

## PUBLIC WATER SUPPLY FOR CITIES—SOME GENERAL CONSIDERATIONS.\*

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**I**N the modern sense the waterworks of a city includes the source of supply and the equipment required to deliver the water through a distributing system to the point where it is utilized. The development of public water supplies in accordance with this interpretation has been of comparatively recent occurrence. In the United States there were only 53 public water supplies in 1850. Since that date, however, the installation of public water supplies has been general and it is estimated that at the present time there are fully 6,000 public water supplies. Prior to the invention of pumping machinery for lifting water the development of water supplies was practically nil. In 1582 in London the first pumps for water supply purposes were placed in operation. An important development in assisting the installation of public water supplies was the introduction of the steam pump in London in 1761. An impetus in water supply development came in the latter part of the 18th century when cast iron mains were introduced as a means of distributing the supply. Previous to that time wooden pipes only had been used.

In the early development of water supplies little attention was given to the quality of the supply. It was not until 1829 that serious consideration was given to the quality of the water. In that year the first filter was installed for the East Chelsea Water Company at London. About 1850 the germ theory of disease was seriously advanced and it was at this time the claim was made that typhoid fever was caused by a specific organism transmitted in sewage. This marked the beginning of the use of filters as a sanitary precaution in the improvement of water supplies, although definite proof of the existence of the typhoid germ was not secured until 1880 and 1881. The early development was the so-called slow sand filter which is still now extensively used in European countries and also in the United States. It was not until 1893 that studies were made leading to the development of the so-called mechanical or rapid sand filter. This process is known as the American system of filtration, although its origin was in England. At the present time it is estimated that there are 350 municipalities in the United States utilizing mechanical or rapid sand filters to purify their water supplies. The slow sand filters have not met with such favor in this country due no doubt to the fact that they are less suitable in the treatment of muddy water. At the present time there are about 50 municipalities using slow sand filters in the United States.

**Sources of Water Supply.**—The original source of all water is the rainfall which precipitates upon the surface. A portion of this rainfall is absorbed by the soil and percolates into the underlying formations. Another portion flows from the surface through streams and rivers to their points of discharge. An appreciable amount is lost by evaporation and another portion is utilized in the support of plant life. The portions in which we are interested for water supply purposes comprise that which percolates into the soil, becoming a source of ground water supplies, and that which passes off into the streams, becoming a source of surface water supplies.

Ground water may be obtained by means of wells, springs, or collecting galleries. Depending upon the elevation of the ground water with relation to the surface of the ground, it will require one or two sets of pumps to deliver it into the mains. The quality of ground water is dependent upon the formations from which it is obtained. Thus, by passage through a limestone formation the water will absorb hardness. If it comes in contact with iron salts, which are almost always present, it will absorb the iron by solution. It may also take on objectionable tastes and odors due to the absorption of sulphur compounds. In general, ground waters are less desirable than surface supplies, judged from their mineral characteristics.

Surface water supplies are derived from streams, lakes or reservoirs. With lakes or large rivers it is unnecessary to provide storage of raw water for a continuous supply for the pumps. With small rivers and creeks, however, it is frequently necessary to construct impounding reservoirs to store a sufficient portion of the excess flow of the stream to serve during dry weather. The quality of surface water supplies is dependent upon numerous factors, the most important of which is the density of population upon the drainage area. Theoretically every dwelling on the drainage area contributes to the pollution of the stream. The degree of pollution is, therefore, determined by the population. It is, of course, possible to reduce the extent of pollution by proper disposal of sewage. Regardless of the treatment of sewage, however, it is generally conceded that no surface supply collected from a catchment area which is populated is safe for drinking purposes without purification. This is particularly true in Ohio and in other densely populated localities where the streams are almost universally used as carriers of sewage.

**Conditions Governing Choice of Source of Water Supply.**—Statistics of public water supplies of United States show that a large percentage of the supplies are obtained from ground water sources. Practically all of the villages and small cities of Ohio obtain their supplies from wells, springs or collecting galleries. As the population increases, however, it is found that the ground water supplies will not furnish a sufficient quantity of water. Of the cities in Ohio with populations of 25,000 or more, five obtain their supplies from wells and nine are provided with water supplies of surface origin. Four of the well supplies are inadequate and two of them are supplemented by surface water. The indications are that unless unusually favorable conditions are encountered a city of more than 25,000 population must depend upon a surface source of water supply. In any case the most serious consideration must be given to the question of quantity in determining the choice of a ground or surface source of water supply.

It may be stated generally that the fundamental condition governing the choice of the water supply is the quantity available. It is obviously unwise to develop a source of supply which within the life of the installation will fail to furnish a sufficient amount of water. In determining upon the quantity available assumptions must be made to estimate the growth of the city and the increased use of water. The quantity thus determined must be supplied during the most extreme dry weather conditions which can be anticipated. It is not enough to supply a sufficient quantity of water for 350 days of the year and meet a deficiency during the remaining short period.

Of almost equal importance to the question of quantity is the quality of the supply. Having two supplies pro-

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