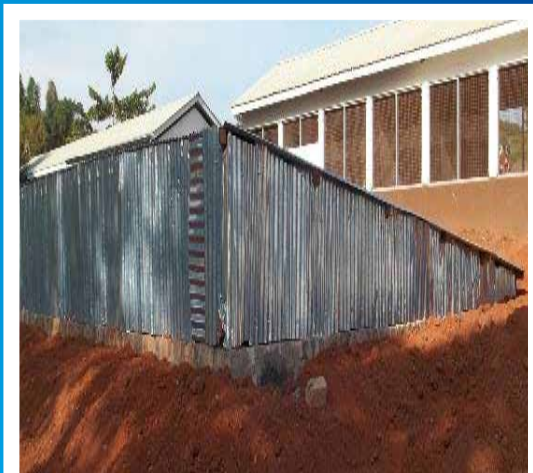


# Uganda Rainwater Association (URWA)

## A CONSTRUCTION DOCUMENTATION FOR THE PROMOTION OF 3R (RECHARGE, RETENTION AND RE-USE)



*Contributing Authors: Paito Obote, Ronald Ssebuliba,  
Compiled by Kikundwa .A. Birungi.  
2013*





## Table of contents:

About URWA .....	4
Introduction.....	4
Overview of RWH Practices.....	5
Design of RWH Systems.....	6
Pond construction .....	6
Pond design .....	6
Pond excavation .....	8
Lining of the pond .....	10
Pond covering .....	12
Water collection system .....	14
Construction of the ferro cement tank .....	15
Construction process .....	15
Construction of first flush device .....	23
Guttering .....	25
Operation and maintenance .....	25
BOQs for ferro cement tanks .....	27
Construction equipment and tools .....	28
BOQs for the pond .....	29

## About URWA.

Uganda Rainwater Association (URWA) is a national membership non-governmental organization (NGO) that was formed in 1999. URWA supports communities to improve their socio-economic situation through mobilization, information, skills and experience sharing. The major focus of community support has been rainwater harvesting for domestic water supply, but has now extended to rainwater harvesting for production and environment conservation. The organization works closely with the Directorate of Water Development (DWD) for policy guidance and direction.

URWA is a member of the Southern and Eastern Africa Rainwater Network (SEARNET), and Great Horn of Africa Rainwater Partnership (GHARP) regional co-ordination bodies, which seeks to strengthen co-ordination and information sharing among national associations in their efforts to promote rain water harvesting for increased Security, poverty reduction and improved livelihoods in the region.

URWA develops/documents innovative Rainwater Harvesting (RWH) technologies and Approaches that are shared nationally and internationally with its country and Regional partners, consisting of individuals, organizations and institutions. URWA maintains her networks with a number of organizations in the eastern and southern Africa engaged in development and promotion of RWH practices where wealth of experiences, lessons, and skills are accessed through these networks that facilitate rapid mainstreaming and uptake of RWH for the various sectors.

## Introduction

The key facilities we are focusing on are a 50m<sup>3</sup> pond to store rainwater for crop and animal production, and a 20m<sup>3</sup> ferrocement tank for domestic use. This guide will serve as a reference document for maintenance of the facilities and future replication.



## Overview of RWH Practices

In general, RWH is a practice of collecting and storing rainwater for future use, which can be broadly classified under:

- Potable water supply.
- Water supply for crop production.
- Water supply for livestock.
- Water for environmental conservation.

RWH systems consist of key components: catchment area/surface; collection system; and storage facility. Common catchment surfaces are: building roofs (thatched or hard surface); paved/stabilised or grass covered ground surface (yards or roads); rock outcrops; and natural ground surface. Storage tanks are made from various materials, the common ones in Uganda being: ferro-cement; plastic; corrugated iron; masonry (bricks, cement blocks, or stones); and reinforced concrete. The tanks can be constructed above ground, below ground, or partially below ground with the below ground tanks normally requiring a pump to extract the water.

Potable water supply requires clean RWH components (catchment surface, collection system, and storage facility) to ensure acceptable quality of the water stored and consumed. Rigorous O&M is therefore necessary to maintain high standard of hygiene. Roof or rock catchment systems with properly covered storage tanks are the common features of RWH for potable water supply.

