Water Storage and Treatment

CISTERNS

Cisterns for family use are most practical in areas of adequate rainfall and where
ground water is difficult to obtain or where it contains too many minerals. A sealed well usually requires no filtration, no chemical disinfection, and little upkeep, while a cistern needs all of these. And cisterns generally cost more to build than wells. Cistern water has few minerals, however, and is ideal for washing clothes.

A cistern water supply has four basic parts: tank, catchment area, filter, and pump. (Pumps are discussed in the section on "Water Lifting.")

Cistern Tank

The tank described here can be used for sanitary storage of rainwater for family use. It can be constructed of reinforced concrete sealed with asphalt sealing compound.

The cistern tank must be watertight to prevent surface contamination from

**polluting the supply. Reinforced concrete is the best material because it is strong,
it has a long life and it can be made watertight.**

A manhole and drain must be provided so that the tank can be cleaned. (See Figure 1.)

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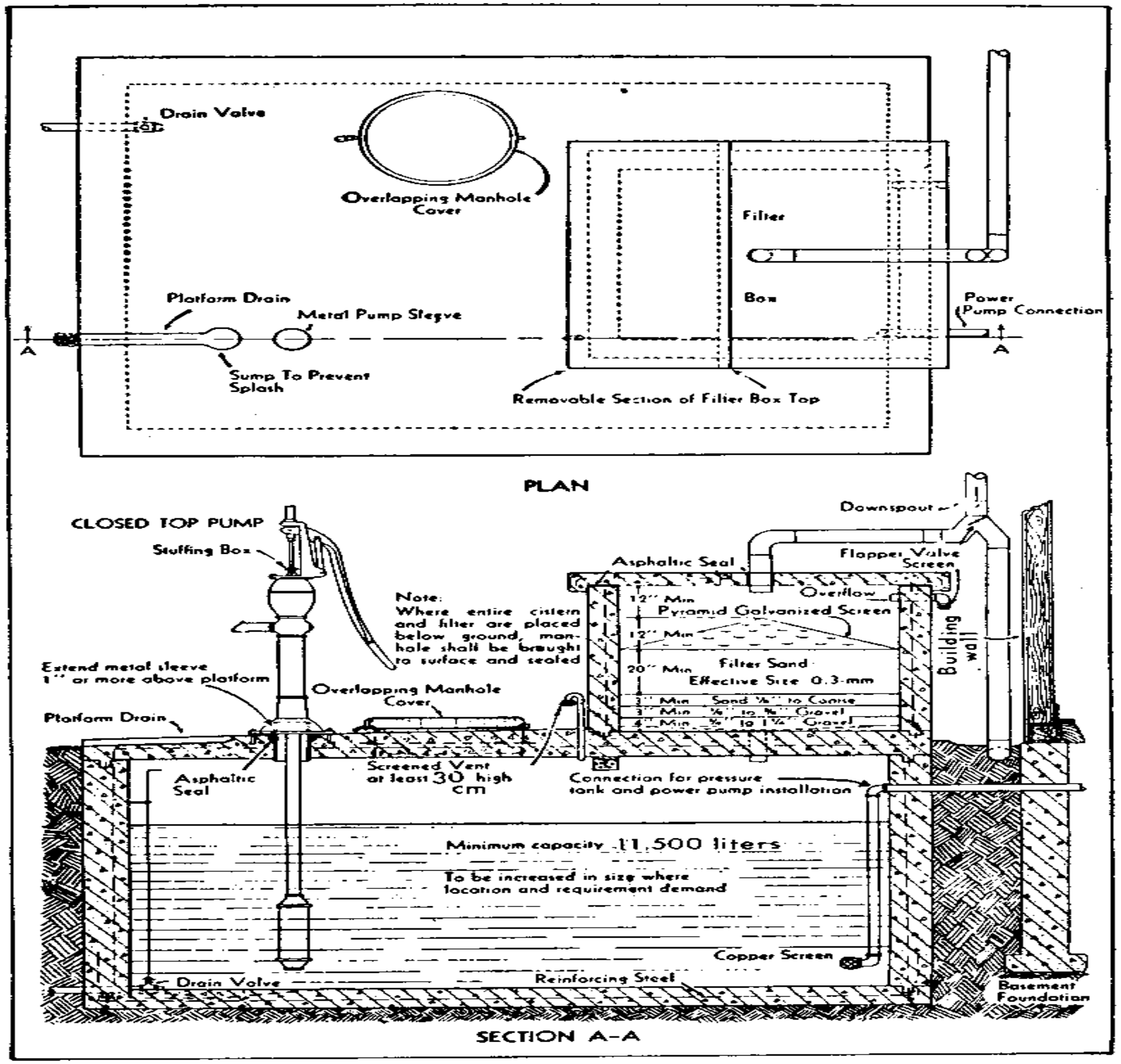
FIG. 1 CISTERN WITH SAND FILTER (PUMP INSTALLATION OPTIONAL)



