ARTESIAN WELLS AND METHODS OF PUMPING THEM.*

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THERE has not hitherto been much discussion on the subject of the design, construction and operation of water supplies obtained from underground sources, particularly those from driven wells. In a great many localities the underlying formation is such that a water supply from a driven well system is impossible to obtain, but there are hundreds of situations where it is possible to obtain an artesian supply, and consideration should be given to this source, even when a filtration plant is available.

It is often stated that artesian supplies are not permanent in character. The writer disputes this point, because his experience, extending over a great many years, has led him to believe that the fault is not with the underlying water-bearing strata, but either with the construction of the wells themselves or to bad condition, due to neglect. There are many cases where the yield from the wells has steadily fallen off, and where it was possible, by developing the wells, and possibly changing the method of pumping, to bring the wells back to their original and sometimes to an even greater yield. . . . The writer refers particularly to wells driven through sand or gravel formation, where the use of a strainer is necessary. Of course, in the case of wells driven into the rock, it is only possible to obtain from any rock-hole the amount of water contained or flowing through the crevices and fissures in the rock. With sand holes, however, the yield from any well is greatly affected by methods of construction and development of the well when drilled. The writer has drilled wells that yielded 15 gallons per minute which have been brought up to over 300 gallons per minute before being put into service.

In places where there is a choice between artesian well water and a surface water supply that has to be filtered before it is possible for the water to be used, more consideration should be given to an artesian supply if the cost of the plant and the cost of water delivered to the pressure pumps is close enough to allow of debate. This opinion is based solely on the ground of the purity of the supply. . . .

The writer refers particularly to the purity of supplies from driven wells, and admits at the same time that driven well water in almost every case is harder water than that obtained from surface streams. In very few cases, however, does driven well water have to be treated either to clarify or purify it. The installation of a filter plant for the clarification of a surface supply is not the end of that problem; ceaseless vigilance in the care of the filter is the only price of safety. There are localities where it is debatable whether an artesian supply is better and more economical to operate than a supply taken from a surface stream that is to be filtered, and still other localities where there are no surface streams, and the municipality is compelled to resort to artesian wells.

The problems involved in the laying out of an artesian well system may be grouped under three heads: (1) Location of the wells; (2) methods of drilling and construction; (3) methods of pumping. No consideration will be given in this paper to the methods of pumping from the pump-house up to the storage reservoir, nor to distribution systems. Only the delivery of the water to the suction basin in connection with the main pumps will be treated.

The location of the wells depends upon the extent and surface conditions of the land available for the well field. No rules can be set down for the proper location of wells until test-wells have been drilled, unless the underlying conditions are known from wells in the vicinity. In laying out a pumping plant which will obtain the supply from wells, as a general rule it is best to drill the wells and locate the pump on the lowest possible ground available. The obvious reason for this is that in drilling the wells we penetrate to the underground stream, and the object is to have the pumped level of the water as close to the surface as possible, because, as a general rule, it is more expensive per foot of pump head to deliver the water to the surface of the ground than from the surface reservoir up to the storage tank. If the well field is to be in a well-defined valley, it is preferable to drill the wells in a line across rather than parallel with the direction of the valley, because the underground stream of water may flow in the same general direction as the surface streams. This, however, is not always the case, and before locating definitely any number of wells, it is advisable to drill test-wells at various points.

There have been cases where city councils have taken the matter into their own hands, and have drilled wells on the summit of the hill on which they have decided to place the storage reservoir under the specious reasoning that if they could get a flowing well in the valley, they should get on top of the hill a flowing well, delivering its water freely into the storage reservoir, which would save the expense of pumping. Unfortunately, water will not rise above its source, and the money spent on drilling these altitudinous wells has been thrown away. There are places where it is possible to obtain flowing wells on the summits of high hills, but they are the exceptions which merely prove the rule.

In regard to the location of underground water supplies by the use of forked sticks, magnetic balls, pendulums, indicators for radio activity and other devices, the belief in such occult means is only evidence of the survival of a superstition of the alchemist's age.

The only scientific method of determining the location for a well is to obtain all the information possible about wells in the vicinity, together with all possible data regarding the underlying geological formations. A combination of experience with the aforesaid data and information is of considerable value. In addition to this information, test-wells should be drilled to the maximum depth considered necessary, and should not be less than 6 in. in diameter, so that a pump of reasonable size can be installed, and some conclusion drawn from the yield of the "prospect well." After these "prospect wells," the number of which will depend upon the local conditions, have been drilled and tested, sufficient data is at hand upon which to estimate the total number of wells that will have to be drilled to give the required yield. Great care must be taken to obtain an accurate record of all the formations passed through, and frequent tests must be made to determine the yield at different depths.

Driven wells may be roughly divided into two classes: (1) those where the water supply is obtained from the rock, and (2) those where the water-bearing strata lie above the rock. A third class might be added, a combination of these two.

(1) Where the rock lies at a short distance below the surface of the ground, and the quality of the water

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