INTEGRE

CONSTRUCTION Guide SIMPLE COMPOST TOILETS

SUITABLE FOR PACIFIC ISLAND USE

Pacific Reef Savers Ltd. - April 2017

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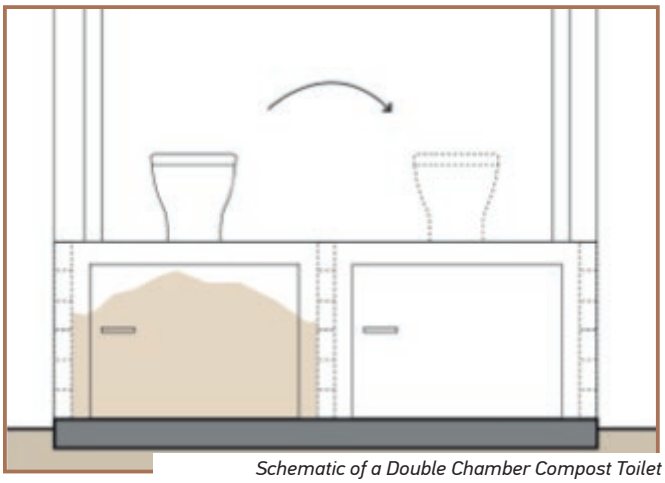
APPENDIX

Compost toilet
construction guide

SUMMARY

This guide is for building a very simple, but effective, compost toilet in a rural place and where financial resources are low. This toilet will be sanitary and perform just as well as a conventionally constructed unit using a septic tank. All the materials used are those expected to be found in a remote, Pacific outer island location.



Schematic of a Double Chamber Compost Toilet

Toilet with bananas planted next to it for the drain

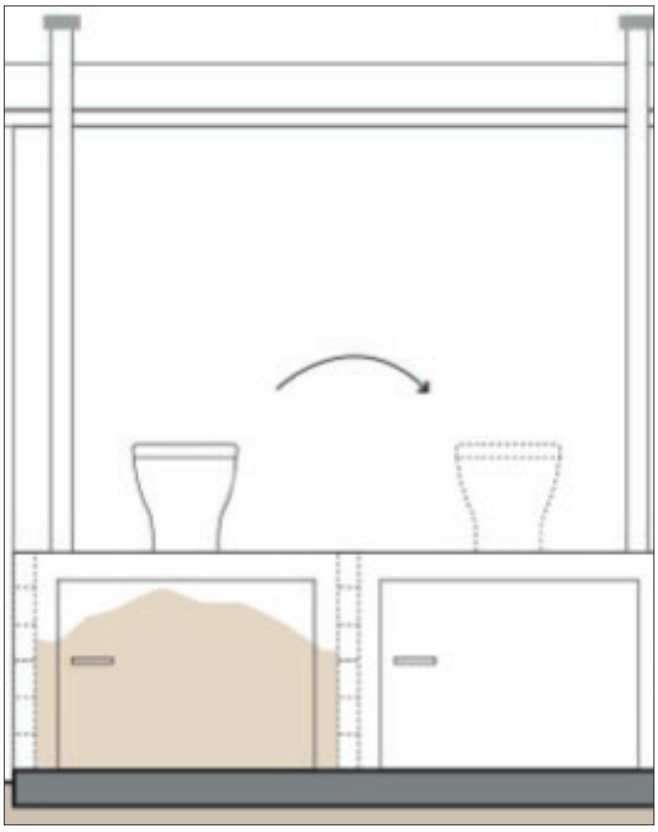
The aim of this guide is to show the basic principals required to make a functioning compost toilet, using the double chamber design, and then let the local builder use their own techniques, local materials and experience to build the complete building. It does not provide a complete prescription of exactly which materials are required, such as how many nails and screws, as this will depend on the design chosen. The approach presented here is to allow the local builder the opportunity to use their own skills and techniques to construct the toilet, and make the toilet suit local building ideas and methods.

