UNIT 20 RURAL WATER SUPPLY

Structure

20.1 INTRODUCTION

Provision of safe and adequate water is of prime importance for healthy living. Clean and safe environment cannot be imagined without water. In fact, water is of prime importance for living beings. And the water for human consumption has to be safe to protect from health hazards and adequate for meeting necessary requirements.

It is said that around 70% of Indian population live in rural areas and their economic condition is not good. Most of the people are below poverty line and they are more prone to health hazards due to water born diseases because proper quality of water is not available to them. In rural areas, predominant diseases that have been recorded are enteric bacterial infections like dysentery, diarrhoea and other intestinal disorders. Sometimes, there is attack of gastro-intestinal diseases in epidemic form and many deaths are reported. Main cause of spreading of cholera and typhoid is also contaminated water. This is mainly due to consumption of unsafe water. In fact, health benefits gained by the investment in water supply schemes are more compared to expenditure done on cure of these diseases. Unfortunately, a significant portion of some rural population in our country are not having protected water even for their drinking purpose.

Before the advent of our National Five Year Plans in 1951 progress in rural water supply was in a haphazard manner. In the First Five Year Plan (1951-56) provision for water supply schemes was made in the States from the funds available for Community Development Works and Local Development Works included in the Plan. The National Water Supply and Sanitation Programme was formally launched by the Government in the year 1954. Central and State Governments grant-in-aid was made upto 75% of the cost of schemes, the balance was to be supplemented by the beneficiaries.

Until the end of the Fourth Five Year Plan (1969-74), the water supply programme could not get required priority in the national planning process. The total investment on the water supply and sanitation was of the order of Rs. 655 crores and 35% of this was in rural area. Resulting in only 5% of villages could get safe water supply. Subsequently, the drinking water for villages was included in the Minimum Needs Programme as a result of which rural water supply and sanitation could get a share of Rs. 481 crores out of total outlay of Rs. 1031 crores in water supply and sanitation. Subsequently, in the Sixth Five Year Plan (1980-85), out of the total outlay of Rs. 3,922 crores, Rs. 2,485 crores was invested on rural water supply programme and looking at the importance of the programme, the rural water supply programme was brought under the revised 20-point programme and by the end of Sixth Plan, 54 per cent of rural population were covered by the rural water supply scheme. During subsequent plan periods, there has been continuous effort to provide safe water supply to rural population. But in spite of all these efforts, a large number of rural population has not been able to get safe water supply.

Since rural population exists in isolated patches, hence, the scheme has to be devised in such a manner that all isolated patches may get water supply through isolated schemes or the continuous one as the case may be.

Looking at the vast amount of area to be covered, economy is an important criteria in making a successful programme for rural water supply. At first stage, the aim is to provide at least safe drinking water to the whole population of the country. Hence, while selecting the source, economy should be the main criteria for selection.

Objectives

Objectives of this unit are to discuss the present state of rural water supply in our country. After going through this unit, you will be able to know about

- criteria for source selection for rural water supply,
- suitable source of water,
- lifting of water for rural water supply and protection from contamination, and
- disinfection and treatment for rural water supply.

20.2 CRITERIA FOR SOURCE SELECTION

While selecting a source of water for rural area, first priority should be given to a source, which needs no treatment and pumping. If such source is not available then detailed investigation should be done to select a source, which requires minimum treatment. Geological investigation of the area should be carried out for estimation of yield. Sometimes information from local people is a good guide for the investigation. Information includes the history and performance of existing wells and flow estimates from nearby streams and geological conditions of the area. Quality of water from existing wells may be analysed.

After getting information about the site and water yield, following alternatives may be tried in order of preference.

(i) Water which requires no treatment to meet bacteriological, physical and chemical requirements and can be delivered to the consumers by gravity is in ideal condition of no pumping and no treatment and is the most economical. But it is mostly limited to springs.

(ii) Water requiring no treatment to meet physical, chemical and bacteriological requirements but to be pumped should be given second priority. Such condition is met from deep wells where water is drawn from pumps.

(iii) Water, which requires simple treatment and delivery is through gravity system, is to be given third priority.

(iv) Water requiring simple treatment and to be delivered by pumping is the last alternative because this will be most expensive. Water supply from surface sources are included in this category.

After selecting the source, following points should be kept in mind for ensuring safe water to the consumers :

(i) Collection system should not damage the quality of water.

(ii) The treatment employed should be simple and economical.

(iii) Around the source, a depth of 3 meters from ground should be made watertight to avoid pollution from contaminated surface water.

(iv) Where public wells are provided, special drainage system must be provided for used water.

(v) In case of springs, water should not be exposed to atmosphere.

(vi) While providing drinking water from well, septic tanks, sewers, sub-surface pits should be at least 15 meters away from the well.

(vii) Soak-pits and sewage disposal works must be located on the downward slope of the ground at least at a distance of 30 m from the well or source.

20.3 SOURCES OF WATER

The primary source of water is rainfall. A portion of rain percolates into ground, some portion evaporates and the remaining runs off on the surface finally meeting the ocean. Water that flows over the surface, passes through streams while the water that percolates accumulates above the hard stratum forming sub-surface flow whereas some portion goes into faults and fishers of underlying rocks.

While planning for a source of water for rural supply, the surface flow should be avoided, because of its likelihood of direct pollution and heavy cost involving construction of weirs and purification units and their operational and maintenance cost. But in absence of sufficient ground water or sub-soil water being highly saline surface water may be used as an alternative.

In fact, the sub-soil sources are the most common and suitable source of water supply in rural areas. It is highly reliable in quantity and quality involving cheaper cost of execution. Dug wells are the oldest and most common source of water in rural areas of our country. When properly located, constructed and protected, they are sure to be satisfactory. Other sub-soil sources are springs and infiltration galleries. Rain water cisterns are used sometimes to supplement supplies which store rain water.