Reproduced from US Public Health Service, Joint Committee on Rural Sanitation (1950) *Individual water supply systems*, Washington, p. 32

A vent and a place through which chlorine can be added easily for disinfection are also necessary. (Note: Chlorine can be added through the vent by removing the U elbow. Lubricate the threads of the elbow to make removal easy.)

The size of the cistern depends on the family's daily needs and the length of time between rainy periods. If a family needs 94.6 liters (25 U.S. gallons) of water a day and there are 125 days between rainy periods, then the cistern must hold:

94.6 liters x 125 days = 11,835 liters

or

25 U.S. gallons x 125 days = 3,125 U.S. gallons

A cistern with an inside size of 3 meters x 2 meters x 2 meters (7 1/2' x 7 1/2' x 7 1/2') holds 11,355 liters (3,000 U.S. gallons). The top surfaces of the cistern walls should be about 10cm above ground.

To be sure that the cistern is watertight, use about 28 liters of water per 50kg sack of cement (5 1/2 U.S. gallons per 94 pound or one cubic foot sack) when mixing the concrete. (See section on "Concrete Construction.") Tamp the concrete thoroughly and keep the surface damp for at least 10 days. If possible, pour the walls and floor at the same time. The manhole entrance must be 10cm (4") above the cistern surface and the cover should overlap by 5cm (2"). Slope the bottom of the cistern, making one part lower than the rest, so that water can be more easily siphoned or bailed out when the cistern is being cleaned. You can do this by scraping the bottom to the proper contour. Do not use fill dirt under the cistern because this may cause the cistern to settle unevenly and crack. A screened drain pipe and valve will make cleaning easier.

**An overflow pipe is not needed if a roof-cleaning butterfly valve is properly used.
If the overflow is installed, be sure to cover the outlet carefully with copper window screen. A screened vent is necessary if there is no overflow, to allow displaced air to leave the cistern. The hand pump must be securely mounted to bolts cast into the concrete cistern cover. The flanged base of the pump should be solid, with no holes for contamination to enter, and sealed to the pump cover,
or the drop pipe must be sealed in with concrete and asphalt sealing compound.**

**A small pipe with a screw-on cap is needed to allow for measuring the water in the cistern and adding chlorine solution after each rainfall. The amount of water
in the cistern is measured with a stick marked in thousands of liters (or thousands
of gallons). To disinfect after each rainfall, add a 5 parts per million dosage of chlorine (see section on "Chlorination").**

**A newly built or repaired cistern should always be disinfected with a 50 parts per
million chlorine solution. The cistern walls and the filter should be thoroughly washed with this strong solution and then rinsed. A small-pressure system can be disinfected readily by pumping this strong solution throughout the system and letting it stand overnight.**

Catchment Area

A catchment area of the proper size is a necessary part of a cistern water

supply. Rainwater for a cistern can be collected from the roof of a house. The method given here for estimating catchment size should be checked against the actual size of nearby catchment installations.

The catchment or collecting area should be a smooth, watertight material, like a galvanized sheet-metal roof. Wood or thatch roofs may taint the water and retain dust, dirt and leaves; water from these roofs contains more organic matter and bacteria than water from smooth surfaces. Stone, concrete, and plastic film catchments are sometimes built on the ground. For family use, roofs are usually best because humans and animals cannot contaminate them.

