

WATER SUPPLY.*

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No one factor so directly affects the health, comfort and prosperity of a community as an adequate supply of pure water. The provision of a public supply to replace the individual sources of supply is one of the first indications of the urban development of a community. No problem deserves more careful consideration at the hands of those intrusted with the affairs of the commonwealth, and no other municipal investment better deserves liberal consideration. The last word in the science of water supply engineering has by no means been said, but experience has many lessons to teach us and we can with much greater certainty design and construct satisfactory works than was possible fifteen to twenty years ago. It will be the endeavor of this paper to give you in as brief form as possible an outline of the main features of the problem and in doing so your attention will be called to five subdivisions of the subject, namely,—uses, quality, quantity, sources of supply and method of distribution.

Uses.—The uses to which a public water supply are put fall naturally into three classes, namely,—domestic, commercial and public use. The **domestic** use includes water used for drinking, cooking, washing, and in furnishing the necessary flushing water for a sanitary system of drainage. The **commercial** use of water consists in its use as a motive power in elevators, water motors and hydraulic presses, as a supply for boilers in the generation of steam and directly in many manufacturing industries such as sugar-refining, brewing, in chemical and dyeing works. The most important **public** use of water is perhaps in providing fire protection. There is also its use in street sprinkling, sewer flushing and in parks and playgrounds.

Whatever may be the uses to which it is put, however, in attracting citizens and interesting capital a satisfactory water supply is a most valuable asset.

In considering the question of such a supply its **quality** is of primary importance and should not be sacrificed to any consideration. The question of quality must be considered from both a scientific and a popular view point. It is an indisputable fact that many waters which are so turbid or so discolored, that a storm of protest would follow their appearance at the taps of the consumers, are nevertheless practically harmless to public health. On the other hand there may be lurking in the clear, cool water which the public uses with expressions of appreciation, the germs of a deadly disease. Those responsible for the public water supply must, however, recognize that, not only must the public's health be safeguarded, be he ignorant of danger or not, but his senses of sight, taste and smell must not be offended.

The quality which should be obtained depends on the uses to which it is to be put. A domestic supply should be potable, free from dissolved constituents, free from disease producing bacteria, must not be unduly turbid and should not be too hard. Water for commercial purposes must have characteristics depending upon the use to which it is to be put, but for boiler purposes a hard water is not satisfactory. Water for fire purposes, if confined to its own mains, is not affected by questions of quality.

In considering the quality of water therefore we must know something about its potability, color, turbidity, dissolved constituents, hardness and bacterial content. It is well to understand just what these terms signify and what weight is to be attached to each. We shall, therefore, consider each somewhat in detail and in doing so shall endeavor to avoid technicalities as much as possible.

Potability.—A potable water is one which is pleasant to drink, cool and free from odor or objectionable tastes. These characteristics of a water are affected by the growth of algae in water when at rest, as in ponds, reservoirs or lakes, and by the dissolving in it of mineral or organic matter with which it has been brought in contact. Ground waters such

as well waters and spring waters are usually cool and pleasant to the taste, but may be unduly hard and in some cases may have dissolved mineral constituents. Surface waters are in most cases not unduly hard, but due to the growth of algae or to mineral or organic constituents may be objectionable to taste or smell.

Color.—A perfectly satisfactory water should be colorless. Ground waters are for the most part free from color, but some surface waters, especially those draining swampy areas, are highly colored by the soluble organic matter dissolved in them. Color is an optical characteristic, but should not be confused with turbidity, the distinction being that color is due to dissolved constituents while turbidity is due to suspended particles. Filtering or sedimentation will remove the latter but not the former. Colors of water are estimated by comparing them with standard solutions which can be made up to stimulate very closely the natural waters.

Turbidity.—This is a characteristic affecting the appearance of the water and is due to suspended particles carried along with the water by its velocity. It is confined almost entirely to surface waters, more especially river waters, and varies with the conditions of the river, being most noticeable at periods of high water. As has been already stated it is due to the suspension of sandy or clayey particles in most cases, but organic growths may also produce this characteristic. Since turbidity is an optical characteristic we are more concerned with the effect of the transparency of the water than with the total amount of the suspended matter. A much greater amount of sandy particles as compared to clayey suspended matter is required to produce the same turbidity. The amount of turbidity is measured by the depth at which a platinum wire one millimetre in diameter is visible. Other means are employed but all should depend on the testing of the transparency of the water.

Dissolved Constituents.—Many organic and mineral compounds are soluble in water. Their degree of solubility depends on the temperature and chemical composition of the water. Many mineral springs have undoubted medicinal qualities, but would hardly do as a source of water supply. Some dissolved constituents are released by boiling, and so we have the deposit which may be noticed if some waters are boiled and allowed to stand and clarify. Certain dissolved constituents give that peculiarity to water which we term "hardness."

Hardness.—Hardness or absence of hardness is something with the physical indications of which we are all familiar. We say a water tastes hard and housewives know to their sorrow the difficulty of getting a lather with it for washing purposes and its harmful action on the skin. Those using water for boiler purposes or for cooking are quite aware of the objectional scale which is formed in its use. The "hardness" of water is due to the presence of dissolved salts of the alkaline earths, such as lime and magnesia. A great many ground waters and some surface waters have this characteristic. When soaps are added to such "hard" waters insoluble precipitates are produced, and so a much larger amount of soap is necessary. It is estimated that the city of Glasgow saves \$180,000 annually in the amount of soap used since the introduction of the soft Lock Katrine water (Park's Hygiene and Public Health, page 10). Hardness is said to be temporary or permanent depending on the effect of boiling. If the salts of lime occur in certain forms the boiling will cause a precipitate and so the hardness of the water will be lessened. The scale formed by temporary hard waters is more friable and not so objectionable as that formed by the use of permanently hard water.

However objectionable or otherwise a water to be used for drinking or cooking purposes may be on account of odor, taste, turbidity or hardness, these are of much smaller moment than the question as to whether or no organisms capable of directly producing disease are present. All water has more or less bacterial content but it is highly important that a source of supply shall not be polluted with those organisms capable of producing disease. This aspect of the question

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