Rainwater Tanks

……. their selection, use and maintenance

Revised May 1999

Department for Environment Heritage and Aboriginal Affairs
Government of South Australia

SUPPLY SOURCE

Some parts of the world are fortunate in having plenty of high quality water. Here, in South Australia, our water resources are limited in quantity and are not always of high quality.

Water supplies are reticulated to most centres of population in the State but there remain many areas where householders need to provide their own water supplies.

The most common sources of such supplies are roof run-off collected into a rainwater tank, or a groundwater bore where the groundwater is suitable.

There will be situations (depending on rainfall and roof area) where rainwater tanks will not supply water at a level of security normally expected in houses connected to reticulated supplies. Under these circumstances, compromises may be needed. These could include a reduced standard of water supply, rationing water demand during periods of low tank storage, use of lower quality groundwater or dam water for flushing toilets or watering plants, or, perhaps, installation of dry toilets.

Almost invariably, however, emergency or top-up supplies are available from other sources including bottled water or water carting. So the concept of a rainwater tank being the sole source of supply is a limiting situation that often does not apply.

Many people who are connected to the reticulated mains system use rainwater as a source of soft, low salt water, which they use for drinking, or for washing delicate items and watering fragile plants. A later section of this book deals with interconnections.

HOW BIG A TANK ?

To help the selection of the appropriate tank size for individual reeds, the South Australian Water Corporation and Department for Environment, Heritage and Aboriginal Affairs have carried out computer simulation of tank performance. The results are shown in the graphs at the end of this booklet. These graphs apply to those users who intend having rainwater as a sole source of potable supply.

The main factors involved are:

- Rainfall - the average annual rainfall, the pattern of distribution throughout the year and the variation from year to year;
- Roof area - which places an upper limit on the amount of water that can be collected;
- Acceptable level of security - the risk or possibility of the tank running dry. A higher level of security will be required where tanks are the sole source of supply than where rainwater is used to augment existing reticulated supplies;
- Demand - which varies enormously from household to household and season to season depending on:
  - number of people in the household;
  - their water use habits;
  - uses to which rainwater is put;
  - type of water-using appliances (if any) connected to the tank.

Users connected to mains water and who want rainwater as a supplementary will find the following table based on a four-person family in Adelaide a useful guide:

For drinking only	300 litres
For drinking, cooking and some hair washing	1700 litres
For drinking, cooking and final rinse in laundry	3600 – 4500 litres

The absolute maximum water that you can get off a roof, on average is:

water volume (kL) = average annual rainfall (m) x coefficient of runoff x roof area (m^2)

A coefficient of runoff of 0.9 can be used to obtain a rough estimate.

This formula does not allow for water that may be lost because the tank is already full, or the runoff is more than the tank can hold in a heavy storm. Typical calculations have shown that with commonly used tank sizes (10-20 m^3) for houses, about 65% of the rainfall can be captured at 90% security.

WATER QUALITY

It is most important that installation should include an effective means of keeping leaves, debris, animals (including birds and mosquitoes) out of both the intake and the overflow. A reputable tank manufacturer can advise on this. It is also desirable to exclude light as much as possible to minimise the growth of algae. Some fibreglass tanks do not completely exclude light and need to be painted to achieve algae control. In recent years, however, fibreglass tanks have been manufactured with sufficient pigment in the material to exclude light and should therefore prevent algae growth. Check with a fibreglass tank manufacturer for information. Inspection and access points should have tight fitting lids

Since roofs collect contaminants such as atmospheric dust, bird droppings, etc., a device that allows the first run-off to be discarded after a dry spell is desirable. This is particularly important if industrial or rural activities in the area are the source of airborne contaminants. First flush diversion devices are now available on the market and reputable tank manufacturers should be able to advise.

In Port Pirie, the air has a high concentration of lead, suspected to be from wind blown dust. The Department of Human Services recommends that rainwater not be drunk by pregnant women nor women who are breast feeding, nor children less than seven years old. Lead cannot be removed by boiling.

To help reduce corrosion in galvanised steel tanks, installation of a dispenser containing crystals or metaphosphates (e.g. "Tect-A-Tank") is recommended, when they are first filled.

Locating the tank in a shady area, but away from trees, will keep the water temperature lower than if it were exposed. If two or more tanks are installed the inter-connection should be arranged so that maximum turnover of the stored water is achieved.

Even if the quality of the water is not suitable for drinking it could, nevertheless, be safely used for many other purposes including laundry, toilet and garden.

MAINTENANCE

If the tank has an effective inlet strainer and lids, then only a minimum amount maintenance (mostly routine property maintenance which needs to be done whether a tank is installed or not) is required.

- Keep gutters clear of leaves, etc. Check ever three months or more often if trees overhang;
- Clean the inlet strainer whenever necessary, or use self-cleaning strainers. A sludge check should be made every two years and desludging done if there has been a sludge build-up;
- Contractors are available in some areas to desludge rainwater tanks and may be able to do this without losing much water;
  NOTE – with galvanised steel tanks it is important when cleaning not to disturb the film that builds up on the inside walls of the tank as this protects the metal from corrosion. It is also important not to scour the protective internal polymer coating on tanks made with aquaplate.
- Divert overflow or discarded water away from buildings and other structures;
- Boil water from the tank before drinking or cooking if the bacteriological quality of the water is in doubt;
  NOTE - Rainwater does not contain fluoride. If rainwater only is used for drinking, fluoride tablets will help prevent dental decay.