RWH for production (crop or livestock) usually requires large catchment areas like rock outcrops, road surface, and ground surface with equally large storage facilities e.g. valley dams/tanks or ponds; smaller households facilities can also use roof catchment systems. Surface runoff from unprotected ground surface carries a lot of soil particles that can quickly silt up the storage – de-silting is usually too costly for the community. Valley dam or tank boosts surrounding groundwater; shallow wells can be constructed nearby to supply potable water.

RWH for environmental conservation is based on the 3R principles: Recharge, Retention, and Reuse. Various techniques are used to minimise soil erosion, increase soil moisture, and increase groundwater recharge. Soil moisture is used by crops/plants for better yield and increased groundwater can be easily abstracted for various uses (domestic and production).

## Design of RWH Systems

An overview of system design and technology options should be outlined. Many approaches can be used to determine the capacity of storage; storage is necessary to supply water when available water from the source at a particular time is less than the demand. With the water demand and the catchment area in a particular setting being relatively constant, the key factor in determining storage capacity is therefore the variability of rainfall (with time and in intensity).

Where the catchment area is large and the average rainfall is high, a simple approach is to provide storage to supply water through the longest dry period (90 – 120 days for the case of Uganda). The more rigorous approaches for determining storage capacity should only be applied where average rainfall is low or catchment area is small.

## Pond Construction

### 1.1.1 Pond Design

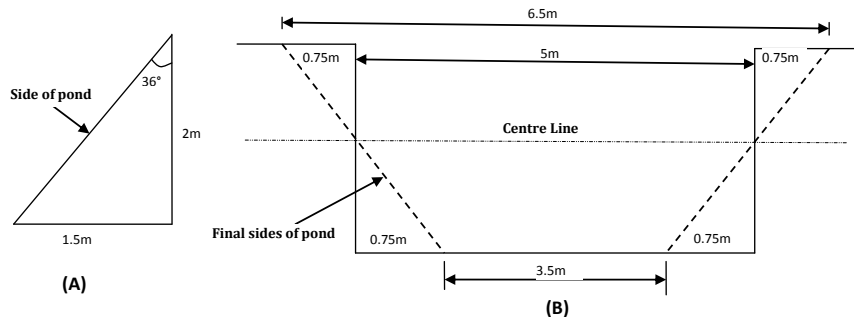
The pond capacity we are focusing on is 50m<sup>3</sup>. The design issues were related to: shape; depth; lining/waterproofing; water quality; and environmental health issues. Various methods can be used to draw water from the pond: using bucket; using manual (hand or foot) pump; or using motorised pump. A treadle pump was recommended for the pond constructed.



**The shape** of the pond is usually square or rectangular in plan with trapezoidal cross-sections. The sides of the pond are slanted to provide stability – the degree of slant (from the vertical) depends on the type of soil and can range from  $15^\circ$  (for very stable and firm soils) to  $45^\circ$  (for weak soils). The sides of the pond constructed slanted at  $36^\circ$  though the soil was fairly stable (i.e. compacted gravel); this was necessitated by the construction method chosen.

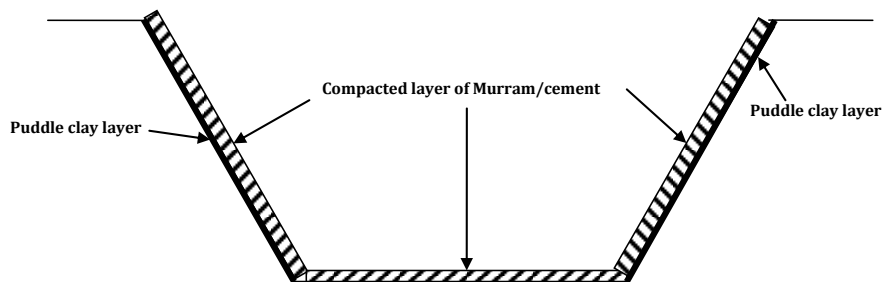
**Pond depth** should be selected such that it is deep enough to reduce on the surface area (i.e. not less than 1.5 metres) and not too deep to cause instability of the sides or reduce seepage due to increased pressure (i.e. not more than 2 metres). The final depth of the pond constructed was 2 metres.