To estimate your required catchment area, estimate the minimum yearly rainfall and the amount of water required by the family during one year. Sometimes the government meteorological section can give you the minimum rainfall expected. If they cannot, estimate the minimum rainfall at two-thirds of the yearly average. Take the average amount of water needed by the family for one day and multiply it by 365 to learn how much is needed for one year. Then use the chart to find how much roof space is needed (Figure 2). Add 10 percent to the area given by

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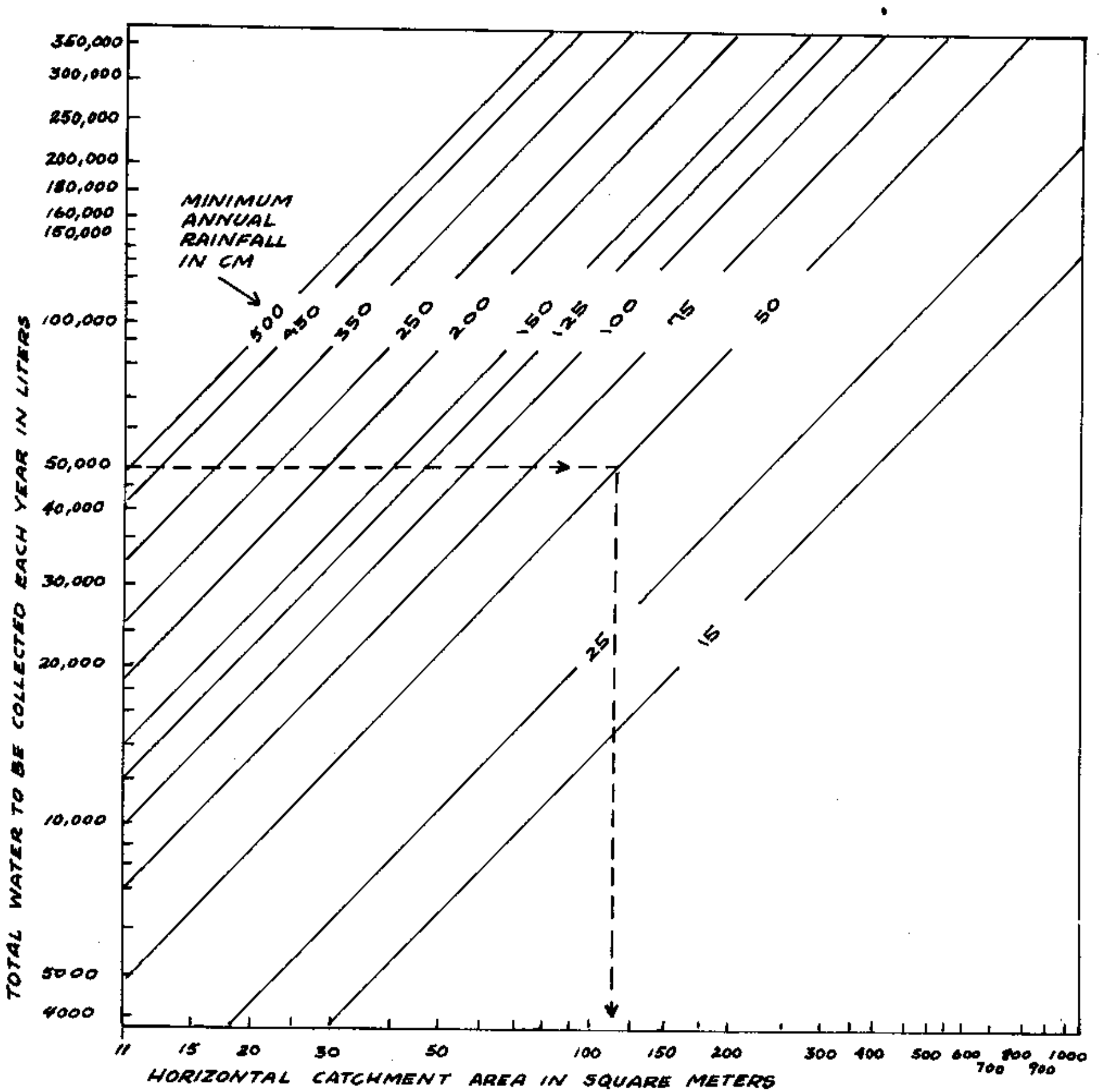

FIGURE 2

the chart to allow for water lost to evaporation and discarded at the beginning of each rainfall.

Example:

With an average rainfall of 75cm a year, and a family needing 135 liters of water a day, then:

2/3 x 75 = minimum annual rainfall of 50cm

365 x 135 liters/day = 49,275 liters a year.

