Rice University Lesotho Sustainability Assessment Project, 2009

Rainwater Harvesting System Manual

What is rainwater harvesting?

Rainwater harvesting is a method of collecting and storing rainwater; this particular system works by installing sloped gutters at the edge of a roof so that rainwater flows into a tank. This system can provide an additional source of water for irrigating crops, washing, or even drinking water if properly treated first. Around 700-800mm of rain falls in Lesotho annually, most of it between October and March. With an efficient collection system, this water can be stored in a tank and used throughout the winter, when water scarcity is a pressing concern.

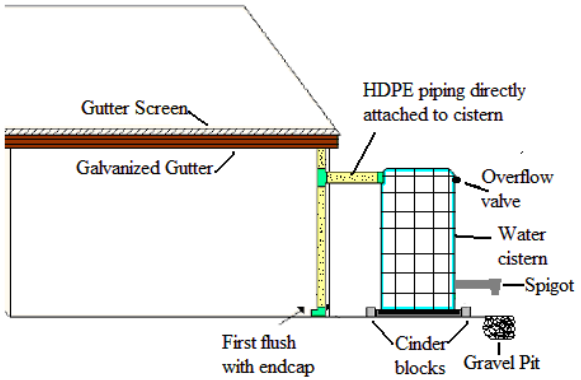

Figure 1: *Schematic design of rooftop rainwater harvesting system*

Making the system sustainable:

The best way to allow this system function for a long time is to keep it clean and secure through routine maintenance. To ensure that debris and contaminants do not enter the storage tank, screens were installed over the gutters, a first flush diverter was added, and the connection to the inlet of the tank was completely sealed. To keep the system secure, a strong foundation for the tank was built so that it will not tip over or get stolen, and a lock was placed on the tap so that water could not be taken without permission. At the Masianokeng L.E.C. Primary School, a brick wall was built around the tank to prevent children from vandalizing the system. At the L.E.C. Church in Motloheloa, soft wire was used to secure the tank to its base.

SYSTEM COMPONENTS:

- **Screen-protected gutters:**

The most basic components of a rainwater harvesting system are the gutters, hung at the edge of a roof. Gutters can be square or round, and can be made of galvanized metal or PVC. The most common type of gutters hung in Lesotho are square galvanized. Prior to hanging brackets on the wood supports of a roof (which will later hold the gutters in place), it is very important to treat to wood. Some options for wood treatment are waterproof gloss paint or carbolineum (use with caution!). These weatherization measures are used to protect the wood from insects and rotting.

In order to collect rainwater, gutters should be hung at a 10° angle so that the rainwater flows toward a tank. In our projects, we used string and a level to ensure correctly angled gutters. To keep the gutters clean all year round, mesh wire screens fastened onto them. Gutter screens are an easy and efficient implementation that can keep your gutters free of debris and keep your tank clean. In order to install gutter screens, wire mesh should be purchased and cut into 25-30mm wide strips. One side of the screen should be nailed through the finishing board or directly to the treated wood that lies along the edge of the roof. Once the gutters are placed onto the brackets and nailed to wooden beams, the gutter screens should be secured by rivets threaded through the top hole of the brackets through the screen layer, and finally, through the side of the gutter.

- **Converting galvanized gutter to PVC pipe:**

Most rainwater harvesting systems in Lesotho are open, meaning that the gutters lead directly to an open hole in the tank. These systems become very dirtied because of animals, insects, and roof residue. To solve this problem, a rainwater harvesting system can be designed so that is completely closed. In our projects, the connection from the gutter to the water cistern is a secured pathway that leads directly to an inlet on the tank. Even the overflow pipe is covered by mesh. The main challenge in building a closed connection to the tank is the problem of converting galvanized gutter to PVC pipe. If a system uses PVC gutters, the problem is avoided because there are manufactured fittings to connect gutters to piping. However, galvanized gutters are less expensive and therefore more widely used. We solved the challenge using two different methods, both of which used similar parts and are illustrated here.

Example 1*: Motloheloa (see Figure 1)*

For the system constructed at the LEC Church in Motloheloa, for each downspout, a 75mm hole was cut into the gutter using bold cutters. Then, the 75mm to 50mm reducer was fitted into the hole and small holes were drilled into each side of the PVC pipe and also into the galvanized gutter on either side of the hole. Then L-shaped brackets were riveted into place to hold the pipe in place. Finally, the connection was sealed generously with silicon glue to prevent any possible leakage.

