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CuveWaters Construction Manual # 3

Pond

*Documentation and Work Instructions for Participants
of Training on Rainwater Harvesting Construction*



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#6 Sustainable Techniques and Practices for Water Harvesting and Conservation
and their Effective Application in Resource Poor Agricultural Production
(copy provided by the Water Research Commission South Africa)

Preface

„CuveWaters – Integrated Water Resources Management in central-northern Namibia” is a joint research project of German and Namibian partners funded by the German Federal Ministry of Education and Research (BMBF). Main research partners are the Institute for Social-Ecological Research (Frankfurt, Germany) and the Technische Universität Darmstadt (Darmstadt, Germany). Partners in Namibia are for example the Ministry of Agriculture, Water and Forestry (MAWF) and the Desert Research Foundation of Namibia (DRFN), the project furthermore closely cooperates with One World Consultants (OWC) from Kenya. CuveWaters has developed different technologies for water supply and sanitation in central-northern Namibia, ranging from Groundwater Desalination to Rain- and Floodwater Harvesting as well as Sanitation and Water-reuse. Between 2009 and 2013 different pilot plants were constructed at different places all over central-northern Namibia.

This Manual was developed as part of the Capacity Development measures within the technology line of rain- and floodwater harvesting. It is intended to guide you through the process of constructing rain- and floodwater harvesting infrastructure in Namibia.

This Manual is part of a series of Rain- and Floodwater Harvesting Manuals for Namibia:

Water Storage:

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#2 Rectangular Underground Tank

#3 Pond

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For more information on organisational, institutional and other general aspects of rain- and floodwater harvesting please have a look in the “CuveWaters Rain- and Floodwater Harvesting Toolkit”.

For more information on the CuveWaters project please visit <http://www.cuvewaters.net>

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Technische Universität Darmstadt

Darmstadt, 02.03.2015

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About

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CuveWaters – Integrated Water Resources Management in Namibia

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This manual is also available on <http://www.cuvewaters.net/Publications>

For more information on Rainwater Harvesting in Namibia please contact

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1 Preliminary considerations

Before beginning with the construction of the pond, these preliminary considerations and following work instructions should be read carefully. Indication of days means working days of 8 hours, although this may vary from one day to another. The labor needed for the construction process as described is about 5 workers per day. This is not viable for the excavation work for the pond itself. If excavation is done manually, up to 12 workers can be blocked for several days. Nevertheless, contracting the excavation to a company which provides digger and operator will be cheaper. Cost for excavation done with a digger can be found in bill of materials (chapter 4). Special skills in construction are not needed for the pond construction.

The construction manual describes how to build a pond of 18 m x 3.5 m and a volume of 80 m³ for water storage as conducted during the CuveWaters project for development and implementation of rainwater harvesting as a part of an Integrated Water Resources Management (IWRM) system.

1.1 Materials & Tools Preparation

Ideally, most materials (see bill of materials) should be purchased and brought on site before start of construction or at least until needed at construction site. Storage facilities for materials and tools should be provided at or close to construction site. The materials should be stored secure against weather conditions (e.g. rain, wind, and extreme heat) and theft. Tools needed for construction of the underground tank should be available for the period of construction.

Material supply

All materials needed for construction can be obtained from hardware shops that can be found all over Namibia. In central-northern Namibia you will find the necessary materials for example in the following shops:

- Oshana Build it, Ongwediva (recommended, first choice)
- Benz Building Supplies, Ongwediva (recommended, second choice)
- Pennypichers, Ongwediva
- Pupkewitz Megabuild, Oshakati
- Chico, Oshakati

Please keep in mind that prices can differ in the different shops and seasonal variations are also common. So plan your construction site and the material supply well in advance and compare the prices in the different shops. Most hardware shops offer delivery of the materials for reasonable fees.

Dam Liner

Please keep in mind that the dam liner necessary for the pond construction is not available in Namibia but can be ordered from Build it South Africa via its Namibian branches. Delivery from South Africa will take up to three weeks, so please plan and order well in advance.

