If concrete or other casing pipe cannot be obtained, a chimney made of burned bricks and sand-cement mortar will suffice. The pipe is somewhat more expensive, but much easier to install.

Source:

A Safe Economical Well. Philadelphia: American Friends Service Committee, 1956 (Mimeographed).

Deep Dug Well

**Untrained workers can safely dig a deep sanitary well with simple, light equipment,
if they are well supervised. The basic method is outlined here.**

Tools and Materials

**Shovels, mattocks
Buckets
Rope--deep wells require wire rope
Forms--steel, welded and bolted together
Tower with winch and pulley
Cement
Reinforcing rod
Sand
Aggregate
Oil**

The hand dug well is the most widespread of any kind of well. Unfortunately, in many places these wells are dug by people unfamiliar with good sanitation methods and become infected by parasitic and bacterial disease. By using modern methods and materials, dug wells can safely be made 60 meters (196.8') deep and will give a permanent source of pure water.

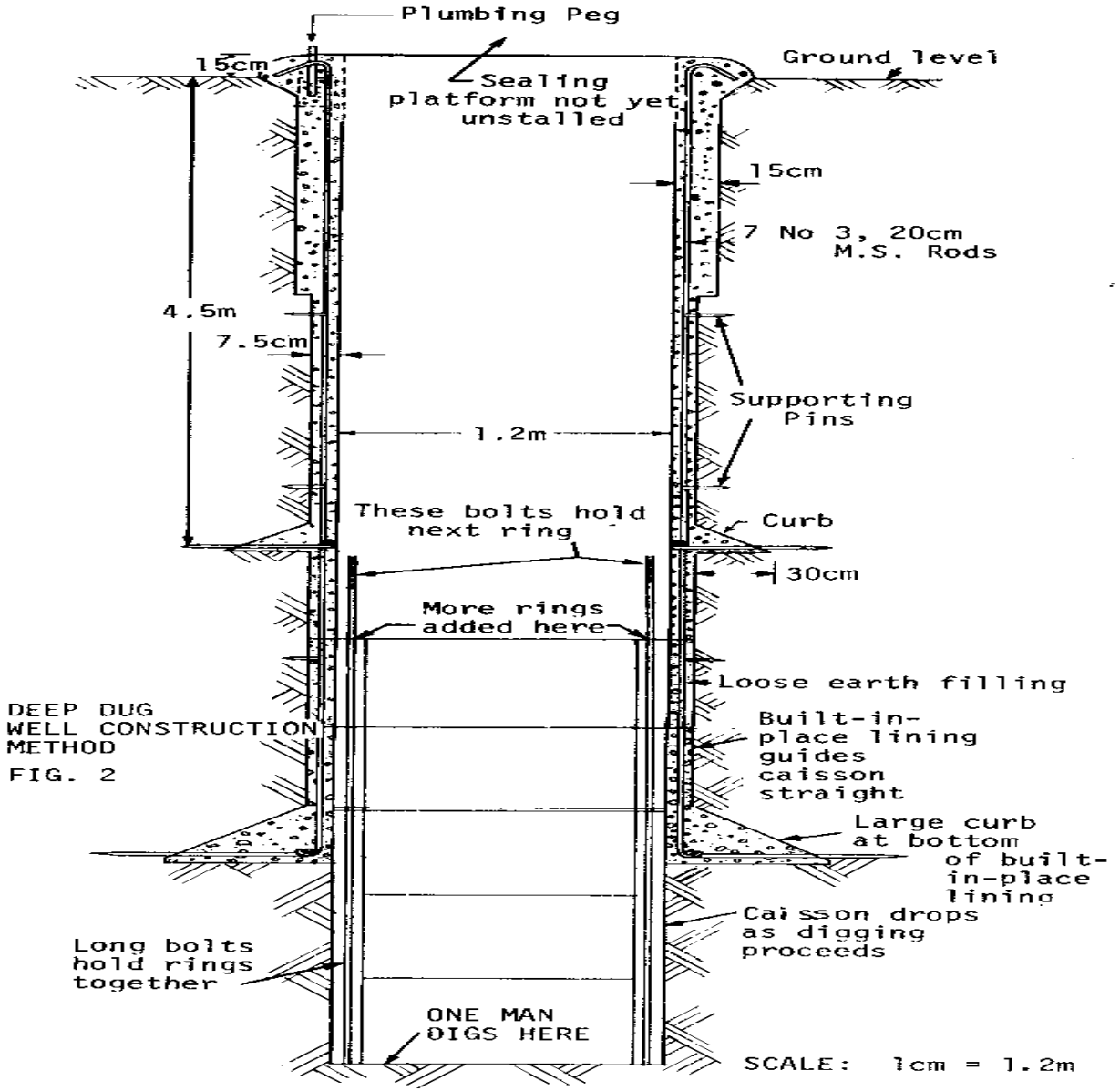
Experience has shown that for one person, the average width of a round well for best digging speed is 1 meter (3 1/4'). However, 1.3 meters (4 1/4') is best for two workers digging together and they dig more than twice as fast as one person. Thus, two workers in the larger hole is usually best.

