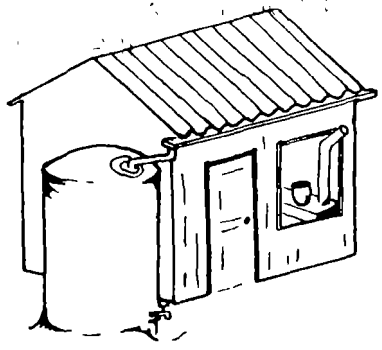
TRANSFER OF

APPROPRIATE

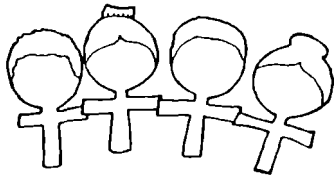
TECHNOLOGY



leaflet number 9

(second edition)

BUILDING A FERROCEMENT WATER TANK



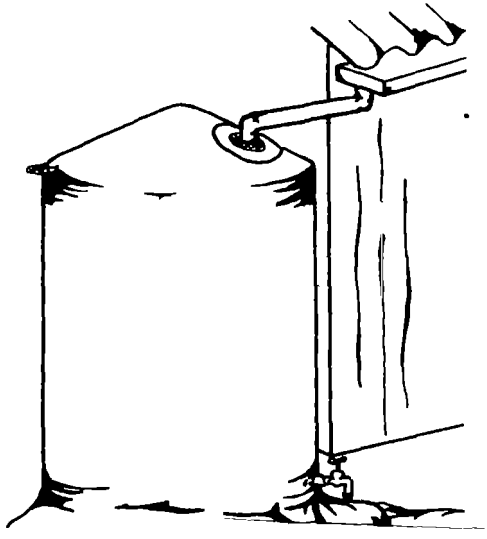
INSTITUTE OF RURAL
DEVELOPMENT

and

WOMEN'S DEVELOPMENT
TRAINING PROGRAMME

The University
of the
South Pacific

P.O. Private Bag
Nuku'alofa
TONGA



This leaflet on the Transfer of Appropriate Technology in the South Pacific is part of a series being produced by the Institute of Rural Development of the University of the South Pacific and the Women's Development Training Programme, based at the Institute.

The leaflets are designed to help transfer appropriate products and processes in the University region. It is intended that this sharing of tools and techniques will mainly focus on those technologies already used or of use in the countries of the South Pacific, by encouraging improvements to traditional technologies or the introduction of new technologies.

The leaflets concentrate on needed technologies which use locally available or inexpensive construction materials and basic building techniques.

This leaflet explains how to make a 1500 gallon ferrocement water tank. The leaflet tells you WHAT YOU NEED in terms of tools, equipment and materials, and WHAT YOU DO to make the tank. One advantage of the tank is that it can also be made bigger or smaller than 1500 gallons. The building technique and tools used are the same, but more or less materials will be needed.

The water tank can be made by both women and men, and is one of the technologies that women have learnt to make at the Women and Technology Workshops that have been presented at the Institute of Rural Development in Tonga and elsewhere in the South Pacific.

Please circulate the leaflets to your contacts and friends and write to the Institute with any questions, comments or suggestions for new leaflets. The leaflets are available freely on request.

In the leaflet a mixture of measurement units have been used. This is to promote general convenience and ease of understanding. Gallons, cubic metre (cu.m), metre (m), millimetre (mm), feet ('), inches ("), kilogram (kg) and pound (lb) are used as shown.

Notes

1. The tank can be built in larger capacities using the same techniques of construction.

2. The tank can be built elevated above ground level, raised up on a foundation for greater ease of use.

see back cover for details.

For further information, comments, suggestions or requests for more leaflets, please contact:

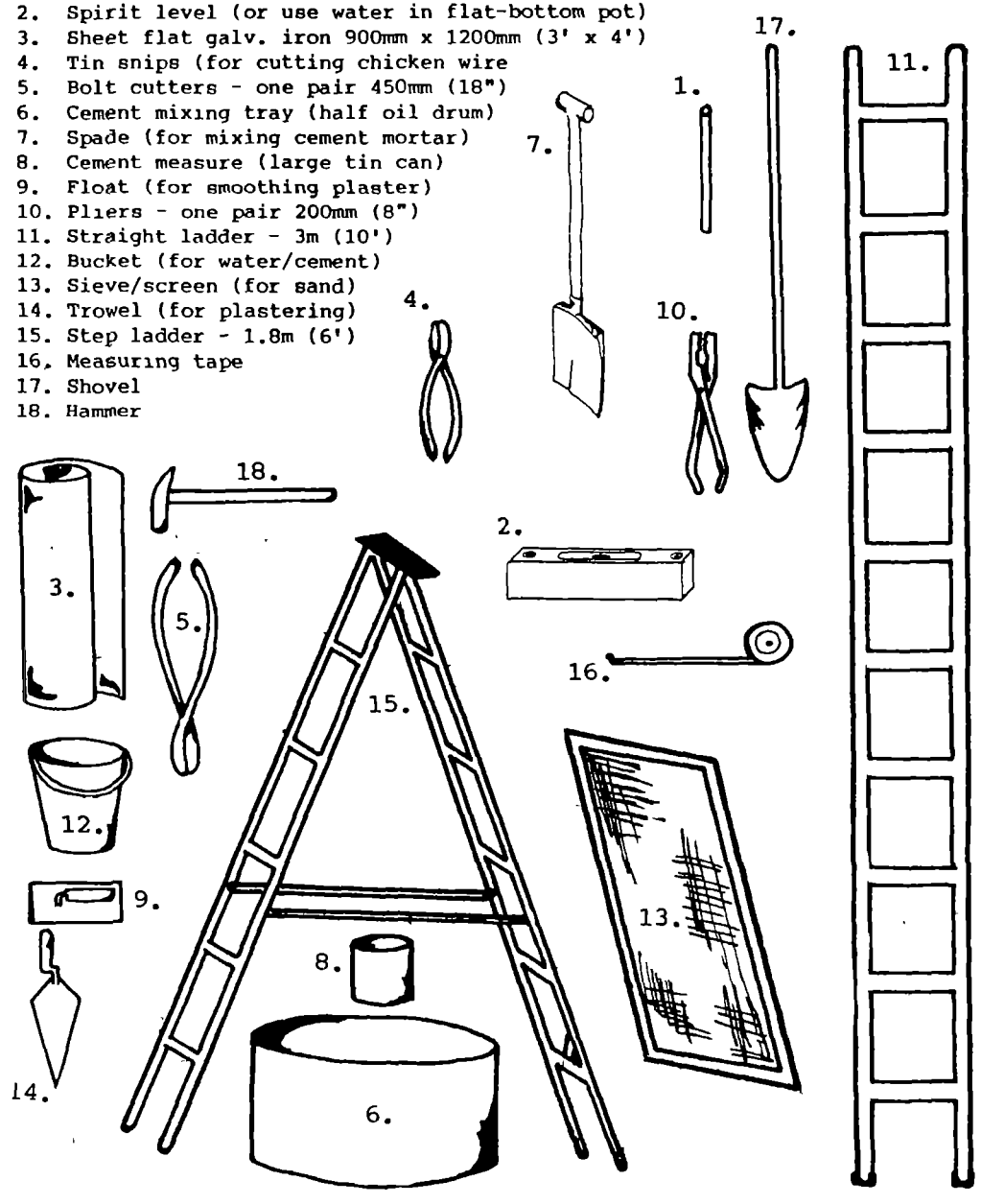
APPROPRIATE TECHNOLOGY LEAFLETS PROJECT
INSTITUTE OF RURAL DEVELOPMENT, UNIVERSITY OF THE SOUTH PACIFIC
POST OFFICE PRIVATE BAG, NUKU'ALOFA, TONGA

WHAT YOU NEED:

To make one 6600 litre (1500 gallon) tank.

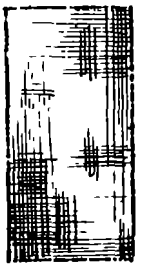
Tools and equipment:

1. Bender (for weld-mesh wire) 300mm (12") of 12mm (0.5") steel pipe
2. Spirit level (or use water in flat-bottom pot)
3. Sheet flat galv. iron 900mm x 1200mm (3' x 4')
4. Tin snips (for cutting chicken wire
5. Bolt cutters - one pair 450mm (18")
6. Cement mixing tray (half oil drum)
7. Spade (for mixing cement mortar)
8. Cement measure (large tin can)
9. Float (for smoothing plaster)
10. Pliers - one pair 200mm (8")
11. Straight ladder - 3m (10')
12. Bucket (for water/cement)
13. Sieve/screen (for sand)
14. Trowel (for plastering)
15. Step ladder - 1.8m (6')
16. Measuring tape
17. Shovel
18. Hammer



WHAT YOU NEED:

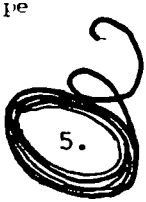
Materials:



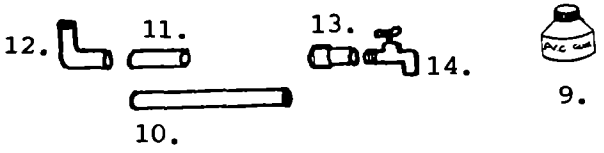
1. 6-inch (150mm) weld-mesh - 2.5 sheets of 2m x 4m (6.5' x 13')
2. Half-inch chicken wire - 1m wide x 35m long (3' x 115')
3. Nylon mosquito screening - 1m x 0.5m (3' x 1.5')
4. Plastic sheet - 3m x 6m (10' x 20')
5. Soft iron tie-wire - 5kg (11lb)

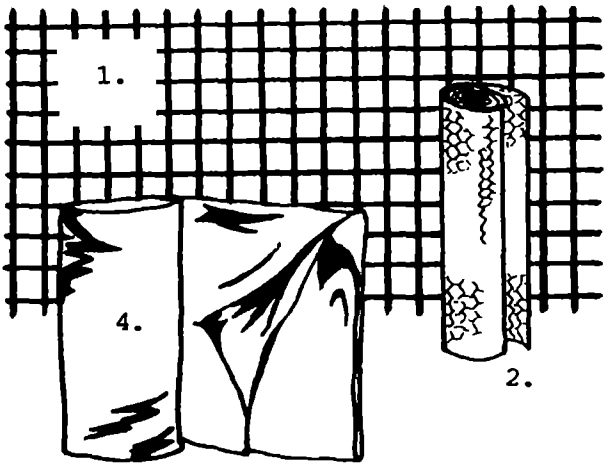
6. Half-inch (12mm) gravel/aggregate - 15 x 40kg (88lb) bags
7. Sand (washed) - 20 x 40kg (88lb) bags
8. Cement - 10 x 40kg (88lb) bags

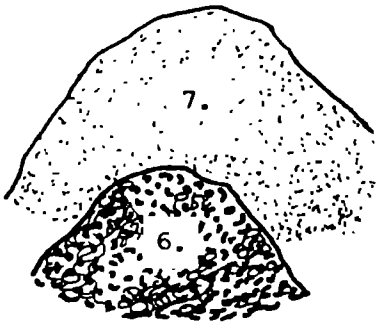
9. Tin of PVC solvent cement (glue) if using PVC fittings and pipe
10. Half-inch (12mm) plastic (or galv) water pipe - 300mm (12")
11. Half-inch (12mm) plastic (or galv) water pipe - 100mm (4")
12. Half-inch (12mm) plastic (or galv) elbow joint
13. Half-inch (12mm) plastic (or galv) tap socket
14. Half-inch tap



And a supply of fresh water to wash sand (if necessary), wash tools and hands and make mortar and concrete.