Round this figure off to 50,000 liters a year. The example worked out on the chart (Figure 2) shows that a catchment area of about 115 square meters is needed. Add 10 percent to this area to allow for water loss, giving a total required catchment area of about 126.5 square meters.

A collecting trough and downspout are needed. Be sure there is a good pitch to the trough so that the water flows freely and does not hold small puddles that can attract mosquitoes and other insects. Troughs and downspouts need periodic inspection and cleaning. Extending the trough increases the catchment area.

Cistern Filter

The sand filter described here will remove most organic matter from water but it will not produce safe drinking water by removing all harmful bacteria. Water collected in the cistern tank should be chlorinated after each rainfall. A catchment area always collects leaves, bird droppings, road dust, and insects. A cistern filter removes as much of this material as possible before the water enters the cistern (Figure 3).

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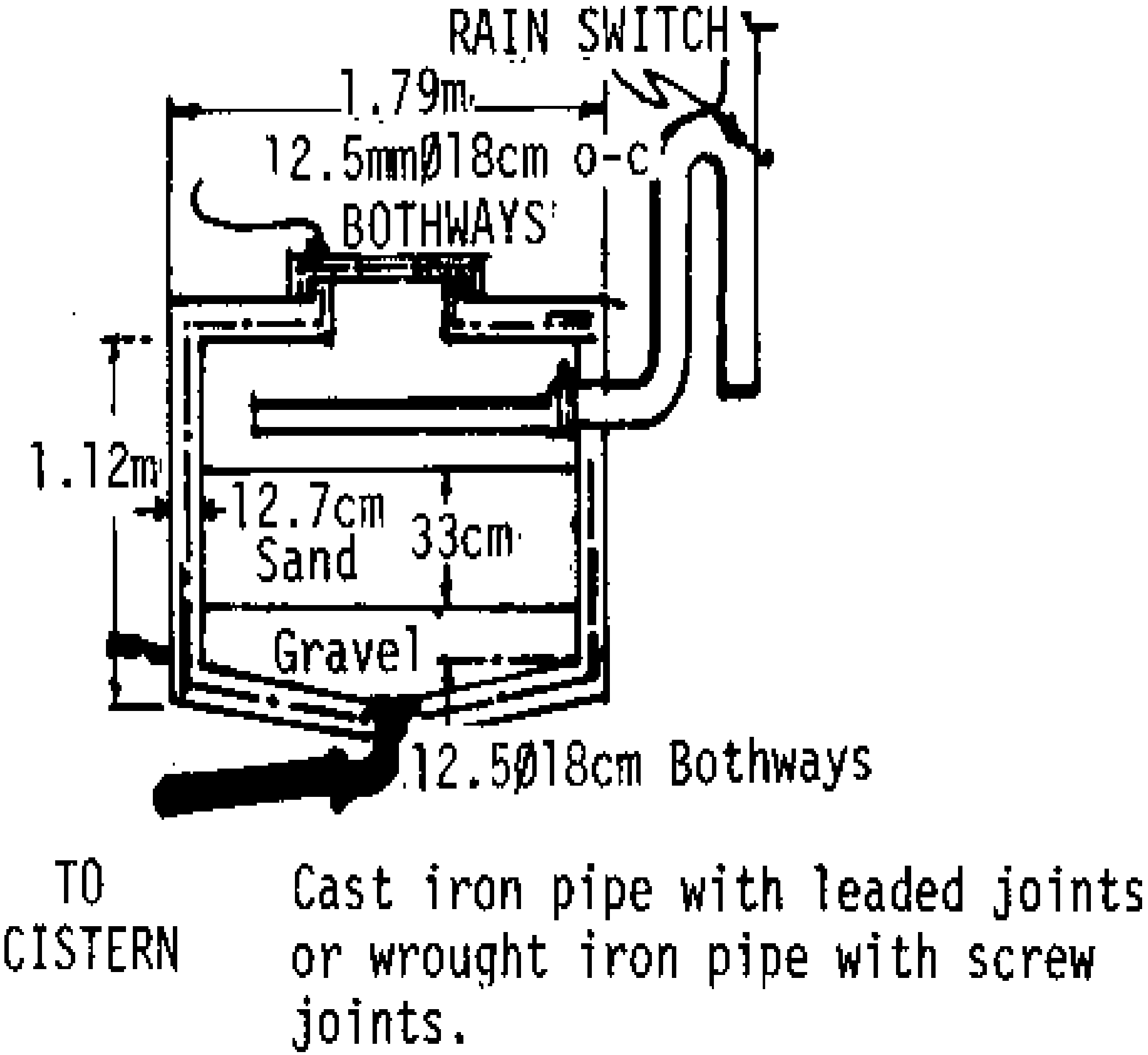