Dug wells always need a permanent lining (except in solid rock, where the best method is usually to drill a tubewell).

The lining prevents collapse of the hole, supports the pump platform, stops entrance of contaminated surface water, and supports the well intake, which is the part of the well through which water enters. It is usually best to build the lining while digging, since this avoids temporary supports and reduces danger of cave-ins.

**Dug wells are lined in two ways: (1) where the hole is dug and the lining is built
in its permanent place and (2) where sections of lining are added to the top and the whole lining moves down as earth is removed from beneath it. The second method is called caissoning; often a combination of both is best (Figure 2.)**

fig2x58.gif (600x600)



If possible, use concrete for the lining because it is strong, permanent, and made

mostly of local materials. It can also be handled by unskilled workers with good speed and results. (See section on Concrete Construction).

Masonry and brickwork are widely used in many countries and can be very satisfactory if conditions are right. In bad ground, however, unequal pressures can make them bulge or collapse. Building with these materials is slow and a thicker wall is required than with concrete. There is also always the danger of movement during construction in loose sands or swelling shale before the mortar has set firmly between the bricks or stones.

Wood and steel are not good for lining wells. Wood requires bracing, tends to rot and hold insects, and sometimes makes the water taste bad. Worst of all, it will not make the well watertight against contamination. Steel is seldom used because it is expensive, rusts quickly, and if it is not heavy enough is subject to bulging and bending.

The general steps in finishing the first 4.6 meters (15') are:

o set up a tripod winch over cleared, level ground and mark reference points for plumbing and measuring the depth of the well.

o have two workers dig the well while another raises and unloads the dirt until the well is exactly 4.6 meters (15') deep.

o trim the hole to size using a special jig mounted on the reference points.

o place the forms carefully and fill one by one with tamped concrete.

After this is done, dig to 9.1 meters (30'), trim and line this part also with concrete. A 12.5cm (5") gap between the first and second of these sections is filled with pre-cut concrete that is grouted (mortared) in place. Each lining is self-supporting as it has a curb. The top of the first section of lining is thicker
than the second section and extends above the ground to make a good foundation for the pump housing and to make a safe seal against ground water.

This method is used until the water-bearing layer is reached; there an extra-deep
curb is constructed. From this point on, caissoning is used.

Caissons are concrete cylinders fitted with bolts to attach them together. They are cast and cured on the surface in special molds, prior to use. Several caissons
are lowered into the well and assembled together. As workers dig, the caissons drop lower as earth is removed from beneath them. The concrete lining guides the caissons.

If the water table is high when the well is dug, extra caissons are bolted in place
so that the well can be finished by a small amount of digging, and without concrete work, during the dry season.

Details on plans and equipment for this process are found in Water Supply for Rural Areas and Small Communities, by E. G. Wagner and J. N. Lanoix, World Health Organization, 1959.