20.3.1 Assessment of Water Requirement

The assessment is based on requirements to be fulfilled and funds available. The requirements may be for individual houses, a particular area or a whole locality. It should be considered that the supply is just for drinking water or for other necessities also for assessment. Following guidelines should be kept in mind while estimating water requirement :

(i) Capacity of one tap is around 10 ltrs / min. Therefore, quantity required = No. of taps × minutes of supply.

(ii) If houses are not having taps and water is being supplied only by street taps, then demand is 18 litres / person / day.

(iii) If house taps are available, then demand is 45 ltrs / person / day.

(iv) Demand for a school may be 45 ltrs / head / day.

(v) For every 200 people, one tap is a must.

(vi) Taps or water outlets should be such located that water carrying distance should not be more than 100 meters.

Table 20.1 gives an idea of water requirement.

Table 20.1 : Water Requirement for Rural Water Supply

Item	Capacity (l / h / d)
Hand Pumps	45 l / h / d
Piped supply including kitchen supply	75 l / h / d
Schools	45 l / h / d
Schools without piping	25 l / h / d
Live-stock	
Horse	50 l / animal / d
Dairy Cow	70 l / animal / d
Sheep	10 l / animal / d
Chicken (100 numbers)	20 l / 100 animal / day
Total quantity should be calculated for 1.5 times, the present population	

20.3.2 Springs

A good spring is a sure source of water although they are not common. But wherever they exist, they are seriously to be considered as a source of water. Before development of a spring, following factors are to be considered as a source of water :

(i) Whether the flow is adequate to meet the requirement even in dry weather.

(ii) Whether the quality of water is satisfactory.

(iii) Whether the spring is located favourably for natural gravity flow. If not whether it would be economically viable to pump the water.

(iv) Whether the spring can be protected from pollution and contamination.

(v) Will it be easier and cheaper to develop the spring than drilling a well?

A spring high enough above buildings and not too far away can supply water by gravity flow. This eliminates the cost of installing and running a pump. An elevation of at least 6 meters is desirable for satisfactory gravity flow. If the elevation is not sufficient for satisfactory pressure at taps, it may be made possible to pipe the water to a storage tank and then pump it to the outlets with small-head pumps as shown in Figure 20.1.

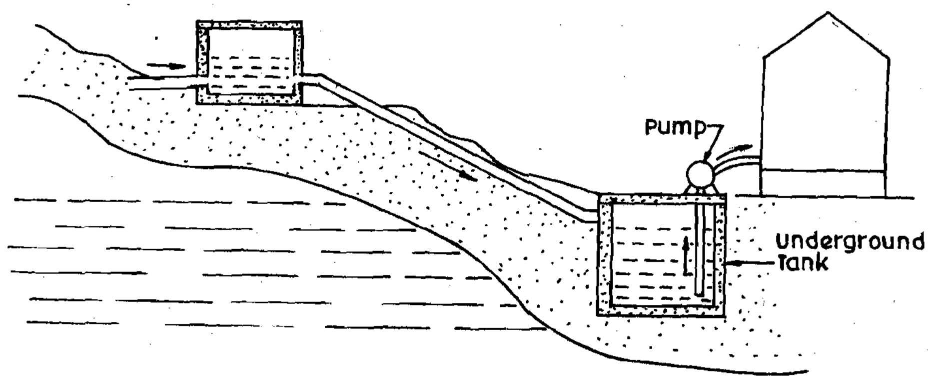

Figure 20.1 : Spring Supply

The size of the storage tank should be such as to hold at least one and half day's supply of water.

20.3.3 Artesian and Infiltration Galleries

Artesian and Infiltration galleries were also used for rural water supply if such water sources exist in the locality. Details of artesian and infiltration galleries have already been discussed in Unit 7.

20.3.4 Ponds

It already has been pointed out that surface water is the last priority in providing potable water for rural water supply. But in addition to drinking water, it is also needed for other household work or for cattle requirements. In such cases, drinking water is supplied through sub-soil water and a pond is constructed to cater other needs of the locality. Following important consideration are to be considered before going for a pond.

(i) Size to build,

(ii) Location,

(iii) Type, and

(iv) Cost.

If the pond is to be used only for limited purpose, it can be relatively small (around 2.5 m deep) and should be located near the point of use. If large volume of water is needed so as to supply water for different purpose then the size must be larger and the location may have to be selected on the basis of available watershed rather than convenience to buildings. For best result the pond should not be less than 2.5 m deep and the catchment area should be several times the surface area of the pond depending upon amount and distribution of rainfall. Allowing for evaporation and leakage losses the capacity of the pond should be about double the estimated demand for water.

The pond should be located where soil is of such a nature that it will hold water. The soil should have low coefficient of permeability and should be clayey in nature. Faulted or porous rock close to the surface also should be avoided. The earth fill around periphery of the pond should be well compacted and should not have more co-efficient of permeability. In order to fill a pond with water, it should be located where there is sufficient watershed or flowing water. A natural source-shaped area with a small flowing stream from where water can be diverted to the pond is ideal location.

There are four types of construction for ponds –

(i) Surface or water-shed ponds

(ii) Spring-fed ponds

(iii) Dugout ponds

(iv) Diversion Ponds.

Surface or watershed ponds get water from surface run-off of rain water from nearby sloping land. Such ponds are obtained by putting a fill across low point land. The fill or embankment must be watertight and should have a spillway to take care of excess water.

Spring fed ponds are built below continuously flowing springs. The usual method is to construct a dam across the spring brook. The dam should be well below the spring so that the pond will not flood the spring. If spring flow is high, then surface water should be diverted. This provides better quality of water and avoids damage of the pond by flooding.

Dugout ponds are made by making holes into fairly level soil, where underground seepage water and surface water can flow and fill the pond. Such types of ponds are very common.

Diversion ponds are made where stream of water is available. Such ponds are constructed near the stream at such a level that at least a portion of stream flow can be diverted to the pond by ditch or pipe. The pond is located such that it will not be over-flooded by the stream in flood season. The flow of water to the pond is regulated by suitable controls on the feed pipe.