**Pond dimensions** were determined using the slant of the sides the depth decided above i.e. for the side slope of  $36^\circ$  and the depth/height of 2 metres, the base (horizontal length) of the slant is therefore 1.5 metres (figure 1 (A)). An easy way to approximate the actual shape of the pond is to start with a square pond with vertical sides i.e. for the pond depth of 2 metres, the length and width of the pond would be 5 metres giving a volume of  $50\text{m}^3$  (figure 1 (B)). From the centre line (at mid depth), rotate the sides of the pond with the upper parts moving outwards 0.75 metre and the lower part moving inwards 0.75 metres giving a total slant base of 1.5 metres; the new dimension of pond will then be 6.5 x 6.5 metres at the top and 3.5 x 3.5 metres at the base (figure 1 (B)).



**Figure 1: Determining pond dimensions; (A) – side dimension and (B) – pond dimensions.**

**Pond Lining** is provided to reduce water seepage and to stabilise/strengthen the sides of the pond against collapse. Different lining materials can be used depending on their suitability and availability of funds; the common lining materials include: (i) polythene sheet; (ii) tarpaulin; (iii) polymers applied to firm soil; (iv) puddle clay (usually mixed with soil); and (v) compacted gravel/Murram stabilised with cement or lime. The materials chosen for the pond constructed were puddle clay combined with compacted Murram stabilised with cement. The desired thickness of the lining was 0.25metre (25cm) on the sides and 0.15metre (15cm) on the base.



*Figure 2: Pond design showing clay and Murram lining*

**Pond Covering** is provided to: (i) prevent breeding of mosquitoes; (ii) reduce water losses due to evaporation; (iii) prevent growth of algae; and (iv) reduce risks of drowning to humans and livestock. The covering used for the pond constructed was iron sheet roof with cladding.

### 1.1.2 Pond Excavation

The actual shape/size of excavation for the pond is determined by adding the desired thickness of pond lining i.e. 0.25metre for the sides and 0.15 metre for the bottom (above) to the desired final pond size/dimensions

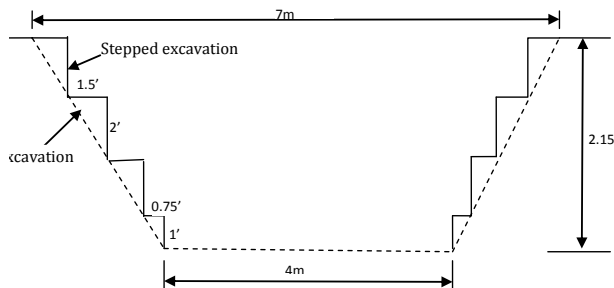


i.e. top dimension: 6.5 x 6.5 metres; bottom dimensions: 3.5 x 3.5 metres; and depth of 2 metres (figure 1). The dimension for excavation was therefore: 7 x 7 metres (top); 4 x 4 metres (bottom); and 2.15 metres depth (figure 2).

Excavation of pond to achieve the desired depth and side slopes was achieved by first excavating such that the sides form steps; the ratio of the horizontal and vertical lengths should be 1.5:2 to correspond to the length of the base and height of the side slant (figure 1). For the pond constructed, the base of the excavated steps was 1.5 feet and the depth was 2 feet (figure 2).

**To excavate the steps:** (i) mark out the top dimensions of the excavation i.e. 7m x 7m; (ii) mark out the first step to be excavated inwards from the top dimensions i.e. approximately 6.1m x 6.1m (1.5 feet from the external lines); (iii) excavate inside the inner square down to 0.6 metre (i.e. 2 feet) and level the bottom; (iv) mark out the second step and excavate as above; (v) repeat step four for the third step; (vi) after the third step, the depth of the tank is already 1.8 metres (i.e. 6 feet) leaving only about 0.3 metre (1 foot) to excavate; the fourth step should therefore only be half the size of the other steps i.e. 0.75' x 1' (figure 3).

After excavating the pond with stepped sides, cut off the steps from the top to the bottom (step by step) as indicated below (figures 3, 4, and 5).



**Figure 3: Pond excavation; first with stepped sides and then with straight sides**



**Figure 4: Stepped excavation for pond**



*Figure 5: Excavation completed by cutting off the steps from the sides of the pond*

## Lining of the Pond

The pond was lined by applying a layer of puddle clay (about 5cm thick) and then compacting a layer of Murram mixed with cement (the mix ratio being 1bag of cement to 12 wheelbarrows of Murram). The cement/ Murram mix was first moistened with water and then compacted in thin, horizontal layers (not more than 15cm) for better compaction.