1.2 Siting recommendations

Study the overall conditions at the site where greenhouse, pond and/or water tanks shall be constructed. Choose the site for the pond, in a way which allows that the rainwater can easily flow from a (roof) catchment into the pond. Also consider that there is enough space for all infrastructures needed (e.g. water pump, storage facility, etc.).

In addition make sure that the pond is not sited next to a tree. The roots would complicate pond construction and may reduce its durability. Minimum distance from trees, and buildings as well, should be 10 m. If possible, choose a site where the ground does not contain a lot of rocks and stones. This will reduce the effort for excavation, when this is done manually.

1.3 Pond size and other dimensions

This manual describes how to construct a pond for water storage of a volume of 80 m³. The dimensions of the pond on the ground surface are 18 m in length and 3.5 m in width. The pond itself is 2 m deep, consisting of an excavation of 1.7 m with sloping sidewalls and of a dam of 0.3 m. The dimensions of the ground surface of the excavation are 15 m x 2 m.

The pond described here is made of a dam liner which ensures the water tightness of the tank. The pond is fenced and covered by shade net which reduces loss of stored water due to evaporation. The pond described in this manual is covered with shade net as with a flat roof. Constructing a pitched roof and/or coverage with a roof made of corrugated iron is possible as well.

If a bigger volume for water storage is needed, the length and the width of the pond can be increased e.g. to 20 m x 4 m which will lead to a volume of 110 m³.

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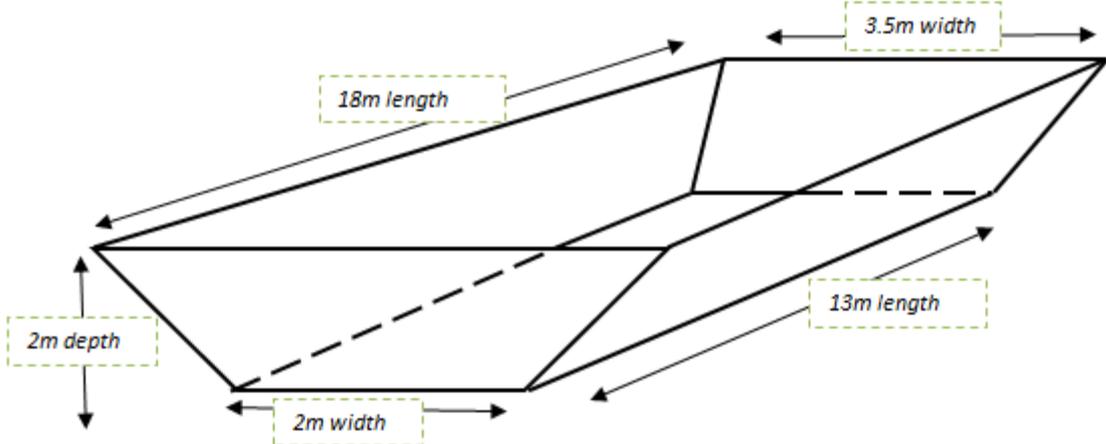


Figure 1: Illustration of pond and its dimensions.

2 General Work Instructions

For the construction of the water storage pond there are no special construction processes needed. No concreting, welding, soldering, or other construction procedures have to be executed and hence there is no need to describe them here.

3 Detailed Work Instructions – Construction Diary

The sequence of actions for construction of a pond described below is an ideal one. Depending on manpower, soil conditions, and weather conditions the overall construction time may be longer than this. Sequence may slightly be changed depending on availability of manpower, materials and tools as well as for weather conditions or other reasons. Some of the steps should be done parallel to work most efficiently. Ensure that all material and tools needed for construction are available at the time they are needed. Usually, 5 workers are sufficient to construct the pond. Nevertheless, excavation does need a lot more manpower, if done manually.

3.1 Day 1: Siting, Preparation, and Excavation

On the first day of pond construction, the site has to be chosen. As well, ensure that all material needed is available when construction is started or at least when specific material is needed during the construction process. When all material is available and pond construction site is marked, the excavation can be done.