20.3.5 Rain Water Cisterns

Rain water cisterns are used as supplementary source of water where ground water is in short supply or is unsuited for needs. Following points are considered before planning for cisterns :

(i) Whether sufficient rainfall is there to make cisterns worthwhile with available collecting area.

(ii) What should be the material for construction?

(iii) Where it should be located?

(iv) Whether some treatment of water will be required to maintain the desired quality of water.

The average annual rainfall and available collecting area (roofs of building or water sheds) determines the amount of water which can be collected. For example, 1 cm. of precipitation on 100 sq. meter of horizontal surface is equal to 1000 litres of water. Therefore, if there is 60 cm. of annual precipitation, then on an 100 sq. meter of collecting area, the amount of collected water will be 60,000 litres. If daily consumption is 250 litres, then it will be sufficient for 60,000 / 250 = 240 days.

The size of cistern to be constructed depends on

(i) amount of water needed.

(ii) amount of collecting area available.

(iii) amount of distribution of rainfall.

If the annual precipitation is distributed throughout the year, then cistern should have capacity of around two months demand whereas if the precipitation occurs only for 2 to 3 months, then the cistern has to be large enough to store the dry season supply. The effective building roof area of collecting water is not the roof area but it is horizontal projection of the roof as shown in Figure 20.2

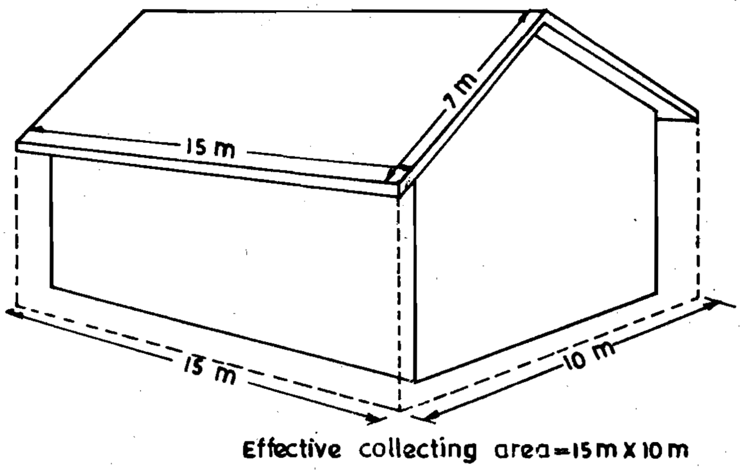

Figure 20.2 : The Effective Water Collecting Area of a Roof is the Ground Area Covered by the Roof

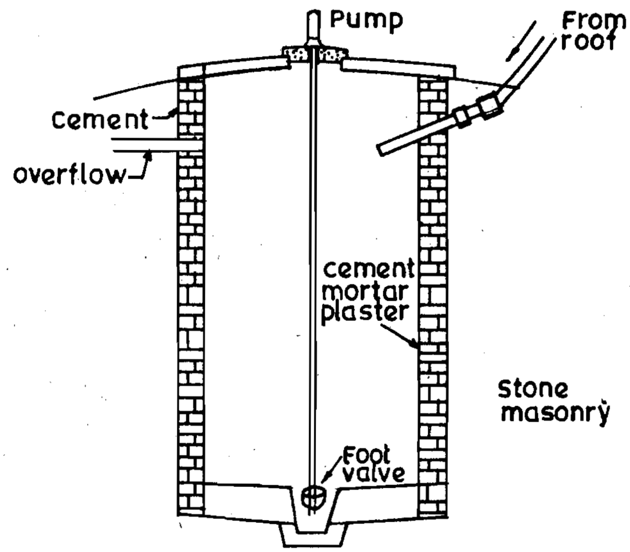

Figure 20.3 (a) : An Underground Cistern Walls Made of Bricks

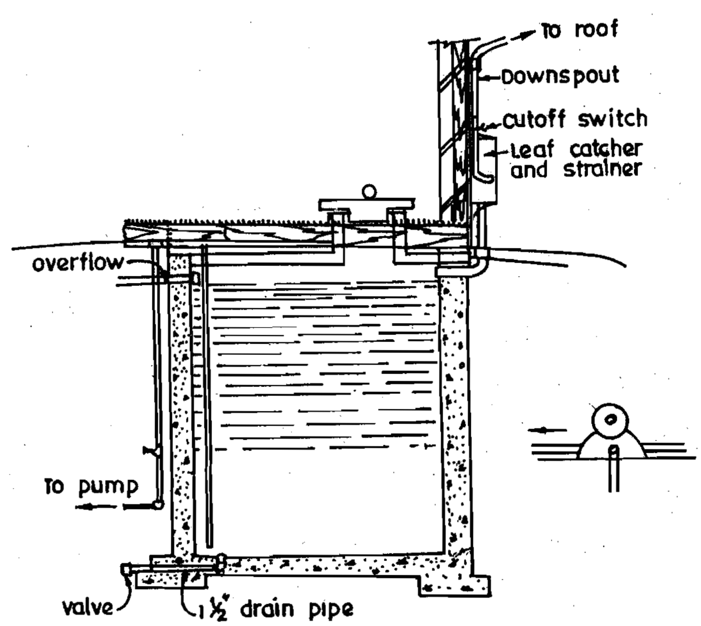

Figure 20.3 (b) : An Underground Concrete Cistern

The best type of construction is by reinforced concrete located in or near the building. Underground location is the best because it keeps water in better condition and at the same time, construction is also cheaper. Two typical types of construction is shown in Figure 20.3(a) and Figure 20.3(b).

20.3.6 Wells

It has been pointed out that sub-soil water is best source of water supply for rural areas and the most common and popular source of ground water are wells of one type or another. A water well may be defined as a hole or shaft sunk into the earth crust to a depth below the free-water level or into deep-water bearing strata for the purpose of obtaining ground water.

There are five common type of wells :

(i) Dug wells

(ii) Driven wells

(iii) Jetted wells

(iv) Bored wells

(v) Drilled wells.

The oldest type of wells are dug wells.

