
TECHNICAL PAPER # 68

UNDERSTANDING WATER WELLS

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PREFACE

This paper is one of a series published by Volunteers in Technical Assistance to provide an introduction to specific state-of-the-art technologies of intrest to people in developing countries. The papers are intended to be used as guidelines to help people chooe technologies that are suitable to their situations. They are not intended to provide construction or implementation details. People are urged to contact VITA or a similar organization for further information and technical assistance if they find that a particular technology seems to meet their needs.

The papers in the series were written, reviewed, and illustrated almost entirely by VITA Volunteer technical experts on a purely voluntary basis. Some 500 volunteers were involved in the production of the first 100 titles issued, contributing approximately 5,000 hours of their time. VITA staff included Patrice Matthews handling typesetting and layout, and Margaret Crouch as project manager.

The author of the paper William Ashe, is the Director of Lifewater International. Mr. Ashe has experience in drip irrigation, wind mills and jet pumps. He has travelled in Haiti, Dominican Republic and Kenya.

The six reviewers who are all VITA Volunteers were, Douglas Denatale who is employed by Whitman & Howard, Inc. and is experienced in geology, Joseph Gitta, self-employed in Beekeeping, William Lorah, a civil engineer with Wright Water Engineers, Robert Moran, a consultant in geology, P. Alan Pashkevich an engineer in Georgia Tech Research Institute, and Don C. Wells, an engineer for the city of Portland.

VITA is a private, nonprofit organization that supports people working on technical problems in developing countries. VITA offers information and assistance aimed at helping individuals and groups to select and implement technologies appropriate to their situations. VITA maintains an international Inquiry Service, a specialized documentation center, and a computerized roster of volunteer technical consultants; manages long-term field projects; and published a variety of technical manuals and papers.

UNDERSTANDING WATER WELLS

By

VITA Volunteer William A. Ashe

BACKGROUND

Safe drinking water is a basic human need. Yet, according to the World Bank, water-borne diseases are the leading cause of infant mortality worldwide. These diseases are among the most serious found in the developing world. There is no single community project for development of long-term social and economic well-being, health, and comfort of a small community that is more important than a safe drinking-water supply.

Wells provide access to ground water, which is almost always safer and cleaner than surface water from lakes and rivers. Digging a well appears simple, and inexperienced and unskilled people have made wells of many types, shapes, and sizes, with a variety of tools. Such wells are usually not the best and often prove dangerous during construction or after continued use. Those used to supply drinking water for humans are often improperly sealed at the surface and thus allow contaminated surface water to drain back into the well. Contaminated water makes people sick. Since the microorganisms (bacteria and viruses) that cause the diseases are too small to be seen, some people find it hard to believe that they are present. They often do not trace the source of their sickness to contaminated water.

This paper tells how to dig a well that provides safe drinking water for human consumption. Wells for animals and irrigation can be constructed to a much lower standard.

The paper intends to help people decide what type of well is best for them and whether hand-dug wells or drilled wells are within their means. Drilled wells can be deeper, safer, and more durable than hand-dug wells but their construction is more expensive and in many rural areas, the equipment or funds for drilling may not be available. Fortunately, simple machinery has been developed that can be used if money or expertise is not too scarce. Although this brings drilled wells within reach of some communities, they remain too costly for others. In these cases, hand-dug wells provide an alternative for producing safe drinking water.

Many good "how-to" books are available that describe in detail the construction of different types of water wells. A few are listed in the Bibliography.

PRINCIPLES

Ground Water

When it rains, some of the water soaks into the ground and is trapped in porous soils. Other water flows into and through layers of loose or porous rock. This is ground water. Water saturated layers of rock and soil that can yield a supply of water sufficient for wells or springs are called aquifers. The level of the top of the saturated layers is called the water table (Figure A). The water table may be fairly close to the

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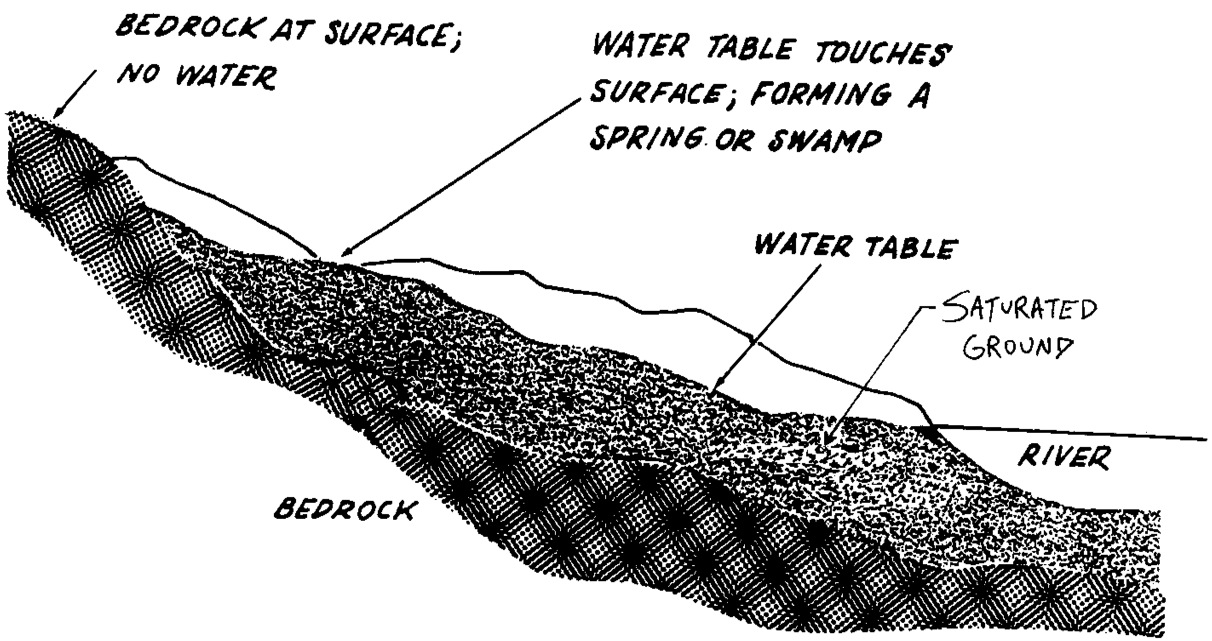

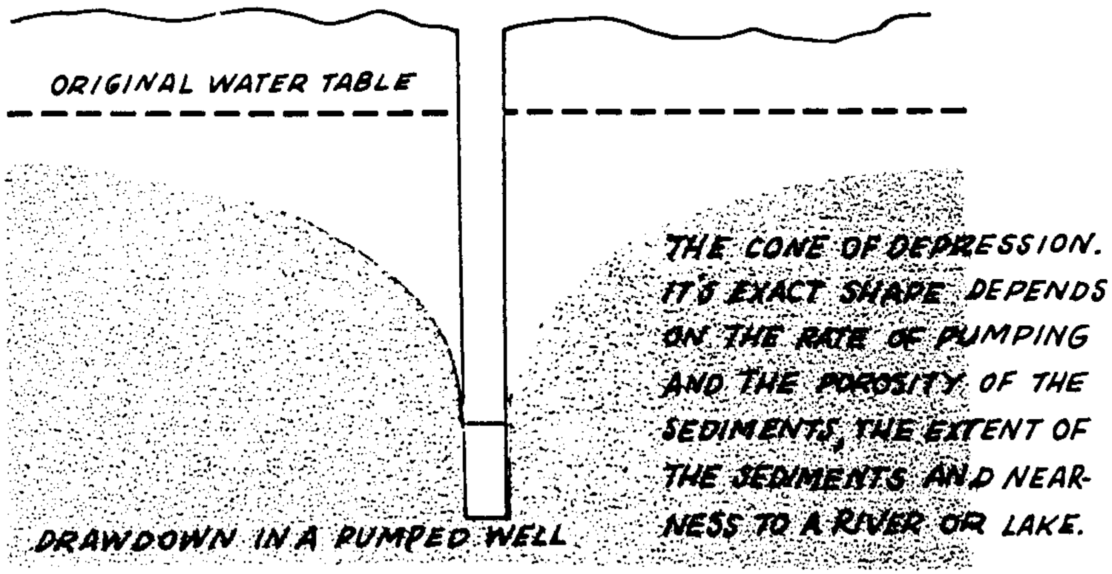

surface or deep below ground. During rainy weather the water table may be higher than normal and during dry seasons it may be lower.

How Wells Work

A water well is a hole that is dug, driven, or drilled through the earth, into the aquifier, to remove ground water for human use. The sides of the hole can be left without support, but are often supported by brick, stone, concrete, steel pipe, or other materials. Water is removed from the well by a variety of methods, of which the simplest is lowering and raising a bucket or other container. A variety of pumps can also be used; these may be hand operated or powered by petrol, electricity, wind, or other means.

