no ground movement from moisture changes

Class S – Slightly reactive clay sites with only slight ground movement from moisture changes

Class M – Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes

Class H – Highly reactive clay sites, which can experience high ground movement from moisture changes

Class E – Extremely reactive sites, which can experience extreme ground movement from moisture changes

Class P – Filled sites including soft or unstable foundation, soils, such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils, soils subject to erosion, reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.

Note: For deep-seated movements, typical of dry climates and corresponding to a design depth of suction change equal to or greater than 3 metres, the classification Classes M, H and E shall be modified to M-D, H-D or E-D.

Sand Bedding

A bedding sand layer 50 to 100 mm in thickness shall be placed over the compacted soil base to the level of the underside of the slab.

Vapour Barrier

The vapour barrier shall be installed immediately beneath the concrete slab-on-ground and footings. The vapour barrier shall not be punctured. Laps shall be 200 mm at joints. Plumbing penetrations shall be taped or sealed with a close-fitting sleeve. Where shallow bulk piers are used, the vapour barrier shall line the pier hole to enable the piers and footings to be poured integrally.

Reinforcement

Reinforcement shall be placed in accordance with the drawings such that the following laps and cover are achieved. Three N12 corner bars 2.0-metre long shall be placed at all re-entrant corners.

Reinforcement	Minimum Required Laps
Bars	500 mm
Fabric	2 cross wires overlapping
Trench mesh	500 mm

Bar chairs shall be placed at one metre centres both ways. Bar chairs shall incorporate wide bases and be placed on metal bases that do not puncture the vapour barrier. Where fabric with 7 mm bars at 200 mm centres (SL72), or lighter, is used, the bar chair spacing shall be reduced to 800 mm. Bar chairs shall be placed to give the following clear cover.

- 40 mm in concrete in contact with unprotected ground
- 40 mm in concrete exposed externally
- 30 mm to a sealed vapour barrier
- 20 mm to the internal surface

Placing Concrete

Trenches and footing excavations shall be dewatered and cleaned prior to concrete placement so that no softened or loosened material remains.

All concrete shall be compacted by mechanical immersion vibrator.

Notes

1. Formwork - Edge forms for suspended concrete slabs are often difficult to secure and keep straight. When permanent steel sheet formwork is used, preformed metal edge forms may also be screwed to the sheeting by short metal straps.
2. Reinforcement Cover - The lapping of welded fabric reinforcement in the top face of a slab will significantly increase the thickness of reinforcement and reduce the cover. The slab thickness shall be such as to provide both sufficient cover and sufficient effective depth.

Finishing Concrete

Concrete surfaces shall be finished as noted below unless specified otherwise.

- Floor slabs - Steel float.
- External paths, driveways, and parking areas at less than 10% slope - Fine broomed steel float.
- External paths, driveways, and parking areas at greater than 10% slope - Coarse broomed steel float.
- Vertical surfaces exposed in the completed building - Rubbed back to fill all voids and provide smooth surface.
- Vertical surfaces not exposed in the completed building - Off form finish.

Curing Concrete

All concrete shall be cured using a sprayed curing compound. Wax-based compounds shall not be used in areas requiring the subsequent application of curing adhesives.

Notes

1. The Builder shall apply and maintain the curing system; or ensure that the Contractor correctly applies and maintains the curing system.
2. Sprayed emulsions require less attention than moistening and covering the slab.

Stripping Formwork

Unless adverse weather or the use of retarders delays the hardening of concrete, the minimum stripping time for formwork shall be 3 days.

Bedding Sand Bedding

Bedding sand shall comply with the Drawings, Building Regulations and relevant Standard (AS 2758.1). Unless stated otherwise, sand shall be clean, free from salts, vegetable matter and impurities, and with the following grading:

Sieve	Percent Passing
4.75 mm	90 to 100
2.36 mm	60 to 100
1.18 mm	30 to 85
0.600 mm	15 to 60
0.300 mm	5 to 30
0.150 mm	0 to 15
0.075 mm	0 to 10

Vapour Barrier

Vapour barriers shall comply with the Drawings, Building Regulations and relevant Standard (AS 4200). Unless stated otherwise, vapour barriers shall be not less than medium impact resistance polyethylene vapour barrier 0.2 mm thick.