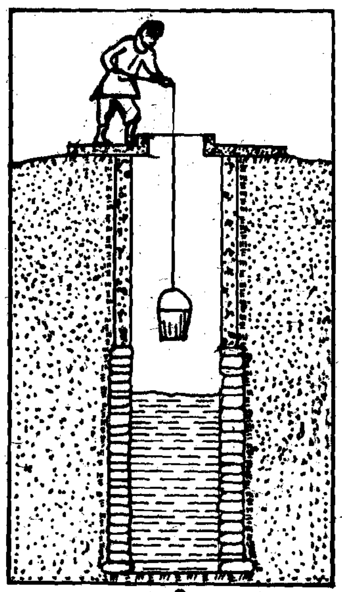

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Figure 20.4 : A Dug Well

As shown in Figure 20.4, a hole of 1 m to 3 m in diameter is dug into the earth usually manually until a flow of water is obtained. The hole is then walled and covered to protect it from surface water. Depth of well varies depending upon flow of water below the ground surface. In some cases, it is even 15 to 20 m deep.

In region where there is water in porous strata at shallow depths, driven wells are common.

A well point as shown in Figure 20.5 is driven into the ground at the end of the pipe. If the water bearing strata exists below the bed rock or the strata consists of boulders, then such type of wells are not feasible. They are feasible if the strata consists of alluvial soil below a clayey stratum.

Where the soil can be removed by jetting with water, jetted wells are preferred because they can be constructed economically.

Figure 20.6 shows jetting of such a well. Water from the top is pumped through a rotating cutter with a high velocity which dislodges sand and silty soils, which is flushed out to the surface as shown in figure. When the required water stratum is available, a pipe screen followed by casing is driven down the hold and a pumping unit attached for outlet of water.

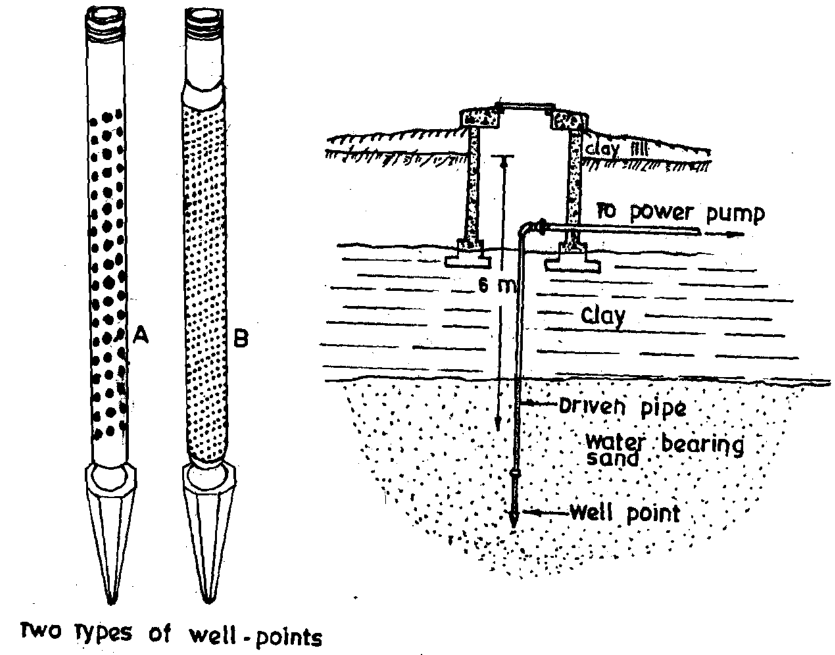


Figure 20.5 : A Driven Well

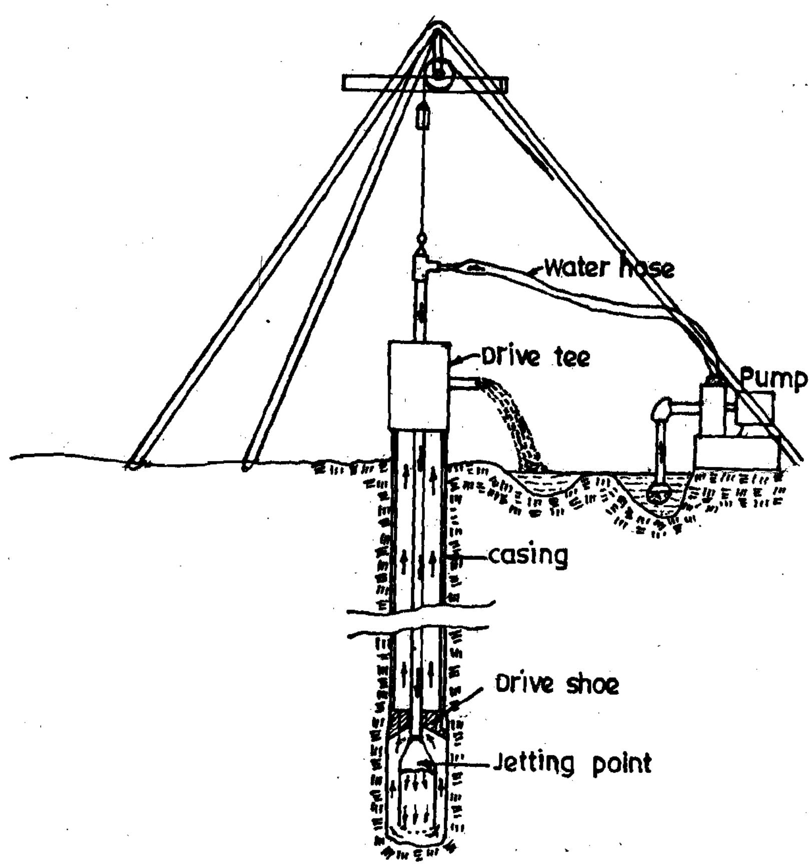


Figure 20.6 : A Jetting Rig for Constructing a Jet Well

Bores wells are similar to jetted wells but method of drilling down the earth is different. In a treated of jetting, wells are bored with special boring equipment known as bore-hole augers. Such wells are bored where soil upto water-bearing strata is soft and free from stores and boulders.