Murram compaction can be done manually using earth ram or using mechanical compactor. A mechanical compactor was used for the pond constructed; a wide strip of Murram (i.e. about 40cm) was therefore compacted to allow the compactor to pass without falling off (figure 6). Each layer was properly compacted – the plate compactor made four to five passes on each layer. When compacting manually, a narrow strip of about 20cm can be compacted thereby saving on cement used.



**Figure 6: Apply a layer of puddle clay (left) then apply a layer of cement/Murram and compact (right)**

Continue compaction/lining in layers up to the top before trimming off the excess compacted Murram to the desired thickness of about 20 centimetres. To trim off the excess Murram, mark out the desired top dimension of the pond (i.e. 6.5 x 6.5 metres) and trim carefully from top to bottom up to the desired bottom dimension of the pond (i.e. 3.5 x 3.5 metres) (figure 7).

After trimming, apply about 20 centimetre thick layer of Murram/cement to the bottom of the pond and compact thoroughly to complete the pond lining phase. The soil moisture provides adequate curing for the cement used in stabilising the Murram to allow it to set and dry properly. **In cases where the soils do not hold water, a dam liner is used for lining the pond.**



**Figure 7: Continue compaction in layers up to the top (left) and trim off excess compacted Murram (right)**

## Pond Covering

The pond covering and cladding was galvanised sheeting on timber frames. A plinth wall was first constructed to (i) level the top of the pond and (ii) carry the covering and cladding. Timber frame (trusses and purlins) are then fixed on timber wall plates attached on the plinth wall (figure 8) to receive the sheet covering and cladding (figures 9 and 10).





***Figure 8: Erecting timber frames on the plinth wall for pond covering***



***Figure 9: Fixing roofing sheet covering over the pond***



***Figure 10: Cladding fixed with provision for future access for maintenance; excavated soil is pushed back against the plinth wall to protect the wall and prevent under-scouring by surface runoff***

## Water Collection System

The pond constructed will store rainwater from an adjacent roof catchment system as well as water from the pond covering. Drainage channels were constructed to receive the rainwater from the roofs and convey it into the pond through an inlet in the plinth wall (figure 11). Rainwater from the main roof catchment is collected in gutters and downpipes and then channelled into the pond.



**Figure 11: Drainage channels under construction (left) and with collection box completed (right)**



# Construction of the ferrocement tank.

The tank needs to be constructed together with water jar to act as a first flush for the big tank. The purpose is for ensuring that the big water system receives only clean water after the dirty water collecting in the first flush system.

## Construction process

### Step 1: Siting (Positioning) of Rainwater Harvesting (RWH) Tank.

Siting of a tank should take into consideration a number of issues:

- **Accessibility** – the tank should be placed in an area that is easily accessed by the users.
- **Proper/easy guttering** – the tank should be placed preferably on the lower side of the roof for ease of guttering; the tank should not also be more than 2 metres from the wall.
- **Convenience** – the tank should not hinder movement of people around the house or indeed block the passage of air through the house i.e. should be at least 1 metre from the wall.
- **Firm foundation** – the tank should be positioned on a firm ground to reduce risk of cracking or sinking that may affect the tank.
- **Appearance** – the tank should not badly affect the beauty of the house, instead it should add to the beauty where possible.
- **Availability of space** – this eventually determines where the tank will be located. Ideally tank should be located at the end of the house – generally out of the way but still accessible.

## Step 2: Constructing Tank Base



**Base construction**



**Applying concrete on the base**

## Excavation for Foundation

After determining the location of the tank, prepare the ground for the foundation construction:

- Clear the ground of vegetation cover and the top soil and remove the material from site – the area cleared should be wider than the base of the proposed tank.
- Excavate to level the ground and spread the soil elsewhere in the compound – the levelled ground should also be wider than the base of the proposed tank starting about 1.2 metres from the wall of the house.
- After leveling and clearing the ground, fix a peg in the ground at the centre point of the tank and mark





out a circle of a diameter for the foundation on the ground with a stick tied to a firm building string attached to the centre peg.

- With the same centre, mark out a second inner circle to achieve a foundation strip of 0.3 metres.
- Excavate the foundation strip with a hoe or pick axe up to firm soil – minimum depth of foundation strip should be 0.3 metres.

