Water for the World

Selecting a Well Site
Technical Note No. RWS. 2.P.3

Selecting a well site properly is important to ensure that the well will tap into a reliable source of good quality ground water, and to ensure that the water will not be contaminated in the future. Selecting a site involves considering existing wells, local geography, quality and quantity of ground water, possible sources of contamination, accessibility to users, and proposed methods of well construction.

This technical note describes the main considerations in selecting a well site. Read the entire technical note before beginning the selection process.

Useful Definitions

AQUIFER - A water-saturated geologic zone that will yield water to springs and wells.

CONTAMINATE - To make unclean by introducing an infectious (disease-causing) impurity such as bacteria.

DRAWDOWN - The distance between the water table and the water level in a well during continued pumping.

GROUND WATER - Water stored below the ground's surface.

IMPERMEABLE - Not allowing liquid to pass through.

PERMEABILITY - The ability of soil to absorb liquid.

POROSITY - A soil's ability to store water.

WATER TABLE - The top, or upper limit, of an aquifer.

General Information

If possible, the well site should be selected by a qualified engineer who has made a thorough field investigation. This investigation may be expensive and time-consuming, but it is one of the most important steps in developing a source of ground water. The investigation, or part of it, may have been done during the earlier planning stages. See "Planning How to Use Sources of Ground Water," RWS.2.P.1.

Whether an engineer or someone else selects the site, a map of the village and surrounding area should be obtained or produced. Add to the map all relevant features discussed in this technical note. See Figure 1.

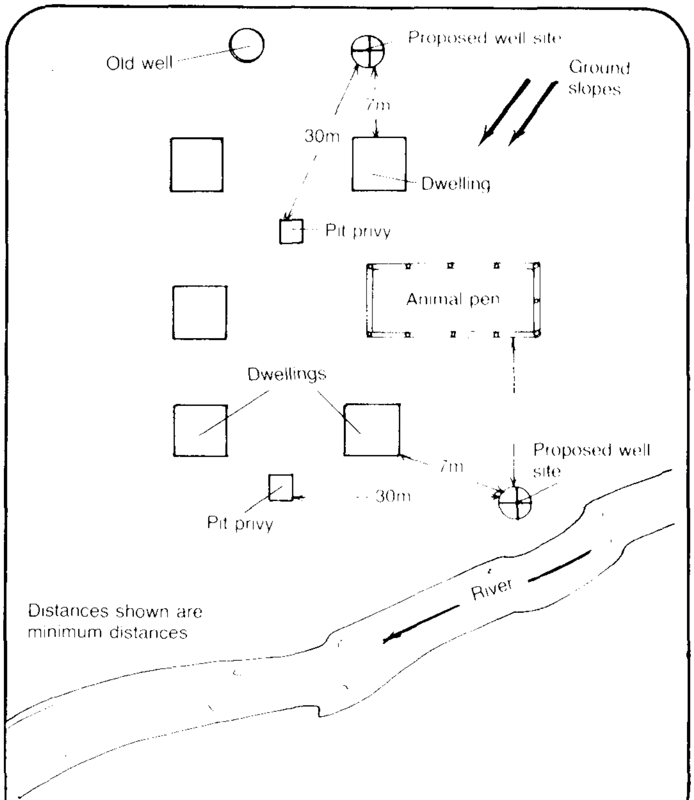

Figure 1. Location Map

Existing Wells

The primary objective when sinking a new well is to sink it where ground water is likely to be found. Existing wells are the best indication of the presence of ground water. Where possible, sink a new well near an old one--ground water will probably be reached at about the same depth. The history of the old well will provide information on seasonal changes in the water table, which may indicate that the new well should be deeper than the old one.

If the new well is to be used in addition to the old one, care must be taken not to sink it too close to the existing well. Otherwise, the yield of one or both wells may be adversely affected. This is due to the effect that a well has on the surrounding water table.

When water is pumped or lifted out of a well, the water level in the well falls below the original level, called the static level, until it stabilizes at a new level, called the pumped level. The distance between the static level and the pumped level is the drawdown. The water table surrounding a well curves down to the pumped level, forming a cone of depression. See Figure 2. If the cones of depression of two wells overlap, the pumped level in one or both wells will be lowered and the yield will be decreased. Draw all existing wells on your map, similar to Figure 1.