Most hand-dug wells are less than 30 meters deep, but deeper wells have been successfully constructed under special conditions (Figure B). Machine-drilled wells have been drilled several

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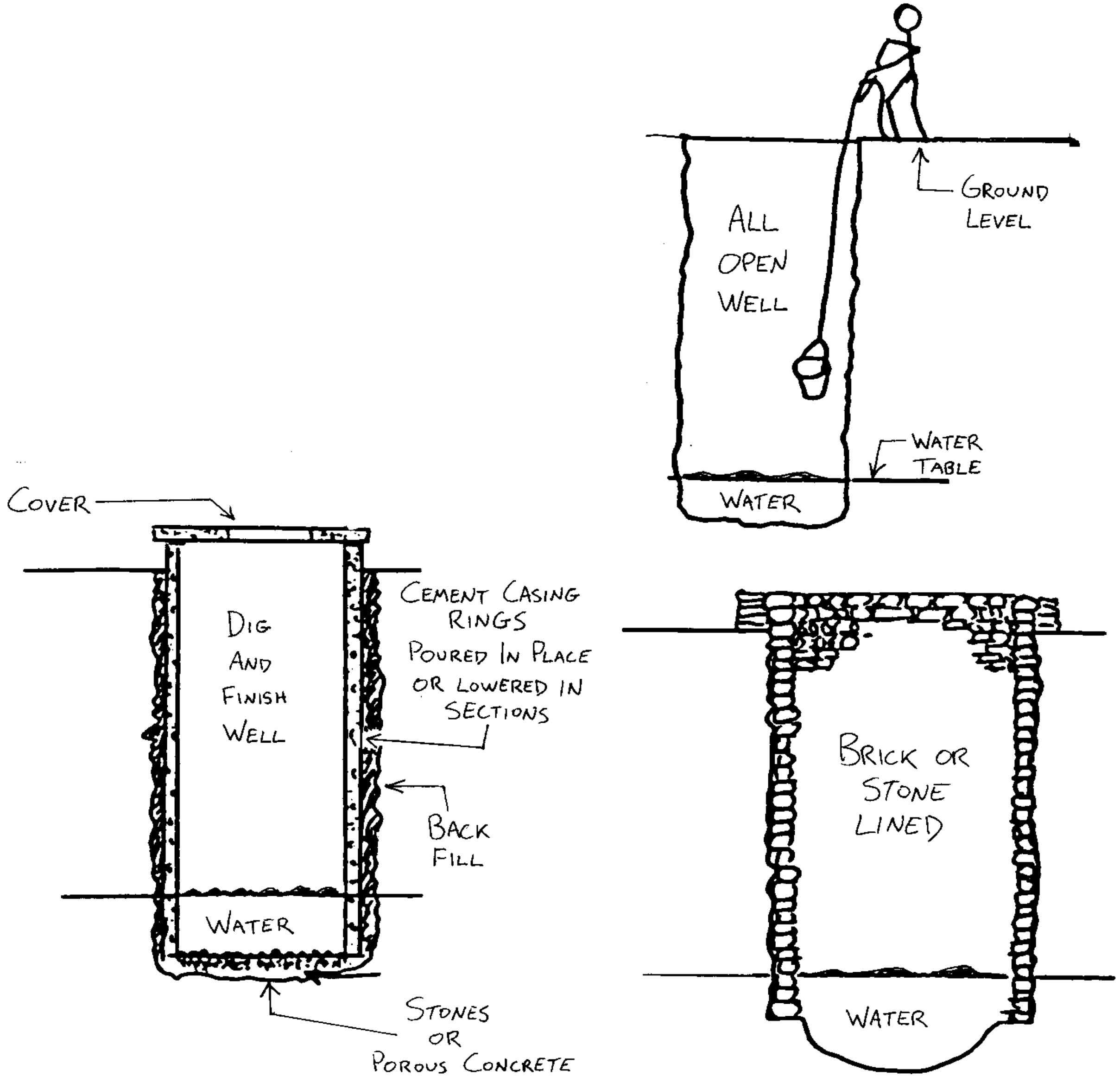

FIGURE B

hundred meters deep.

When a hole, or well, is drilled or

dug into an aquifer, a pool develops at the bottom of the hole. If undisturbed, the well will fill to the level if the water table. When the well is finished and in use by drawing water out, new water flows in to refill the well; this process is called recovery. The rate of recovery depends on the coarseness of the soil and the amount of gravel in the aquifer. In sand and gravel aquifers, recovery is very fast. In fine-grained sand it is slower.

There are basically three sections to a well:

o The sanitary seal at the top,
o the well casing or well support in the middle, and
o the well intake or well screen at the bottom.

The top section must be finished so that it stands higher than the ground and is sealed on the outside from surface water that would otherwise drain into the well. Clay or concrete can be used to seal the well for a distance of at least five meters away from the casing. The middle section should be straight and well supported with a strong wall or casing to keep the surrounding soil from caving in.

The lowest, or water-bearing, section should extend as deeply

into the aquifer as possible.

The well screen or well intake of the lowest section must allow the water to flow into the well but not admit fine soil particles (Figure C). For the

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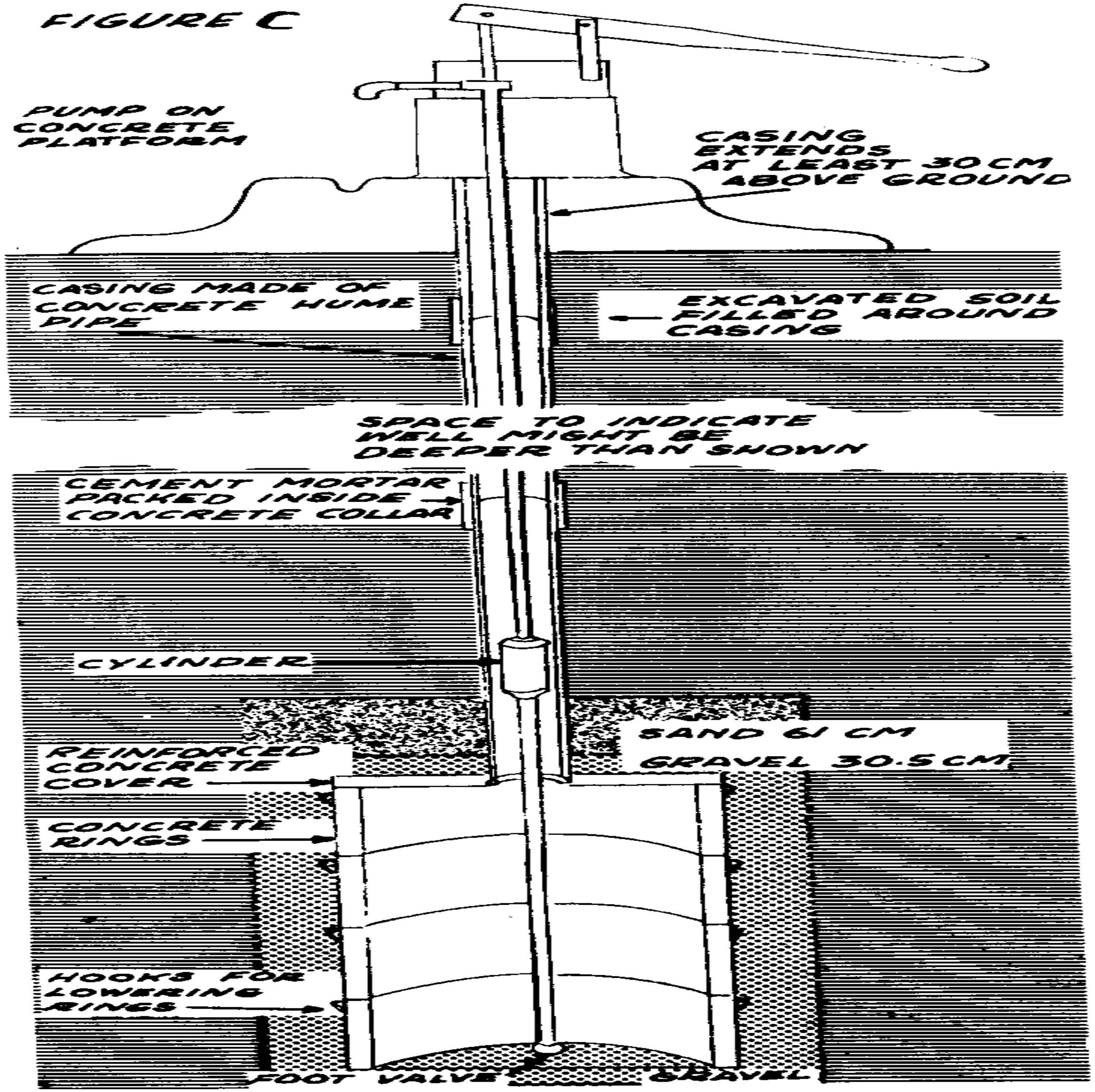
FIGURE C



water to enter the well, it is important that the well casing have many small holes. If only the bottom of the casing is open to the aquifer, only a small amount of water can be pumped. If the casing in the aquifer has many small holes (slots in steel or plastic pipe, or drilled holes in concrete) more water will be available to the well and the water is likely to be cleaner. This is true because the presence of many holes will lower the entrance velocity of the water, which thus will carry fewer particles.

Some wells are made without a casing. In sandy soil, prefabricated concrete rings, stones, or bricks can stabilize the walls. But often a concrete well casing must be made in place. Concrete for well casings should be made from a mixture of one part cement, two to three parts sand, and four to five parts gravel. To make the more porous concrete for the water bearing portion of the casing, use one part cement, one part sand, and four parts gravel. Mix in the normal way with about five gallons of water per 50 kg bag of cement.

WHERE AND WHEN TO DIG THE WELL

Avoid areas of poor water quality. Checking local maps and the closest water wells to the proposed new site can give valuable information on the quality of water that can be expected f rom the new well. Samples of water f rom existing wells can be sent to a laboratory to determine the mineral and bacterial content.