Tanks without effective inlet strainers and lids, and poor maintenance of tanks, roofs and gutters may present a health risk. However, if a tank is properly installed and then given the small amount of attention outlined above, its water should be quite safe to drink.

ROOFING MATERIALS AND PAINTS

Lead based paints (including primers) should never be used on roofs from which rainwater is collected.

Tar-based roof coating materials are not recommended if rainwater is to be collected as the phenolic and other organic compounds they contain will impair the taste of the water.

The first few run-offs from roofs painted with acrylic paints should be discarded. Detergents and other chemicals dissolve out of these paints when they are freshly applied. Similarly, the first few run-offs from new cement or metal tiles should not be used for drinking.

The run-off from new fibre cement roofs from one entire winter should be discarded due to the leaching of lime.

MATERIALS AND COSTS

Tanks are available in galvanised steel, aquaplate, zincalum, fibreglass, and concrete. Stock sizes range from 450 - 22 500 litres, though not all sizes are available in the materials listed. Larger sizes can be made to order. Storage is also available which is incorporated into the roof gutter by a small enlargement, and therefore does not take up ground space.

There is no right or best type; the choice depends on the individual household's requirement and finances. Some types of tanks are more expensive than others but can be expected to last longer and the trade-off is a matter of personal decision.

The cost of tank water also cannot be precisely stated. It is certainly not free, but its exact cost depends on usage in relation to the cost and life span of the tank and associated items.

When calculating the total cost, to the price of the tank itself must be added:

- any alteration to gutters and downpipes that may be necessary;
- a tank stand in most cases;
- plumbing to take water into the house;
- a device to reject initial run-off after dry periods if the situation warrants having one;
- a pump if necessary.

Any licensed plumber or tank manufacturer may be approached for help in installing prefabricated tanks. For big tanks or those cast on site, it may be necessary to ask the advice of a builder or structural engineer. It is advisable too, to look into the planning requirements of local councils, regarding rainwater tanks. In areas without local council authority (as in the far north of South Australia), building regulations should be consulted. Neither the South Australian Water Corporation nor the Department for Environment, Heritage and Aboriginal Affairs give structural advice on rainwater tanks.

Concrete or brick tanks may be waterproofed by applying proprietary sealants e.g. cement based material (glass fibre reinforcement), silicon sealers, fibreglassing or PVC liners.

The Government of South Australia believes water is a valuable resource. However, it does not believe that rainwater tanks should be compulsory, because some people may desire to not use this water or neglect to maintain the tanks. Some councils are requiring that "leaky" rainwater tanks are installed in new areas to reduce the peak run-off into the street. The aim is to keep the tanks as empty as possible to allow as much rainwater as possible to be captured during a storm and let out slowly. Householders could take advantage of this system by using the water in the laundry, toilet, hot water systems and other uses that will use up the water steadily.

The Government of South Australia does not provide subsidies for rainwater tanks.

FURTHER ADVICE AND INFORMATION

Installation: (including strainers diverters etc., and maintenance). Contact tank suppliers See under "Tanks and tank equipment" in the Yellow Pages of the telephone directory.

Size: contact tank manufacturers. See under "Tanks and tank equipment" in the Yellow Pages of the telephone directory.

Water quality
Health aspects: A comprehensive guide to minimising health risks associated with rainwater tanks *Guidelines for the collection care and control of rainwater in tanks* and *Guidance on the use of rainwater tanks. National Environmental Health Forum monographs. Water series 3* by D A Cunliffe 1998 is available from the South Australian Health Commission. Telephone (08) 8226 6530. The latter can also be purchased through the Internet at http://www.health.sa.gov.au/pehs/publications.htm.

Other quality aspects (odour, colour, etc.): Contact the Australian Water Quality Centre, Port Wakefield Road, Bolivar Telephone (08) 8259 0211.

Mosquito larvae
Contact the health department of your local council or the Department of Human Services.

Surplus rainwater
It may be possible to store excess rainwater in the subsoil or underground aquifers for later withdrawal through application of aquifer storage and recovery technology. This technology has been successfully incorporated into a residential development at Brompton, Adelaide, South Australia. The University of South Australia is monitoring its performance. More information and brochures on infiltration trenches are available from the University of South Australia (Department of Civil Engineering), The Levels SA 5095, Australia.

Information on bores can be obtained from the Groundwater Section, Primary Industries and Resources South Australia (PIRSA), 101 Grenfell Street, Adelaide SA 5000, Australia, and a permit can be obtained from the Department for Environment, Heritage and Aboriginal Affairs (Environment Protection Agency) 77 Grenfell Street, Adelaide SA 5000, Australia.

If you are contemplating groundwater recharge, you should contact your council building inspector regarding council by-laws and the potential effect on the footings of your home.

Water conservation
Water conservation measures are given in the brochures *How to Save Water in your home* and *How to Save water in your garden* available from the South Australian Water Corporation, Corporate Communication Unit. Telephone (08) 8204 1249.

Water consumption could be reduced by recycling grey water (from shower, bath and laundry). However, greywater can be contaminated by disease-causing organisms, especially in dwellings with infants and incontinent persons, and must be regarded as dilute sewage. Grey water can also affect soil structure. Grey water may be used if treated to produce a water quality that complies with the 1999 *South Australian Reclaimed Water Guidelines (Treated Effluent)*. The grey water guidelines are available from the Department for Environment, Heritage and Aboriginal Affairs at http://www.environment.sa.gov.au/epa/pub.html. Permission to re-use grey water must be obtained from your Council Environmental Health Officer and, in sewered areas, also from the South Australian Water Corporation.