Work instructions:

- Choose a site for the underground tank according to the considerations in chapter 1.2.
- Mark the dimensions of the pond on the ground with wooden pegs and cord. Both, interior dimensions at lower surface of the pond (13 m x 2 m) and dimensions above the surface (18m x 3.5 m) have to be indicated. This results in two rectangular areas where the smaller is centered.
- Excavate the ground as indicated by the smaller rectangle. Excavation shall be 1.7 m deep and excavated ground shall be put around the larger rectangle marked on the ground.



Figure 2: Marked construction site and ongoing excavation work.

3.2 Day 2: Excavation

On the second day of pond construction the excavation for the pond is continued. When soil conditions are good, excavation can be finished that day. If soil conditions worsen, the excavation could take longer than two days.

Work instructions:

- When the excavation is 1.7 m deep, form sloping sidewalls of the pond by removing soil from the walls of the excavation. Start of the slope is the cord on surface level; end is the surface of the excavation.
- The soil from the excavation shall be banked up to form a dam around the pond of 0.3 m height and 0.5 m width.



Figure 3: Construction of the sloping sidewall of the pond.



Figure 4: Excavation and dam for pond completed.

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3.3 Day 3: Installation of dam liner

On the third day of pond construction, the dam liner will be installed to the pond. The liner is essential for water storage and has to be handled with care to avoid any damage.

Work instructions:

- Unfold the dam liner from its transport packaging on even and free ground. Inspect dam liner for damages and holes that would cause loss of stored water.
- If dam liner is undamaged roll it up to allow an easy installation to the pond.
- Place the rolled up dam liner along the small side of the pond and start pulling it across the pond.



Figure 5: Dam liner inspection.

Figure 6: Pulling dam liner across the excavation of the pond.

- Dam liner for above mentioned pond size should be 26 m x 9 m. To bury the overlapping liner, make a trench of appropriate depth and width. Put overlapping dam liner in and cover it with soil.
- When dam liner is in place and secured by burying its edges, an area of 21 m x 6 m around the pond has to be indicated by putting wood pegs into the ground and stretching cord from one to another. This indication is where the pond will be fenced and the roof made of shade net will be attached.
- Cut wooden poles to pieces of 1.2 m length. In total 16 pieces of 1.2 m each are needed.
- Ram the wooden posts into the ground along the indication. For each of the long sides of the pond 7 posts are needed. The distance from one to another is 3.5 m. In the middle of each of the short sides one pole has to be put into the ground. Posts should be 50 cm in the ground and 70 cm above it.



Figure 7: Burying overlapping dam liner in the ground and covering it with soil.



Figure 8: Installation of posts around the pond for fencing.

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3.4 Day 4: Completion of fencing and preparation of shade net.

On the fourth day of pond construction, the fencing around the pond will be completed and prepared for the installation of the shade net. Furthermore, the single lengths of shade net have to be joined to form an appropriate cover for the pond.

Work instructions:

- Cut wooden poles to pieces of 3.5 m length, position, and nail them on top of posts (put into the ground the day before). For the long sides of the tank 12 pieces of 3.5 m length each are needed.
- Position and nail wooden poles of 3 m length on top of posts of the small side.
- Stretch binding wire across the pond and tie it to the vertical poles of the fence. This will support the shade net from sagging.
- From one short side to the other short side in total 5 lines of wire have to be stretched. The lines have 1 m distance to the wooden fence around the long side as well as to the next wire.
- From on long side to the other long side in total 11 lines of wire have to be stretched. The lines have a distance of 1.75m from the wooden fence around the small sides as well as to the next wire.
- Finally joint the lengths of shade net together with needles and twine to make a shade net of 22.5 m x 7.5m.



Figure 9: Binding wire attached to the fence of the pond.

3.5 Day 5: Installation of shade net

Day 5 of construction is the completion day of the pond. The shade net will be placed upon the pond and fixed to the wooden fence.