1

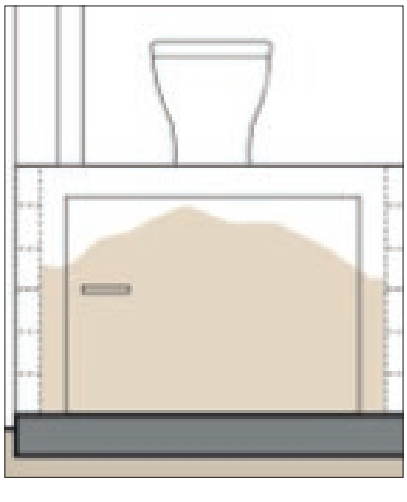
General design

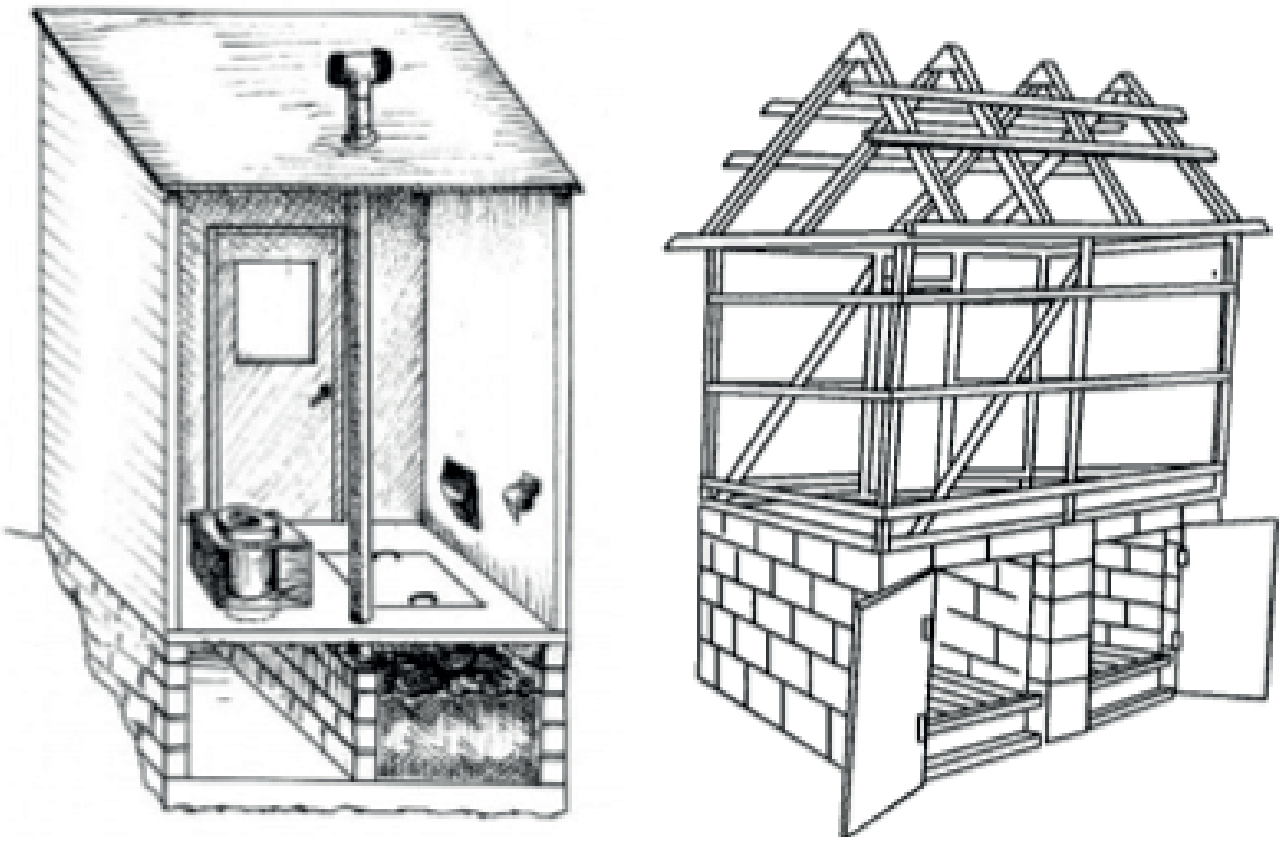
THE DOUBLE CHAMBER COMPOST TOILET USES TWO CHAMBERS UNDER THE FLOOR OF THE TOILET.

Only one is in use at any time: a chamber is used until full or for one year, whichever happens first, then the next chamber is used. Once the second chamber is near full, or after a second year, the first chamber can be dug out and the compost can be put aside for another year of secondary composting. The basic design is shown below.



Schematic of a Double Chamber Compost Toilet





Two examples of compost toilet construction using the double chamber as a base

The toilet chamber provides the foundation for the toilet room, and is made from concrete blocks, with some framing timber to attach the hatch covers and floor. These blocks are used to build a simple double chamber, where only one chamber is in use at any time, and the other is composting the waste for a time before it is suitable to dig it out. The upper toilet room can be made in a variety of ways, to suit local practise and desires. Two types shown below use either framing timber and plywood, or framing and local materials:

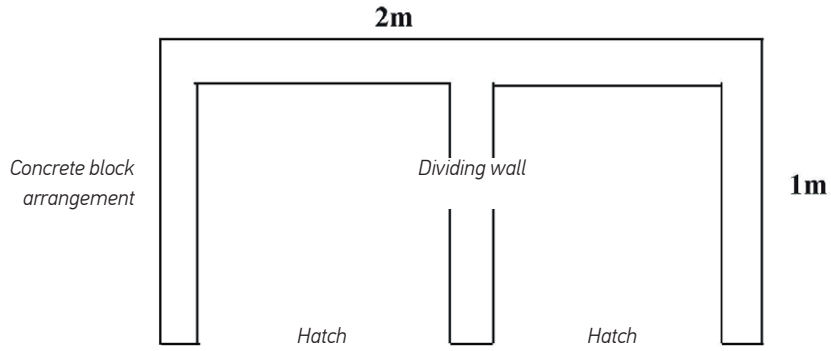
A simple Compost toilet built using concrete blocks, framing timber, roof iron and pandanus leaves.

2

Chamber Construction

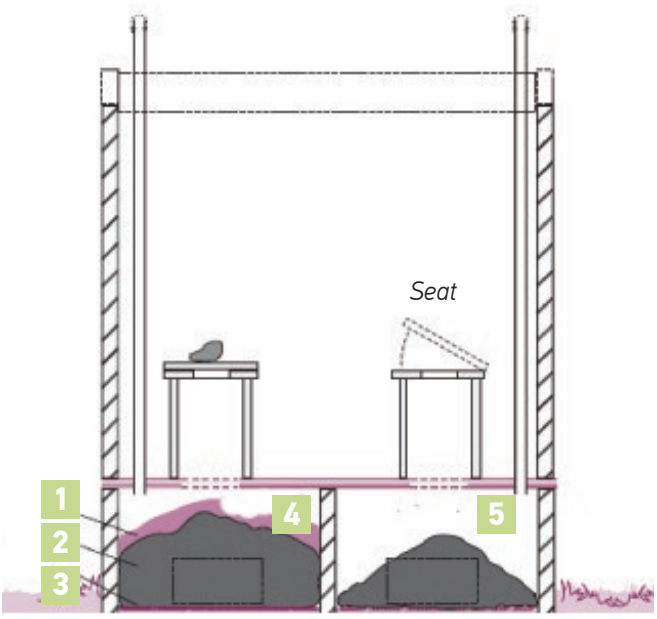
CONCRETE BLOCKS ARE GOOD TO USE AS THESE ARE WIDELY AVAILABLE, CHEAP, AND WILL NOT DEGRADE FROM THE CORROSIVE EFFECTS OF THE COMPOST.