In areas of known salt damp, a damp-proofing membrane with high impact resistance is required.

Adhesive tape shall be PVC for normal applications, or polyethylene tape for fixing to higher strength or thicker membranes.

Bar Chairs

Bar chairs shall comply with the Drawings, Building Regulations and relevant Standard. Unless stated otherwise, properties shall such that:

- Reinforcement is positioned in the top half of the concrete slab
- Reinforcement in footings has 40 mm in concrete in contact with unprotected ground and 30 mm to a sealed vapour barrier

Reinforcement

Reinforcement shall comply with the Drawings, Building Regulations and relevant Standard (AS 4671, AS 2870). Unless stated otherwise, properties shall be not less than:

- Deformed bars - 500 MPa, normal ductility (N)
- Square fabric, rectangular fabric, and trench mesh - 500 MPa, low (L) or normal (N) ductility ribbed wires
- Fitments -500 MPa, low (L) or normal (N) ductility ribbed wires
- Round bar (e.g. R250 N10 for dowels) - 250 MPa round

Concrete

Concrete shall comply with the Drawings, Building Regulations and relevant Standard (AS 3600 or AS 2870). Unless stated otherwise, properties shall be not less than:

- Characteristic compressive strength of 20 MPa (Strength grade N20) for residential ground slabs and footings to AS 2870
- Characteristic compressive strength of 25 MPa (Strength grade N25) for other structures to AS 3600
- Maximum aggregate size of 20 mm
- Of sufficient slump to facilitate the nominated means of placement
- Subject to plant control testing.

Site-mixed 20 MPa concrete shall comply with the following specification. For each cubic metre of concrete, mix

- 320 kg of portland or blended cement (8 No 40 kg bags or 16 No 20 kg bags);

- 0.5 cubic metres of clean sharp sand;
- 1.0 metre of coarse 20 mm rock aggregate; and
- 220 litres (11 No 20 litre buckets) of drinkable water.

Formwork

Formwork shall comply with the Drawings, Building Regulations and relevant Standard (AS 3610).

Curing Compounds

Curing compounds shall comply with the Drawings, Building Regulations and relevant Standard (AS 3799). Unless stated otherwise, curing compounds shall be hydrocarbon, solvent-based acrylic, water-based acrylic or wax-based acrylic. Wax-based compounds shall not be used in areas requiring the subsequent application of curing adhesives**.**

Joint Material

Joint material shall comply with the Drawings, Building Regulations and relevant Standard (AS 2870). Unless stated otherwise:

- Backing rod for control joints, expansion joints and articulation joints shall be expanded polystyrene tube or bead or, rigid steel backing profile with closed cell foam adhered to the metal profile face.
- Joint sealant shall be gun grade multi-purpose polyurethane sealant.

Concrete Jointing Accessories

Concrete jointing accessories shall comply with the Drawings, Building Regulations and relevant Standard (AS 2870). Unless stated otherwise, concrete jointing accessories shall have appropriate properties to ensure they fulfil their intended function and can be accurately installed.

- Dowel Cradles shall provide accurate horizontal and vertical alignment of dowels.
- Crack Inducers shall provide an adequate crack to relieve contraction stresses.
- Rebate Moulds shall be constructed of a rigid PVC material and form a true square or rectangular rebate.
- Dowel Sleeves shall include provision for longitudinal expansion in the ends of all sleeves, stiffening ribs to minimise distortion, end clips to ensure correct alignment during pour and end closures to prevent entering of slurry.
- Expansion Caps shall fit a variety of dowel sizes and provide internal compression pins for longitudinal expansion.
- Permanent Flexible Plastic Capping shall be UV treated PVC material and provide a bevelled edge to the joint.
- Removable Capping shall be PVC material and provide a bevelled edge to the joint.
- Foam Filler compression strips shall be closed cell polyethylene foam.
- Key Joint Joiners shall provide accurate alignment of key joints in both horizontal and vertical directions without interrupting the capping line.