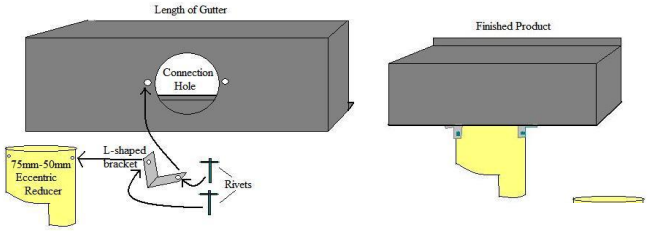

Figure 2: *Converting galvanized gutter to PVC pipe using local resources (Motloheloa LEC project)*

Example 2*:Masianokeng Primary School (see Figure 2)*

For the system installed at the Primary School in H Motloheloa, a slightly different approach was used. In this case, 75mm lipped PVC parts and round galvanized gutters were purchased from the Built It in Ladybrand. The conversion here was a bit simpler: a 75mm hole was cut into the gutter using boldcutters, and the lipped PVC was placed in to the holoe and secured in place with silicon glue.

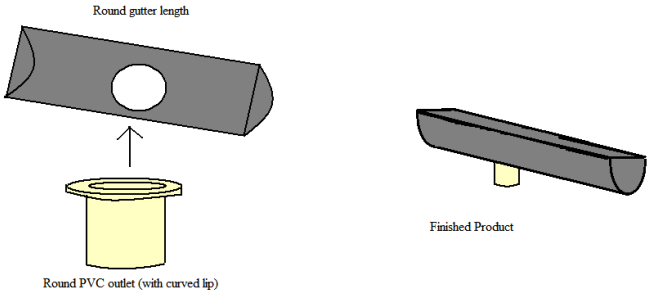

Figure 3: *Converting galvanized gutter to PVC pipe at Masianokeng Primary School*

- **Connection to tank:**
Figure 3 shows each component of the connection to the inlet of the tank. The series of fittings used is not the only way to accomplish a closed connection; it is simply what was organized based on the materials available in the Maseru area. Reference the provided list of stores and their available parts for information on how to buy the necessary fittings.

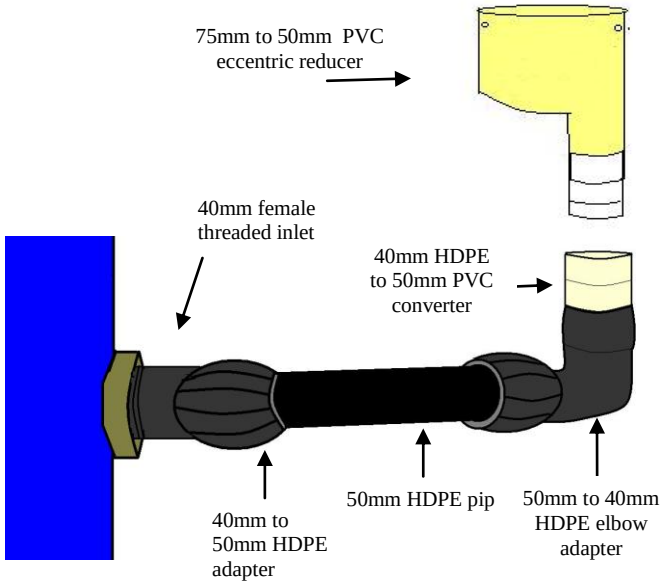

Figure 4. *Diagram of the closed connection from gutter downspout to inlet of water tank*

- **First Flush Diverter:**
The first flush system collects the initial rainwater that falls during a storm. The purpose of this is to lead the initial debris and sediment that is collected from the roof into the first flush pipes rather than into the tank. After these pipes are full, relatively clean water will flow into the tank.

To calculate the amount of water that the first flush should collect, first measure the surface area of the roof. For every 100 square meters of roofing, use 4 meters of 110mm PVC pipe for storage. If you use PVC pipe with a diameter larger than 110mm, you can use a shorter length of pipe.

The first flush system is connected to the gutters in a way that is similar to the connection to the tank (the galvanized gutter downspout must be converted to PVC pipe). Then a 110mm to 50mm eccentric reducer can be connected to the downspout. A system of 110mm PVC pipe and 90 degree bends are then connected ad designed so that the pipes can run along the wall of the building. Holderbats are necessary to secure the pipe to the wall so that the gutters do not bear the weight of the water. Next, a small ball is used as the manual valve for the first flush. As the pipes fill up with water, the ball rises until it hits the eccentric reducer, at which point the pipes are blocked and clean water can flow into the tank. If the first flush pipes extend along the ground, it is important to ensure that the ball is prevented from entering these ground pipes. You can use a screen, a piece of wire drilled across the diameter of the pipe, or a piece of glued plastic across the diameter of the pipe to stop the ball. Figures 4a and 4b depict how the first flush mechanism works.

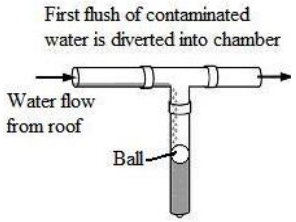

Figure 5a. *As initial rainwater fills up the first flush pipe, the ball valve in the first flush rises.*

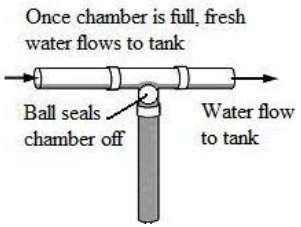

Figure 5b. *Once the rainwater completely fills the pipes, the ball valve rises and the clean water flows to the tank*

At the end of the first flush, there is a screw-off end cap so that the cap can be easily removed for cleaning. The cap should not be screwed on tightly so that it can allow for water to drain slowly. This prevents the build- up of pressure in the pipes. Another possible method of slow draining is to drill tiny holes in the first flush pipes.