Work instructions:

- Pull the shade net of 22.5m x 7.5m across the pond and adjust it in a way overlap on all sides is similar.
- Tie the shade net to the wooden fence with twine.
- Make a hole into the shade net, where the downpipe from the gutters will drain the water into the pond.



Figure 10: Pulling the shade net across the pond.



Figure 11: Tying the shade net to the fence of the pond.

To reduce evaporation, the pond can be covered with shade net and plastic sheeting. The plastic sheeting will reduce ventilation, which leads to higher temperature in the pond. Nevertheless, water cannot evaporate through the plastic foil. Instead of shade net, it is also possible, to cover the pond with a roof made of corrugated iron.



Figure 12: Completed pond with shade net and fenced additionally with wire.

Your pond is ready!

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4 Estimated Bill of Material

	Material	Quantity	Approximate Amount in N\$
1	Gum Poles 50/75mm x 3.6m	20	1400
2	Gum Poles 75/100mm x 4.2	5	730
3	Binding Wire 2mm x 200m	1	100
4	Twine Sisal 1 Ply 500gr.	8	210
5	Nails Wire 120mm x 5mm 1kg	4	85
6	Dam Liner, 26m x 9m	1	9500
7	Shade Net 80%, 3m	65	4900
	Total Materials		16925
8	Proposed Labor (man days)	25	2500
9	Excavation Work (hiring for 1 day)	1	5650
	Grand Total		25075

Material needed for drainage system from rain catchment to pond is not included in this bill of material.

5 Bill of Tools

	Tools	Quantity	Approximate Amount in N\$
1	Spade	2	210
2	Shovel Round	4	410
3	Handle Hoe	3	110
4	Hoe Head	3	135
5	Hammer Claw 500gr	2	340
6	Plier, combination	2	100
7	Seewing Needles	5	20
8	Plier, combination	2	100
9	Hand Saw 550mm	2	210
10	Tape Measure 5m x 25mm	2	80
11			
	Grand Total		1715

Amount of tools needed depends on number of workers supporting the construction of the ferrocement tank. Tools and Quantity listed above is suitable for 5 workers in general and 10 for excavation.

6 Construction Procedure Table

The day of preparation was not counted in the detailed work instruction, but is counted in the table below.

Day	Activity	Materials used	Remarks
Day 1	Purchase and supply of materials.		
Day 2	Siting, Preparation, and Excavation	Twine / cord Wood peg	
Day 3	Excavation		
Day 4	Installation of dam liner	Dam liner 27m x 9m Twine / cord Wood peg Gum Poles 75/100mm x 3m	
Day5	Completion of fencing and preparation of shade net	Gum Poles 75/100mm x 3.5m Shade Net Twine Nails Binding wire	
Day 6	Installation of shade net.	Twine	

7 Maintenance of the Pond

The pond is a very robust water storage solution. Position of dam liner directly on the ground reduces stress for components of the tank. Nevertheless, the coverage with shade net is very sensitive against mechanical loads and damages due to objects lying on top of it. Do not place any objects on top of the shade net! Furthermore, do not try to step up on the coverage made of shade net! It is not strong enough to carry your weight.

In any case regular maintenance and repair on demand may be necessary during the lifetime of the pond.

7.1 *Visual inspections*

Once a year, latest short before wet season, when pond is empty or close to be empty check if the dam liner of the pond is still without damages. Rips and holes in the liner lead to water leakage and as a result loss of water for horticulture.

7.2 *Cleaning the pond*

Short before the wet season begins, or at any other time the pond is not filled with water, clean the pond with a brush and/or cloth. First remove large objects, such as leaves, by hand. Then, remove dirt, dust and mud from the ground of the pond.

7.3 *Repair of cracks*

In case the dam liner is ripped and/or a hole was recognized during the inspection the dam liner should be repaired as soon as possible. In general, two methods are possible. Method one is gluing a piece of dam liner on top of the liner of the pond with super glue. The second method is melting a piece of liner and sealing the hole in the liner with the melted material.

Rips in the shade net should be stitched together with twine.