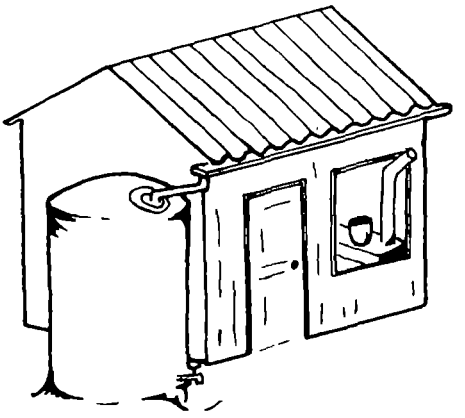


Note: for larger tanks you will need more materials; for an elevated tank you will need 15 concrete blocks and approximately 10 x 40kg 88lb bags of gravel/aggregate to raise the tank by one layer of blocks

WHAT YOU DO

CHOOSING A SITE FOR THE WATER TANK

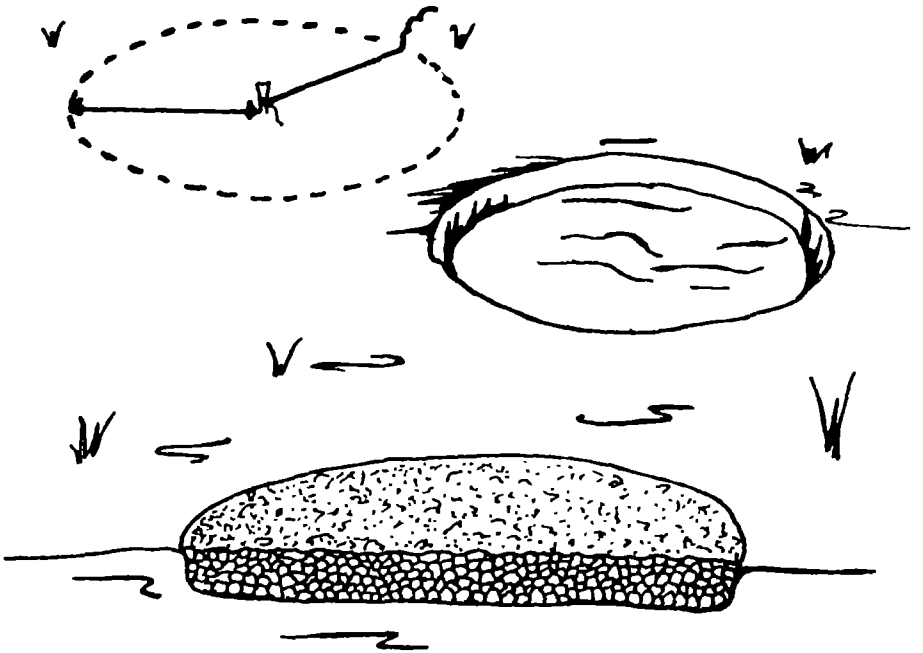
In choosing the site for your water tank there are several things to remember - the ground needs to be as flat and firm as possible, close to the roof water catchment (house guttering and down-pipe) and convenient to use - near to the kitchen, but the tank should not get in the way.



MAKING THE FOUNDATION AND BASE FOR THE TANK

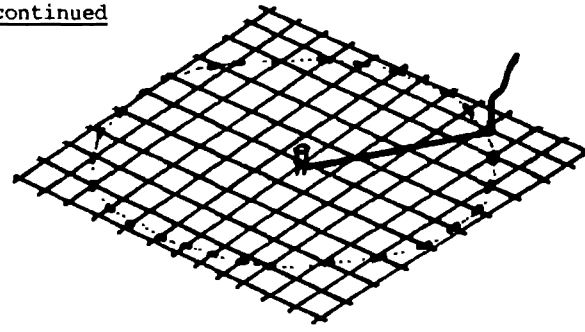
1. Clear the site of the tank to prepare for the base, and level if the ground is sloping or bumpy. A 6600 litre (1500 gallon) tank is 2m (6.5') in diameter - you will need an area at least 3m (10') round. When a site has been selected, cleared and levelled, put a stake into the ground where the middle of the tank will be and mark out a circle of 1.5m (5') radius. Dig this circle down to a depth of 300mm (12"). Fill the hole with the gravel/aggregate and pound the stones down to give a firm base.

Note: for larger tanks - measurements required are on back cover.

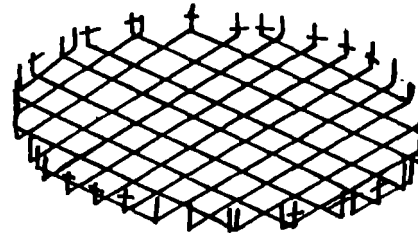


Making the base of the tank - continued

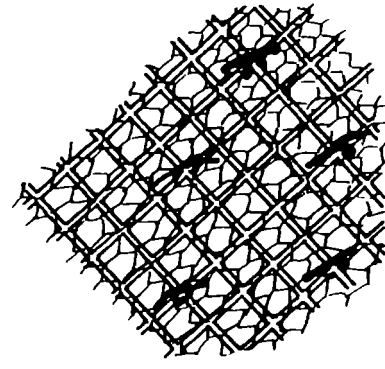
2. Cut a piece of weld-mesh 2m (6.5') square and mark out a circle of radius 1m (3.25'). Using a piece of string marked at 1m tied to a stick which is placed in the centre of the weld-mesh, mark out a circle on the weld-mesh with chalk or felt-tip pen.