## Constructing Plinth

- Construct plinth and water collection chamber out of stone or clay bricks masonry bonded in mortar (cement to sand ratio of 1:3). The plinth can be raised above ground to accommodate a Jerrycan; where the roof level may be too low to accommodate a raised tank, the plinth should only project slightly above ground and the collection chamber constructed partially below ground.
- Fill up the base of tank with compacted hardcore ready for concreting.
- Cut and join pieces of weld (BRC) mesh to the required diameter (e.g. 1.8 metres diameter for 4m<sup>3</sup> tank) as reinforcement for the tank base. Join the pieces using binding wire ensuring an overlap of at least 15cm or 1 complete square for BRC mesh.
- Fix the washout and the delivery pipes using binding wire onto the mesh before casting concrete. Ensure that the delivery pipe is aligned on top of the water collection chamber.
- Cast 5 – 7cm thick concrete base (1:3:6 ratio) to cover the reinforcement leaving about 20cm of the mesh at the edge uncovered ; the exposed/uncovered mesh would be used for fixing the wall mesh/ mould.

## Step 3: Constructing Tank Wall

### Fixing the mould and mesh

- Join the required number of weld mesh sheets (1.2m x 2.4m each) with binding wire to form the mould that would be fixed along the circumference of the tank wall. The sheets should be lapped appropriately to form the overall dimension i.e. the width being slightly longer than the tank height (say 1.9 metres) and the length slightly longer (for lapping) than the circumference of the wall; the circumference of the wall is determined by multiplying the central diameter of the wall (Table 1) by 3.14.
- Roll in the ends of the joined sheets of weld mesh and fasten them together using binding wire to form a cylindrical shape of the tank wall.
- Cover the mesh/mould with gunny bags joined together with sisal strings – the gunny bags should lie flat on the mesh and stretched to remove creases.
- Place the mould on the tank base and centre it using a string the length of the tank radius tied to the centre peg/nail and tie the mould from the inside with binding wire on the uncovered floor mesh.
- Wrap the chicken mesh tightly on the wall mould and join the ends using binding wire straightening out any creases that may appear.
- Tightly wrap the galvanized wire continuously over the chicken mesh at 10cm spacing; tie the galvanized wire through the gunny bags onto the mould mesh at regular intervals to prevent it from slackening as you continue wrapping. Note that over tightening the galvanized wire may seriously deform the wall mould making it difficult to align.



- Align the wall mesh vertically using sisal strings tied on the mould mesh in areas that are deformed and pulled to align the mould sufficiently then tied to pegs driven in the ground.

## Plastering Wall

- Prepare mortar of ration 1:3 using clean, sieved sand ensuring that the mortar is not too wet or too dry.
- Press the mortar onto the mesh in about 1cm thick layer.
- When first layer to set adequately (for at least 12 hours), untie the binding wires used for holding the galvanized wire on the mould and apply the 2<sup>nd</sup> layer of mortar on the outside (about 1.5 cm thick) and trowel hard with a wooden float to give a smooth finish .
- When the second layer is sufficiently set (for at least 12 hours), untie the binding wires fixing the mould mesh on the floor reinforcement mesh and those that were used to join the weld mesh and remove the mould from the tank .
- Prepare a little concrete (1:3:6 ratio) and finish concreting the floor up to the wall.
- Prepare mortar (as above) and adding leak-seal/waterproof cement (as specified by the manufacturer) and press about 1 cm thick (third) layer on the inside. Remember to insert the overflow pipe and plaster all around it.
- When the third layer has set adequately (for at least 8 hours) apply another 1.5cm thick mortar (with waterproof cement) as 4<sup>th</sup> layer on the inside to make a total wall thickness of about 5cm.

- Prepare mortar screed adding waterproof cement and place about 2.5cm thick layer on the floor ramming it hard for proper compaction and trowel it smooth; the finished floor should slope towards the washout pipe
- When the fourth layer on the wall has set adequately (for about 2 hours), trim off the excess mortar and trowel hard with wooden float.
- Prepare a thick cement slurry and then apply about 2mm thick layer on the inside wall and the floor pressing it smooth with steel float or trowel.