Drilled wells are made with special drilling rigs as shown in Figure 20.7.

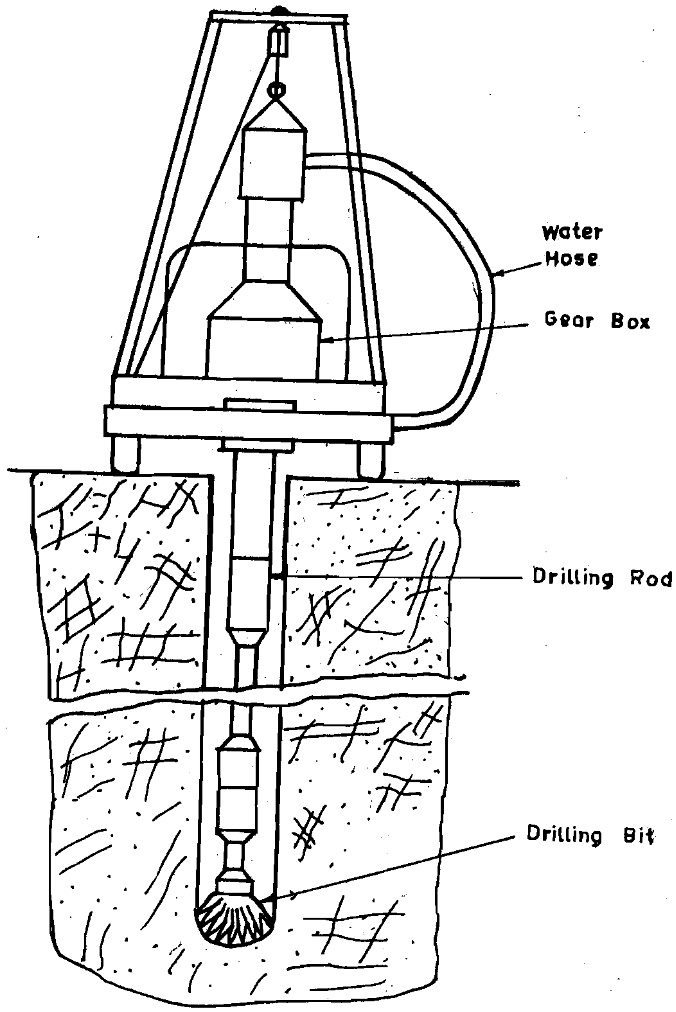


Figure 20.7 : A Rotary Drill Rig

The drilling bit is rotated in the hole and the cutters on the side of the bit cut through the various formations to deepen the hole. Cuttings are flushed out with compressed air or pumped out. Rotary drills are very common and are used for drilling wells from 10 cm to 20 cm diameters. Large dia holes are used to supply large volume of water even for irrigation and city water supply system. Drilled wells when cased into bed rock and properly sealed at the surface provide maximum protection from contamination and pollution. Deep drilled wells mostly penetrate more than one water bearing stratum hence, they provide a stronger flow. In most of the region a satisfactory source of water is obtained at a depth around 30 meter or less. But in rocky regions, sufficient water is available even at 100 metre depth.

20.4 LIFTING OF WATER

Lifting of water through buckets is a very old system of lifting water from wells. First it was just taken out of the well pulling water filled bucket with hand (Figure 20.4).

Later on some liver system was applied which proved to be convenient (Figure 20.8).

Pulley system also helped in reduction of effort in lifting water.

Subsequently bucket pump was evolved in which small buckets attached to an endless chain is rotated over sprockets (as shown in Figure 20.10) so that each bucket dips into water and gets filled up carries water to the top and empties it into the spot as it passes over the top sprocket. The system became very popular for small dug wells.

Subsequently, lift and force pumps came into use for lifting water. Lift pumps are used for lifting water from lesser depth and are also classified as shallow well pumps. Force pumps are designed to pump water from a source and to deliver it to a higher elevation or against pressure. Since they lift water from deep drilled (wells, they are also known as deep well pumps).

