RAINWATER STORAGE

1. Introduction

Rainwater collection from the roof depends on a number of factors. Unless these are suitably matched the supply would not be satisfactory. The factors are:

(a) the average annual rainfall and its variability through the year;

(b) the roofing material and the available area of the roof;

(c) the daily rate of consumption of water;

(d) the storage volume and the material of the tank; and

(e) the desired reliability of the supply.

2. Relationship of rainfall, its variability, roof area and storage volume

The higher the average annual rainfall, the smaller the collection area of roof required for a given rate of consumption. In order to allow for variation in actual rainfall from the monthly averages, it is advisable to have the available roof area to be twice the theoretical area.

If the pattern of rainfall is fairly uniform through the year, the size of storage tank for a given rate of consumption would be relatively smaller. The tank size could be as small as to hold 50 days consumption where rainfall is quite uniform through the year. Where most (such as 75%) of the annual rainfall occurs in 3 or 4 months it will be necessary to size the tank to hold 100 to 120 days of consumption. This assumes that the available roof collection area is twice the theoretical area. Where the available roof area is less than about 1.4 times the theoretical area, the required storage volume tends to increase very steeply. The size of the tank determined from these considerations should normally give an average reliability of supply with a failure rate of about once every 5 years. If an average chance of failure of supply of once a year is acceptable, the calculated tank size can be reduced by about 30% in areas of high rainfall and by 40% in areas of lower rainfall.

3. Design

The theoretical relationship outlined in para 2 can be expressed as:

$A = 365 \times C/R$ where

A is the roof area acting as the catchment in square metres,

C, the daily average consumption of water by the household in litres, and

R, the average annual rainfall in millimetres

However, for the reasons stated earlier the practical value of the roof catchment is:

$A = 2 \times 365 \times C/R = 730\ C/R$

In order to assess the size of the storage tanks Fiji has been divided into 2 categories - areas with a more uniform spread of rainfall and those with rainfall concentrated over 3 or 4 months of the year. In the case of the areas with a more uniform rainfall, it is estimated that a storage capacity of 80 days consumption would be adequate to provide a reasonably reliable supply with the risk of failure of only once in 5 years. For a similar level of reliability in areas with an uneven spread rainfall, the estimated storage is equal to 100 days consumption.

Taking a family size of 5 members, each consuming no more than 30 litres per day of the stored water, the minimum roof area and storage capacity required in representative regions in Fiji have been calculated for the average rainfall in those regions. These are shown in Table 3. If the family size and/or daily consumption is different, the rquired roof area and tank size can easily be calculated from the Table.

TABLE 3
MINIMUM ROOF AREA AND TANK CAPACITY FOR RAINWATER COLLECTION

Total tank capacity of 15 kilolitres (3400 gallons)		Total tank capacity of 12 kilolitres (2700 gallons)	
Minimum roof catchment to drain into storage (m^2)			
64	50	40	30
Sigatoka/Nadi Lautoka Lau group Yasawa group	Ba Vanua Levu Kadavu	Suva/Nausori Rakiraki Taveuni	Navua Monasavu Rotuma

Example: If the family size considered in say, Rotuma is 7 and the daily consumption per head is 20 litres, the required roof catchment = $30 \times 20 \times 7/(30 \times 5) = 28\ m^2$
Tank size = $12 \times 20 \times 7/(30 \times 5) = 11.2$ kilolitres (2500 gallons)

Note: If a risk of failure of supply once a year is acceptable, the tank size can be reduced by 30%.

4. Effect of roofing material and the environment

Rainwater in general is very pure and hence many metals dissolve in it much faster than in land based water. For instance if any lead is used in the roof for flashing or in the form of lead-based paint, the rainwater would leach the lead into the storage tank. If this happened. the water would not be potable. The nature of the materials used in the roof must be ascertained and their safety confirmed before a decision is taken to use the run-off from the roof. In general galvanised iron sheets, zinc-aluminium coated sheets and a number of other products are safe .

As far as possible leaves and twigs must not be allowed to fall on the roof. The leached extracts from some leaves would make the water unfit for consumption. In addition the organic matter from leaves and twigs would encourage the growth of micro-organisms in the tank, thereby polluting the water. Accumulation of any dust on the roof, such as from industrial activity nearby would also make the water unfit.

5. Tank material

Tanks are generally made of galvanised or zinc-aluminium coated steel plates and sometimes of fibre glass. Whereas suitable fibre glass would be inert and therefore not affected by the rainwater, galavnised steel could. The greater the purity of the stored water, the greater the risk of the galvanising getting leached out very fast. If the roofing sheets are of galvanised steel, the stored water would already contain some of the zinc from the roofing material and hence the tank would last longer. This is not the case where the roofing is of zinc-aluminium coated or painted steel or of some other man-made material.

In order to prevent the corrosive effects of pure rainwater on the tank coating, suitably formulated metaphosphates are commercially available. These produce a protective film inside the tank and thus extend the life of metal coated tanks. Such methods must be used from the very first filling of the tank. There are also plastic protective coatings compatible with potability which are applied to metal tanks. The inside of the tank must not be painted with any ordinary paint.

In no case must lead be used in any form such as in sheets for flashing or as paint etc on roofs from which water is collected.

6. Erection of rainwater tanks

It is best to erect the tank in a shady location but away from falling leaves which could clog the strainer, and in the case of translucent material like fibre glass, have a dark colour to exclude light. Organic growth could develop on the sides of tanks in the presence of light and warmth. When the tank is part empty the organic growth would decay and give off gases, discolour the water, and produce corrosive acids. The absorption of the gases and acids could also give the water an unpleasant flavour.

The overflow pipes fitted to tanks for the disposal of excess inflow of rainwater must be adequate to prevent uncontrolled overflow. Such pipes must not terminate very close to storm water drains and soak pits as otherwise unpleasant gases might enter the tank. The pipe end and all openings to the tank must be fitted with strong, durable mesh to prevent birds, mosquitoes and other insects gaining entry into the tank.

No copper pipe should be used with any metal water tank. The inlet pipe must discharge the water through a durable strainer fitted well above the high water level. The inlet must not be close to the tank wall. Where tanks are interconnected each tank must receive at least some of the water directly from the roof. No tank must get its supply entirely from other tanks. It is convenient to have individual domestic tanks of no greater capacity than 4 or 5 kilolitres (1000 gallons).