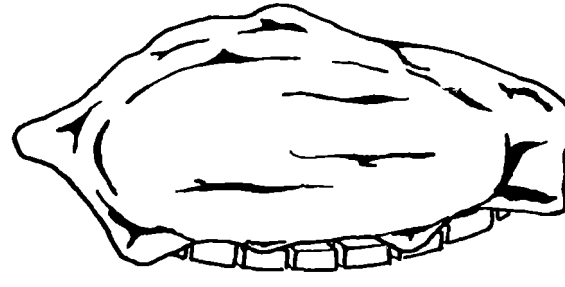
3. With the weld-mesh flat on the ground, using the pipe bender bend the edges of the mesh upwards along the marked circle to form the bottom of the sides of the tank. The weld-mesh may need to be cut so that it can be bent upward at the edges into the circle.



4. Measure and cut out 3 pieces of chicken wire each 2.2m (7.2') long. Take the pieces of chicken wire and place one along a diameter of the weld-mesh circle, bend the ends upward with the weld-mesh wall bottoms of the tank. Then put the other two pieces of chicken wire at either side of the first, overlapping by 250mm (10"). Tightly tie the chicken wire together to the weld-mesh circle with pieces of tie-wire cut to 100mm (4") long and bent into a "U" shape. You have now made the tank base reinforcement.

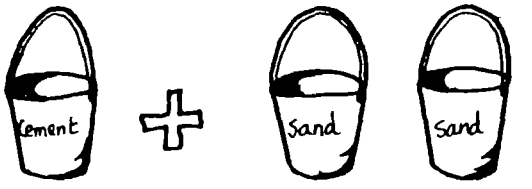


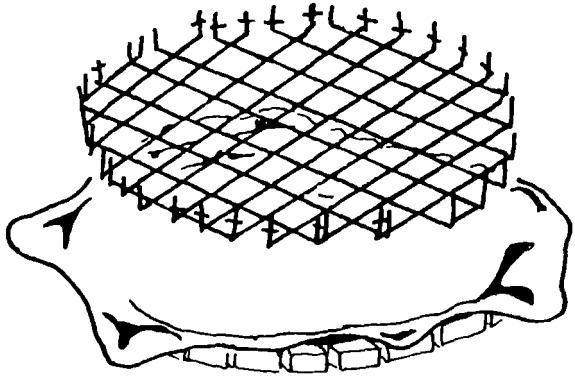
5. Cover the compacted tank foundation with 3m x 3m (10' x 10') of plastic sheet and place the base reinforcement centrally on the foundation, with the wall bottoms facing upward. Lift the plastic sheet upward at the sides and place bricks, blocks or rocks behind the plastic, to hold it against the sides. Then fold back the plastic over the bricks. This is the temporary mould for the tank base.



Making the base of the tank - continued

6. Make a mortar by mixing 1 part of cement and two parts sieved/screened washed sand. Mix well and add water - not too much water, and use fresh water, not salt water. Lift the weldmesh/chicken wire base reinforcement away from the plastic sheet mould, without moving the plastic or bricks, and with a spade and trowel fill the mould with mortar to a depth of 25mm (1"). Take care that the mortar is pressed down and into the corners of the mould. Put the reinforcement onto the mortar, hold down and cover with more mortar to a total depth of 50mm (2"). Leave to dry.





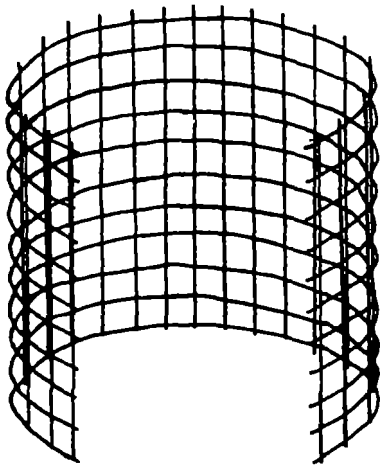
Note on mortar drying:

Mortar takes about a day to dry, but needs up to a week to "cure" to reach full strength. When the mortar is curing, after initial drying, keep the mortar wet with fresh not salt water.

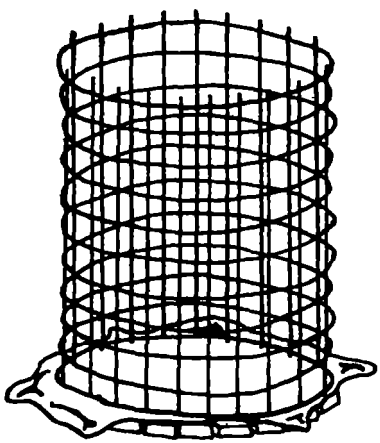
MAKING THE SIDES OF THE TANK

Reinforcing framework:

1. When the base is dry (after 24 hours) take a piece of string and measure around the outside where the base wire is bent up to form the bottom of the tank walls. Securely join with tie-wire two sheets of weldmesh at their 2m ends, with a 150mm (6") overlap. Take the string used to measure around the wall bottoms and mark this length onto the 12m (39') length of weld-mesh. Add on an extra 150mm (6") for an overlap, and cut off the rest of the weldmesh at this line.