Contamination from surface sources must be avoided in selecting the proposed well site. For example, avoid latrines, animal stalls or barns, creeks, cemeteries, agricultural fields (pollution from pesticides, herbicides, etc.), and roads (fuels and coolants). The well should be constructed 50 to 100 meters from the nearest potential source of surface contamination.

The water level in a well often changes from season to season and from year to year. In dry seasons the water level will often be low. wells that have penetrated the aquifer deeply are less likely to go dry. For this reason it is best to dig the well during the dry season. Some wells penetrate more than one aquifer and are therefore more dependable for a permanent supply of water. Moreover, water from deeper aquifers is less likely to be contaminated.

HEALTH AND SAFETY DURING CONSTRUCTION

Health Measures

During well construction, precautions must be taken to clean any tools that have been used in other projects because they may be a source of contamination. The well should be covered after each day's work to protect it from falling debris. Sanitary toilets should be provided for the construction workers, who should be warned against using the area near the well for this purpose. Defecating or urinating in the well during or after construction should be strictly prohibited.

Safety Measures

Many risks are associated with a hand dug well, especially if the open type is decided upon. Understanding these risks and strictly obeying simple safety procedures will minimize the chance of an accident. The biggest risk is a massive cave-in that traps the diggers. Other dangers arise from objects falling from the surface on top of the diggers and misunderstood instructions from the diggers below to the workers above. Without necessary vertical supports and casing rings that stand above ground level, a worker may accidentally fall into the well. The rope and pulley assembly used to lower objects into the well can fail or the bucket can be allowed to descend too rapidly. Heavy tools may cause blows to the foot or hand.

Conditions inside a well are often hot and humid, and hard labor under these conditions can cause fatigue and fainting. Fresh air sometimes becomes displaced by other gases or it may become very scarce. Petrol-engine exhaust and natural explosive gases from within the earth are particularly deadly. Hence, a ventilation system is a must when working below 10 meters. Pipes or hoses to carry fresh air from the surface to the diggers must be used. A hand operated fan or bellows can be the responsibility of one person at the surface who ensures that the ventilation system is operating continuously while the diggers are working in a well deeper than 10 meters.

A further hazard arises when continuing to remove the soil after the water table is reached. To dig the well deeper, the water must be removed as it flows in from the surrounding aquifer, either by pumping or with buckets. The inflow carries soil with it, thus undermining the part of the well hole below the water table. Eventually, as the soil is brought out with the water that is removed, a doughnut-shaped cavern will form around the well hole. This greatly increases the danger of cave-in.

To minimize the danger, build a caisson having the same diameter as the well hole and lower it to the bottom (Figure D). It can be made of 200-liter

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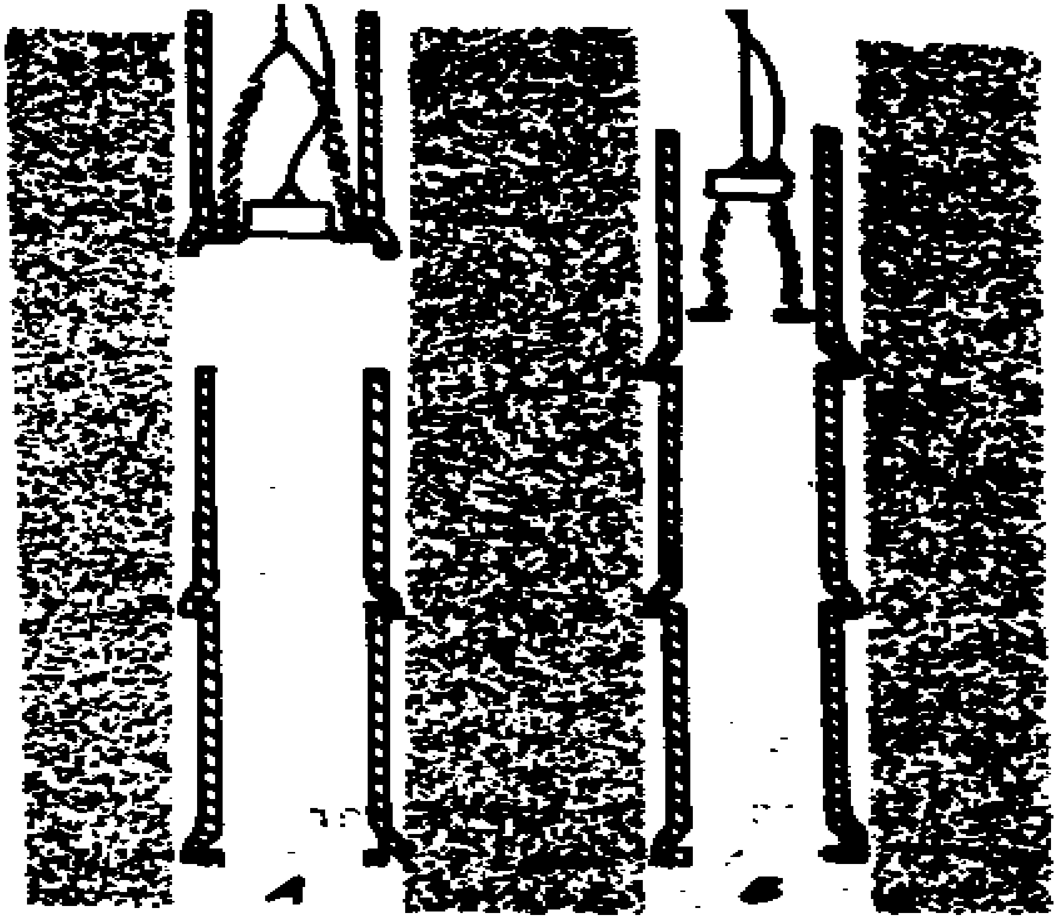

Figure D

oil drums by cutting down one side and splicing together as many as are needed to reach the needed diameter.

If metal drums are not available, wood or bamboo slats overlaid with plastic sheet will do. In this way, the migration of silt and sand into the hole will be prevented or greatly reduced, while the water is being removed to permit further digging. The caisson should be loose enough to settle down as the hole is deepened. If necessary, a second caisson can be built and placed on top of the first one.

V. WELL-DIGGING METHODS

Whether hand or machine methods are used, digging is easiest in areas of loam, sand, or gravel and where small stones are present (Table 1). Digging a well is very difficult in highly compacted soils, fissured (cracked) rock, and rocky terrain. It is important to select the equipment most appropriate for the soil type and terrain.

TABLE I

TYPES OF WELLS AND SOIL CONDITIONS

GENERAL GUIDE OF SIZES AND CONDITIONS FOR EACH TYPE OF DRILLING SYSTEM

MACHINE DRILLED

HAND HAND PERCUSSIONAUGERROTARYAIR
DUGDRILLED HAMMER

Diameters
1-20m 10-20cm 15-50cm 15-50m 15-50m 15-50m

Depths
2-40m 10-50m 20-500m 20-500m 20-500m 20-500m

SOIL TYPES
FOR DRILLING

Top Soil yes yes yes yes yes yes
Sandy loam yes yes yes yes yes yes
Clay yes yes yes yes yes yes
Silt yes yes yes yes yes yes
Sand yes yes yes yes yes yes
Sand stone slow no yes no yes yes
Lime stone yes no yes no yes yes
Gravel yes yes yes yes yes yes
Cobble stones yes no no no no no
Boulders ? no no no no yes
Dense rock no no no no no yes

Hand-Dug Wells

Unsupported wells. Open wells typically have diameters of 1 to 3 meters though wells larger than 4 meters in diameter are sometimes dug. The wells may be 10 meters deep or less, without a supporting wall and surface supports or frame.

Supported wells. Hand-dug wells are generally built by one of two methods. In the first method, temporary forms are used to prevent the walls of the well from caving in as digging goes on. After digging is completed, the temporary forms are removed and the wall is then reinforced with steel, plastic, bricks, rocks or cement casing. (Wood or nondurable materials should be used only for the temporary forms and not for permanent well casing). This method is faster and less expensive than the second type, but is more likely to cave in. It is appropriate if the well is relatively shallow and large in diameter and the soil is very compact.

The second type of hand-dug well is constructed by reinforcing the vertical walls as the well is dug so that when the water table is reached, the reinforcement casing materials of the first and second sections are already in place. The last portion of the well to be completed (the water-bearing section) is dug and cased as deeply into the aquifer as possible. Deep penetration of the aquifer can be achieved if water is pumped from the well during construction (Figure E).