Masonry

Scope

This section covers the construction of partially reinforced hollow concrete blockwork used as the walls of buildings constructed on concrete slab-on-ground.

Relevant Standards

AS 3700 Masonry structures

AS 3700 Supplement 1 Masonry Structures – Commentary

AS 4773.1 Masonry in small buildings – Design

AS 4773.2 Masonry in small buildings – Construction

AS/NZS 4455 Masonry units and segmental pavers

AS/NZS 4456 Masonry units and segmental pavers - Methods of test

AS/NZS 2904 Damp-proof courses and flashings

AS/NZS 2699.1 Built-in components for masonry construction - Wall ties

AS/NZS 2699.2 Built-in components for masonry construction - Connectors and accessories

AS/NZS 2699.3 Built-in components for masonry construction - Lintels and shelf angles (durability requirements)

AS 3972 Portland and blended cements

AS 2758.1 Aggregates and rock for engineering purposes - Concrete aggregates

AS 3660.1 Termite management – New Building work

AS 3660.2 Termite management – In and around existing buildings and structures - Guidelines

AS/NZS 4671 Steel reinforcing materials

AS 3600 Concrete structures

AS 2870 Residential slabs and footings – Construction

Mortar

For general applications (except as listed for M4 or M2), Type M3 mortar shall be used, and shall consist by volume of:

- 1 part GP or GB cement, 1 part lime, 6 parts sand (water thickener optional)
- 1 part GP or GB cement, 5 parts sand plus water thickener

For the applications listed below, Type M4 mortar shall be used, and shall consist by volume of:

- 1 part GP or GB cement, 0.5 part lime, 4.5 parts sand (water thickener optional)
- 1 part GP or GB cement, 4 parts sand plus water thickener
- 1 part GP or GB cement, 0-0.25 parts lime, 3 parts sand (water thickener optional)

This applies to:

- Elements in interior environments subject to saline wetting and drying
- Elements below a damp-proof course or in contact with ground in aggressive soils
- Elements in severe marine environments
- Elements in saline or contaminated water including tidal splash zones
- Elements within 1 km of an industry producing chemical pollutants.

Damp-Proof Course

Damp-proof-courses shall be built into the masonry in accordance with the Drawings, Building Regulations and relevant Standard (AS 3700). Unless stated otherwise, damp-proof-courses shall be:

- Placed under walls to provide a continuous damp-proof barrier around the building
- Lapped not less than 150 mm at joints
- Projecting through the entire width of the masonry and project beyond the external face of the masonry
- Stepped at changes of floor level
- Positioned (if applicable) under the coping of any parapet more than 300 mm above adjoining roof cladding
- Positioned (if applicable) in chimney stacks, 150 mm to 300 mm above the highest junction of roof and chimney
- At least 75 mm above finished surface level of adjacent paved, concreted, or landscaped areas that slope away from the wall
- At least 50 mm above finished paved or concreted areas sloping at least 50 mm over the first 1 m from the building and protected from the direct effects of the weather by a carport, verandah or similar
- At least 150 mm above the adjacent finished ground in all other cases.

Flashings

- Flashings shall be built into the masonry in accordance with the Drawings, Building Regulations, and relevant Standard (AS 3700). Unless stated otherwise, flashings shall be:
- Fixed with clouts to timber studs or built into an inner leaf of masonry as applicable
- Built into the external leaf of walls exposed to weather, extending across the cavity,
- Turned up 150 mm and nailed to the frame or built 30 mm into an inner leaf of masonry,
- Positioned at openings (unless they are protected by an overhang), where they shall extend 100 mm past the end of opening and be turned up to prevent leakage.

