BUSH TECH #29

Pump selection and storage for water supplies

Background

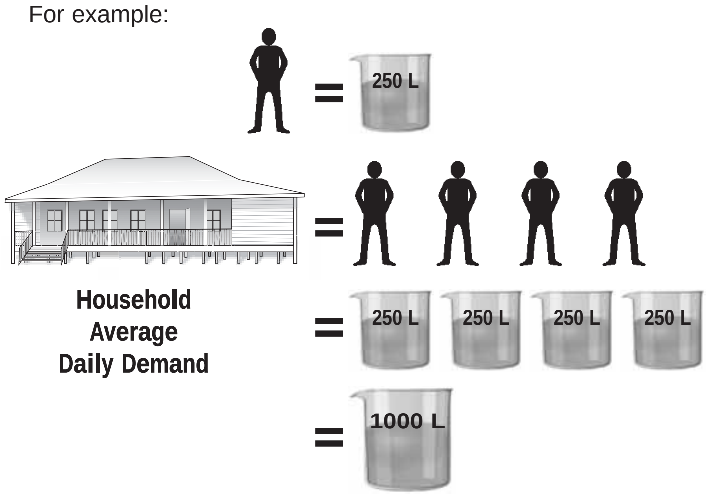
A safe and reliable water supply is essential for a healthy community. This BUSH TECH deals specifically with water supply from surface water sources, such as streams, shallow wells and billabongs and takes you through steps of sizing appropriate water supply systems, it particularly focuses on pumps and storage tanks. Surface water supplies are often used by communities. A good design will ensure that the system will be able to provide enough water.

How much water do you use?

250 litres per person per day (L/p/d) will provide a basic level of supply, and is likely to be appropriate for most small household-scale supplies. However, if your household has flush toilets, automatic washing machines or evaporative air conditioners or a garden, your water usage will be much higher. In this case, you may need around 400 L/p/d. If your stream or billabong is small, you may wish to consider the use of dry toilets to avoid using the extra water for toilet flushing (see BUSH TECH #18 and #23)

The total household requirement (or *average daily demand*) can then be found by multiplying the per-person demand by the usual number of occupants.

For example:



How much storage do you need?

You will need a storage tank, and it should be able to hold at least two average days' demand, but remember that more storage means a more secure supply, in case of equipment failure or any problems with your source water. Seven days' demand is a safer storage size to aim for.

The tank should be elevated so that it will provide enough pressure at the taps. A tank stand will be high enough if the bottom of the tank is about 4.5m off the ground. In hilly areas, the tank can be sited on a hill to avoid the cost of a tank stand.

How much pressure should the pump provide?

The amount of pressure that a pump provides is referred to as head. The required head has two components; static and friction. The static head is simply the vertical difference (metres) in height between the top of the highest storage tank and the water surface, e.g. 12 m high. To find the *friction head*, you need to know the length and diameter of the pipe. The calculations can be simplified as follows.

In most small outstations, we can assume that the pipe diameters are less than 250 millimetres (mm), so the frictional head is 10 metres (m) per km. To find the frictional head, just divide the length of the pipe in metres by 100, e.g. 50 m pipe ÷ 100 = 0.5 m.

If the pipe's diameter is greater than 300 mm, assume that frictional head is 5 m per km. To find the frictional head, divide the length of the pipe by 200.

Once you've found the frictional head, just add it to the static head to find how many metres of head the pump should provide. In our example, this is 12 m + 0.5 m = 12.5 m. Comparing this value to the pump head rating provided by pump manufacturers will tell you if the pump you are considering is able to pump the water through the pipe and up to your storage tank.

How much water can different pumps deliver?

Petrol pumps deliver water at a very fast rate (around 350 L/min for the commonly-used petrol Onga 350 model), so they can be used to fill a large tank in an hour or two. If a generator is used, the delivery rate depends on how long it is run for each day.

Small solar/electric pumps are much slower (only 350 L/hr or 6 L/min for the Flojet 2130-132), so it is necessary to set a minimum pumping rate. These types of pumps should deliver around 2.25 times the household's average daily demand each day. This increased capacity is to account for variation in demand and in supply of power to the pump due to weather conditions.

To calculate your minimum pumping rate, multiply your *average daily demand* (ADD) by 2.25. For example:

Required Flow Rate = 2.25* 1000 L (ADD) = 2250 L/day

Pump types and energy sources

There are a variety of pumps available in Australia that use different mechanisms. When deciding on your pump, you need to consider your available fuel source and the ongoing costs associated with them, including costs of maintenance and/or the available skills in your community.

Broadly, pumps can be divided into centrifugal and positive displacement type pumps. Centrifugal pumps are often used with diesel or petrol motors (AC power); they have a fixed minimum operating speed. So when the energy supplied to the pump drops below a certain level, it stops pumping. Petrol or diesel fuel can deliver this constant high operating speed, however you will need to consider the ongoing costs of fuel.

Solar and wind power are more variable energy sources. ***Positive displacement pumps*** will continue to pump with variable energy input, the flow rate will just vary in proportion to the incoming power (usually DC power). This means that when there is more power (i.e. more wind or sun) they will pump more, and less power they will pump less. This makes them well suited for use with renewable energy sources. Renewable energy systems can have higher capital costs, but the advantage is that you will never need to purchase fuel.