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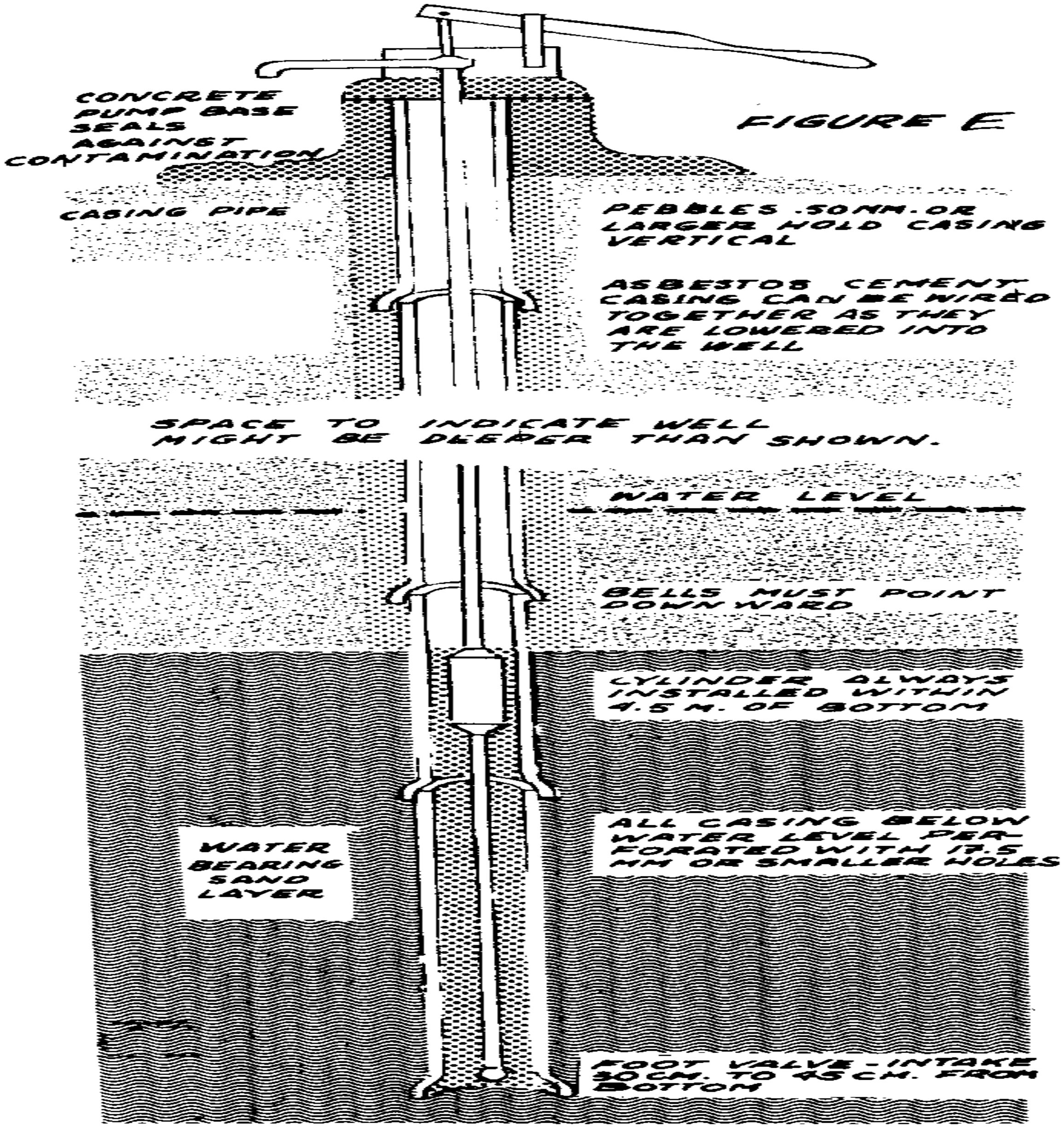

Concrete-Cased Wells

Wells can also be classified according to the methods for making and installing the concrete casing sections.
"Dig and Finish" wells vary in diameter from one to three meters. They are constructed by completely digging the first section followed by digging the second section a meter at a time. At each meter of depth cement is poured to finish the casing before digging is resumed. This sequence is repeated until the aquifer in reached. The water-bearing section of the well is then completed by lowering surface-constructed casing sections to the bottom and allowing then to sink into the aquifer.

"Dig Complete and Finish Complete" is a method used with wells that are usually no deeper than 20 meters. The soil must be firm and temporarily supported to reduce the risk of cave-in. This kind of well is dug without interruption until the aquifer is reached and then is finished by lowering the casing (made at the surface) into the well from the top.

A third method is "Pour and Form." In this method forms made of metal or strong plywood are placed at the bottom of the completed

well. Concrete is poured, and the forms are moved up about a meter at a time until the well casing is complete. Another type of form is used at the surface, where its casing can be constructed without the restricted working conditions within the well. After the casing has cured, the forms are removed. Reinforcement rods are installed and locating rings can be formed easily by the molds. A major disadvantage of this and the Dig-and-Finish types is the need for a heavy framework with a strong rope and pulley assembly to safely lower the heavy concrete casing into the well.

Hand-Drilled Wells

To drill a well 5 to 20 meters deep in soft soils, an auger is rotated at the surface by one or several workers using handles attached to it. The auger should be withdrawn from the hole at every meter or so and cleaned at the surface. When drilling is completed, a plastic or steel casing should be lowered to the bottom. Usually, hand pumps are then installed at the surface.

A percussion device can be used to drill a well 20 to 60 meters deep through more compact soils. A tripod or framework is supported vertically with a rope and pulley (Figure F).

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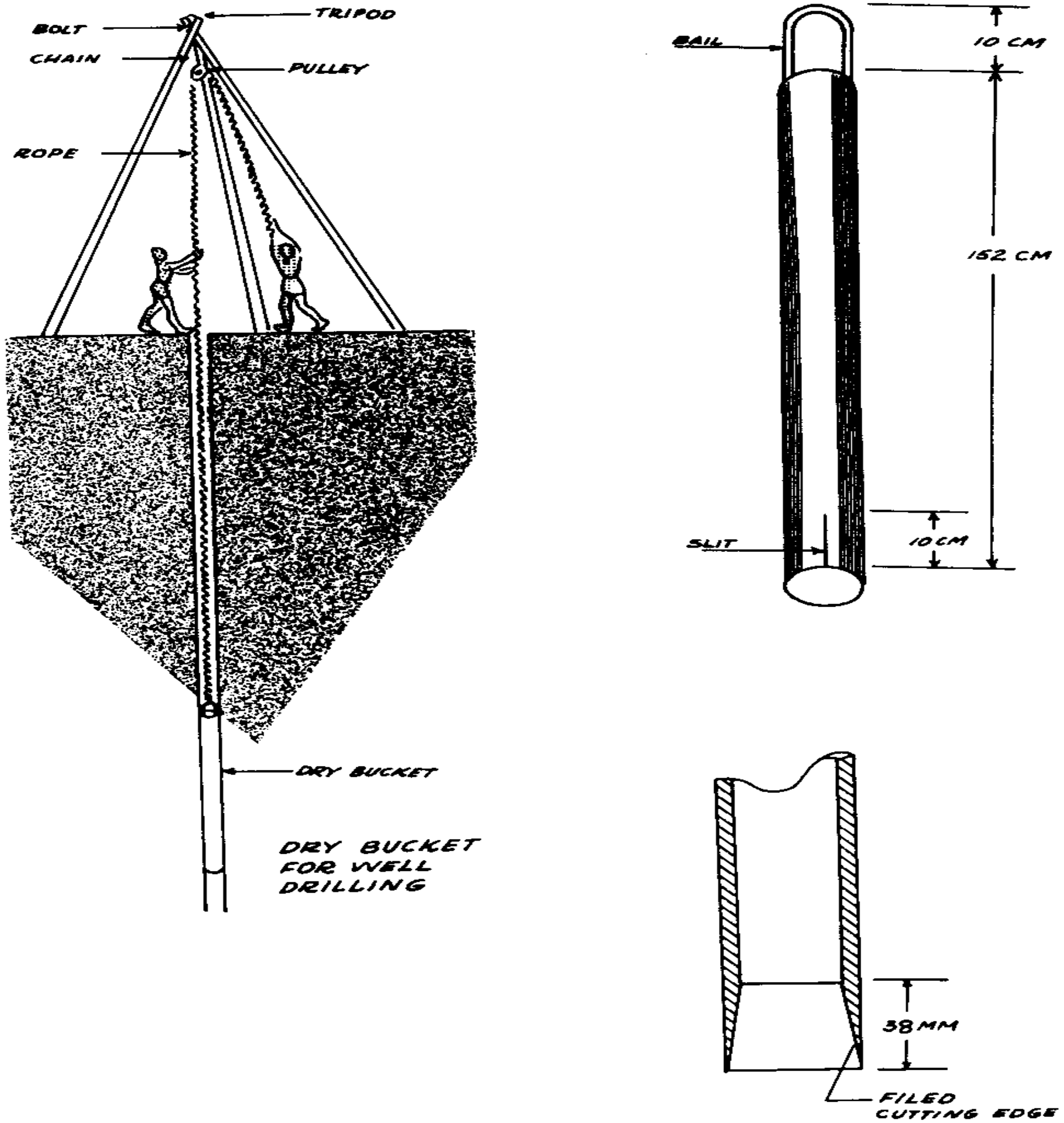

FIGURE F

The rope is attached to the drilling tool and in a bouncing motion should be repeatedly pulled and dropped. This will penetrate

the earth deeper and deeper as the weight of drilling tool causes loosening of the soils. Sometimes tools are constructed to trap the earth inside, much like an auger, and are brought to the surface and cleaned each step of the way (Figure G). Other tools