The concrete blocks are placed in an m formation, so providing two chambers, with access to dig them out at the rear. Looking from above at the block arrangement, the plan view, looks like this:



THE SIDE VIEW LOOKS LIKE THIS

The toilet use is moved from one side to the other, depending on which chamber is used. The chambers will need a capacity of about 1 cubic metre each to suit a family of four to six, and the rotation time will be about one year. For more users make the chambers bigger.



Dry earth	1
Compost	2
Straw	3
Vault full	4
Vault in use	5

3

Access doors

EACH CHAMBER NEEDS AN ACCESS DOOR SO THAT THE COMPOST CAN BE DUG OUT EASILY.

This door can be screwed in place as it only needs taking off once a year or so. Best to use large hex-head screws of the 'Tek Screw' type, as these are easy to take in and out multiple times. The access door can be plywood, but if cement board is available this can be better as it will not rot if damp compost is lying against it.

To fix the doors to the concrete blocks, bolt some framing timber to the face of the concrete blocks, so that the access door can be screwed into the framing timber. The picture below shows this. Gaps between the blocks and the timber should be filled with mortar or a suitable silicone sealant to keep flies out. The doors will be about 1m x 1m, and so the material used must be thick enough to be strong at that size, so at least 6mm thick. Too thick and they will be heavy to handle. Two handles like drawer handles can be added to each door to make it easier to handle if desired.

If the toilet is built on a sloping land, then the door to the toilet should be on the up- hill side, and the access doors on the downhill side. When arranged like that, this results in less steps up into the toilet.

On an atoll island where the ground is usually flat, it may be possible to find a suitable slope by an old borrow pit or taro pit. But in that situation, take care that any drainage from the toilet is not going into ground water just below the surface of the old taro pit, as this will contaminate ground water, especially important if the house has a well close by.

Access hatches fixed with hex-head screws for easy removal and replacement.

4

Chamber Floor

THE FLOOR OF THE CHAMBER SHOULD SLOPE GENTLY DOWN TOWARDS THE ACCESS DOORS, WHERE THE DRAIN WILL RUN ALONG THE BOTTOM EDGE.

If on an island with plenty of soil, the floor can be direct on the ground, as worms and bugs will come up through the ground to work on the compost.

On an atoll with a sand floor, there is a need to avoid contamination of the local water lens, which may be close to the surface. In this case, a simple sand and cement floor, sloping towards the doors and the drains, will direct any liquid leachate into the drain.

The floor of the chamber should have sticks placed on it, so as to provide a way to get air into the compost. This is very important to make the compost process work. A bundle of sticks in each upper corner of the chamber will also help keep the air moving. The picture below shows this.

Sticks laid on the floor, and in the corners, of the chamber help air move through the compost. (The black pipe in the photo is from the urine catcher fitted to the toilet pedestal).

When digging out the compost, there is no need to completely empty the chamber, as a little of the old compost will help to start the process in the new. But whilst the bundles of sticks in the corners might be good to leave for another two years, the sticks in the bottom will probably need to be renewed. If the bottom sticks are thin, then they will slowly compost too during the fallow time when the chamber is composting but not in use.

Sticks laid on the floor, and in the corners, of the chamber help air move through the compost. (The black pipe in the photo is from the urine catcher fitted to the toilet pedestal).

5

Ventilation
and vent pipes

THE CHAMBERS NEED AIR FLOW SO THAT OXYGEN CAN GET INTO THE COMPOST PILE AND KEEP THE COMPOST PROCESS WORKING.

Oxygen is one of the two things that kills any pathogens and makes the compost safer to handle when dug out. The other is the heat generated from the compost pile, as microbes bio-degrade the waste. To get enough oxygen requires a small air vent into the bottom of the chambers, and vent pipes to suck the air out above the toilet, drawing air slowly through the compost pile.

The toilet works best for the user when the vent pipe is drawing air up and out away from the toilet chamber, giving a slight negative pressure inside the chamber under the pedestal. Thus, when the toilet seat is lifted up, air is drawn DOWN into the toilet chamber. This makes it much less likely that the user gets a smell rising from the compost pile when first opening the toilet lid. This also means it is very important to keep the toilet seat and lid down when not in use.

BOTTOM VENT

The vent in the bottom need only be small, and covered with a fine metal wire mesh (stainless steel is best as it will not corrode). The vent can be 100mm x 100mm or so, it doesn't need to be big. This needs to be placed down low on the chamber wall. The mesh will stop flies and other insects getting into the chamber, but let the air in. One method is to fit the wire mesh at the bottom of the central piece of framing timber that the access doors fix to. If a gap is left behind the bottom row of concrete blocks by not putting any mortar in the vertical joint behind the end bottom block, then a gap will exist on the inside of the framing timber when it reaches the ground. Drill a number of 12mm holes in the framing timber plate and then nail to gauze over the timber, and this will give some air flow at the bottom of both chambers, as the gap next to the bottom centre block can feed both chambers. There will usually be other small gaps in the construction of the chamber, and these are not a problem as long as they are small enough to keep flies out, as they will also let a little air in, which is fine.