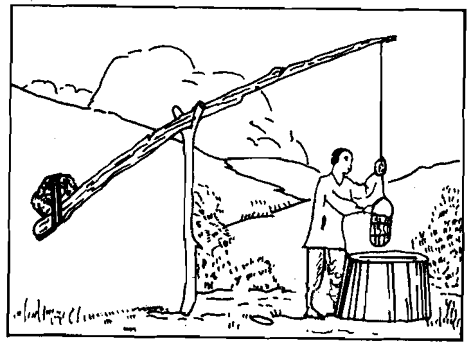


Figure 20.8 : Liver System for Drawing Water from a Dug Well

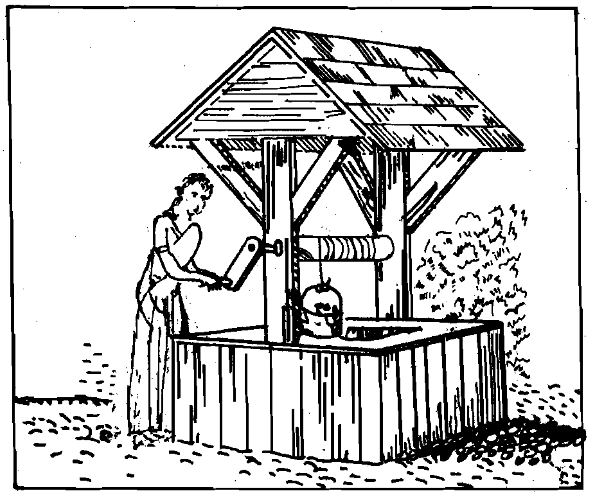


Figure 20.9 : Pully System for Drawing Water from a Dug Well

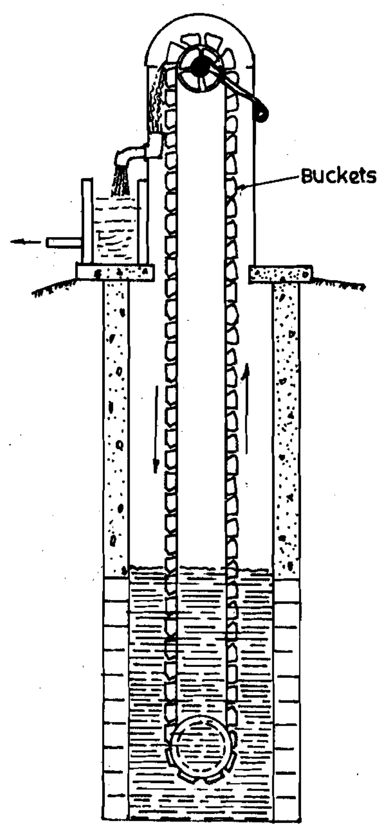


Figure 20.10 : A Bucket Pump

20.4.1 Lift Pumps

Lift pumps lift water up from the source by suction. The pump reduces the atmospheric pressure on the water in the suction pipe and the atmospheric pressure on the water outside of the suction pipe pushes water up into the pump. Figure 20.11 shows the operation of a lift pump.

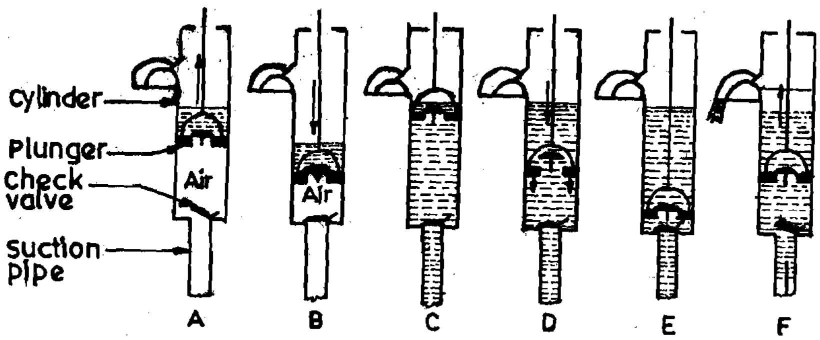
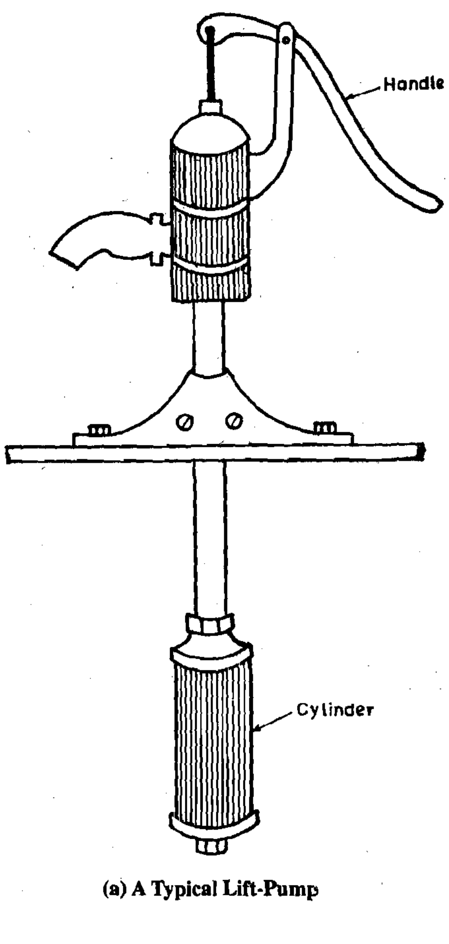
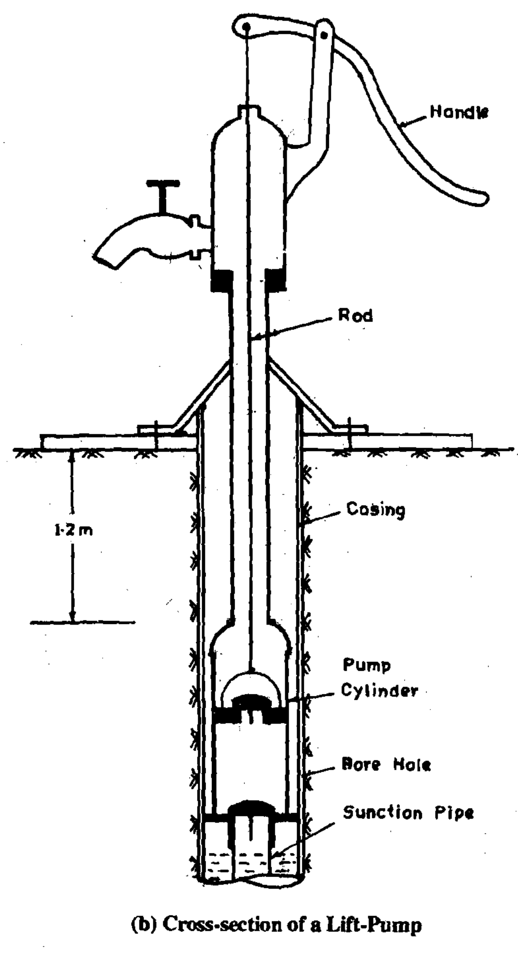


Figure 20.11 : Stages in the Cycle of Operation of a Plunger Type Lift Pump

First the pump is primed putting water from the top and the plunger is raised (A). Due to presence of water, air does not pass the plunger, hence a part of the atmospheric pressure is lifted off the water in the pipe. Air and water in the pipe follow the plunger upward.