- **Tank Foundation:**

A strong foundation is important for the security of the tank. If the tank is to be placed on top of soil, a foundation must be dug. For a 5,000L tank, digging trenches that are 1m deep is sufficient. These trenches should be filled with gravel and a wire mesh grid should be placed on top of the layer of gravel. Then, a concrete slab should be poured. A square cinderblock base should be constructed in the trenches on top of the concrete slabs. A second row of cinderblocks should be added. Next, then the same procedure of adding gravel, wire mesh, and concrete should be done for the center of the foundation until the concrete slab is level with the top of the second row of cinderblocks. After waiting for the foundation to dry (at least 24 hours), the tank can be installed. The tank can be secured to the foundation using softwire that is placed underneath the concrete slab. If the tank is being placed on a cement surface, do not dig but build up around the tank with a base made of bricks or cinderblocks. If there is a concern about vandalization or about sun damage, a brick wall can be built around the tank.

- **Gravel pits:**

Gravel pits allow for water to permeate into the ground without ponding or causing a puddle at the location of water outlets. This drainage control may be necessary at the overflow outlet of the tank, at the end of the first flush where water is emptied, at the overflow gutter downpipe, or underneath the tank spigot. To construct a gravel pit, dig a hole at the location of the water outflow that is 30cm deep and 46cm in diameter. Fill the hole with gravel. Use common brick to make a square around the hole and mortar the bricks to secure them in place. Add a top layer of sand.

Figure 6. *Picture of completed system in Motlohelo*

Created by Marielle Schweickart and Maggie Murphy

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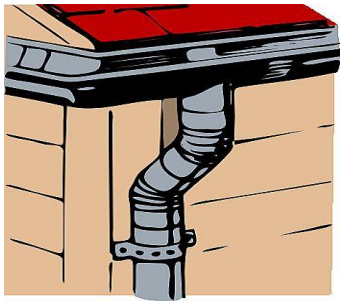
Maintaining Your Rainwater Harvesting System

To ensure that the system functions for a long time, it is very important that the system undergoes regular maintenance and is kept secure.

Gutters

- ✓ EVERY MONTH, check for rusting or leaks in gutters. Use sandpaper and aluminum gloss paint to fix the rusting areas, and use silicon glue to repair leaks in the gutters. Make sure the gutters are secured to the wooden flashings and that the wood has not begun to rot.



Gutter Screens

- ✓ EVERY MONTH, make sure the gutter screens are not damaged or clogged with leaves or dirt. If the gutter screens are clogged, water will not flow into the gutter because it will be blocked! Sweep the screens to clean them out.
- ✓ If the screens have been damaged, replace them. The screens are made of wire fly mesh that is cut into pieces that are 25-30 cm wide and are long enough to cover the length of the gutter. The wire mesh can be purchased at Thetsane Hardware or at many local hardwares.

First Flush

- ✓ After EVERY RAINSTORM, the first flush must be cleaned out. Unscrew the end cap slowly and drain water from the pipes. Remove any debris that have collected at the bottom of the pipe. Screw the end cap back on, but not all the way so as to allow for the pipes to drain slowly during a storm. The slow drain prevents a build up of pressure in the pipes.

Gravel Pits

- ✓ EVERY MONTH, check the pits to see if any debris or garbage have accumulated there. Clean the pit out and add a fresh layer of sand to ensure that drainage can still occur.

Tank

- ✓ EVERY YEAR, clean and disinfect your tank to prevent slime, algae, bacterial growth, and the build-up of sediments. This will allow the tank to last longer and for the water to remain clean.
- ✓ When cleaning, do not enter the tank! To clean the tank, first drain all the water from the tank and close the tap. It is preferable to wait until the tank is almost empty (at the end of the dry season), to clean the tank. Wash and remove dirt from inside surfaces of the tank with water. Drain the wash water and sediment from the bottom of the tank by opening the spigot. Use chlorination to disinfect the inside surfaces of the tank. You can add chlorine tablets to the tank, or you can add bleach (5ml of bleach per L of water added) and mix it very well. Once the water inside the tank is chlorinated, let the chlorine solution sit in the tank for 3-5 hours, and then drain the tank completely. Now, fresh water can be added to the tank. Run the water from the spigot until there is no smell of chlorine, and then continue normal usage of the tank.
- ✓ If there are many days where the outside temperature is less than 0 degrees Celsius, then water should be drained from the tank. This is to prevent water in the tank from freezing and to prevent the tap from busting.
- ✓ Note: The spigot connected to the tank should be tightly closed and secured with a lock after every use.

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