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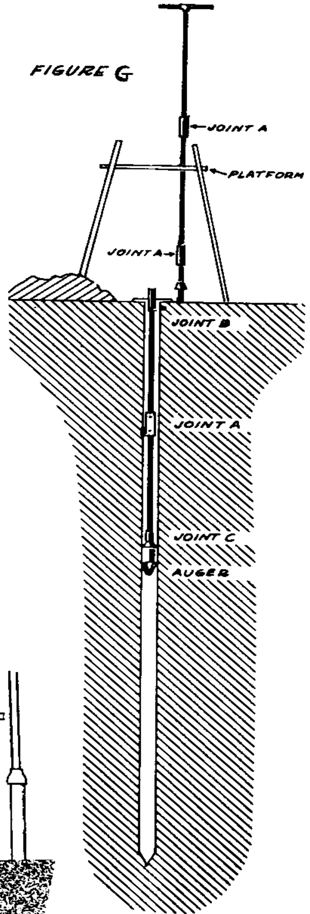

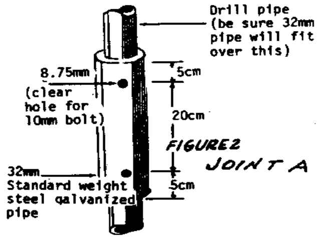

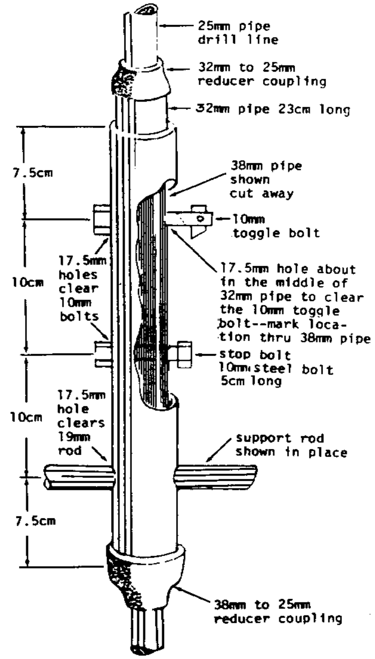

FIG.3 JOINT B

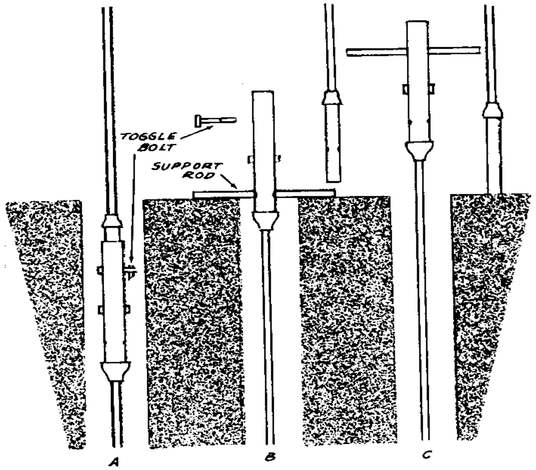

FIGURE 4 JOINT B IN OPERATION

are designed to loosen the soils, with a long narrow bailing bucket to lower into the well. Water is poured into the well to form mud. The soil can then be removed with the bucket.

Machine-Drilled Wells

Small Machines. Small well drilling machines with engines are available to bore a hole in the earth. These machines are efficient, of moderate cost, and require only a few days to sink a well. Water is pumped down through the center of the drill pipe to lubricate the bit in the bottom of the well. As the drill rotates, it cuts the soil, which is flushed back to the surface with the returning water. The water-mid slurry is then be pumped back down the drill stem. When the drill pipe penetrates all of the aquifer, the well is completed as described below (Figure H).

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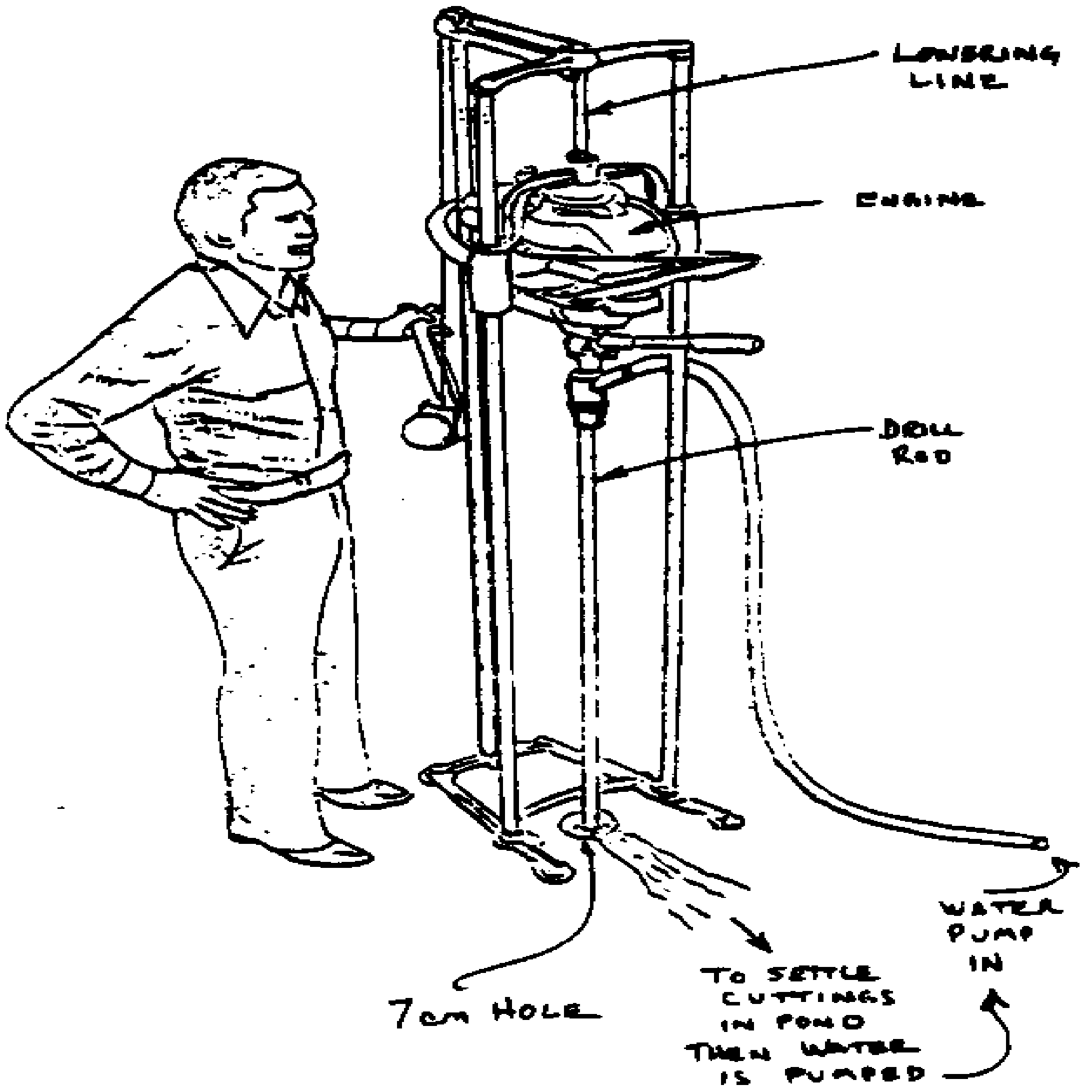

Figure H

Wells can also be driven into the earth with drive points using specially designed hammers or tripod driving tools (Figure I).

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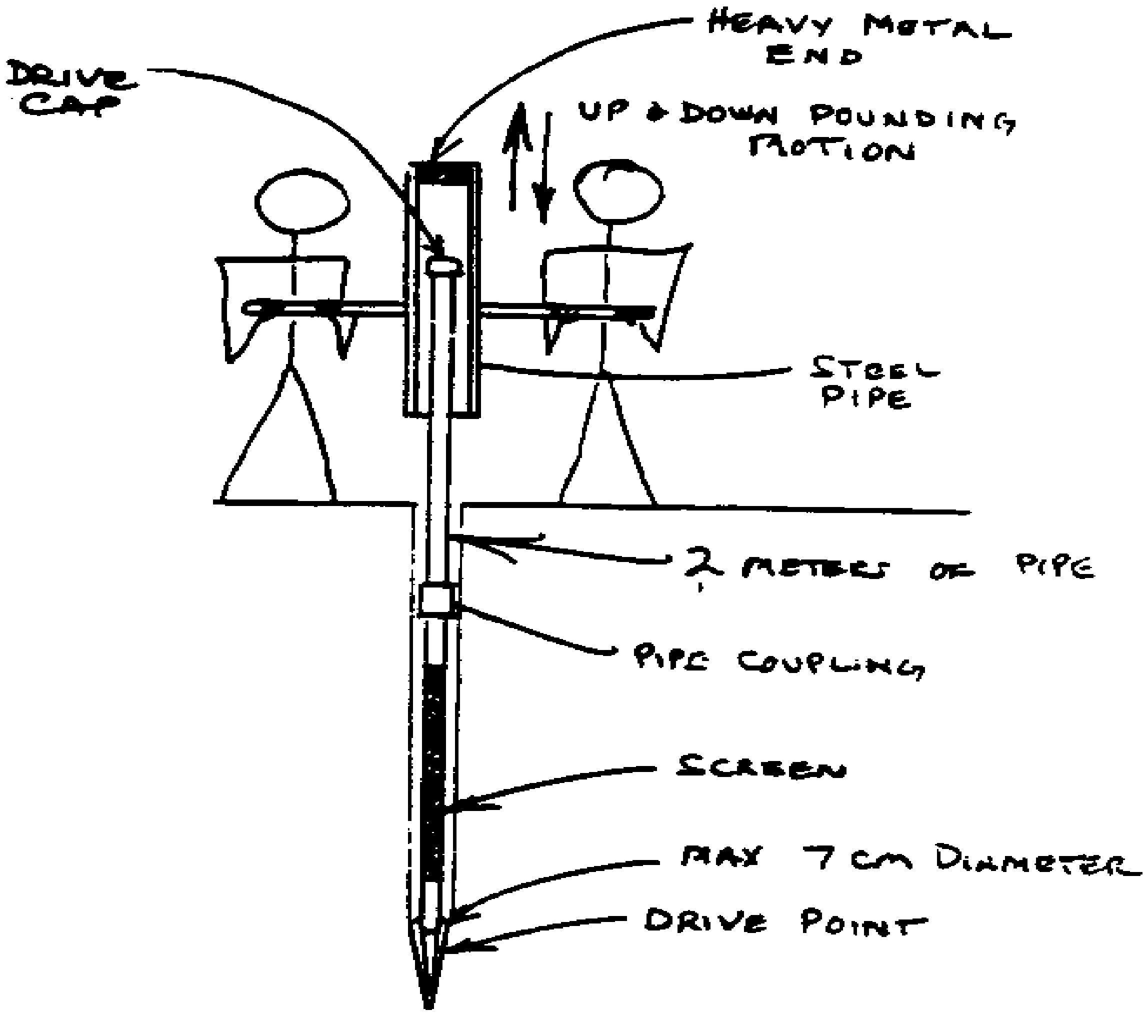