Water from the kitchen sink has high organic content, which could cause smells if reused. Its reuse is not recommended.

"Total water cycle management" includes considering the use of groundwater for appropriate uses, composting (dry) toilets and on-site treatment of sewage for reuse.

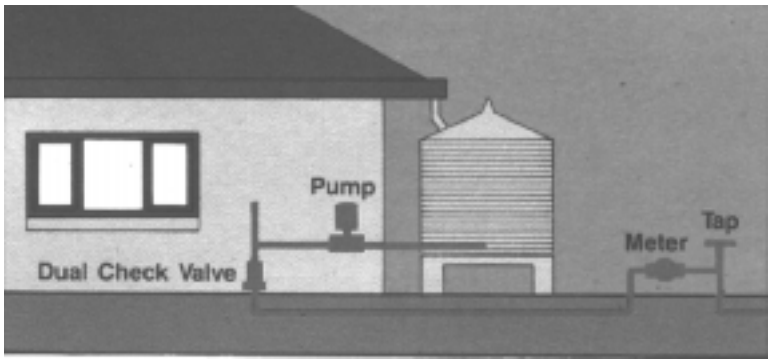
Interstate and overseas experience
Cases of rainwater tanks self-sufficiency, together with water recycling, have been documented for conventional houses by the Australian Capital Territory Electricity and Water Authority (ACTEW) in Canberra, which has a climate similar to Adelaide's, and for a townhouse in Sydney by Michael Mobbs.

Some web sites of interest include that of the German Rainwater Institute at www.behaelterverband.de/regenwasser.html and of Professor Sieker at the University of Hannover in Germany at www.sieker.de/natrwbew.htm

INTERCONNECTION

You can interconnect your rainwater tank with the mains supply, PROVIDING THAT YOU INSTALL A RESIDENTIAL DUAL CHECK VALVE.

This valve must comply with Australian Standard 2845 and be installed above ground on the mains water service before the connection with your tank. See drawing.



OTHER USES OF RAINWATER

Apart from its use as a resource, water storage has also been used as a thermal buffer to insulate houses against wide fluctuations of heat and cold. It is also possible to use the evaporation from the surface of a storage to cool buildings through ventilation, provided that adequate measures are taken to keep the water free from organisms such as legionella and to protect the water from pollution.

TANK SIZING GRAPHS

The graphs at the end of this booklet can be used to estimate the size of tank appropriate to your needs.

USING THE GRAPHS

1. Determine size of roof. If doing this by measuring the outside of the house, allow for eaves overhang. Include garages, carports and verandahs only if runoff from them will go to the tank. More than one tank may be required to collect water from different areas of the roof. The slope (pitch) of the roof is unimportant, it is the flat or plan area that matters.

2. Calculate demand. Firstly, decide what the rainwater is to be used for (Keep in mind that some uses may require expensive plumbing or even a pump and header tank). An assessment of the average daily water use per person in Adelaide for a range of domestic applications is presented in Table 1. This assessment may be used as a guide to help selectively estimate individual water demand requirements.

However, in many instances, roof area and average annual rainfall may not be sufficient to maintain rainwater tanks as a sole source of supply. Under these circumstances a review of the various methods of conserving water may be necessary, such as the installation of dry toilets and aerated shower nozzles; using bathroom and laundry wastewater on the garden; using saline groundwater to mix with rainwater, and using groundwater or farm dam water in the toilet, etc. (See suggested conservation strategies listed under conservation measures 1 and 2 in Table 1). Before installing a dry toilet (and above ground sullage disposal) local council approval should be obtained.

Note that the graphs have been prepared assuming constant demand in litres per day. You will know from experience, however, that demand can vary significantly with the time of the year.

3. Determine average annual rainfall. Refer to maps 1 or 2, pinpoint your locality and proportion the average annual rainfall for your locality from surrounding rainfall isohyets (lines of equal rainfall). If your house is located near a rainfall station, use the average annual rainfall of that station if the period of record available is more than 25 years.

4. Degree of security. Select a degree of security that you feel is appropriate to your lifestyle. If you choose a 99% degree of security, this means that your roof catchment/rainwater tank system should supply the demand you have selected 99% of the time. However, should you select a 90% or 80% degree of security, it will be increasingly, necessary for you to ration demand when tank levels are low.

5. Estimate the tank or capacity required. Turn to the graph which best represents your selected requirements for demand and degree of security. In many instances your demand will not be exactly the same as indicated on the graph, in which case you will need to adjust your roof area to use the graph.

$$\text{Adjusted Roof Area} = \frac{\text{Actual Roof Area x Demand (Graph)}}{\text{Demand (Required)}}$$

On the horizontal axis at the bottom of the graph, locate your adjusted roof area. Draw a vertical line upwards until it intersects the average annual rainfall line appropriate to your location. If your rainfall value is part-way between two curves sketch one in yourself. Draw a horizontal line from the point of intersection to the left hand vertical axis and read off the tank size required.