FIGURE 3

The sand filter is usually built at ground level and the filtered water

runs into the cistern, which is mostly underground. The largest pieces, such as leaves, are caught in the splash plate. The splash plate also distributes the water over the surface of the filter, so that the water does not make holes in the sand. Several layers of copper window screen form the splash plate.

If a filter is made too small to handle the normal rush of water from rainstorms,
the water will overflow the filter or dig a channel in the sand, ruining the filter.
The filter area should be not less than one-tenth of the catchment area. A typical
filter would be 122cm x 122cm (4' x 4') for a family-sized unit where rainfall intensity is average.

About every 6 months, remove the manhole cover and clean the filter. Remove all matter from the splash plate and scrape off and remove the top 1.25cm (1/2") of sand. When the sand is down to 30cm (12") in depth, rebuild it with clean sand to
the original depth of 46cm (18").

The first runoff from the roof, which usually contains a great deal of leaves and dirt, should be

discarded. The simplest way to do this is to have a butterfly valve (like a damper in a stovepipe) in the downspout. After the rain has washed the roof, the valve is turned to let the runoff water enter the filter. A semi-automatic filter is shown in Figure 4.

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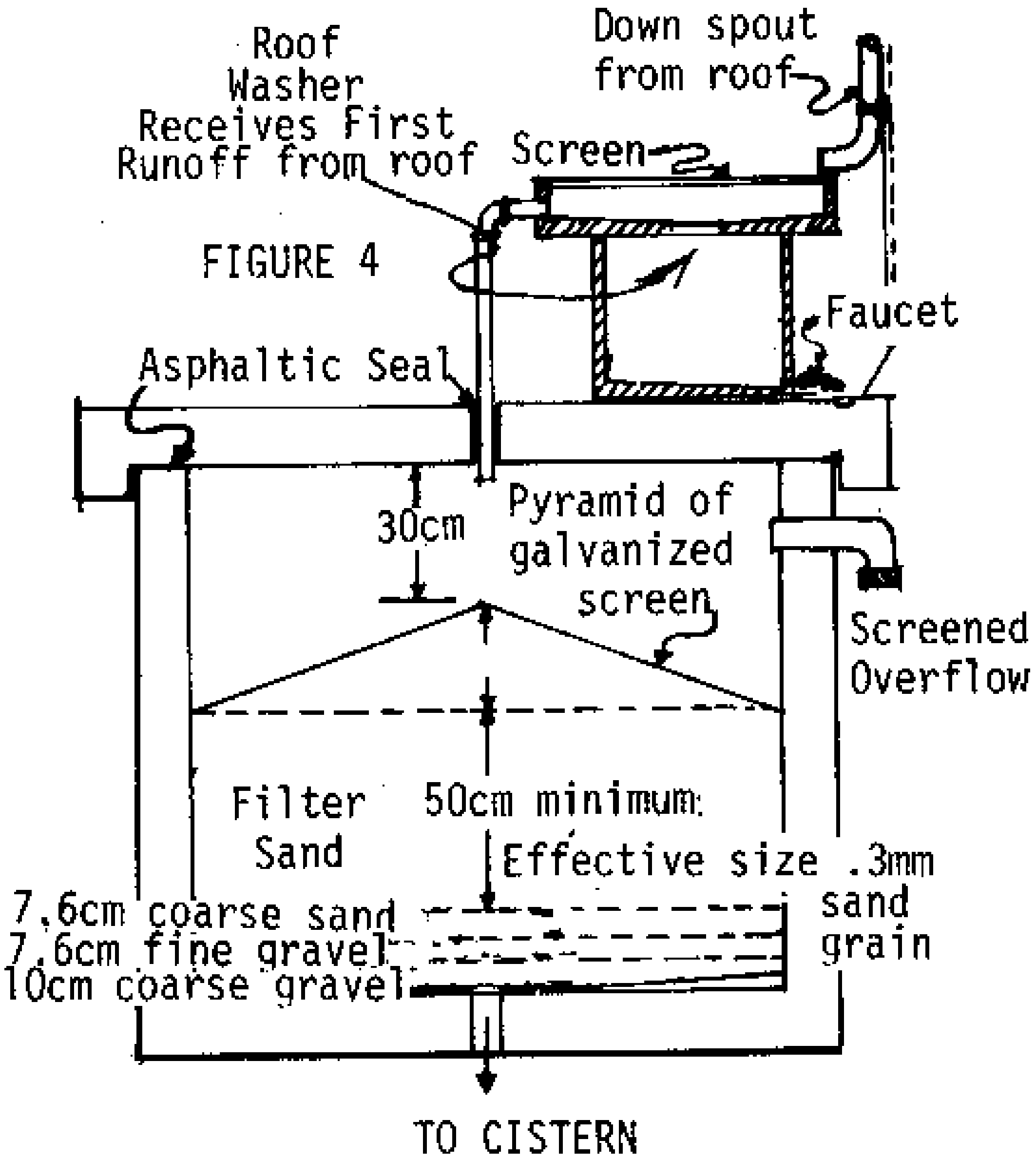
FIGURE 4