Reconstructing Dug Wells

**Open dug wells are not very sanitary, but they can often be rebuilt by relining the top 3 meters (10') with a watertight lining, digging and cleaning the well and
covering it. This method involves installation of a buried concrete slab; see Figure 3**

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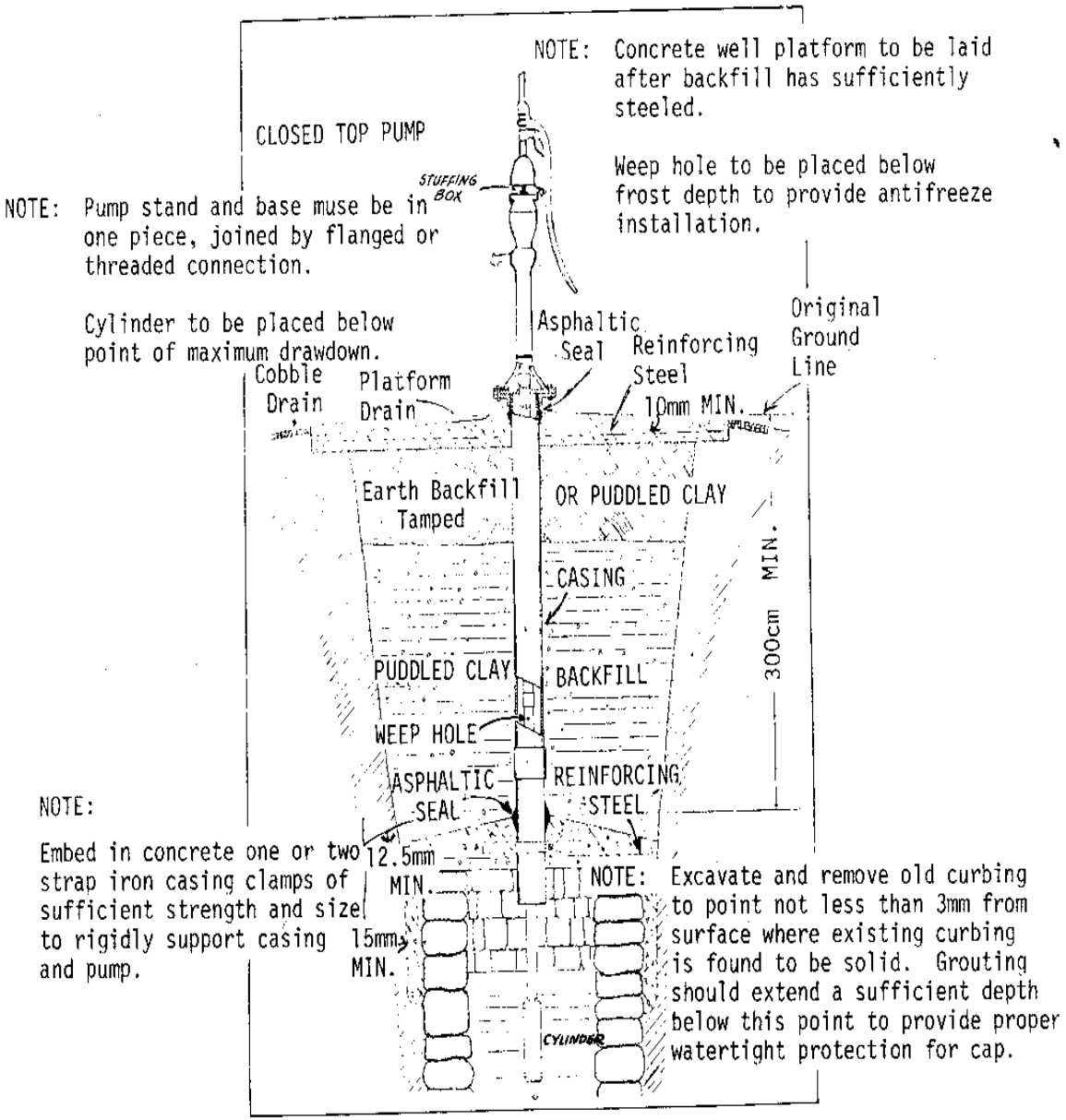

FIGURE 3

for construction details.