The tank size calculated from the graph is based on the adjusted roof area instead of the actual roof area. To correct for this difference, multiply the estimate of tank size by the ratio if demand required to demand from graph:

$$\text{Adjusted tank size} = \frac{\text{Demand (Required)}}{\text{Demand (used on graph)}} x \text{ tank size (Graph)}$$

to give the corrected estimate.

If the vertical line does not intersect the average annual rainfall curve for your area, this shows that your roof area is not big enough to provide your demand at the security desired. Under these circumstances revise either the demand requirements or the security you are prepared to accept and try another graph.

6. Double check. You can check the tank capacity indicated by calculating how many days it would take your household to empty the tank starting from full, with demand as previously determined and with no rain. Then compare that with the length of time without rain or practically no rain that is common in your area.

It also would be wise to check with your neighbours. Their experiences would be a good guide to the accuracy of your calculations.

If you find that your security of supply appears to be more than adequate, you might try reducing the tank capacity by up to the equivalent of your monthly demand. But it is suggested that you seek advice before making such a change.

EXAMPLE

Roof Area – House, garage, outhouses connected to supply system = 220 m^2

Demand - In-house use only, for a 3-person household. Refer to Table 1, Page 8 - Estimates of Domestic Water Usage in Adelaide.

In-house use	**Demand litre/person/day**
Showers	35
Toilet	35*
Clothes and washing	32
Dishwashing	18
Drinking and cooking	7
TOTAL	**127**

* Where a dual flush cistern or low volume flush toilet is used, this figure would have to be adjusted.

Using the above figures the estimated demand for a three-person household would be 127 x 3 = 381 L/day.

Average annual rainfall = 530 mm/year. Degree of security required = 99%.

Size of tank

The demand of 381 L/day is slightly less than 400 L/day represented in the graph. Therefore, adjust roof area so that you can use the graph.

$$\text{Adjusted Roof Area} = \frac{\text{Actual Roof Area x Demand (Graph)}}{\text{Demand (Required)}} = 220x\frac{400}{381} = 231m^2$$

There is no tank size available within the range of graph J to provide the demand required.

Try reducing demand

Estimate your minimum demand requirements by considering all the conservation measures available to reduce your consumption. Refer to Table 1 for guidance on conservation.

	Revised Demand L/person/day)	**Conservation measure adopted**
Install dry toilet or recycled water	0	2
Install aerated shower nozzles and restrict time under showers	31	1 or 2
Use washing machine with full load only	20	1
Dishwashing	12	1 or 2
Drinking/cooking	6	1 or 2
TOTAL	**69**	

So for a three person household, the estimated demand is reduced to 3 x 69 = 207 L/day.
Refer to Graph G - demand 200 L/day, degree of security 99%.

Adjusted Roof Area = 220 x 200/207 = 213 m^2.

From Graph G, the size of tank required for an adjusted roof area of 213 m^2 and average annual rainfall of 530 mm is 44 000 litre.

But this estimated tank size of 44 000 litre based on a demand of 200 L/day needs to be adjusted to a required demand of 207 L/day Therefore the size of tank required is:

Adjusted tank size = 44 000 x 207/200 = 46 000 litre

NOTE - if roof area and average annual rainfall had still been too small to calculate a tank size it would have been necessary to review the degree of security you are prepared to accept, or the need to impose increasing restrictions on your demands as the volume of water in the tank is reduced.

TABLE 1: ESTIMATES OF DOMESTIC WATER USAGE

		Conservation Measures	
	Adelaide*	**1**	**2**
Activity	**L/person/day**	**L/person/day**	**L/person/day**
Shower	35	31(1)	31(1)
Bath	14	-	-
Toilet	35	32(2)	-
Clothes Washing	32	20(3)	17(4)
Dishwashing	18	12(5)	12(5)
Drinking/Cooking	7	6	6
Car Washing	3	3	3
Recreation (pools etc.)	3	-	-
Leaks	28	-	-
TOTAL	175	104	69
GARDEN	175	-	
GRAND TOTAL	350	104	69

(*) See *Information Bulletin No. 12 - Water Consumption and Conservation*. EWS Department, SA (March 1992).

NOTES
Certain conservation devices may be used to reduce the liberal water demand estimated for Adelaide as shown in column 1, Table 1 above:

For example:
1. Use of aerated shower nozzles, conservation measure 1 or 2;
2. Use of dual flush toilet if low flush toilet not already installed, conservation measure 1, or use of recycled water or biological toilet, conservation measure 2;
3. Use of top-loading improved washer, conservation measure 1;
4. Use of front-loading washing, conservation measure 2;
5. Careful economical use of water in dishwashing.

In the above estimates for conservation measures 1 and 2, allowance has not been made for leakage from the rainwater tank nor for use of water in gardens. Shower and laundry wastewater can, however, be recycled for use in the garden.

IF YOU HAVE A COMPUTER

If you have a computer with a spreadsheet software package (e.g. Quattro, Lotus or Excel) or a programming package (e.g, Fortran or C++) you can do your own calculations.

1. Obtain monthly rainfalls for your location from the Bureau of Meteorology. A long period (at least 50 years) of record is required, including the 1930's which was a long period of drought in many areas;

2. Calculate the run-off, allowing for losses including water which sticks to the roof and evaporates.

$$Q_t = \max\left[0, A\frac{P_t - B}{1000}C\right]$$

where
Q_t = monthly runoff (m^3) in month t
A = coefficient of run-off
B = initial loss (mm)
C = roof area connected to tank (m^2)
P_t = monthly rainfall (mm) in month t
A and B are coefficients accounting for losses due to evaporation and adherence to roof surface. A = 0.8 and B = 2 mm have been used in calculating the graphs in this book, If you have a tank already you could calculate your own values for A and B by taking measurements of rainfall and water volume in the tank before and after rain. Use several measurements and average. If first flush devices are fitted, B may be larger than 2 mm.