In building the filter, it is important to use properly-sized sand and

gravel and to make sure the filter can be cleaned easily. The filter must have a screened overflow.

Sources:

Wagner, E.G. and Lanoix, J.N. Water Supply for Rural Areas and Small Communities.
Geneva: World Health Organization, 1959.

Cisterns. State of Illinois, Department of Public Health, Circular No. 833.

Manual of Individual Water Supply Systems. U.S. Department of Health, Education and Welfare, Public Health Service Publication No. 24.

SELECTING A DAM SITE

A water reservoir can be formed by building a dam across a ravine. Building a dam takes time, labor, materials, and money. Furthermore, if a dam holding more than a few acre-feet of water breaks, a great deal of damage can be caused. Therefore, it is important to choose a dam site carefully, to guard against dam collapse, and to avoid excessive silting, porous soil, polluted water, and water shortages because the catchment area is too small. Careful selection of the dam site will save labor and material costs and help ensure a strong dam.

The preliminary evaluation described here will help to determine whether or not a
particular site will be good for building a dam. Remember that dams can have serious environmental consequences and an improperly constructed dam can be

extremely dangerous. Consult an expert before starting to build.

Six factors are important in site selection.

1. Enough water to meet your requirements and fill the reservoir.

2. Maximum water storage with the smallest dam.

3. A sound, leakproof foundation for the reservoir.

4. Reasonable freedom from pollution.

5. A storage site close to users.

6. Available materials for construction.

7. Provision for a simple spillway.

8. Authorization from local authorities to build the dam and use the water.

One acre-foot of water is equivalent to the amount required to cover an acre of land (30cm of water covering 0.4 hectares) to a depth of 1 foot. One acre-foot equals 1,233.49 cubic meters. The annual rainfall and type of catchment (or natural drainage) area will determine the amount of water the reservoir will collect.

Catchment Area

A catchment area with steep slopes and rocky surfaces is very good. If the

catchment area has porous soil on a leak-proof rock base, springs will develop and will carry water to the reservoir, but more slowly than rocky slopes. Trees with small leaves, such as conifers, will act as a windbreakers and reduce loss of
water from evaporation.

Swamps, heavy vegetation, permeable ground, and slight slopes will decrease the yield of water from a catchment area.

Rainfall

The average catchment area will, in a year, drain 5 acre-feet (6,167 cubic meters)
into a reservoir for every inch (2.5cm) of annual rainfall falling on a square mile
(2.59 square kilometers); that is, about 10 percent of the rainfall.

Location

The best location for building a dam is where a broad valley narrows with steep sides and a firm base on which to build the dam (see Figure 1). Ground that