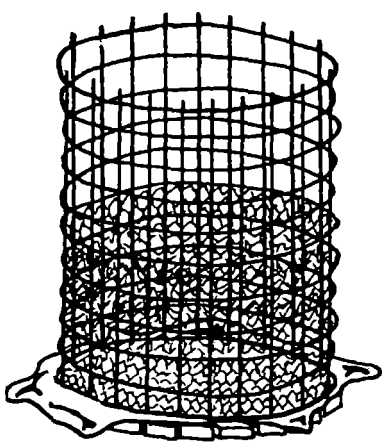
2. Bend and form the weld-mesh into a cylinder of 2m (6.5') diameter and 2m high, with the edges overlapping 150mm (6"), and tie loosely with tie-wire at 6 places on the overlap, so that it can be adjusted to fit around the base if necessary.



3. Place the weld-mesh cylinder around the base of the tank making sure it fits well. Make adjustmants for a close fit if necessary, by adjusting the tie wires at the seam, then secure extra tie-wires to the overlap.

4. Tie the weld-mesh cylinder to the the base wire bent up to form the bottom of the walls.

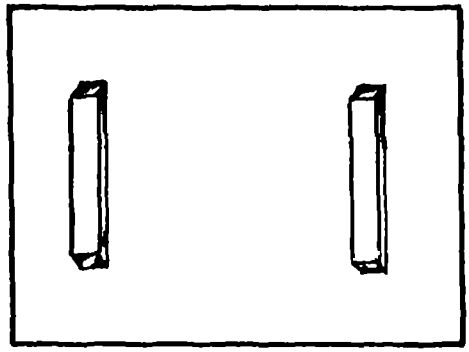
5. With the string used to mark the length of weld-mesh, measure 4 pieces of chicken wire to fit around the inside and outside of the weld-mesh cylinder walls. Fix the chicken wire rolls to the inside and outside of the mesh wire from the base upward, leaving a little overlap with the of the base - one layer on the inside and one layer on the outside. Tie the chicken wire to the reinforcing mesh walls as you go with tie-wire. Check that the tie-wires lie flat and do not stick out, as this will make plastering difficult.



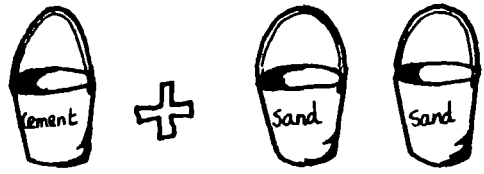
PLASTERING THE SIDES OF THE TANK

The tank is plastered from the outside. Two people are needed inside the tank to hold the moveable mini-formwork, two people plaster from the outside and two others are needed to screen the sand and mix the mortar. If more people are available, use two teams of two people on the inside, and two teams plastering on the outside. At least two more people will also be needed to screen (sieve) sand and mix mortar for the plasterers - a total of eight to ten people to plaster the tank. The people inside the tank can get in and out using a ladder or bush timber scaffold outside and step-ladder, table or oil drum inside. Be very careful not to knock the walls and disturb the wet mortar when climbing in and out.

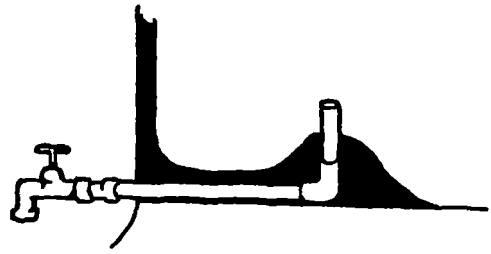
Plastering is not a difficult job provided you have the correct tools and mix the mortar properly. In the tools listed under "Tools and Equipment" you will need to make a tool to act as a piece of "moveable mini-formwork". To make this take the piece of flat galvanised steel roofing sheet of 900mm x 1200mm (3' x4') and onto the back nail two handles made of 80mm x 50mm (3" x 2") planed timber as shown on drawing.



To prepare the tap unit take the 100mm (4") length of PVC piping and attach the elbow joint to one end with PVC solvent glue. Then take the 300mm (1') length of PVC pipe and glue this into the other arm of the socket. Glue the tap socket onto the other end of this 300mm pipe and screw on the tap.



It is best to install the tap unit in the base of the tank before plastering, as shown in the drawing, with the tap positioned closest to the kitchen for greatest convenience. Insert the tap unit in a suitable position, with the 100mm pipe pointing upwards. Firmly tie in the tap unit with wire and mortar around the unit, covering underneath the unit and around the upright pipe inside the tank to make sure it is secure. Be careful not to block this pipe when plastering the inside of the tank - put a temporary cover onto the top of the pipe when the cement is dry.



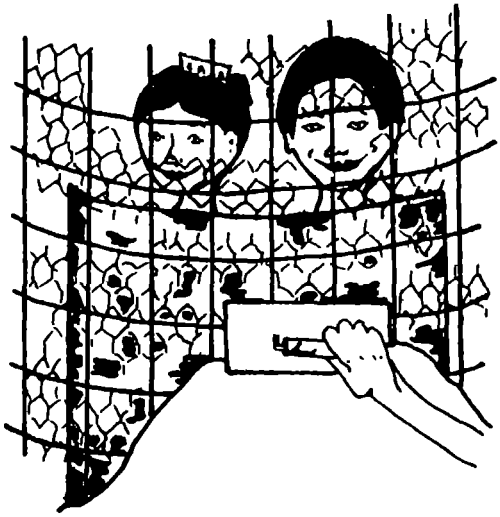
Note: Galvanised Pipe Fittings

Galvanised steel pipe fittings can be used for the tap unit instead of PVC. Galvanised pipe and fittings are stronger, but more expensive.