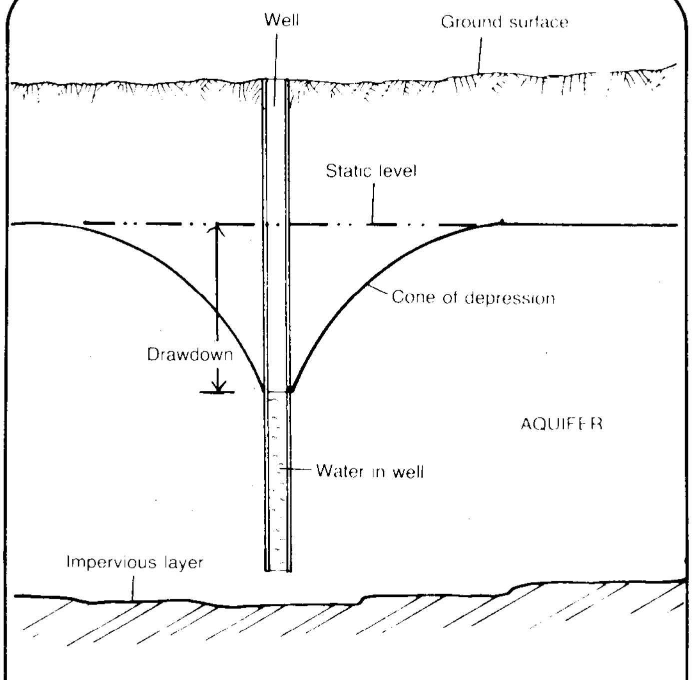

Figure 2. Cone of Depression

Local Geography

If no wells exist, the presence of ground water can be indicated by surface water, topography, and certain types of vegetation.

Surface water. A successful well can generally be sunk near a river because the river will replenish the ground water and reduce changes in the water table. Water taken from such a well is usually cleaner and cooler than water taken from the river. If the well is deep, water may be available even when the river is temporarily dry.

Topography. Ground water gathers in low areas. Therefore, the lowest ground is generally the best place to sink a well. In hilly areas, valley bottoms are the best places for wells. An exception to this could be where there is a spring on the side of a hill. The spring may indicate lateral movement of ground water over a layer of impermeable soil. If so, a successful well could be sunk uphill from the spring. This may have the advantage of bringing the source of water closer to the community or dwelling.

On your map, draw all rivers, springs, and topographical features.

Vegetation. Certain types of vegetation can indicate that ground water lies near the surface. The most useful indicators of ground water are perennial plants (those present year-round), especially trees and shrubs. Annual plants, such as grasses, are not good indicators, because they come and go with the seasons. The dry season is probably the best time to survey vegetation for indications of ground water.

Quality of Ground Water

Once ground water is located, its quality must be tested before constructing permanent wells. The water must be clean, clear, and good-tasting, and be free from disease-causing organisms. For information on testing water, see "Determining the Need for Water Treatment," RWS.3.P.1, and "Analyzing a Water Sample," RWS.3.P.3. If the ground water is contaminated, another source may have to be found.

Quantity of Ground Water

The quantity of a groundwater source is nearly as important as its quality. Unfortunately, the only way to test the yield of an aquifer is to dig a well and pump it. See "Testing the Yield of Wells," RWS.2.C.7. You can, however, make a rough estimate of the yield by identifying the sediment and rock which compose the aquifer.

The two most significant elements of an aquifer are its porosity and permeability. Porosity governs the amount of water that an aquifer can contain. Permeability governs the amount of water that can be brought to the surface. For example, some aquifers may contain large quantities of water, but their rate of yield is too slow to suit the needs of the user. Porosity and permeability depend on a number of factors including particle size, arrangement and distribution.

Table 1 shows the estimated yields of aquifers composed of different types of sediment. The table should not be used for exact calculations but only for indications of yield.

Table 1. Estimated Yields of Aquifers

Sediment Composing the Aquifer	Estimated Yield (liters per minute)
Sand and gravel	11400; could be less based on pump and well design
Sand, gravel, and clay	1900-3800
Sand and clay	1900
Fractured sandstone	1900
Limestone	38-190; more if near stream, or if there are underground caverns
Granite or hard rock	38 or less
Shale	less than 38

If the quantity of ground water is insufficient, another well site will have to be found. The new site may replace or supplement the old site.

Possible Sources of Contamination

A well should not be dug in areas where the ground water is likely to be contaminated. A well site should be uphill and at least:

- 50m from a seepage pit or cesspool;
- 30m from a subsurface absorption system;
- 30m from a pit privy;
- 30m from animal pens, barns, or silos;
- 15m from a septic tank;
- 7m from a drain, ditch, or house foundation.

The well site should not be subject to flooding during the wet season or any other time. This will be of greatest concern where the well is in a low area or near a river that yearly overflows its banks. The site can be protected from flooding by building small dams or ditches to prevent flooding the well. If not, another site should be considered.

Draw all possible sources of contamination on your map, as in Figure 1.