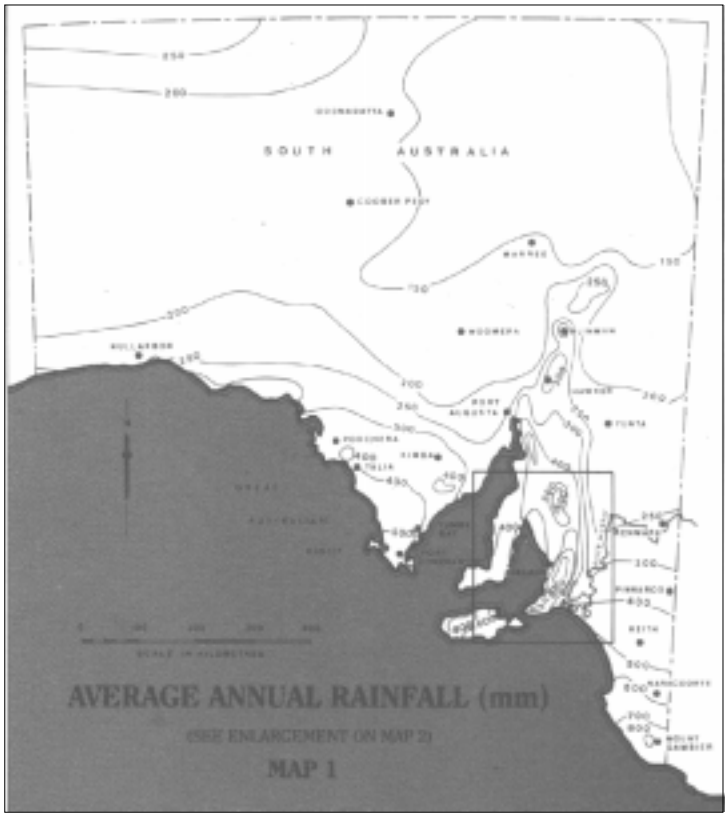
3. Calculate the volume of water in the tank at the end of each month.

$$V_t = \min[\max(V_{t-1} + Q_t - D_t, 0), T]$$

whereV_t = volume of water in tank at end of month t (m^3)
V_{t-1} = volume of water in tank at start of month t (m^3)
Q_t = monthly inflow (m^3) during month t
D = monthly demand (m^3)
T = tank volume (m^3)
For the first month, assume that the tank is empty.
If V_t = O, then a failure is recorded.

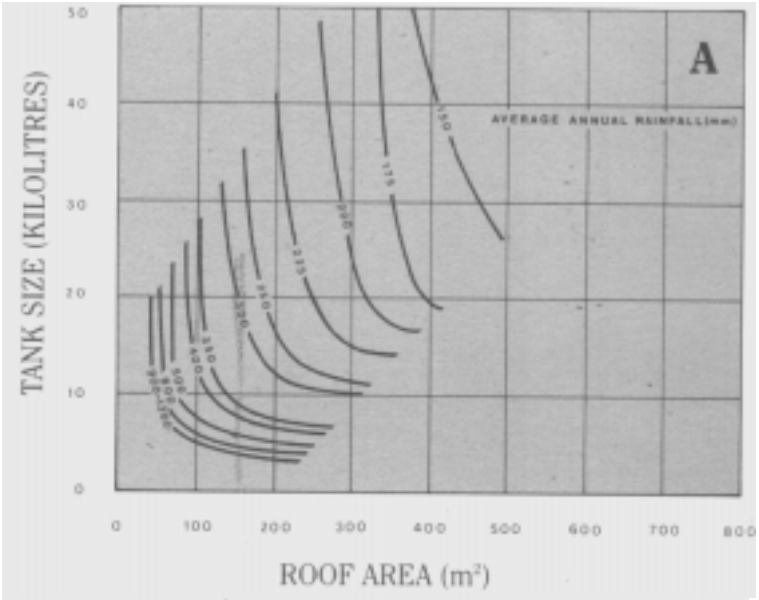
4. Total the failures and divide by the number of months in the period of record, to give a monthly time failure.
Reliability % [or security (%)] = (1 - failure) x 100