Tools and Materials

Tools and materials for reinforced concrete
A method for entering the well
Pump and drop pipe

Before starting, check the following:

o Is the well dangerously close to a privy or other source of contamination? Is it close to a water source? Is it desirable to dig a new well elsewhere instead of cleaning this one? Could a privy be moved, instead?

o Has the well ever gone dry? Should you deepen it as well as clean it?

o Surface drainage should generally slope away from the well and there should be effective disposal of spilled water.

o What method will you use to remove the water and what will it cost?

o Before entering the well to inspect the old lining, check for a lack of oxygen by lowering a lantern or candle. If the flame remains lit, it is reasonably safe to enter the well. If the flame goes out, the well is dangerous to enter. Tie a rope around the person entering the well and have two strong workers on hand to pull him out in case of accident.

Relining the Wall

The first job is to prepare the upper 3 meters (10') of the lining for concrete by
removing loose rock and chipping away old mortar with a chisel, as deep as

possible (see Figure 4). The next task is to clean out and deepen the well, if that

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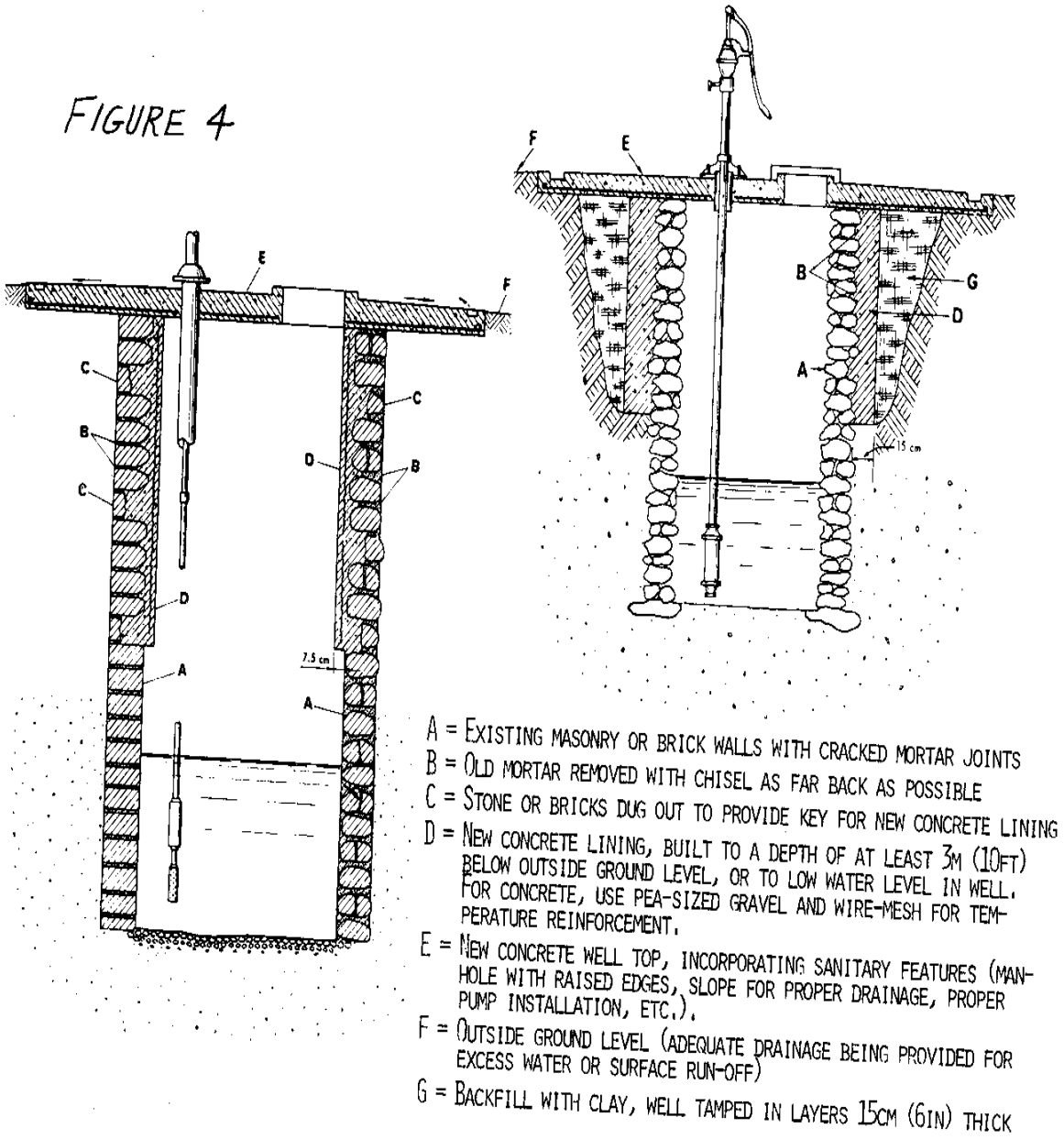
FIGURE 4