(a) A Typical Lift-Pump



(b) Cross-section of a Lift-Pump

Figure 20.12

The space in the cylinder below the plunger is filled with air from the pipe. At the top of the cylinder below the plunger stops and the check valve closes due to its own weight and the air in the cylinder is thus entrapped. When there is downward stroke air is compressed between the plunger and the bottom of the cylinder. When the pressure becomes greater than the atmospheric pressure above the plunger plus the weight of the valve, the air lifts the valve and escapes through the priming water as shown in (B). On the next upstroke, more air is drawn out of the pipe and water rises higher finally flowing into the cylinder under the plunger (C). When the cylinder and pipe gets filled up with water as at C, the check valve closes and water is entrapped in the cylinder. On the next downward stroke, the plunger and valve pass through water as shown at in D. When plunger reaches at the bottom, the cylinder plunger valve closes and water is trapped above the plunger (E). On the next upward stroke water above the plunger is lifted out of the pump (F) and at the same time, water is drawn into the cylinder through the check valve. On each successive stroke, step E is repeated and on each successive stroke, step F is repeated. Thus, the pump delivers water at each up stroke. Figure 20.12 shows the full assembly of a lift pump, which is commonly used in rural water supply.

20.4.2 Force Pumps

The principle of operation of a force pump is the same as that of single acting plunger type of lift pump as explained in the section 20.4, except that it is enclosed at the top and, hence, is used to force the water to higher elevations or against pressure. Such pumps are mostly having an air chamber to even out the discharge flow. On the upstroke of the plunger, the air in the air chamber is compressed and on the downstroke the air expands to maintain a flow at the outlet while the plunger goes down. The trap tube serves to trap air in the air chamber so it cannot leak out around the plunger rod. The pump is called single acting because the cylinder discharges only on the upstroke. They were suitable for shallow wells.

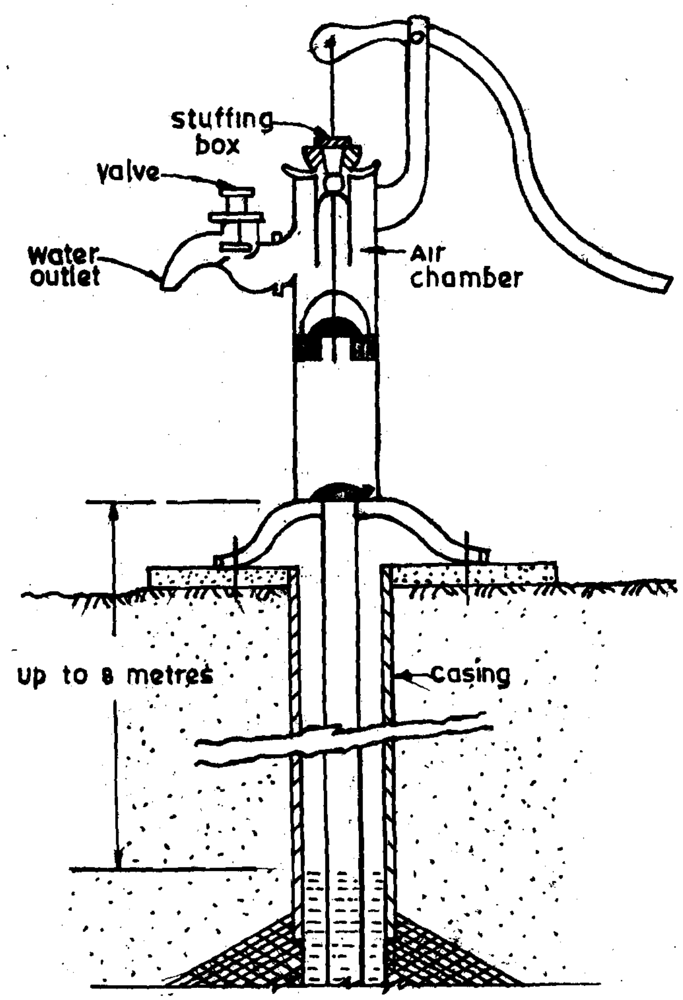


Figure 20.13 : A Single Acting Shallow Well Force Pump

When the cylinder is placed down in the well, it is known as deep well force pumps. When cylinder placed down, the pump can pump water from a depth greater than 6 meters. Figure 20.14 shows such a deep-well force pump.

Differential force pumps are similar to the single acting force pumps except that they have a differential cylinder or an enlarged plunger rod, which evens out the discharge flow. There are many types of force pumps used for pumping water. Table 20.2 describes some ones.

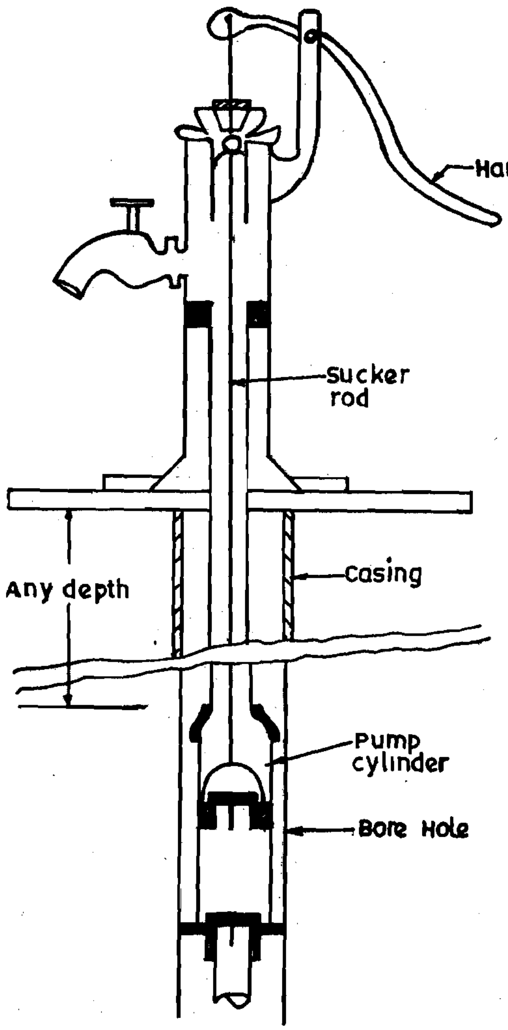


Figure 20.14 : A Single Acting Deep Well Force Pump

Table 20.2 : Force Pumps

Shallow Well	Deep Well
(i) Single acting plunger type	(i) Single acting plunger type
(ii) Differential plunger type	(ii) Differential plunger type
(iii) Double-acting piston type – Single cylinder – Duplex	(iii) Double-acting piston type
(iv) Centrifugal – Single Stage – Multi-stage	(iv) Jet with Centrifugal
(v) Turbine - Multistage	(v) Submersible with multistage centrifugal
(vi) Jet with centrifugal or turbine	(vi) Turbine usually multistage
(vii) Helical, rotary, screw type submersible	(vii) Helical rotary screw type

Piston type, jet type, turbines and other types of pumps have already been discussed in Unit 17. When large quantity of water is required for the whole community, such pumps are used.