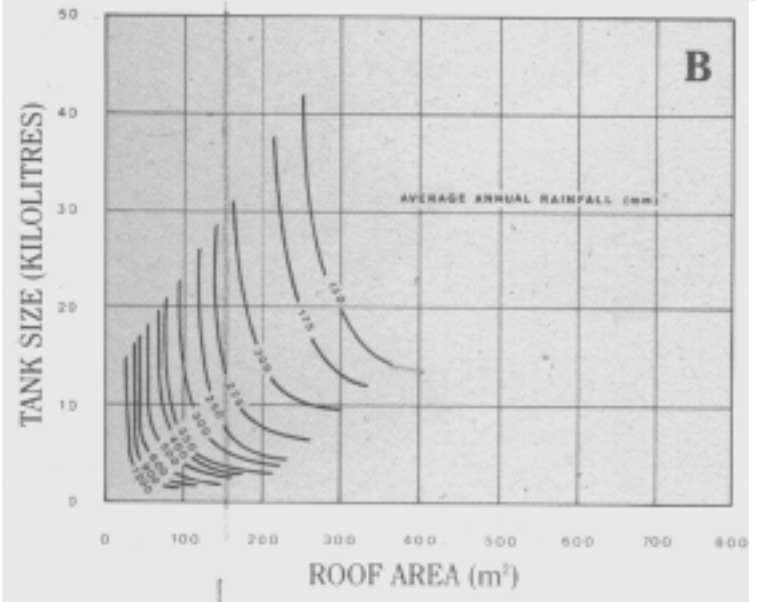
5. Change the demand by trial and error, until you get the desired level of security.
The following graphs indicate the tank size required for rainfall patterns and averages prevalent in the more populated areas of South Australia. The variability of rainfall is a very important factor in determining the storage required, and the graphs should be used with caution in the drier areas.

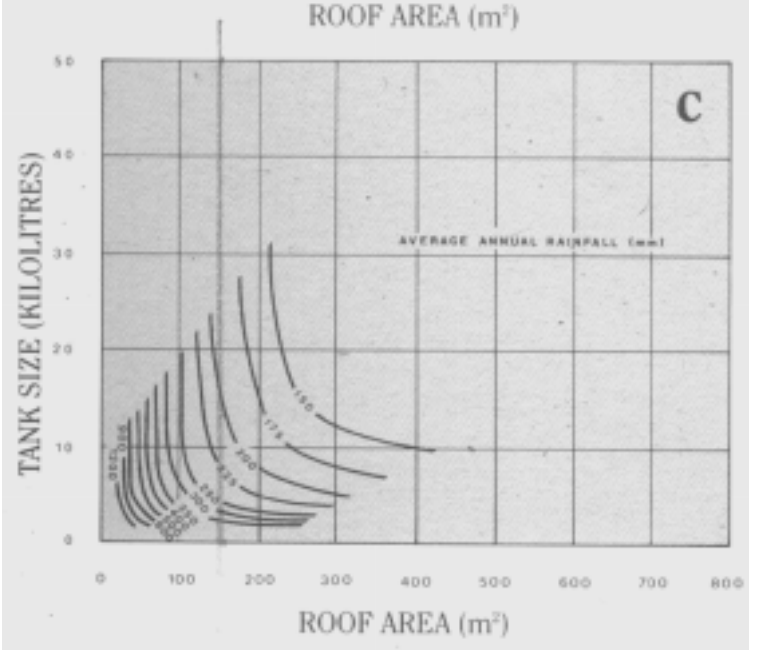

SOUTH AUSTRALIA
AVERAGE ANNUAL RAINFALL (mm)
(SEE ENLARGEMENT ON MAP 2)
MAP 1


ENLARGEMENT OF SECTION IN MAP 1
MAP 2

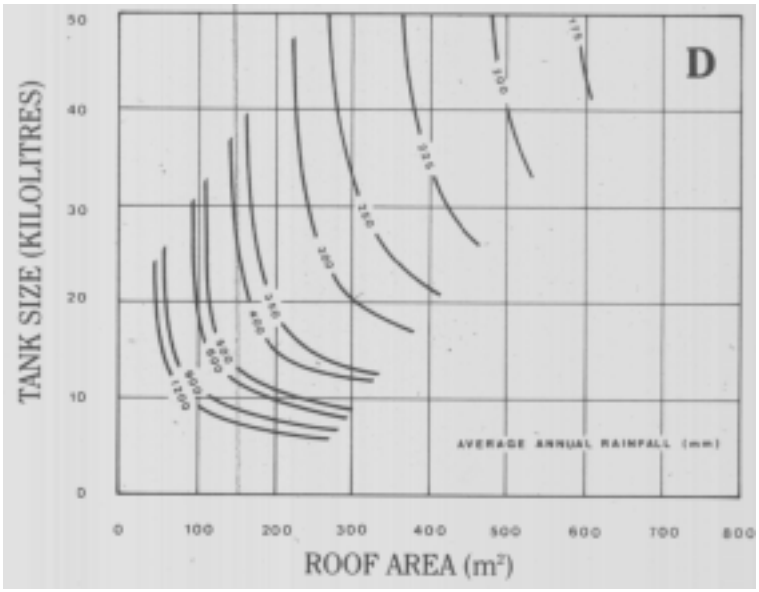
Raintank Yield
Demand 60 L/day
Degree of security 99% graph A
Degree of security 90% graph B
Degree of security 80% graph C