TOP VENT

Top venting is done via a long pipe. PVC drain pipe is usually readily available, and works well. The bigger the better, so if 100 or even 125mm pipe can be found, use it. The pipe should go up well above the roof of the toilet, about 300mm above the roof. Paint it black so it gets hot in the sun, and as it warms up the air inside will rise, and suck air up from below, so helping to draw air, and oxygen, into the compost pile.

The simplest way is to put a straight pipe, one on each chamber, up through the floor of the toilet, and through the roof. In hot countries this works fine. In cooler places, the pipe needs to be on the sunny side of the toilet (as shown above), so may be better coming out one side and drawing air from both chambers, depending on how and where the toilet is built. It will need a wire mesh cover over the top to stop flies getting down inside the pipe into the compost pile.

Toilet with bananas planted next to it for the drain, and the black painted vent pipe is shown.

6

Drainage

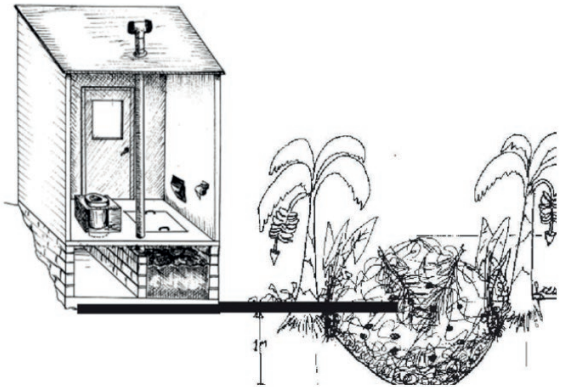
ANY LIQUID THAT TRICKLES OUT OF THE COMPOST PILE IS CALLED LEACHATE.

This will need to be directed away from the chambers, as the pile will not compost well if it is too wet. Too much urine can cause the compost toilet to smell, as urine has ammonia in it, which has a strong smell.

Placing bananas next to the toilet to act as the drainage processing system is a simple way to deal with any liquid that comes out of the toilet or water from hand washing. As the amount of liquid will be small, the bananas will easily suck up the liquid and feed on it. The bananas should be planted using the Banana Circle technique for best effect. The compost pile in the middle of the bananas acts as the processing plant. As urine is usually sterile, there should be no problem, but the pipe should be buried as soon as it comes out of the chambers and set well into the middle of the banana circle.

A simple open drain should be placed inside the chambers, along the bottom, lower, edge, running across both chambers and away from the toilet, into the banana circle next door. This can be a piece of PVC pipe that is cut in half along its length, so it is like a gutter, or a pipe with many holes drilled along one side will do. It can run under the vertical framing timber that is fixed to the blocks, which the access doors screw into. Set it so it has a gentle run downwards; at the point it leaves the chambers and goes outside, fit the open pipe into a closed one. A suitable size pipe will be 40- 50mm.

The drain from any hand-washing sink should run into this drain pipe, and if a urine catcher is used, this can also run into this pipe. This way, when the sink is used at the end of the toilet use, for washing hands, the drainage system is flushed too. This is another good reason to include a hand-washing facility with the compost toilet. As only a little water is used each time, rather than the 10 litres per flush of a water toilet, water use is low, and the toilet roof, along with a rain water drum, can be sufficient to provide water. Where a urine catcher is used, a cup of water should be put down the urine tube after each use to keep it clean and avoid build up of salts in the pipe.



Drain excess liquid from the toilet chambers into a banana circle next to the toilet.à proximité des toilettes.

7

Toilet Room

Floor

THE FLOOR OF THE TOILET ROOM IS SET JUST ABOVE THE CONCRETE BLOCK CHAMBERS.

Plywood is a suitable material for the floor, or boards. The floor needs to be airtight enough so that any gas from the compost will not come up through the floor, and strong enough for two people at a time to be able to walk on, to be safe. The toilet pedestal may be set on the floor.

To fix the floor to the concrete blocks, use local techniques from house building where framing timber is fixed to concrete blocks. A simple method is to set pieces of steel reinforcing rod into the top row of the blocks, with concrete in the middle of the blocks, with holes drilled in the framing timber so that the frame, or top plate as it is called, can be slipped over the rods. Once the concrete has gone hard, the rod can be bent over to hold the top plate in place (or bed the rods over first and push them down into the wet concrete with the framing timber). This is a simple and cheap, but effective, approach. However, special anchor bolts can also be used that are designed for this job, if they are available. Threaded rod can also be used, where a nut is placed on a length of 12mm threaded rod, and then this is passed through the top plate timber into the soft concrete below during construction, whilst the concrete is wet. Local practise will probably dictate which method is used. Once a wooden frame is in place it is easy to build off in timber for the rest of the toilet room.

The floor can be laid on the framing timber. Where the bent-over rods will sick up on the top plate, this can make it hard to lay a plywood floor direct on the top plate. This can be addressed be either packing up the top plate with extra pieces of timber that fit around the rods, or else making a rebate in the top plate around the hole where the rod passes through, so that the bent rod - or nut on a threaded rod - is set down below the surface of the top plate. This then makes it easy to place the plywood floor down. Again, local practise will show the way as this is a typical building problem.