Termite Protection

Masonry walls in buildings shall incorporate termite protection. Refer to the separate specification on Termite Protection in “Concrete”.

Mortar Joints

Mortar joints shall comply with the Drawings, Building Regulations and relevant Standard (AS 3700). Unless stated otherwise, mortar joints shall comply with the following:

- Mortar joint shall be 10 mm thick.
- Mortar joints in hollow blockwork, shall be face shell bedded and shall be ironed, unless a flush joint is specified for aesthetic reasons.

Provision for Timber Shrinkage

In masonry veneer construction, a gap in accordance with schedule below shall be left between the timber frame and the top of the masonry, and at window sills, to accommodate timber shrinkage.

Location in timber framed buildings	Minimum Clearances (mm)	
	Unseasoned hardwood frame	Other timber frame
Sills of lower or single storey windows	10 mm	5 mm
Roof overhangs of single storey buildings	16 mm	8 mm
Sills of second storey windows	20 mm	10 mm
Roof overhangs of two storey buildings	24 mm	12 mm

Reinforced Masonry Construction (Excluding Retaining Walls)

All construction of reinforced concrete masonry shall comply with the Drawings, Building Regulations and relevant Standard (AS 3700). Unless stated otherwise, the following shall apply:

Vertical steel reinforcement shall be tied using tie wire to steel starter bars through clean-out holes in each reinforced core and fixed in position at the top of the wall by plastic clips or template. Starter bars shall be tied into position to provide the specified lap above the top surface of the footing. The starter bars shall be held in position on the centre line of a reinforced blockwork wall by a timber member or template and controlled within a tolerance of +,- 5 mm through the wall and +,- 50 mm along the wall.

Horizontal steel may be laid in contact with rebated webs of Double U or H blocks. It shall be held in position by steel ties or plastic clips. Cover to horizontal steel in lintel blocks shall be maintained by the use of wheel type plastic clips.

The minimum cover (from the edge of the steel reinforcement to the inside face of the block core) shall be 20 mm, except where specified otherwise. In severe marine environments, saline or contaminated water including tidal and splash zones, and within 1 km of an industry in which chemical pollutants are produced, the minimum cover to the inside face of the block core shall be 30 mm.

For houses (and similar buildings) consisting of partially reinforced concrete masonry on concrete slab-on-ground, control joints shall not be built in.

For other reinforced concrete masonry applications, control joints shall be built into reinforced concrete masonry at all points of potential cracking and at the locations shown on the drawings. The spacing of control joints should not exceed 8.0 metres, except that the spacing of control joints may be increased in reinforced masonry walls meeting the following criteria:

- Consisting of at least 190 mm hollow concrete units,
- Built less than 3.0 metres high,
- Incorporating a top reinforced bond beam,
- Incorporating N16 horizontal reinforcement at not greater than 400 mm centres,
- On a site with rock or slightly reactive foundations,
- With a reinforced concrete footing of adequate stiffness.

Hollow Concrete Masonry Units

Hollow concrete masonry units shall comply with the Drawings, Building Regulations and relevant Standard (AS/NZS 4455.1) and the following properties:

- Dimensional Category DW4;

- General Purpose Salt Attack Resistance Grade (except for applications requiring Exposure Grade including saline wetting or drying, aggressive soils, severe marine environments, saline or contaminated water including tidal or splash zones, or within 1 km of an industry producing chemical pollutants);
- Characteristic Compressive Strength not less than a value specified by the Engineer or 15 MPa (measured using face shell bedding), whichever is the lesser;
- Characteristic Lateral Modulus of Rupture not less than 0.8 MPa;
- Mean Coefficient of Residual Drying Contraction not more than 0.6 mm/m.
- When intended for face applications and exposed to the weather:
    - Permeability not more than 2 mm/minute
    - Efflorescence Potential of Nil or Slight
    - Colour and texture within an agreed range.
- If units are intended to incorporate both horizontal and vertical reinforcement and are not protected both sides by a waterproof membrane, they shall be "H" or "Double U" configuration such that:
- Units may be fully grouted and may be reinforced both vertically and horizontally;
- Cores such that concrete grout may flow easily around and enclose the reinforcement in all cores; and provide cover is consistent with the requirements for durability, strength, and fire resistance as appropriate.