Figure I

Large machines. Larger wells (10 to 50 cm in diameter) can be drilled quite efficiently with a truck-mounted machines quite

efficiently using an auger, or a percussion, rotary, or air hammer. Steel or plastic casings are lowered when the drilling is complete.

Several kinds of earth augers (Figure J) are used in well drilling.

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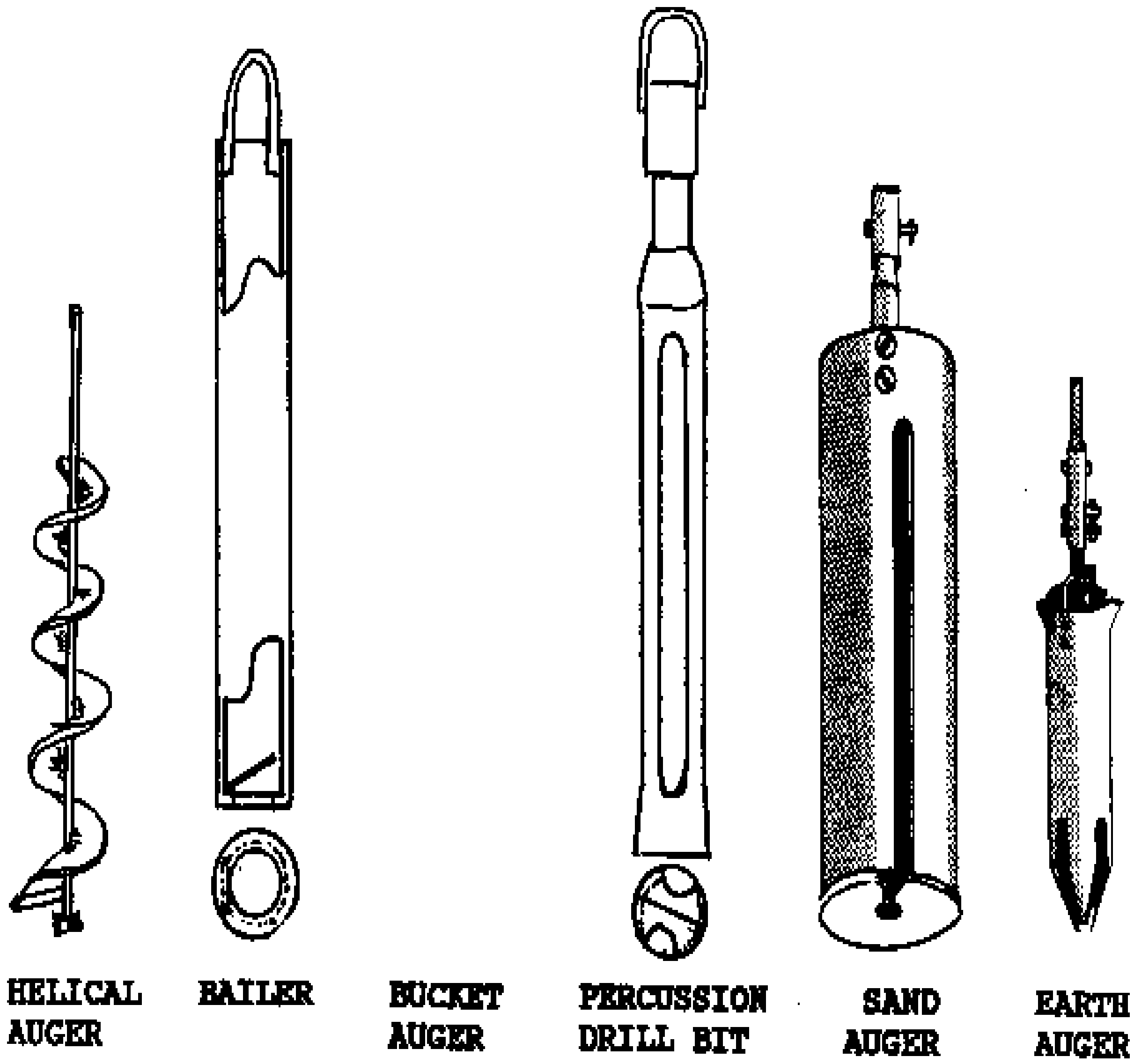

Figure J

Each is suitable for a particular soil condition. Another method involves using an engine driven pump and water power to "jet" the well into the earth. In this method, water is forced down an inner pipe and through a cutting bit. The water returns to the surface through a larger pipe. Both pipes are moved back and forth to allow the cutting edge at the bottom to force the drilled and loosened soil to come up to the surf ace with the pumped water to the surface. The pipes slowly sink into the ground. The success of this method depends on soil conditions. Rocks or pebbles usually stop the process.

VI. WELL PUMPS

Suction and Down-Hole Pumps

An important decision is whether the water can be pumped by suction or whether a "down-hole" pump must be used. Suction pumps can be used in shallow" wells--those where the water tables less than 8 meters below the surface. A well with a water lifting requirement greater than 8 meters is considered a "deep" well (Figure K). Atmospheric pressure can force water up pipes to a

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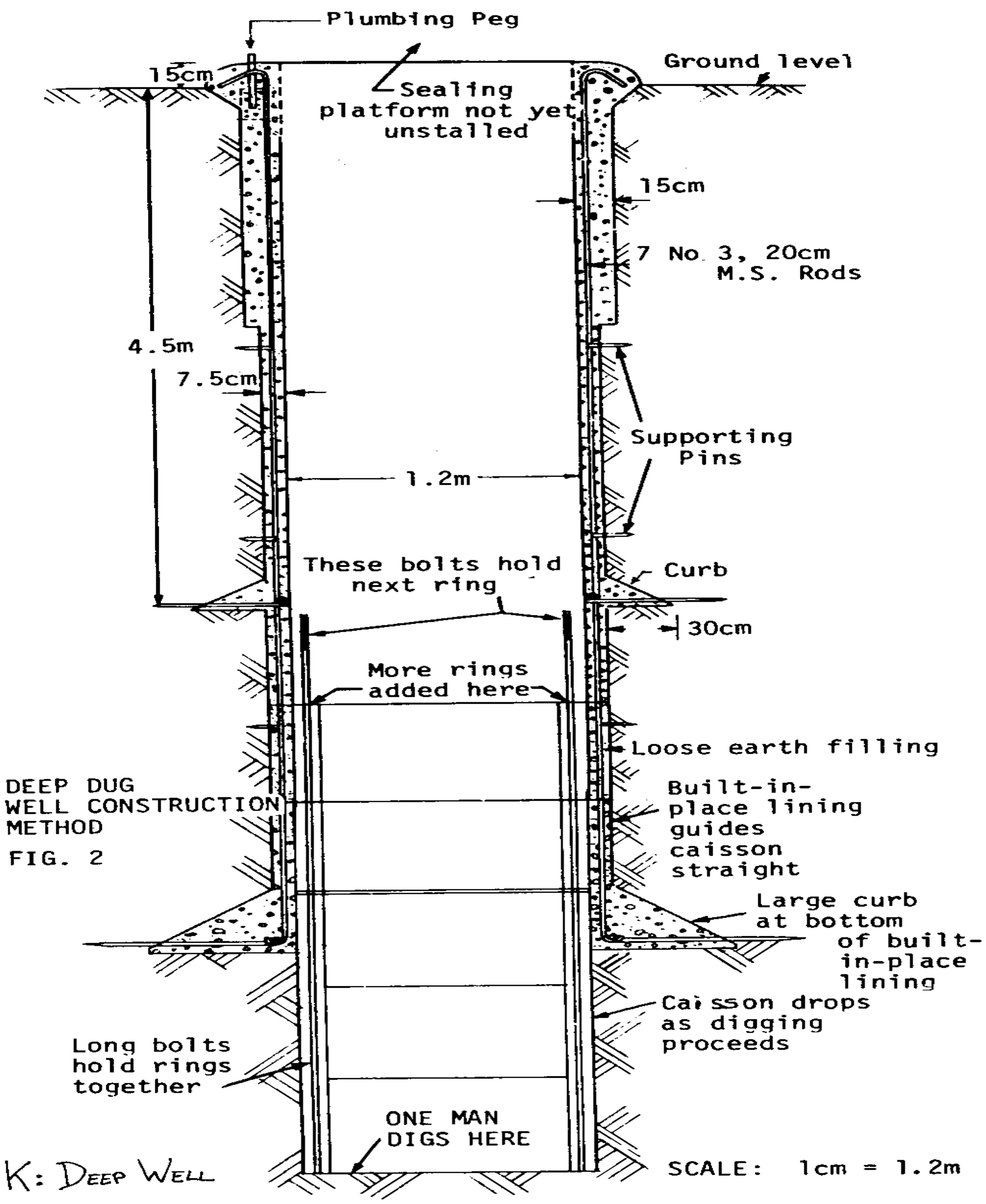

FIGURE K: DEEP WELL

theoretical maximum of 10 meters. At greater depths, operation of a suction pump is not possible. Down-hole pumps can be used at any depth.