Plastering the sides of the tank - continued

1. Mix mortar using the ratio 1 cement to 2 sand (washed and screened). Do not add too much water - the mix needs to be quite "stiff" so that you can plaster the sides of the tank without the plaster falling off.

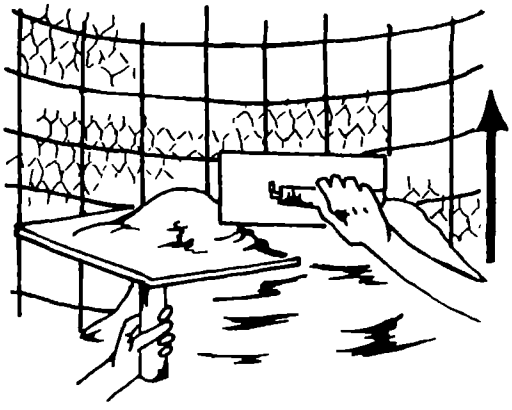
2. With a team of two people inside the tank pushing the piece of "moveable mini-formwork" against the sides of the tank, begin plastering from the outside of the tank. Starting from the base of the tank, work around the tank in a band the height of the mini-formwork - 900mm (3').



Apply the mortar with a float (square trowel), wiping the mortar on in an upward sweeping movement. Two people can work plastering on the outside. When moving the mini-formwork when you have plastered one section of 900mm x 1200mm (3' x 4') be careful to slide it along to the next section rather than pulling it off, as this may also pull off wet plaster.

3. When you have completed one 900mm (3') band, start plastering another band to a total height of 1800mm (6'). Then leave for at least 24 hours, watering regularly after initial hardening to help "cure" the mortar.

4. When dry, plaster the inside of the walls using the usual mortar of 1 cement to 2 sand. Keep the inside of the tank wet to help the plaster to stick better, and begin plastering from the bottom, pressing hard, forcing the new mortar into the chicken wire. Cover the chicken wire to a depth of at least 50mm (0.25 "). Make the plaster smooth with a trowel/float.



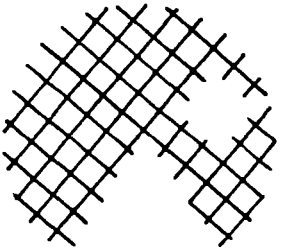
5. Plaster the outside of the tank in the same way as the inside. Leave for a day and water it to keep the tank wet and help "cure" the mortar.

MAKING THE TOP OF THE TANK

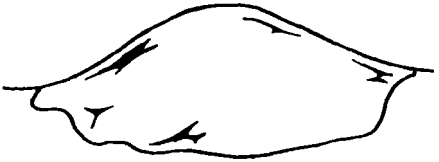
The tank top is made separately, then lifted and fitted onto the tank.

Note - if you make a larger tank the top will be heavier and harder to lift and fix on - you will need more helpers.

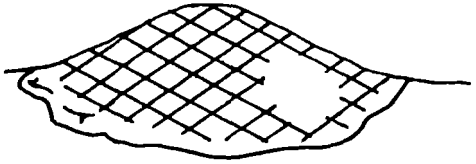
1. Cut out a square of weld-mesh the diameter of the tank - 2m (6.5'). Cut a slit in the mesh from the middle of one of the sides to the middle of the square. Pull the two edges of the slit together and make into a cone shape about 300mm (1') high, and tie the edges tightly together with tie-wire. Trim the corners of the mesh with bolt-cutters to give a circle of 2100mm (7') total diameter.

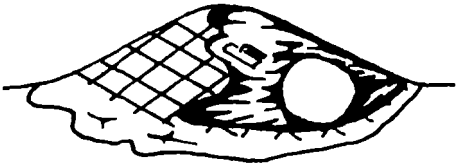


Now cut out a hole of 600mm (2') diameter opposite the slit to make an entrance and filling hole for the tank. Cover the weld-mesh top with one layer of chicken wire and tie on with tie-wire. The reinforcement for the top is now finished.

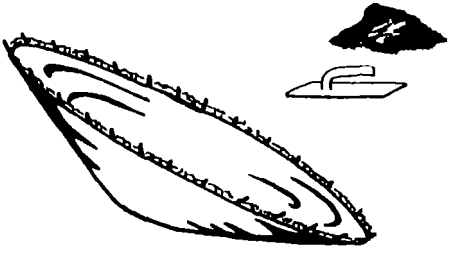


2. Make a pyramid heap of soil or sand the same shape as the top. Put a piece of plastic over the heap. Place the top mesh reinforcement on top of the plastic, making sure it is a good fit - if not, reshape the heap. Lift off the mesh and cover the heap with plastic sheet to make a makeshift mould.





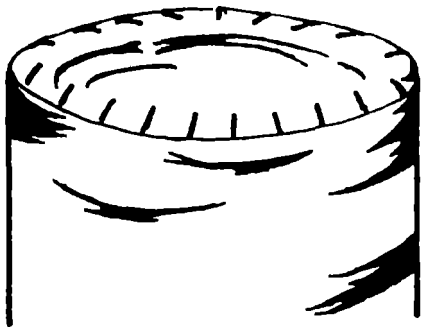
3. Mix a mortar (1 cement: 2 sand again) and apply to the reinforcement through to the plastic. Put on as little mortar as possible or the top will get very heavy to lift. Plaster up to 150mm (6") of the edge all round, to leave some wire free to join to the top of the tank sides. Plaster carefully around the tank entrance hole and give the outside a smooth finish.