## Step 4: Constructing Tank Cover/Roof

### Preparing Mould for Tank Cover

- Mark out a circle of diameter equal to the central diameter of tank wall on a leveled ground.
- Either excavate the inside of the circle to form a uniform curve about 22 – 25cm deep at the centre (depending on the size of the tank) or heap soil inside the circle and compact it to form a uniform curve about 22 – 25cm high at the centre . Make the curve smooth and firm using compacted sand/soil to reduce the corrugations.
- If surface of the curve is not firm, line it with gunny bags to prevent soil mixing with mortar. Cut and place chicken mesh on the curve joining the pieces by hooking with the cut wires on the edges to make it lie flat on the curve. Then cut, shape, and tie galvanized wire as reinforcement for the roof over the chicken mesh pressing it down wire hooks driven into the ground; the access hole should be marked out with a ring (50cm diameter)made of galvanized wire .

## Plastering the Cover

- Apply about 2cm of well mixed mortar (ratio 1:2) all over the surface excluding the access hole.

*Note that the tank cover should be made during the first days of construction to give enough time for it to dry/set adequately for lifting. The cupped method is risky because the cover has to be flipped over before placing on the tank.*

## Covering the Tank

- Lift the dry cover (after at least 5 days), wash it, and place it on top of the tank wall (Figure 14).
- Trim off excess mortar and mesh on the edge of the cover and join the protruding wires and mesh together with that of the wall.







Roofing of the tank

## Construction of the First flush device

A first flush system has to be installed so that the first water that falls on the roof is collected in a cistern and used for activities that don't necessarily require very clean water like for agriculture, livestock or cleaning. Then the rest of the water collected can go into the main storage system to be used for cooking drinking and other domestic activities that may arise.

## Process

- (a) Construction of the base
- (b) Construction of the walls
- (c) Construction of the cover





**Setting of the first flush device base**



**Setting of the first flush device base**



**Construction of the base of the first flush device.**



**Construction of the first flush device cover.**



## Guttering

They are usually fixed to a wooden or plastic fascia board. Good guttering matters. Failure of guttering is the commonest cause of failure in established RWH systems and sometimes even prevents new systems from ever functioning. It is common to see gutters that are twisted, that are bent, that leak at the joints or that fail to intercept the roof run off well. Gutters are installed to capture rainwater running off the eaves of a building. Some gutter installers can provide continuous or seamless gutters. For potable water systems, lead cannot be used as gutter solder, as is sometimes the case in older metal gutters. The slightly acidic quality of rain could dissolve lead and thus contaminate the water supply.

**Procedure:** Tie a string with reasonable inclination from one end to another end of the fascia board. Fix clips/ cramps with 2" nails. Ensure 90cm spacing between each other. Place gutters with an overlap of about 15cm. Connect bend and down pipe leading to the tank. Rainwater harvesting gutters are mainly PVC plastic and galvanized metal gutters. PVC gutters are more recommended as they do not rust so water quality will be maintained over a long period of time. The correct installation of gutters is most important so that there are no flat areas where debris and water may pool, as these may provide sites for mosquitoes to breed.

## Operation and Maintenance

Issues of sustainability of the facilities, good hygiene and sanitation practices ensure good quality water and proper usage of the facilities that were discussed. There is always a session normally conducted on the last day after when all the construction techniques have been got. The topics revolve mainly around proper operation and maintenance of the facilities constructed.

Regular inspection, cleaning, maintenance and occasional repairs of all tank /pond components ensure that the maximum amount of good quality rainwater is collected.

The following tasks should be done at least once a year to keep the catchment well maintained:

1. Keep the house and tank roof in good condition. Repair any holes in the roofing material to prevent leaking. Seal any nail holes that are leaking.
2. Clean the house roof between rainfalls. Debris and excrement from birds and small animals can be removed by sweeping the roof often.
3. Keep the gutters in good condition. Be sure that they are firmly fixed to the roof and that they are joined to prevent spilling. Repair any holes in the gutter to prevent leaking. Check bamboo or wood gutters once a year for rotting. Replace them if there is any sign of rot.
4. Periodically remove leaves and other debris from the gutters to avoid clogging and water overflow, and also contamination of the water itself.
5. Wash out the tank using the washout pipe in preparation for the rains to clean out soil and dust that has settled on the floor of the tank.
6. Regularly inspect taps to ensure that they are not broken or leaking. A leaking tap can quickly lose thousands of litres and drain a surface tank. Any leaks should be fixed immediately.
7. Regularly check tanks for any cracks. Any leaks should be repaired immediately.

