neighboring town that received no aeration. As the majority of places needing waterworks contain a population of about 5,000 inhabitants I will confine my subject to the necessities of such places.

The waterworks plant of a small town will cost more per capita than larger towns, but those who have yet to secure a supply have the advantage of avoiding the mistakes of previous towns which have already got their plants constructed. We find that several of our older cities are in the hopeless condition of water wasters, and the quality of water delivered would have been considerably superior had the plants been properly constructed and managed from their commencement. The waste and misfortunes of the large cities can be avoided, and the cost per head largely decreased by using reasonable judgment and engineering skill. The improvements made in pumping appliances lately have so far reduced the cost of lifting water, that the cost of pumping a town's water supply need not form much of an objection. In fact a good engineer might supply all the heat necessary to work the pumps from the refuse and garbage thrown away by the water consumers, and by so doing would not only pump the water without buying any fuel, but also dispose of a very grave nuisance at the same time by cremating the garbage. When pumps are used to secure a water supply, the carrying pipe from the pump-house to the water tower, or to the point where the distributing mains commence to branch off, should be laid on a rising grade the whole way, avoiding any dips where grit or dirt may accumulate, or bending over small hills, thus creating hogbacks in the line of pipes where pockets of air will lodge and cause a resisting pressure that jars the pipes, loosens the joints, producing sudden water hammers, vibrations, etc., which sometimes damage the line of pipes, besides taking more fuel to drive the pumps. If a waterworks plant be well constructed and designed twenty-five imperial gallons per head per day is abundant for strictly domestic purposes. For trade purposes, for public baths and other extraordinary requirements an extra supply should be provided. Probably a daily supply of 150,000 gallons would answer for all purposes for a population of 5,000.

It has often been proved a greater economy to tunnel or bore a road for the water mains under small hills, than to bend the pipes over the crown of the hilltop, also to bridge over a narrow ravine, and construct a frost-proof viaduct to pass the water mains over, than to make a quick and sudden depression. Because the extra cost is afterwards more than covered by the reduction in the general repairs and the smoothness that is established in working the appliances throughout the whole plant. When water mains are placed under shallows and a depression is made in the line of supply pipes a proper cleanout valve placed at the lowest point is essential, and when the main pipe is bent over the crown of a hill it is absolutely necessary to place an automatic air-escape valve at the very highest point, or the water will not always flow freely through the pipes, because pockets of atmospheric air will repeatedly lodge.

There is no advantage in placing supply pipes down in the streets larger than is necessary to carry the maximum quantity of water to serve the section or district at any hour of the day for domestic purposes, because the water creates a growth of calcareous formation all around the walls inside the pipe, that will continue to reduce the size of the bore until it becomes reduced to the size necessary to easily pass the maximum quantity used. By using good judgment in arranging the position of the main pipes, cleanout valves, and air escape valves, and if the supply be afterwards intelligently cared for, the formation of obstruction can be avoided. The 8 and 10-inch pipes may be dispensed with where 6-inch pipe is ample to serve for domestic purposes, because the whole force of the water supply of the town may be made to concentrate to any part of the town when necessary to extinguish a large fire. We dwelt fully on the subject of laying pipes in our article of June, 1897, and need not repeat it here. It is a wise policy to secure a supply of water that will serve the town by gravitation if possible, even if it should cost fifty per cent. more to provide the plant. I gave several reasons for this statement in 1897 and may here repeat that it saves the cost of pumping and the risk of a breakdown of the machinery just when a supply is most needed. There are also sanitary grounds that weigh in favor of gravitation schemes, besides the works are always cheaper to manage after they are fully completed. The rainfall is the source of all water supplies, though the supply may be secured in the indirect way of being drawn from wells, springs, rivers, or fresh water lakes. If the substance of the water is changed by passing through moss and other vegetation, it is called surface water, and often moorland water, thus the quality of water is generally named by the chemical or mineral strata it passes through and which it incorporates. The water from springs is not always suitable for a town's water supply on account of its hardness or because it is impregnated with chemicals or minerals. It is possible by mechanical means to remove the hardness, and often by processes of aeration to remove the chemical or mineral gases the rain water may have absorbed. When rain falls on to high table land and hills it percolates through the soil and the rocky strata to a depth often of over 100 feet to hollow caverns, with large reservoirs holding in store immense quantities of water that has filtered through. If the reservoirs had no overflow outlet to keep them from rising beyond a certain level, then the whole cavern would fill with water, and form such a heavy hydraulic pressure that an earthquake or shock would occur as soon as the water and the pressure of the water was able to weaken the side walls of the hill. Generally, each underground water-collecting reservoir has an overflow, and many of these overflows travel a great many miles before they burst forth out of the land and secure the name of spring water; of course, the point where the water issues forth is at a lower level than the surface of the water in the underground reservoir. Spring water is often far superior in quality to deep well water, because it has gone through similar processes of filtration by passing through the earth's stratums, and also got further improved by a thorough aeration in the draughty caverns under the hills.

There are two counties in England that possess such water-bearing caverns that fortunately have a passage from the outside to the interior. I have been over a mile into the heart of those caves, I found that they contained flowing rivers, water falls, numerous small cascades spraying water, and domes and massive arches forming the roof that extended beyond what my eye could see with the aid of a torch, and many of the domes would exceed in height any of our tallest towers. Hanging from the roof were thousands of stalactites, each delivering a large drop of water at short periods. Our guides assured us that the caves could be traversed for many more miles, but a novice on his first attempt of exploring the bowels of the earth is generally fully satisfied with going one mile and spoiling his clothes. But there was plenty of air in rapid circulation in both the caves. I have spent considerable time down at the bottom of deep coal mines, where the best of