The machinery or "action" (including the piston, diaphragm, and so on) of a suction pump is at the surface. The action of down-hole pumps is below the water table.

Positive-Displacement and Centrifugal Pumps

The two commonly used types of waterwell pumps for the wells described here are positive displacement (or piston) and centrifugal. Each has its limitations and advantages.

Centrifugal pumps run at higher speeds than can be obtained with hand operation. They are usually powered by petrol or diesel engines, or by electric motors. Positive displacement pumps are used for hand-pumped wells. Their cylinders can be mounted at the surface and the water can be dispensed from the well through a single pipe. In deep wells, the cylinders can be installed at the bottom of the well, from where they push the water to the surface. They can be hand driven, powered by a submersible motor at the bottom, or driven by a shaft linked to an electric motor at the surface. Singlestage centrifugal pumps can be used at the surface to draw the water

from shallow wells, but in deep wells, several stages of centrifugal pumping may be needed.

A jet pump (Figure L) is another type

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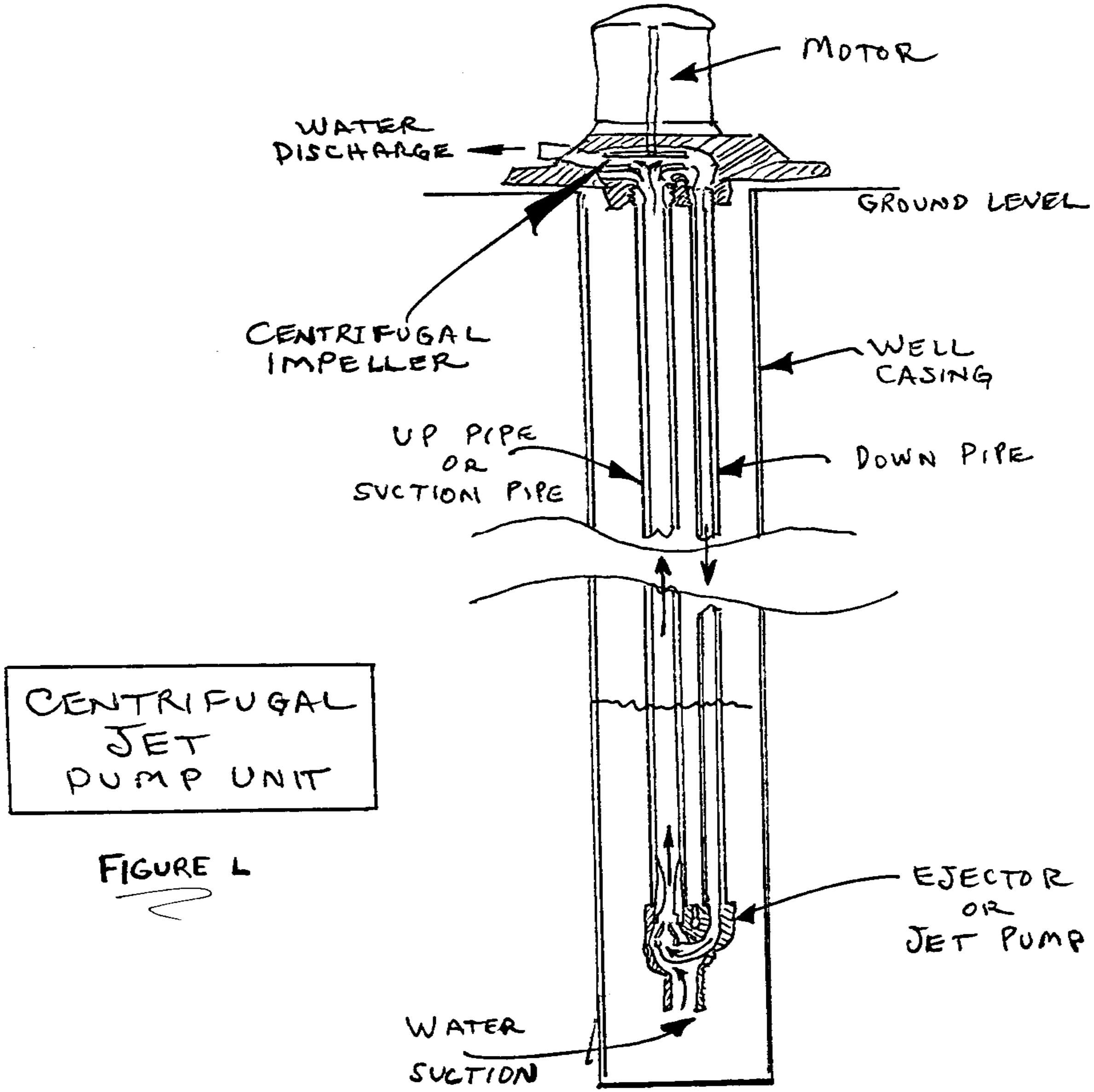

of centrifugal pump used at the surface for pumping water from deep wells. It circulates water down one

pipe through a high-pressure nozzle and returns it to the surface through a second pipe when a small portion is drawn off for use. This system is efficient only at depths less than 15 meters.

Power for Pumps

If hand pumps are not used, windmills may be a good choice for lifting water from shallow or deep water wells in rural communities, where conventional power supplies or fuel costs are very expensive (Figure M). The initial cost of windmills is high, but

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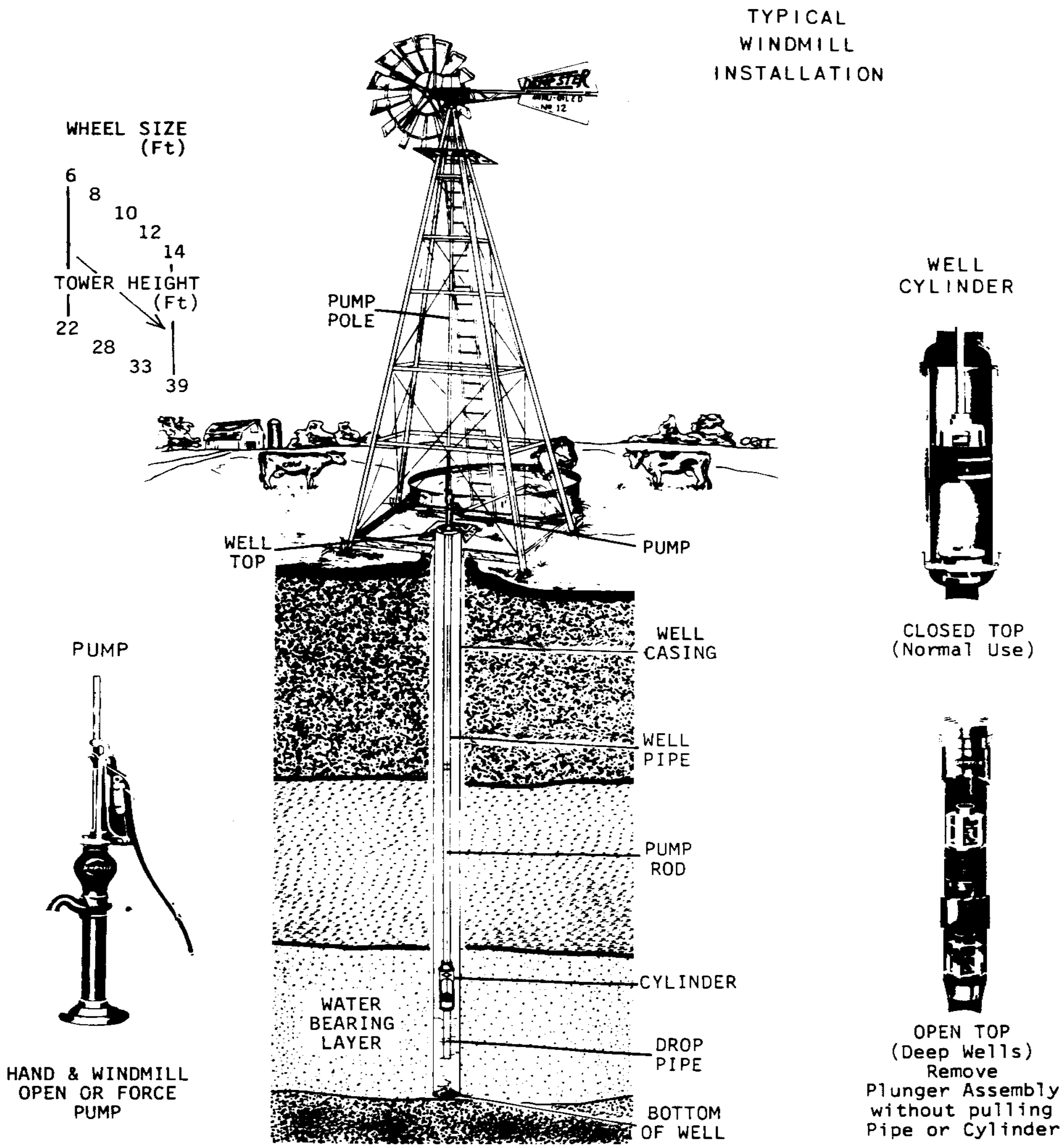

they are dependable machines and last many years. When a single well is to be used as a community project, a windmill can be an excellent investment.