4. Leave for 24 hours, watering to keep the top moist.

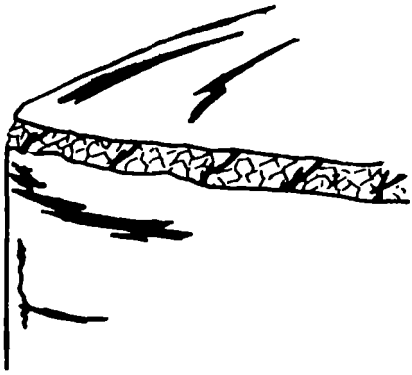
Making the top of the tank - continued

5. Lift the top and carefully turn it over, mix a mortar (1:2 again), and plaster the inside of the top of the tank.



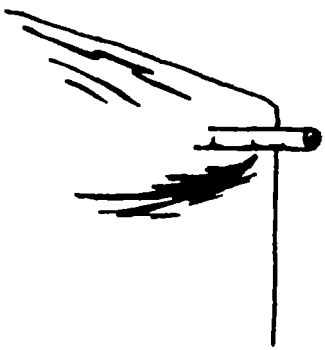
6. Leave for another 24 hours, watering to keep the top moist.

7. Going to the tank, bend the wires sticking up at the top of the walls over into the tank slightly, using the length of steel pipe as a bender, as shown. Make sure they are bent at the same height, they are all level and at the same angle.



8. With as many helpers as possible (at least 8-10 people, and more for a larger tank) carry the top and place in position on the tank. Bend the mesh wires on the top and walls to give a good fit, and tie on the top securely with tie-wires.

9. Cut a foot of plastic water pipe, insert and tie-wire to top side of tank for the overflow. Position overflow to drain in convenient direction. Plaster the join between the top and the walls.

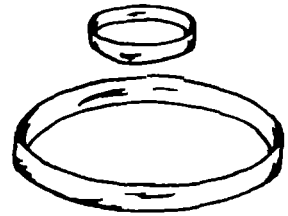


10. Leave for 24 hours, watering to keep moist, and smooth plaster the inside and outside of the join, wetting the mortar before plastering.

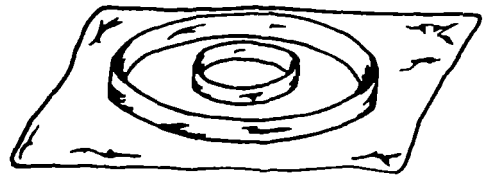
MAKING THE LID FOR THE TANK

The lid of the tank fits over the hole in the top and serves as a filling, inspection and cleaning hole for the tank. As with the tank sides and top, after each stage of building the lid, following initial drying, keep the lid wet to help the mortar to cure.

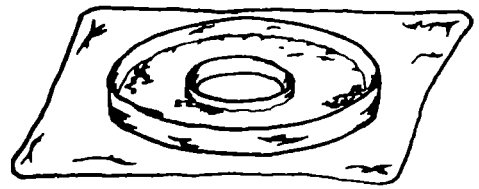
1. Find a piece of flat and firm ground. Cut a piece of tin sheet 50mm (2") wide and 2.5m (8') long. Bend into a circle of 760mm (30") diameter, with a 50mm (2") overlap, and tie the ends together. Cut another piece of tin sheet 50mm wide and 1016mm (40") long, and bend into a 300mm (12") diameter circle, with a 50mm overlap, and tie the ends together.



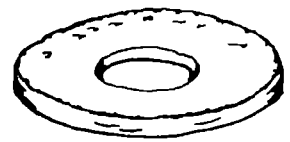
2. Place a piece of plastic sheet 1m (3') square onto the ground and put the small and big circles of tin onto the plastic, with the small circle in the middle of the big circle as shown.



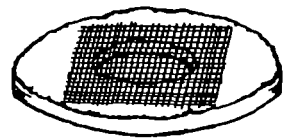
3. Cut a single layer of chicken wire to fit in between the two circles of tin in a ring.

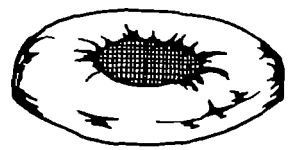


4. Remove the chicken wire ring, and mix the usual cement:sand mortar (1:2). Fill the space between the two circles with mortar to a depth of 12mm (0.5 "), making sure that the mortar reaches into the edges. Place the chicken wire ring onto the mortar, hold down, and add more mortar to cover the chicken wire to a total depth of 25mm (1").



5. Remove both tin circle moulds and cut two pieces of plastic mosquito screen 460mm (18") square to fit over the hole in the middle. Place the two pieces of screen over the hole, hold tightly and mortar over the edges up to the hole. Finish the lid by smoothing the mortar.





Leave for 24 hours, watering to keep the top moist.

Making the lid for the tank - continued

6. To fit the lid onto the tank, mix some mortar (usual 1:2), and place a ring of mortar around the edges of the hole in the tank top, first wetting the area. Make the mortar thickest at the sides of the hole - about 50mm (2") thick. Place the 900mm (3') square plastic sheet over the hole and mortar ring and carefully place the lid centrally onto the hole and mortar ring, pressing down the mortar to give a flat support surface. Add extra mortar if there is not enough to give a flat surface.

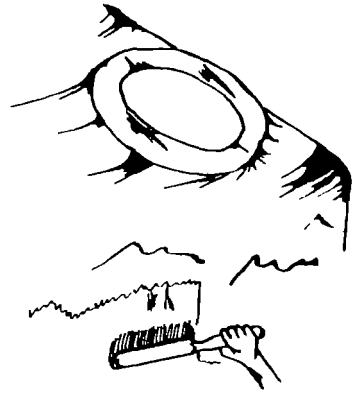
7. The main construction is now finished, but do not forget to keep the tank walls, top and lid wet to help cure the mortar for maximum strength.