The floor will need holes for the toilet pedestals and also a vent pipe or two.

The floor can be made smaller if the pedestals are built in along one side of the toilet. These should be built along the side opposite to the access hatches, and at the high end of the sloping floor of the chambers below. Where this approach is used less floor, but more framing to build-in the pedestal frames, will be needed.

8

Toilet pedestals

THE PEDESTALS CAN BE BUILT-IN TO THE STRUCTURE SO THAT NOTHING NEEDS MOVING, DEPENDING ON DESIGN, FOR EXAMPLE THE PICTURE BELOW WHERE ONE CHAMBER IS IN USE AND THE OTHER SET ASIDE (WITH THE BLUE LID).

Or else use a stand-alone pedestal. Two access points for the chambers blow are used, one closed off when not in use.

Two access points for the chambers blow are used, one closed off when not in use.

A stand-alone, commercial pedestal can be used, and then moved across for use on the other chamber to avoid having to buy two pedestals.

If a commercial pedestal is used, for example using a urine catcher, using one pedestal and moving it will save money, but give you a nice looking pedestal. Pedestals can be local built, and moved across, or one on each chamber.

An important aspect of the toilet for the user is that it is hard to see the compost pile below. This depends on how much light can get in from above. If a built-in, or home made, pedestal is used, it is a good idea to use a tube running down below the seat, as this will cut down the amount of light getting in, and so reduce the view of the compost pile. The tube needs to be corrosion resistant, and easy to clean. A piece of stainless steel pipe of around 200mm diameter can be good. A large PCV drain pipe would do too, but it will need to be 200 mm, too small and it will get dirty easily. A simple pedestal can even be made using a strong bucket and cutting out the bottom, and dropping the bucket into a wooden frame so that the top is held in the frame. A toilet seat is then placed on the top. The wooden frame of the toilet should be taking the weight, not the tube or bucket, unless the tube used is strong enough.

The toilet seat must close up so that no air - or very little - can get in under the seat. This helps to prevent smells rising up the toilet pedestal, as noted above. If the toilet seat doesn't seal up well, a lid that fits under the toilet seat can be made with plywood. This is then placed over the hole anytime the toilet is not in use, as below.
The user must have easy access to a bucket containing the Bulking Agent, whatever type is used. This can be neatly done by setting the bucket into the pedestal framework, as shown below.

A lid under the toilet seat can keep the chamber sealed well if the seat will not.

Bucket of Bulking Agent - to add after each use - set into the pedestal framing. This toilet uses sawdust as a Bulking Agent, but any fine, woody material will do.

9

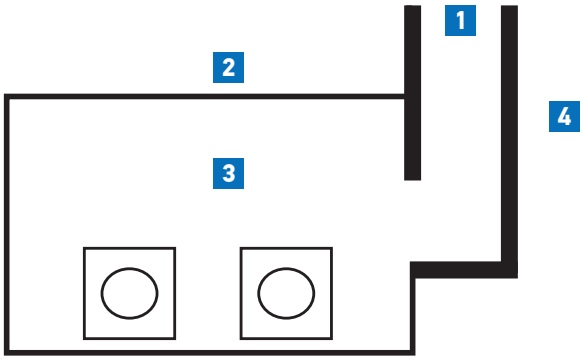
Toilet Room

THE TOP PART OF THE BUILDING, THE ROOM WHERE THE USER SITS TO GO TO THE TOILET, CAN BE MADE OF ANY TYPE. USING LOCAL MATERIALS FOR THATCHING CAN BE FINE, AND THE TOILET ROOM DOES NOT NEED TO BE COMPLETELY WEATHER PROOF, AND SOME NATURAL VENTILATION OF THE TOILET ROOM IS A BIG ADVANTAGE.

If the roofing is metal it can then be used to catch water, and a drum placed next to the toilet on a stand can hold the water and it can then be used to feed a small hand- basin, or even just a tap, for hand washing, which is very important after toilet use.

A door should be put on the toilet room; or another way, when using traditional building materials, is to build a screen so that access to the room is not direct and people cannot see inside, or even see when someone goes to the toilet, if that is appropriate. Screens can be easily made using woven coconut palms, as is common for fencing and screens. From above, the plan view might look like this:

A Kiribati example of using local materials for the toilet room (a local woven mat was used as the door for this example). Note iron roof and gutter for rain water.



1 *Entrance*
2 *Access Doors this side*
3 *Toilet Room*
4 *Screen of Coconut or similar*

The walls of the toilet room can be easily made of plywood or sheets of roofing iron, depending on what is preferred. A simple wooden frame can use framing timber or even local round timbers, as the structure is light and small. A few cross braces will make the structure strong. The toilet room is attached to the concrete base using standard construction techniques of the locality. Many houses made from concrete blocks require wooden structures to be attached to the concrete blocks, for example roofing beams, and so these aspects are normal construction issues to address. It is a very good idea to have the toilet room as a well ventilated space, for example large gaps under the roof, or even put some windows or shutters so these can be opened to let the air in. This will keep the room nice and airy and avoid build up of any toilet smells, just as any type of toilet room will benefit from regular ventilation. For example the toilet below shows a large gap at the top of the walls, under the roof, and a big opening window to let fresh air in!

Note the gaps under the roof framing and sliding windows to let the air in; sink for hand washing is in the corner.