Accessibility to Users

The well site should be as close as possible to the village or dwelling. As the distance between the well and the user increases, the per capita water consumption decreases. This is shown in Table 2. The table should not be used for exact calculations but only for indications of consumption.

Political considerations may influence accessibility. There may be pressure to put the well near the dwelling of the village chief or other influential member of the community. A compromise may be necessary.

Methods of Well Construction

The proposed method of well construction must be suitable to the soil conditions at the well site. If not, another site must be found or another method of construction must be considered. Table 3 shows some of the limitations of well construction methods based on soil conditions. For more information, see "Selecting a Method of Well Construction," RWS.2.P.2.

Table 2. Water Consumption and Distance to Water Source

Distance to Source	Estimated Consumption (liters per person per day)
More than 1000m	7
500-1000m	12
Less than 250m	20-30
In the yard of the dwelling	40

Table 3. Well Construction Methods and Soil Conditions

Construction Method	Unsuitable Soil
Hand Dug	Hard rock, large boulders
Driven	Hard rock, heavy clay, boulders, coarse gravel
Jetted	Hard rock, boulders
Bored	Hard rock, boulders larger than auger
Cable Tool	None

Summary

When all alternative well sites have been determined, draw them on your map, as in Figure 1. Then select the best site. When examining a site, you will no doubt find that even though it may rate well in some ways, it rates poorly in others. Selecting the best site is often a matter of judgment and experience. You must weigh the relative advantages and disadvantages of each site. Figure 3 is a simplified example of four alternative sites from which a village must select one.

Site #1 would allow easy access to ground water because the water table lies close to the surface of the ground. However, limited water would be available because the layer of impermeable rock also lies near the ground surface. Thus, slight fluctuations in the water table would drastically affect the availability of water.

Site #2 is the site closest to the village, and therefore has the greatest accessibility. However, the water table is quite deep and may be difficult to reach. The aquifer cannot be penetrated too deeply, because of the position of the impermeable layer.

At Site #3, the aquifer can be reached without digging very far down. The aquifer can be deeply penetrated. This would ensure a reliable water source. However, the site is some distance from the village, and below the homes.

At Site #4, the most water can be reached with the least difficulty. The site is at the greatest distance from the village. It is in a low spot that may be subject to flooding.

Each site has advantages and disadvantages. The project director, the villagers, and the village leaders must decide which site is best for the community.

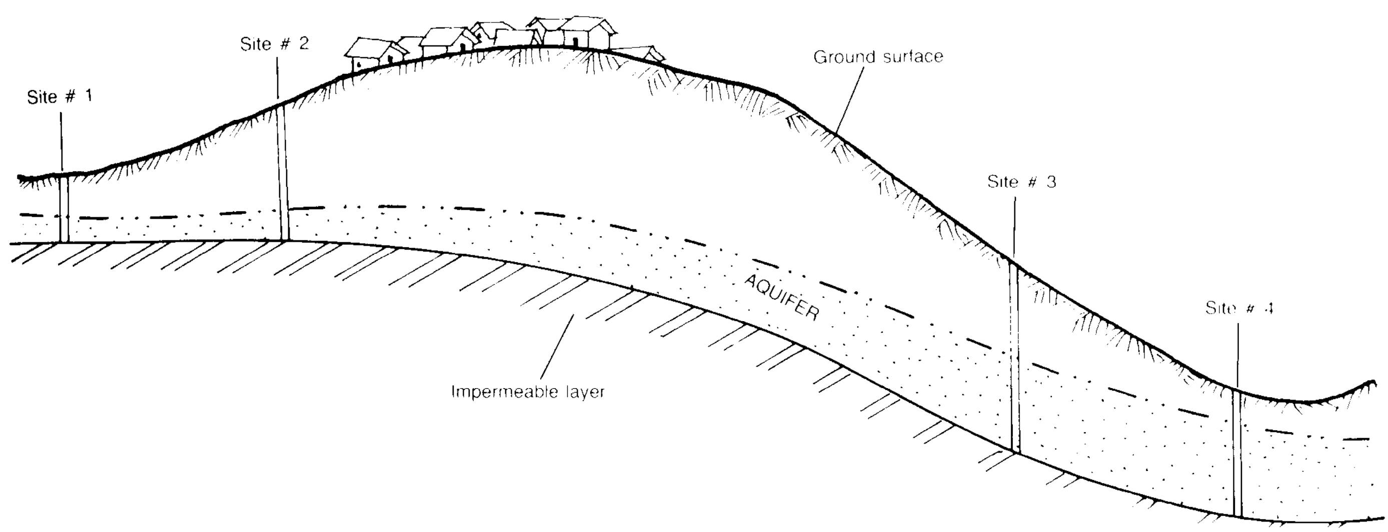

Figure 3. Alternative Well Sites