FINISHING THE TANK

Now that you have constructed the tank, a few touches are needed to finish the tank. These include coating the tank with a cement slurry, making a soakaway pit, installing the gutter and connecting the tank.

Coating the sides of the tank

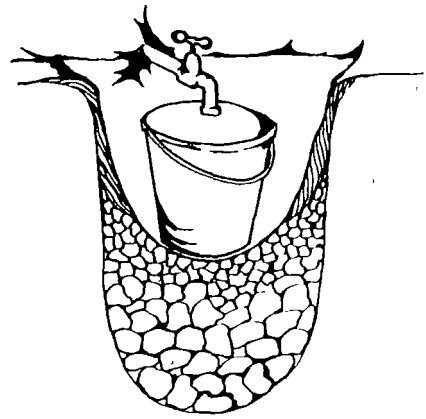
1. While the tank is still wet, mix some cement and water together to form a thick paste and paint over the inside and outside of the tank. This will help to seal the tank. Coating the outside of the tank will make the tank look better, but is not essential.



A soakaway pit for the tank

You will also need to make a hole for a soakaway under the tap for helping to drain water spilt from the tank to avoid puddles that can be health risks and allow mosquito breeding.

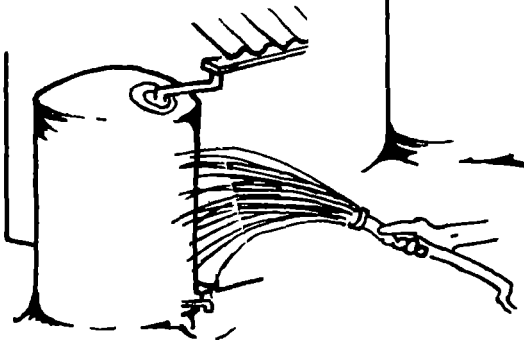
To make the soakaway pit, dig a hole under the tap about 1200mm (4') deep and 900mm (3') diameter close to the edge of the tank. Take some stones and fill the soakaway hole to about 600mm (2') deep, with bigger stones at the bottom. Then plaster the sides and around the top of the soakaway pit with the usual mortar (1:2).

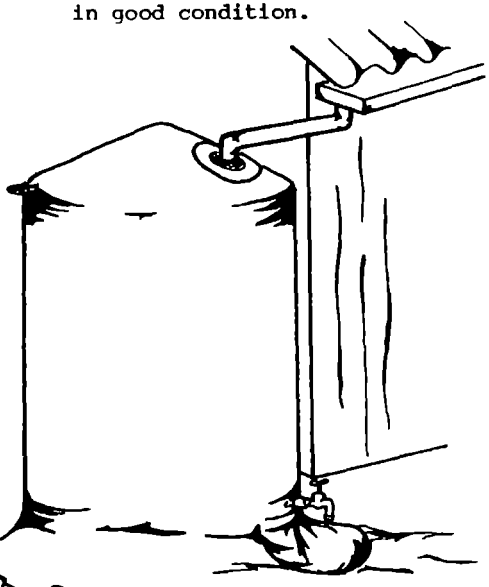


Installing the gutter and tank filling pipe

If your roof does not have a gutter you will need to fit one. Fit as long a gutter as possible to catch the most water. The gutter will need a gentle slope toward the tank filling pipe, so that the water flows to the tank and does not leave puddles in the gutter in which mosquitoes can breed. The tank filling pipe will also need a slope down to the filling lid. Cover the overflow pipe with plastic mosquito screen to keep out the insects, and the tank is ready for filling. PVC gutter and pipe is the lightest and cheapest to fit.

It is important to fit good guttering correctly: keep it clean and maintain it in good condition.





The tank is now finished. Do not allow the tank to fill too quickly or it could be damaged - follow the next instructions.

FILLING THE TANK

With a new tank it is important that the tank has been kept wet for a week while the mortar is curing, and to put water in the tank slowly when you first fill it. The tank may crack if the mortar has not been wetted or if it is filled too quickly. To fill the tank, allow the tank to fill a foot every few days, taking about 2 weeks to fill completely, so the tank can cure properly. This way the tank should last for many years.

TANK REPAIRS

The tank can be repaired if necessary if it leaks due to over-quick filling or other damage. If the tank is badly cracked, cut out the crack and carefully re-mortar the hole. If the tank has a slow leak, it is possible to repair this by filling the tank and adding two or three cup-fulls of cement powder to the water and stirring well, like adding sugar to tea. Do not take any water out of the tank and allow to settle for two weeks, by which time the leak should have stopped and be ready for use. If the leak continues, try the cement trick again.

NOTES

1. The tank can be built in larger capacities using the same techniques of construction. For the same height of tank, the following table tells you what size the diameter will need to be for larger volumes:

Volume		Diameter	
cu.m	gallon	metre	feet
6.6	1500	2.00	6'7"
8.4	1900	2.25	7'5"
10.3	2300	2.50	8'2"
12.5	2800	2.75	9'0"
14.9	3300	3.00	9'10"

2. The tank can be built elevated above ground level, raised up on a foundation. You can use one layer of standard size concrete blocks (approximate size - 140mm x 190mm x 380mm; 5.5" x 7.5" x 15") to elevate the tank by 190mm (7.5"). Two layers of blocks can be used to elevate the tank by 380mm (15"). In a standard size tank raised up by one layer, 15 blocks will be required.

(If you have any questions about the tank, please write to or telephone the Institute of Rural Development in Tonga).

NOTES - for your own notes and reference:

The leaflets project is supported by the European Economic Community (EEC) and the Australian Development Assistance Bureau (ADAB) through the Soroptimist Internationals of Victoria and Tonga.