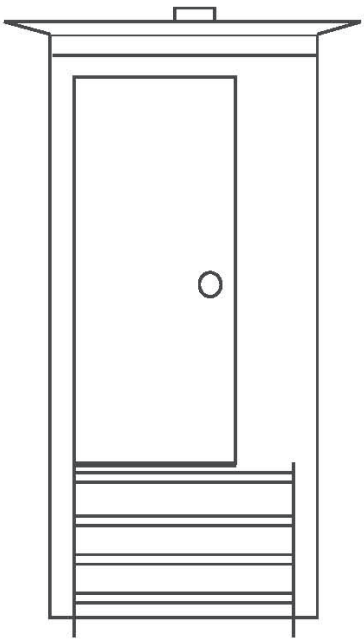
10

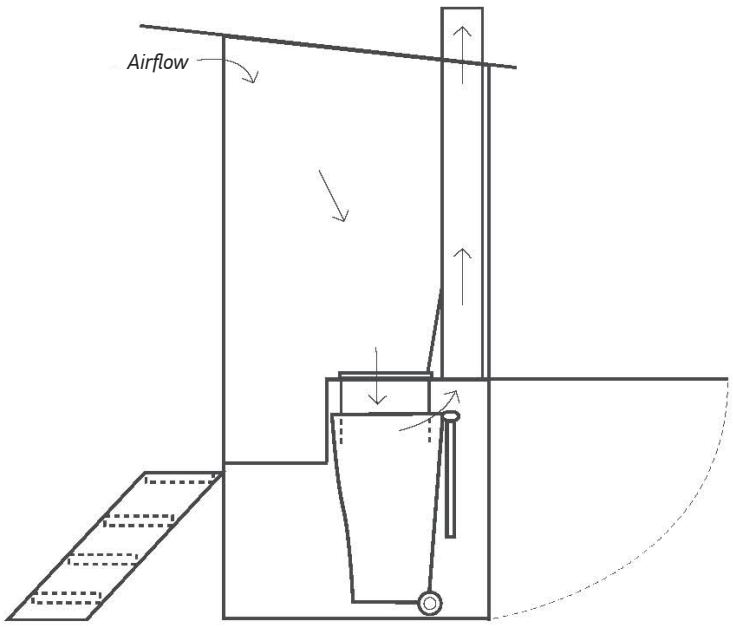
Temporary Toilets

IT IS POSSIBLE TO BUILD A PORTABLE COMPOST TOILET, FOR EXAMPLE FOR USE WHEN BUILDING A NEW HOUSE, OR WORKING ON A SPECIFIC SITE FOR A MONTH OR MORE. THESE TOILETS USE SMALL 120 LITRE WHEELIE BINS, AS USED FOR HOUSEHOLD RUBBISH, TO COLLECT THE COMPOST.

The wheelie bins are left some months to compost, and then tipped into a shallow pit and covered with earth for a year or more of secondary composting, before using the compost. The wheelie bins are reused. Two wheelie bins can be enough for two or three people.

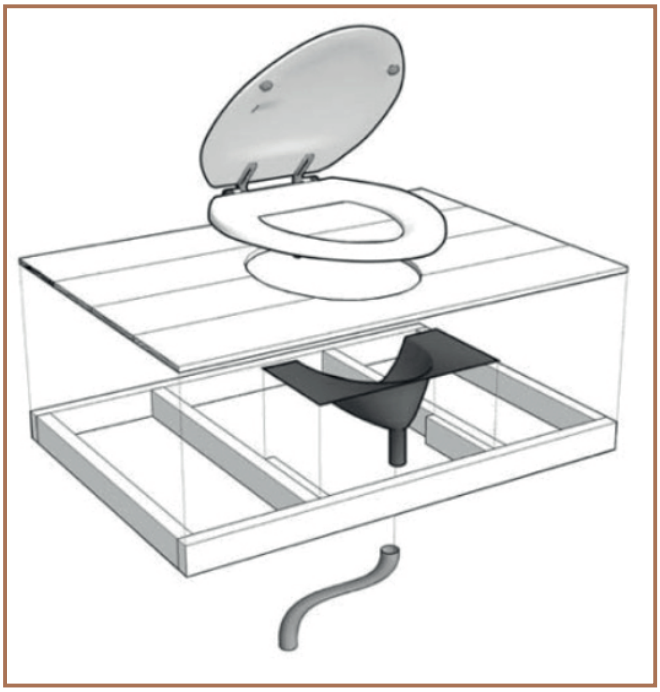
SCHEMATIC DIAGRAM OF A PORTABLE COMPOST TOILET





To make a portable toilet, framing timber and plywood are the best materials. No concrete blocks are used. The toilet should also incorporate a urine catcher, and a suitable size plastic container can be used to collect the urine, as the toilet may not have a drainage system if it is portable. This way no external drainage works are required. The urine catcher can be added to the toilet seat, as in the pictures below, showing a commercially available urine catcher[1].

A portable compost toilet built for rural use in New Zealand



Addition of a urine catcher, showing main parts

urine container under the seat

or using an external container

[1] *https://www.freerangedesigns.co.uk/index.php/urine-separator-for-compost-toilet.html*

A wheelie-bin is easy to handle and easy to move, with a flip-lid, commonly used for municipal rubbish and recycling collection. Wheelie bins serve very well as the receptacle for a portable toilet. The standard full size is 240 litres, but a half size 120 litre unit is best for a portable toilet, so as to keep the building height lower.