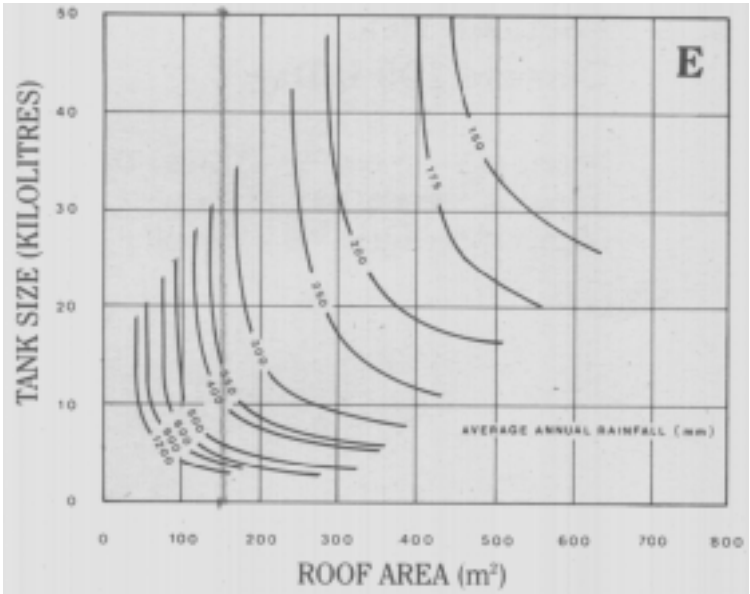


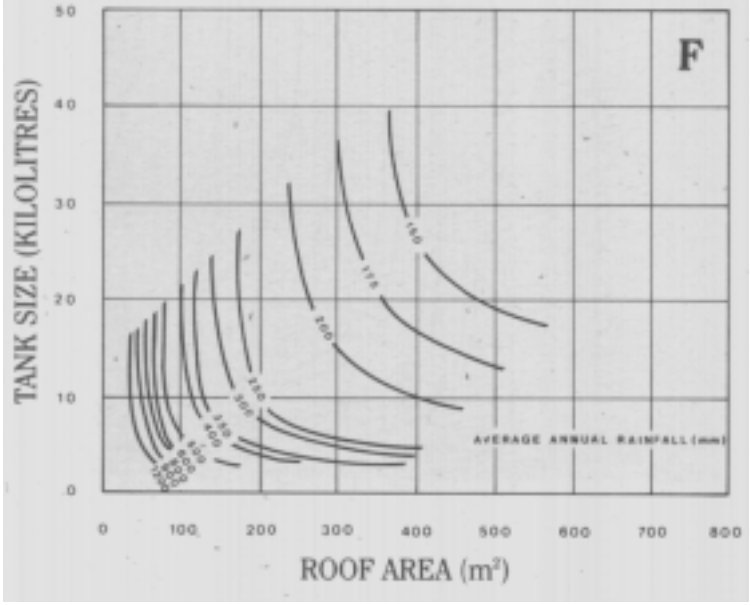




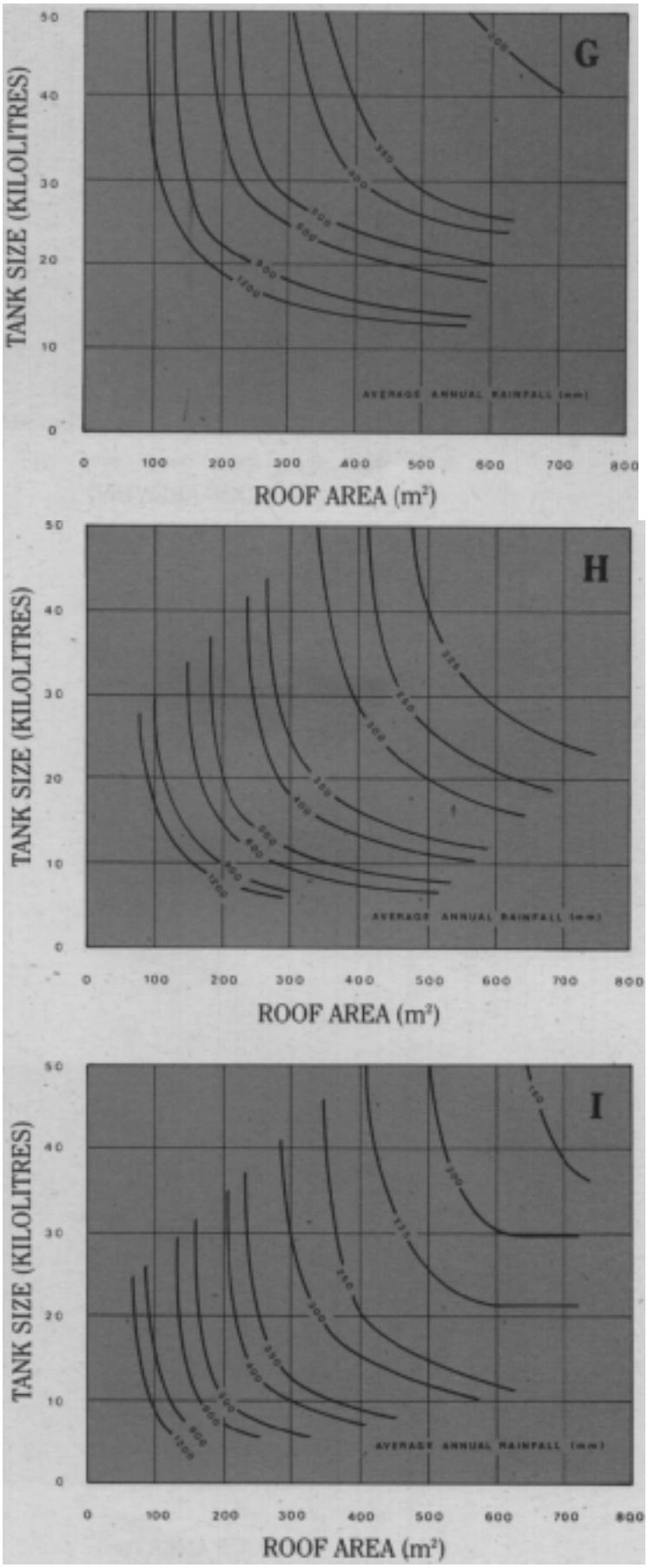
Raintank Yield
Demand 100 L/day
Degree of security 99% graph D
Degree of security 90% graph E
Degree of security 80% graph F