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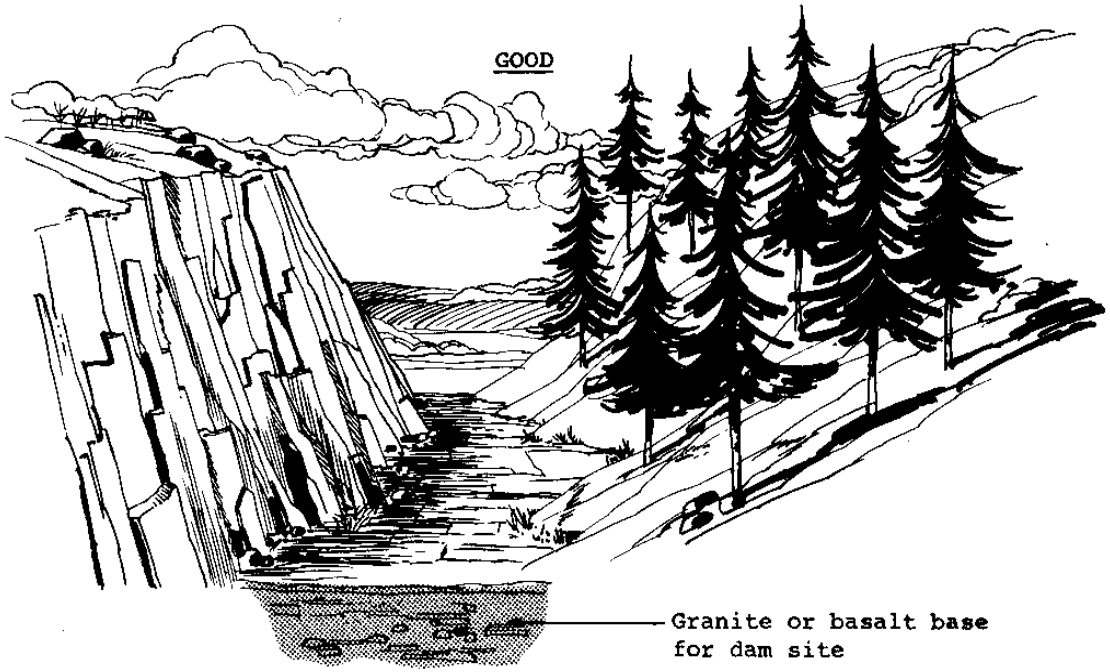
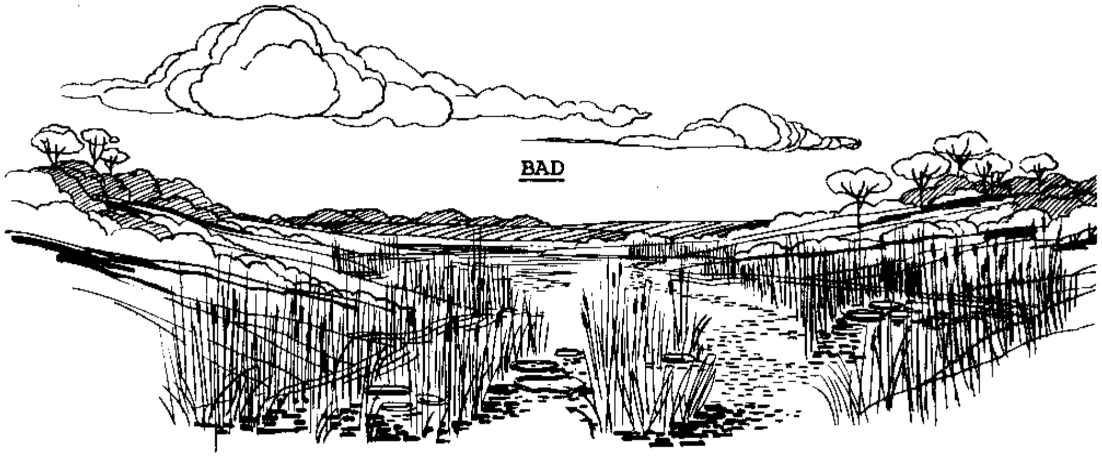


FIGURE 1



contains large boulders, weathered or fissured bedrock, alluvial sands, or porous rock is not good. The best bases for building a dam are granite or basalt layers

at or near the surface or a considerable depth of silty or sandy clay.

Location of a dam upstream from its point of use can lower pollution and may allow for gravity feed of the water to its point of use.

It is best if stone is nearby when building a masonry dam. When building an earth dam, rock will still be required for the spillway. The best soils for earth dams contain clay with some silt or sand. There should be enough of this soil close to the dam site for building the entire dam of reasonably uniform material.

Source:

Wagner, E.G. and Lanoix, J.N. Water Supply for Rural Areas and Small Communities.
Geneva: World Health Organization, 1959.