Access to remove the wheelie bin is through a flap at the rear

One person can easily wheel a 120 litre bin for bin-replacement, storage, and secondary compost processing. Ventilation, pile aeration, and drainage can be built into the bin itself, which would allow full-term composting within the bin, but this can mean more bins are required to get enough for a full rotation of up to two years. It is good to place a small bundle of long, thin sticks in two corners, and a few sticks in the bottom of the bin, to help the air get into the compost and help the composting process whilst the waste is in the bin. The photo below shows this effect by using pieces of PVC pipe and a false floor in the bin, which can be very effectively used, but the pipe needs holes in the sides all the way up to allow air in. Also, shape the bottom of the pipe so it is not flat on the bin floor so as to allow air in from underneath. Small holes in the bottom of the bin will help air get in too. Air is important to bring in oxygen so as to kill the pathogens.

How to use pieces of PVC pipe to allow air to circulate through the compost pile.

Appendix

I

Bird's Eyes

BOUGHT ITEMS

- Wheelie Bins – 120 litres – two or three
- 1 Urine Separator;
- a door and handle;
- handle for access flap at rear;
- toilet seat;
- chimney pipe.

TIMBER & ROOFING MATERIALS

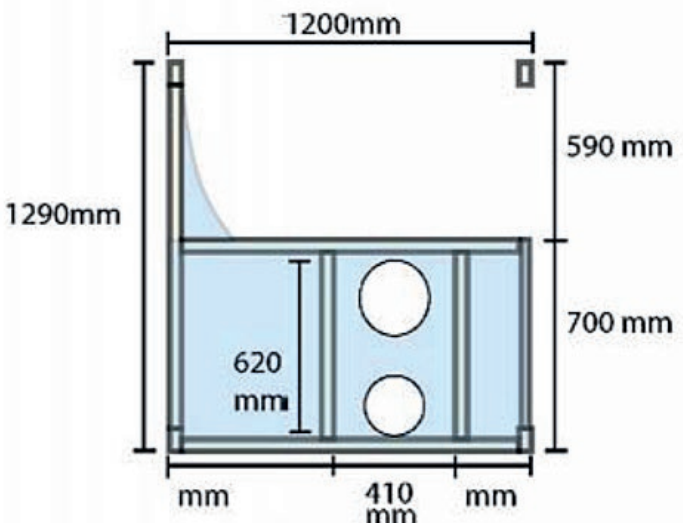
- 70 x 45mm x 44,40m @ $5,84/m
- 100 x 25mm x 3,60m @ $6,28/m
- 50 x 25mm x 14,40m @ $1,93/m
- 12mm plywood x2 @ $52.20/sheet
- 7mm plywood x4 @ $47.30/sheet
- Clear-light roof sheet 2400x690
- 75mm screws and 35mm screws

II

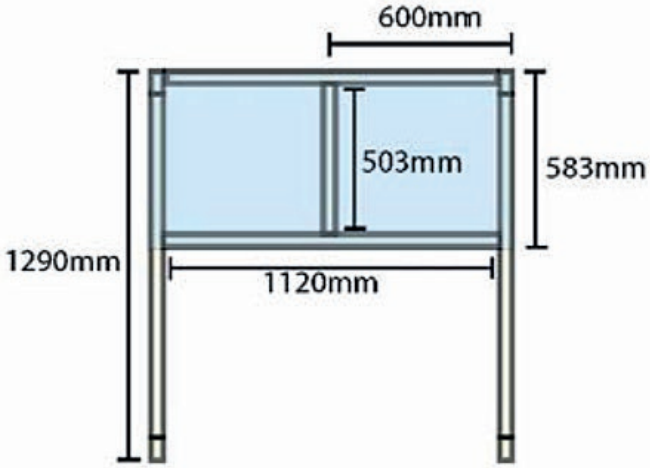
Bird's Eyes Plans

THE MAIN MATERIALS ARE DIMENSIONS OF A SUITABLE PORTABLE DESIGN ARE SHOWN BELOW:

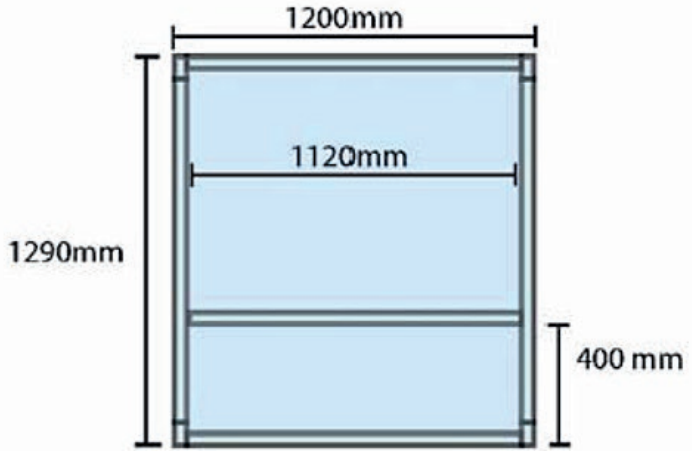
BIRD'S EYE SEAT



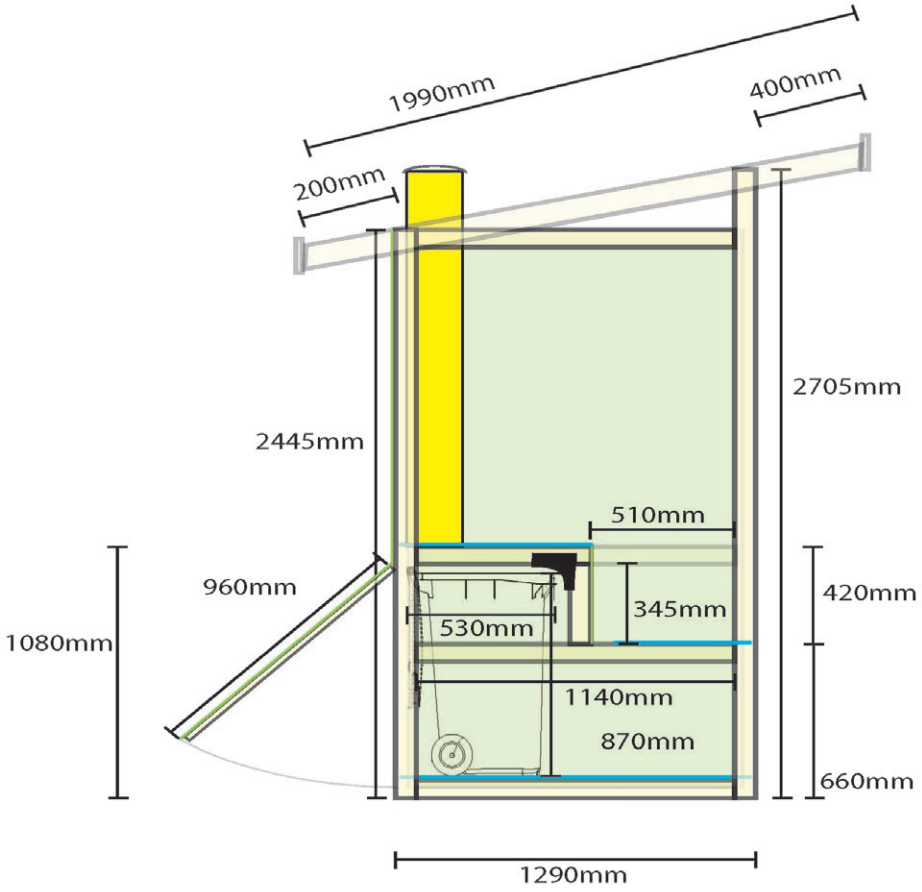
BIRD'S EYE FOOT-FLOOR

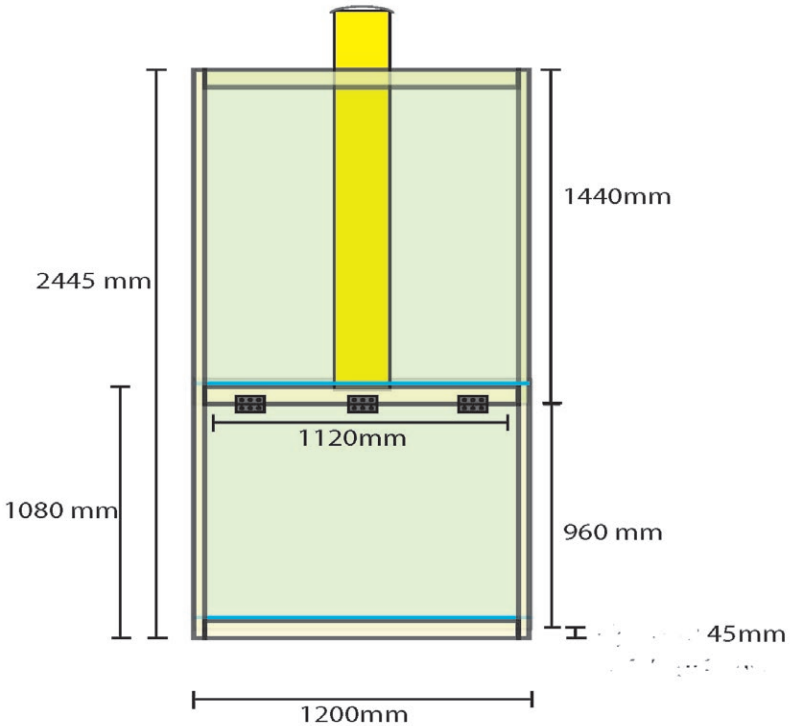


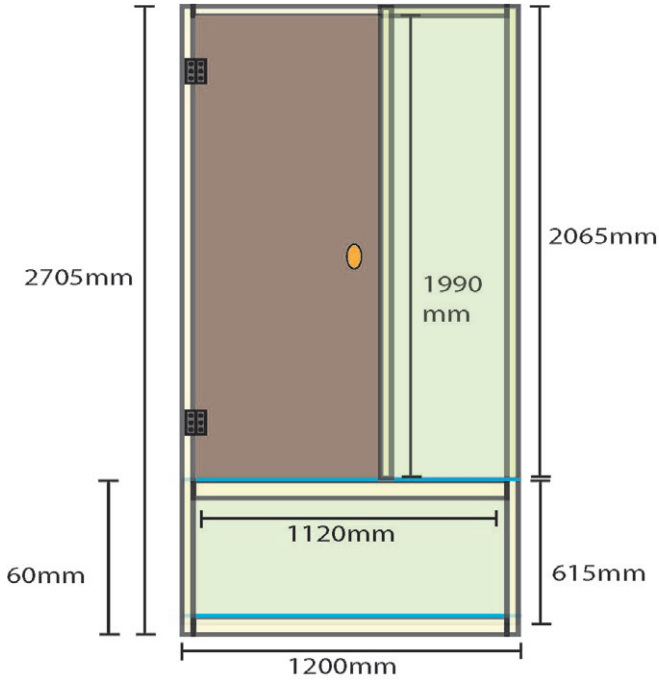
BIRD'S EYE BIN-FLOOR



BIRD'S EYE CLEARLIGHT ROOF







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