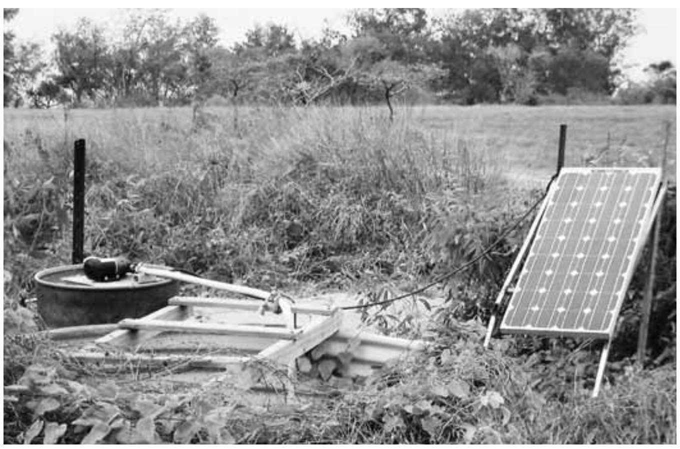
BUSH TECH #29

Pump selection and storage for water supplies

Common types of positive displacement pumps include:

- **Helical rotors** are reputed to be one of the most durable mechanisms for solar pumping in remote areas and are considered to be very reliable, requiring limited maintenance. Helical rotor pumps are submersible and can be used to pump from boreholes as well as from surface water sources using solar energy. They can provide a very wide range of head and flow rates. The initial cost however, is higher than fossil fuel pumps, beginning at around $4000. Two widely available brands are manufactured by Mono and Grundfos. Helical rotor pumps may be appropriate for very remote outstations because they require very little attention and often last longer than petrol pumps.
- **Diaphragm pumps** pump much slower than fuel alternatives and so are more suited to smaller outstations with low water demands. Some small electric diaphragm pumps are capable of being directly coupled to solar panels (DC power) and may be used for households or outstations with a small average daily demand of less than 1000 L/day. Two widely available brands of diaphragm pumps are Flojet and Shurflo.These pumps costs around $250, plus the cost of the solar equipment brings the total cost to around $1100.

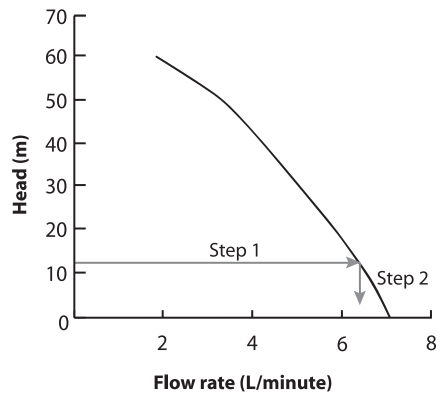
  Diaphragm pumps can only provide about 3 m of suction lift. This means the pump has to be close to the water, so it can't be used to pump from deeper wells or bores.



Solar-coupled diaphragm pump in shallow well, Far North Queensland.

Similar pumps are available that use AC power. These are applicable if you use a generator at your outstation. Many generators used on outstations generate more energy than the household uses, so running an electric pump from your generator could mean improving the efficiency of your existing fuel usage.

Many tropical outstations currently use 5 horsepower ***centrifugal pumps*** for water supply. These are inexpensive, reasonably reliable, provide very high flow (and so may be suitable for larger outstations) and can usually be serviced by someone in the area. They do have on-going costs though, as they require an ongoing fuel source (petrol). A petrol pump should provide around 10 m of suction lift, which is the vertical difference in height between the pump and the water surface. This means they can't be used to pump from bores unless the water level is very close to the surface. They are not submersible, so should be kept out of the water. Special care needs to be taken to ensure that they are located away from areas of sudden flooding. They cost around $800, but may have to be replaced after as little as two years if they are not maintained properly.



Source: Flojet 2130-132 Pump Performance Curve (http://www.rpc.com.au, accessed Dec 04)

Pump performance curves

The graph shown above is a *performance curve* for a diaphragm pump used in an outstation in far north Queensland. Performance curves are provided by the manufacturers of all different types of pumps, and you can use them to determine which pump will meet your water needs.

To determine whether this type of pump is suitable for your community, first calculate the required head (explained above) and draw a horizontal line from the "head" axis across to the curved line, as shown in step 1. Then draw a vertical line down from that point on the curve, as shown in step 2.

The vertical line should cross the "flow rate" axis to give the flow rate in *litres per minute* (L/min) that the pump can provide at the head required. For the example above, if the pump needs to provide approximately 13 m of head, it can deliver approximately 6.4 L/min.

This method can be used to read performance curves for most pumps, but it is important to make sure that the units on the graph are the same as the ones you are using. It is standard for head to be in metres, but flow may be commonly expressed as litres per second, litres per hour, or cubic metres (equal to 1,000 litres) per day.

Will this pump meet my needs?

To compare your Required Flow Rate to the flow rate provided by the pump, your Required Flow Rate needs to be in the same units, of L/min. To calculate this, divide your Required Flow Rate by the number of minutes the pump will run on a given day. For solar pumps, this is the approximate number of minutes of sunlight in a day, equivalent to about 6 hours. i.e. 1 day sunlight = 6 hours/day x 60 min/hr) = 6 x 60 = 360 minutes/day).

i.e. 2250 L/day ÷ 360 minutes/day = 6.25 L/min.

If the flow rate you calculate from the pump performance curve is greater than or approximately equal to the delivery rate required, this type of small diaphragm pump may be appropriate for your water supply. If you need a pump to supply at least 6.25 L/min, and this diaphragm pump can provide 6.4 L/min, then this pump will meet your needs. If the pump flow rate is less than your needs, a higher-powered pump that can supply a faster flow rate may be more appropriate. For petrol or diesel pumps, you will need to consider the number of hours you run the pump for each day.

Maintaining good water quality will be discussed in a later BUSH TECH.

Written by Alice Weatherford, CRCWQT student

Edited by Nerida Beard, CAT Alice Springs