A = EXISTING MASONRY OR BRICK WALLS WITH CRACKED MORTAR JOINTS
B = OLD MORTAR REMOVED WITH CHISEL AS FAR BACK AS POSSIBLE
C = STONE OR BRICKS DUG OUT TO PROVIDE KEY FOR NEW CONCRETE LINING
D = NEW CONCRETE LINING, BUILT TO A DEPTH OF AT LEAST 3M (10FT) BELOW OUTSIDE GROUND LEVEL, OR TO LOW WATER LEVEL IN WELL. FOR CONCRETE, USE PEA-SIZED GRAVEL AND WIRE-MESH FOR TEMPERATURE REINFORCEMENT.
E = NEW CONCRETE WELL TOP, INCORPORATING SANITARY FEATURES (MANHOLE WITH RAISED EDGES, SLOPE FOR PROPER DRAINAGE, PROPER PUMP INSTALLATION, ETC.).
F = OUTSIDE GROUND LEVEL (ADEQUATE DRAINAGE BEING PROVIDED FOR EXCESS WATER OR SURFACE RUN-OFF)
G = BACKFILL WITH CLAY, WELL TAMPED IN LAYERS 15CM (6IN) THICK

is necessary. All organic matter and silt should be bailed out. The well may be dug deeper, particularly during the dry season, with the methods outlined in "Deep

Dug Wells." One way to increase the water yield is to drive a well point deeper into the water-bearing soil. This normally will not raise the level of water in the well, but may make the water flow into the well faster. The well point can be piped directly to the pump, but this will not make use of the reservoir capacity of the dug well.

The material removed from the well can be used to help form a mound around the well so water will drain away from the opening. Additional soil will usually be needed for this mound. A drain lined with rock should be provided to take spilled water away from the concrete apron that covers the well.

Reline the well with concrete troweled in place over wire mesh reinforcement. The largest aggregate should be pea-sized gravel and the mix should be fairly rich with concrete, using no more than 20-23 liters (5 1/2 to 6 gallons) of water to a 43kg (94 pound) sack of cement. Extend the lining 70cm (27 1/2") above the original ground surface.

Installing the Cover and Pump

Cast the well cover so that it makes a watertight seal with the lining to keep surface impurities out. The cover will also support the pump. Extend the slab out over the mound about a meter (a few feet) to help drain water away from the site. Make a manhole and space for the drop pipe of the pump. Mount the pump off center so there is room for the manhole. The pump is mounted on bolts cast

into the cover. The manhole must be 10cm (4") higher than the surface of the slab. The manhole cover must overlap by 5cm (2") and should be fitted with a lock to prevent accidents and contamination. Be sure that the pump is sealed to the slab.

Disinfecting the Well

Disinfect the well by using a stiff brush to wash the walls with a very strong solution of chlorine. Then add enough chlorine in the well to make it about half the strength of the solution used on the walls. Sprinkle this last solution all over the surface of the well to distribute it evenly. Cover the well and pump up the water until the water smells strongly of chlorine. Let the chlorine remain in the pump and well for one day and then pump it until the chlorine is gone.

Have the well water tested several days after disinfection to be sure that it is pure. If it is not, repeat the disinfection and testing. If it is still not pure, get expert advice.

Sources:

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

Manual of Individual Water Supply Systems, Public Health Service Publication No. 24. Washington, D.C.: Department of Health and Human Services.