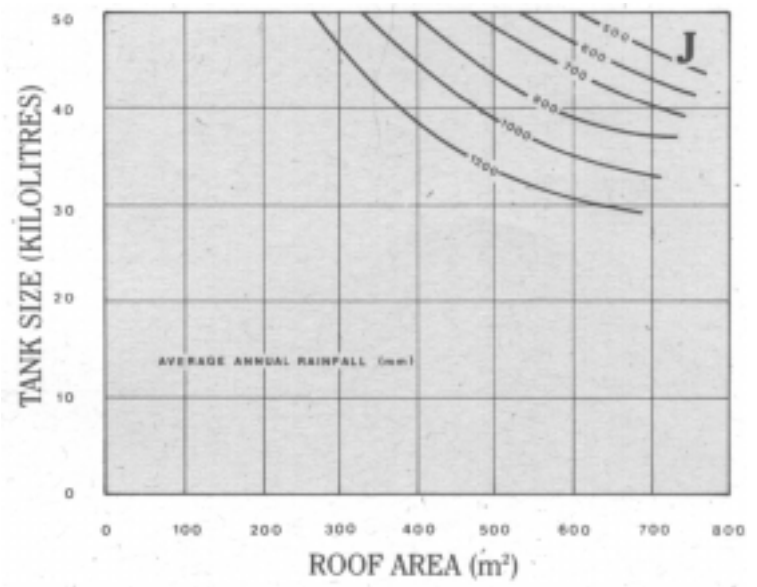


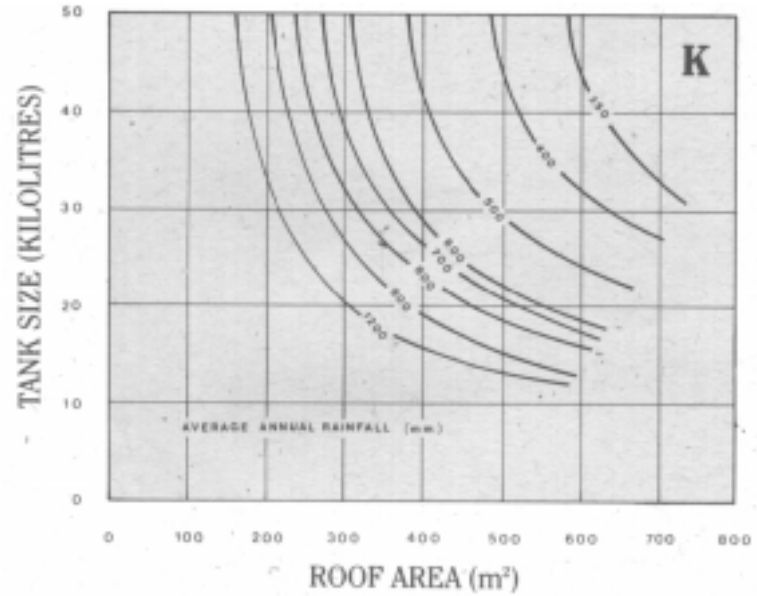


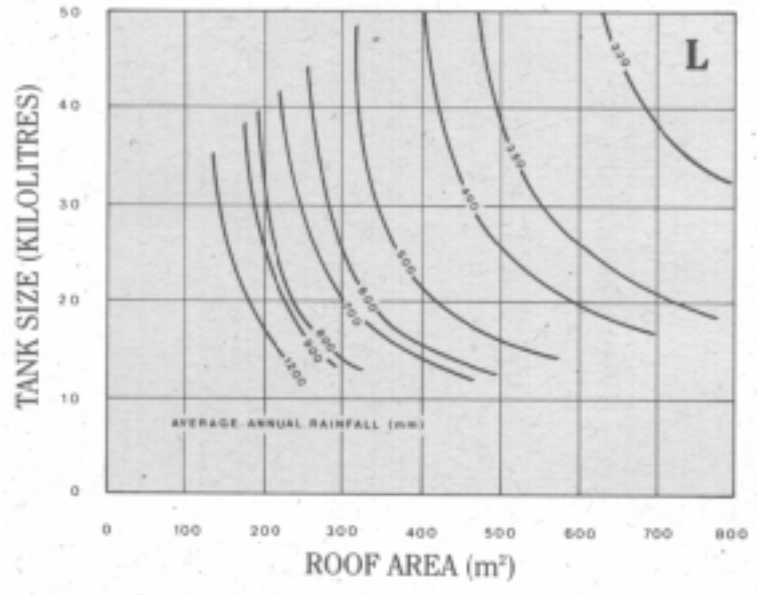
Raintank Yield
Demand 200 L/day
Degree of security 99% graph G
Degree of security 90% graph H
Degree of security 80% graph I



Raintank Yield
Demand 400 L/day
Degree of security 99% graph J
Degree of security 90% graph K
Degree of security 80% graph L







Raintank Yield
Demand 600 L/day
Degree of security 90% graph M
Degree of security 80% graph N