Cement

Cement shall be Type GP portland cement or GB blended cement complying with the relevant Standard.(AS 3972).

Water Thickener

Water thickener shall be methyl-cellulose based.

Sand

Sand shall be well graded and free from salts, vegetable matter and impurities. Sand shall not contain more than 10% of the material passing the 75 micron sieve. Sand within the following grading limits complies with this requirement and is deemed suitable for concrete masonry.

Sieve	Percent Passing
4.76 mm	100
2.36 mm	95–100
1.18 mm	60–100
600 µm	30–100
300 µm	10–50
150 µm	0–10
75 µm	0–4

Concrete Grout

Concrete grout shall comply with the Drawings, Building Regulations and relevant Standard (AS 3700). Unless stated otherwise, properties shall be:

- a minimum portland cement content of 300 kg/cubic metre;
- a maximum aggregate size of 10 mm;
- sufficient slump to completely fill the cores; and
- a minimum compressive cylinder strength of 20 MPa.

Flashings

Flashings shall comply with the Drawings, Building Regulations and relevant Standard (AS 3700, AS/NZS 2904).

Metal and metal-cored flashings shall not be used in locations that expose them to saline ground water or rising salt damp.

Metal flashings shall be compatible with the materials with which they are in contact, and shall not give rise to electrolytic action. If there is potential for electrolytic action to occur, flashings shall be isolated by inert materials.

Flashings intended to hold their shape shall be manufactured from rigid material. (e.g. metal cored material)

Unless stated otherwise flashings shall consist of one of the following options:

- Flashing in Concealed Locations (e.g. cavity flashings) shall be one of the following:
- Uncoated annealed lead having a mass not less than 10 kg/m^2 in lengths not exceeding 1.5 m, but shall not be used on any roof that is used to catch potable water;
- Uncoated copper having a mass not less than 2.8 kg/m^2 and having a thickness of 0.3 to 0.5 mm;
- Bitumen coated metal (normally aluminium) with a total coated thickness of 0.6 mm to 1.0 mm;
- Zinc coated steel with a thickness not less than 0.6 mm;
- Embossed/quilted polyethylene sheet with an average thickness not less than 0.5 mm

Flashings in Exposed Locations (e.g. flashings from the roof to masonry wall) shall be one of the following:

- Uncoated annealed lead having a mass not less than 20 kg/m^2 in lengths not exceeding 1.5 m, but shall not be used on any roof that is used to catch potable water;
- Uncoated copper having a mass not less than 2.8 kg/m^2 and having a thickness of 0.3 to 0.5 mm;
- Bitumen coated metal (normally aluminium) with a total coated thickness of 0.6 mm to 1.0 mm;

Zinc coated steel of thickness not less than 0.6 mm

Termite Barrier Parging Material for Woven Stainless Steel Mesh

Parging material, for woven stainless steel mesh acting as a termite barrier, shall comply with the Drawings, Building Regulations and relevant Standard (AS 3660.1). Unless stated otherwise, parging material shall be a highly modified cementitious grout of a water-dispersed copolymer with a dry mixture of Type GP portland cement and sieved aggregate of a size that passes readily through the woven stainless steel mesh.

Hardened parging material shall provide:

- Termite resistance, when in contact with soil and termite workings;
- Bond strength (mesh to substrate) of not less than 1 kN/m at 28 days for a temperature range of 10°C to 30°C at a relative humidity range of 10%RH to 70%RH; and for at least 60 freeze-thaw cycles in saline solution between −15°C and 18°C.