Modern technology has produced solar cells that convert sunlight directly into electricity. one of the most important applications for solar cells, in rural areas all over the world, is water pumping. Large companies are competing to produce solar cells cheaply, at a cost affordable in the United States and developing nations.

VII. CARE OF THE WELL AFTER COMPLETION

Water in untapped aquifers is sealed from microorganisms and is therefore uncontaminated. Once well digging begins, the aquifer is exposed to then and other particles in the air. For this reason, after the well has been constructed, the water in it must be returned to a safe condition.

First, the completed well should be thoroughly disinfected with chlorine before anyone drinks the water. Ordinary liquid household bleach (containing 5.2 percent chlorine) is commonly used.
The procedure is as follows: (1) Mix two liters of chlorine bleach into 40 liters of clean water (see Table 2). (2) Pour it into the well. If a hand pump has been installed at the surface, pump the water through it and directly back into the well for a few minutes. (3) Allow the well to stand idle overnight: or at least eight hours. (4) Pump the treated water from the well until no chemical odor is noticeable.

Verify your procedure with a local doctor or health care worker in advance. If possible, a sample of water from the well (after

disinfection) should be sent to a laboratory to test its safety as drinking water.

TABLE II

AMOUNTS OF CHEMICALS REQUIRED FOR A
STRONG CHLORINE SOLUTION CAPABLE OF
DISINFECTING WELLS AFTER THEIR CONSTRUCTION(*)

Water Bleaching Powder High Strength Liquid Bleach
([m.sup.3]) (25-354) (g) Calcium Hypochlorite (5% Sodium
(70%) (g) Hypochlorite) (ml)

0.1	10	4.3	60
0.12	12	5.2	72
0.15	15	6.5	90
0.2	20	8.6	120
0.25	25	11	150
0.3	30	13	180
0.4	40	17	240
0.5	50	22	300
0.6	60	26	360
0.7	70	30	420
0.8	80	34	480
1	100	43	600
1.2	120	52	720
1.5	150	65	900
2	200	86	1 200
2.5	250	110	1 500
3	300	130	1 800

4 400 170 2 400
5 500 220 3 000
6 600 260 3 600
7 700 300 4 200
8 800 340 4 800
10 1 000 430 6 000
12 1 200 520 7 200
15 1 500 650 9 000
20 2 000 860 12 000
30 3 000 1 300 18 000
40 4 000 1 700 24 000
50 5 000 2 200 30 000
60 6 000 2 600
70 7 000 3 000
80 8 000 3 400
100 10 000 4 300
120 12 000 5 200
150 15 000 6 500
200 20 000 8 600
250 25 000 11 000
300 30 000 13 000
400 40 000 17 000
500 50 000 22 000

(*) This produces a chlorine concentration of approximately 30 mg/l (ppm). This water should not be drunk by people or animals.

The community should be informed on how to keep the water safe to drink. Users should be trained in simple health procedures and general rules for proper water use. Boiling or chlorinating (Table 3) the water at home is often needed, in addition to basic well sanitation. Washing or cooking should not be permitted in the immediate area of the well. Animals should be restricted from the immediate area of the well and kept at a safe distance. Only repair and maintenance workers should enter the well. Before the well is put back into service after a repair, it should be disinfected using the same method as when the well was first put into service. No pools or stagnant water should be allowed to collect around the well surface. These pools can be breeding areas for insects as well as for microorganisms, and can spread diseases that can be acquired by simply walking through them.

No bucket or ropes with surface dirt should be allowed to enter the well. Ropes and buckets used to draw water from the well can transfer contamination from hands to rope and then to the well water. In this way, any person later drawing water from the well can take home enough microorganisms to make the family ill when they drink it.

VII. MANAGEMENT CONSIDERATIONS

The need for a safe drinking water supply as expressed by the people of the community should be analyzed by workers who are responsible for deciding whether to construct the well. Successful projects require good leadership, planning, and execution, but community initiative, planning, ownership, and support are essential from the start to ensure that the well is built where users want it, that the users understand how it will be paid for, that the well does not adversely affect the social structure of the community, that it is used, that the well and pump are maintained, and that water is clean when drawn and kept under sanitary conditions by its users.

The first consideration should be for good water quality. Other considerations include cost and maintenance of the system. What is the total amount of money needed? Where will the construction money come from? Who will be responsible for repairing and maintaining the well and the pump through the years? If the project is for several wells in a community, a number of issues must be carefully resolved to arrive at the proper decision. For example:

- o the local requirements for water
- o the kind of wells
- o the workers and their pay
- o the type of equipment to use
- o the costs and materials required for construction
- o the availability of the materials

TABLE III

AMOUNTS OF CHEMICALS NEEDED TO
DISINFECT A KNOWN QUANTITY OF
WATER FOR DRINKING(*)

Water Bleaching Powder High Strength Liquid Bleach

([m.sup.3]) (25-35%) (g) Calcium Hypochlorite (5% Sodium
(70%) (g) Hypochlorite) (ml)

1 2.3 1 14
1.2 3 1.2 17
1.5 3.5 1.5 21
2 5 2 28
2.5 6 2.5 35
3 7 3 42
4 9 4 56
5 12 5 70
6 14 6 84
7 16 7 98
8 19 8 110
10 23 10 140
12 28 12 170
15 35 15 210
20 50 20 280
30 70 30 420
40 90 40 560
50 120 50 700
60 140 60 840
70 160 70 980
80 190 80 1 100
100 230 100 1 400
120 280 120 1 700
150 350 150 2 100
200 470 200 2 800
250 580 250 3 500

300 700 300 4 200
400 940 400 5 600
500 1 170 500 7 000

(*) Approximate dose = 0.7 mg of applied chlorine per litre of water.

o permits and advance approvals by local authorities
o financing of continued operation/repairs/maintenance

The local availability of construction materials and water lifting devices should be a major factor in the selection of the type of well to be considered (Table 4). Imported items will raise the cost considerably. Sometimes hand pumps or machine operated pumps will be part of the project. Their selection and maintenance will require people with more advanced skills.

Local authorities must be consulted on laws and regulations that will apply to the new well project. Someone must be assigned to keep records so that details of the project can be reviewed. The records can often be used to resolve disputes or misunderstandings.

TABLE IV

ADVANTAGES AND DISADVANTAGES
OF VARIOUS TYPES OF WELLS AND PUMPS

WELL TYPE ADVANTAGES DISAVTAGES

Hand Inexpensive Unable to dig deep into

Dug water-bearing areas

Easy to do Dangerous to construct

Easy to maintain Contaminates easily

Machine Gets deep in Cost more to drill
Dug Water-bearing areas

Safety in drilling Site must be accessible

Easy to seal Needs expensive casing

Good for hand pumps Requires skilled people

Usually safer water

Cylinder Slow speed Small volumes pumped
Pumps
Low Cost

Easily repaired

Locally available

Simple equipment to
install

Centrifugal Efficient High cost
Pumps
Quiet operation Usually an import item

More costly to maintain

More skilled to repair

Needs high speed driver

Large equipment to install

Not adaptable to windmills

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GLOSSARY

Apron - A slightly sloped concrete pad that surrounds the well and helps prevent contaminated surface water from finding its way back into the well.

Aquifier - A water-bearing layer (stratum) of permeable rock, sand, or gravel.

Bit - The cutting piece at the bottom end of the tool string that loosens the soil or rock to deepen the hole.

Bottom Section - That part of-the well that extends beneath the water table.

Casing - The vertical support inside the well. Cement cylinders, plastic, or steel pipe. Sometimes called caissons, lining.

Curb - A part of the well lining that extends out from the place and prevents it from sliding down.

Cutting Ring - A sharp-edged ring used on the bottom of a lining that is being sunk into place to make sinking easier.

Drop Pipe - That section of pipe in a deep well pump assembly that extends between the pump cylinder from flowing back into the well.

Foot Valve - A valve at the bottom of the suction pipe that prevents the water pulled up into it by the cylinder from flowing back into the well.

Ground Water - Water contained in the part of the gorund that is completely saturated. Ground water accumulates in quantity in aquifiers, from which it can be drawn out of the ground through wells.

Hydrologic Cycle - Continual natural cycle through which water moves from oceans to clouds to ground and ultimately back to the oceans.

Intake Section - That part of the bottom section through which water enters the well.

Level (adjective) - Perfectly horizontal.

Level (noun) - A device used to establish a perfectly horizontal line.

Middle Section - That part of the well between the ground surface and the water table.

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