**Note:** Information taken from the Centre for Affordable Water and Sanitation Technology (CAWST), *Roof Catchment Systems: 2007*.



## Bill of Quantities for a 20,000 Ferro-cement Tank

Item	Description	Unit	Quantity	Comments
	<b>Building Materials</b>			
	Cement (not expired)	Bag		
	Burnt Bricks (Clay)	Pc		For foundation wall
	Chicken Mesh (1/2" or 3/4")	M		
	BRC Mesh (G10) – 2.4m wide	M		For reinforcing the slab
	Galv. Wire (1.5mm)	Kg		
	Galv. Binding Wire	Kg		
	River or lake sand (clean)	Ton		
	Aggregate (1/2" or 3/4")	M <sup>3</sup>		
	Hardcore	Ton		Depends on plinth height
	Water Proof Cement	Kg		
	Delivery Pipe + Tap	Unit		
	Washout – 1 1/4" GI	Unit		With elbow, socket & plug
	Overflow – 2" GI	Unit		
	Manhole Cover/Frame	Unit		Can be made from mortar
	<b>Labour</b>			
	Mason	P/day		

	Supervision	P/day		
	Labourers	P/day		
	Construction Water	Litres		
	Materials Transport (UGX)	LS		May vary with locations

## Construction Equipment and Tools for Ferro-cement Tank

**Table 3: Construction Equipment and Tools for Ferro-cement Tank**

Item	Description	Unit	Quantity	
	Step ladder (2.5m high)	No.		Made from wooden poles
	Weld Mesh (mould)	Pc.		
	Polythene Sheet	M		
	Sisal String	Roll		
	Gunny/polythene bags	No.		
	Wheelbarrow	No.		
	Masonry Trowel	No.		
	Wooden float	No.		
	Spirit level	No.		
	Plumb bob	No.		
	Pliers	No.		



	Club hammer	No.		
	Shovel	No.		
	Concrete rammer	No.		
	Hacksaw	No.		
	Mortar pans	No.		
	Tape measure	No.		
	Straight edge	No.		
	Sand sieve	No.		

## Bill of Quantities for the pond.

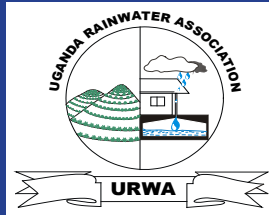
The following Bill of Quantities (BOQ) serves as a budgeting guide; quantities may vary depending on site conditions and availability of key construction materials. The prices/costs indicated are averages from the training – labour charges are however objective estimates since trainees who contributed were not paid.

Item Description	Quantity	Amount (UGX)	Comments
1. Pond Excavation	65 m <sup>3</sup>	550,000	
2. Cement	21 bags	556,500	
3. Murram	10 tons	0	Obtained on site
4. Burnt clay bricks	1000 pcs	270,000	
5. Sand – mixed	1 trip	150,000	Includes transport
6. Hire of compactor	5 days	400,000	Includes fuel



7. Timber for roofing (assorted)	Lot	590,000	
8. Wire nails (assorted)	18 kg	90,000	
9. Roofing nails	6 kg	39,000	
10. Corrugated (GI) sheets	36 pcs	882,000	
11. Stirrups (6mm)	2 pcs	12,000	For tying wall plate
12. GI gutters and PVC drain pipes	Lot	442,000	Includes elbows and brackets
13. Transport of materials	LS	300,000	Excludes Murram
14. Skilled labour (pond construction)	LS	700,000	
15. Casual labour (pond construction)	LS	220,000	
16. Labour (fixing gutters)	LS	200,000	
17. Treadle pump	1 set	420,000	
<b>TOTAL</b>		<b>5,821,500</b>	





# Uganda Rainwater Association (URWA)

UGANDA RAINWATER ASSOCIATION (URWA)

P.O. Box 5315, KAMPALA.

Plot 1109, Mubiru Road Nsambya

Tel: +256-414697139

E-mail: [ugandarainwater@gmail.com](mailto:ugandarainwater@gmail.com)

Website: [www.ugandarainwater.org](http://www.ugandarainwater.org)