20.5 PROTECTION FROM CONTAMINATION

Protective as well as prevention measures should be taken to keep the water free from contamination. For rural water supply, ground water is always preferred because it gets natural filtration while percolating into ground water. Since ground water is taken out of wells hence care should be taken to prevent the well water from contamination. Following care should be taken to safeguard the well.

(i) The well should be covered with watertight cover. In case of dug wells where water is taken by buckets opening at top should be provided such that outside top water does go into the well.

(ii) The lining inside well should extend around a meter below normal water table.

(iii) Sewers and other polluting sources should be kept at least 50 meters away from wells or source of sub-soil water.

(iv) The well should be drilled to a greater depth.

(v) In place of lifting water with buckets, hand pump should be provided which protects contamination to a greater extent.

(vi) Wherever financially viable, deep wells should be provided with pumps and in a tank to get a household supply.

(vii) Contamination of sub-surface source is due to various mineral matter that is being added during the course of percolation. Hence percolation of mineral from effluent of industries should be prevented.

20.6 DISINFECTION AND TREATMENT

The extent of treatment for rural water supply depends on the quality of raw water, operational cost and funds available. Most of the rural supplies drawn from underground sources require a minimum treatment unless the source is polluted. Well water sometimes, contains iron and manganese in solution as bicarbonates in the presence of CO_2. By the simple aeration, CO_2 is expelled and soluble bicarbonates are converted to insoluble carbonate, which is removed by filtration. If water is soft and corrosive due to presence of dissolved oxygen and carbon-dioxide, water is treated with lime by controlling CO_2, which raises the pH up to the saturation level of calcium carbonate. This insoluble calcium carbonate also gives a protective coating to the pipeline. Disinfection of water supply is done with chlorine to remove bacteriological contamination and also to destroy organic impurities. Certain chemical impurities are also oxidised with chlorination. The dose mostly used is 0.05 to 0.10 ppm. The higher concentration is generally used at the time of threatened water-borne diseases. Bleaching powder is also used as a cheap alternative. Well water is chlorinated by pot chlorination as explained earlier. In case the surface water is having turbidity, or is polluted to lesser degree then slow sand filters are used for purification.

In case of uncovered stored water, sometimes, algae growth is there. It is a blue-green growth, which produces scum and objectionable odour. It is harmful to cattle. Algae growth is controlled by treating water with copper sulphate solution. The estimated dose is around 300 gm. per million litre of water. Excess dose should be avoided as it kills fish. If required more than once, the treatment is done per season at an interval of one month or more.

Other organic compounds, odours and tastes are removed by passing the water through activated charcoal filters. Generally small filters are used in house to get better water supply in the house.

SAQ 1

What points should be considered while planning for water supply for a rural area?

SAQ 2

(a) Differentiate between lift pumps and force pumps.

(b) What type of pumps are in more common use for rural water supply?

SAQ 3

Explain with a sketch working of a lift pump for taking out water where water level is 5 meters below ground level.

SAQ 4

Describe a pump with a sketch explaining its function for taking out water from a deep tube well.

SAQ 5

What protective measures should be taken to protect wells from contamination?

20.7 SUMMARY

The unit deals with present state of rural water supply in our country. Gradual development in the field of rural supply after independence has been discussed. Mostly 'sub-soil' that is 'water well' is used for rural water supply because it requires minimum treatment for human consumption resulting in lesser operational cost. Lift pumps are used for shallow wells whereas force pumps are used for deep tube wells.

Although spring water and infiltration water are also good in quality but they are available in a particular region and if available at suitable (higher) elevation, supply to the area having lower elevation can be done even with gravity system making the water supply most economical. But such conditions may be available only in specific geological conditions. In fact deep tube wells with force pumps are the most common method of rural water supply.

20.8 KEY WORDS

Contamination : When the degree of pollution exceeds a certain limit, which is injurious to health.

Deep Wells : A deep well is one which rests on an impervious layer and draws its supply from the pervious formation lying above, through a bore hole made into the pervious layer.

Draw Down : Static water level minus pumping level.

Drilled Wells : They were deep wells made with special drilling rigs.

Dug Wells : Shallow depth wells with a diameter of a few meters.

Force Pumps : Force pumps are similar to single acting plunger type lift pumps except that it is enclosed at the top end, hence, is used to force water to higher elevation or against pressure.

Lift Pumps : Lift pumps lift water up from the source by suction.

Shallow Wells : Shallow wells are in the upper layers of the earth's strata. The water entering the shallow well is derived in the main from shallow percolation.

20.9 ANSWERS TO SAQs

SAQ 1

Water for rural supply should be available to consumers at a minimum cost. For that it is necessary that the source water should have minimum contamination and impurities and it should be at higher elevation so that supply may be done without any treatment or with minimum treatment and under gravity head. No pumping is required. If purification is resorted, it should be at minimum cost. It should have less maintenance and operational cost. The plant and machinery should be of appropriate technology.

SAQ 2

(a) Lift pumps lift water up from the source by suction. Force pumps are similar to single acting plunger type lift pumps except that it is enclosed at the top and, hence is used to force water to higher elevations or against pressure.

(b) If water is available at shallow depth lift pumps are used whereas in case of deep water bearing strata force pumps are used.

SAQ 3

Refer lift pump described in Section 20.4.1 and Figure 20.11.

SAQ 4

Refer force pump described in Section 20.4.2 and Figure 20.14.

SAQ 5

Refer Section 20.5.

FURTHER READING

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