

well with the English practice of treating six times the normal dry-weather flow.

In studying the methods of disposal it has been found that the sewage may be treated with much less offense if it reaches the works in a comparatively fresh state before putrefaction has set in; therefore great care is being taken in the design of the sewer system that the velocity of flow shall not be less than that required to carry the materials in suspension. This is accomplished by providing proper gradients and by the exercise of care to secure smooth surfaces, avoiding all roughness and projections on the interior of the sewer where organic matter might find lodgment and be retained until putrefaction sets in and stench begins. Upon examination of many of the sewers in Europe there was no odor noticeable because the interior surfaces were smooth, either vitrified tile or smooth, glazed brick being used, and all connections so made as to provide a natural flow without the creation of eddies where deposits might occur. It is, therefore, recognized that a solution of a part of the problem of sewage treatment is to construct sewers with smooth interiors and to keep them clean and inoffensive.

In designing the collecting system, it is proposed to construct intercepting sewers at two levels, and in this way to utilize the potential energy in every foot of head and carry to the treatment works by the high-level interceptors the greatest possible volume of sewage, and thus reduce to a minimum the quantity to be pumped.

The collecting systems in many European cities are constructed so as to convey the sewage to one or more suitable locations for treatment, and care is exercised in their designs to secure the greatest economies.

**Sanitary Surveys.**—There are in Philadelphia five large creeks and the Schuylkill River, all of which are tributary to the Delaware River, which forms the eastern boundary of the city. Poquessing Creek flows through a territory but little developed, and is, therefore, not at the present time polluted. The sewage formerly discharged into Pennypack Creek and Wissahickon Creek has been intercepted and the water in these streams restored to a normal condition. A large part of the sewage on the Philadelphia side of Cobbs Creek has been intercepted and the condition of the water in this creek greatly improved. Frankford Creek, which empties into the Delaware River about five miles south of the Torresdale Water Filters, flows in part through a densely built up and industrial part of the city and receives crude sewage from about 140,000 people. It has several dams along its length, and, therefore, low velocities. The water is not only grossly polluted by the discharge of sewage into it, but the deposits of sewage origin upon the bed of the creek add to the nuisance.

The Schuylkill River flows through the city in a generally southerly direction, and about midway there is a dam which forms the end of tidal influence. The section of the river north of the dam has been protected within the city limits by intercepting sewers. Into the tidal portion of the river below the dam, however, there is now being discharged the sewage from about 455,000 people. At times of drought almost the entire up-stream flow is used for water supply, leaving a very inadequate volume of diluting water for the sewage from this large population. The examinations made during the summer months showed the water in this part of the river to be depleted of dissolved oxygen. Furthermore, the tidal velocities in the lower part of the Schuylkill River are insufficient to maintain the sewage matter in suspension, so that in addition to the polluted condition of the water, the putrefying deposits upon the bed of the river increase the nuisance, particularly in warm weather; but as in

the case of Frankford Creek, above described, the natural sedimentation processes and the gasification of the resulting sludge, together with the refreshing action of the tide, lighten the load of organic matter placed upon the waters of the Delaware River.

The Delaware is one of the large rivers of the United States, and forms the natural drainage for portions of the states of Pennsylvania, New York and New Jersey. The normal flow of upland water is at the rate of 4.050 sec.-ft., in addition to which there is a tidal range of  $5\frac{1}{2}$  ft., and it is estimated that during the ebbing of the tide 2,421,000,000 cu. ft. of water flow past the city. As the sewage of the city at present and the effluent from the treatment works in the future must be disposed of in the waters of this river, its present condition has been examined with considerable care and it was found that with the exception of the docks, where sewers discharged, the Delaware River is successfully disposing of the crude sewage of the present population of Philadelphia in addition to that of the neighboring towns. Even in summer weather and in times of extreme drought, there has been no nuisance or offense created, although the amount of dissolved oxygen in the river has been small. The surveys indicated that the river water after passing beyond the points of discharge of the sewage of the city gained rapidly in its oxygen content. The high velocities, due to tidal flow in the river, maintain the sewage matters in suspension, and the examination shows that the entire bed of the river (excepting the docks) is clean and free from deposits of sewage origin.

It must, however, be realized that, with the increase in the population and the consequent added load placed upon the river, its oxidizing power will soon be overtaxed and that the time to begin the building of the collecting and treatment works is at hand.

**Treatment Works.**—The sanitary surveys of the water-courses in Philadelphia show that sewage must be excluded from the creeks and the Schuylkill River, and that the treatment works must be located so as to discharge their effluents into the Delaware River in order to utilize to the fullest extent the great diluting and oxidizing capacity of that river.

It is proposed to locate the first treatment works in the north-east section of the city. The collecting system tributary thereto will eliminate the pollution of Frankford Creek and also prevent the discharge of crude sewage into the Delaware River within the tidal influence of the Torresdale Water Filters, which provide three-fifths of the city's water supply. The degree of treatment required at this works must, therefore, be based upon a hygienic standard in order that the public health will not be jeopardized by overtaxing the economical and safe operation of the water filters.

The second treatment works will be located in the south-west part of the city, near the mouth of the Schuylkill River, the most distant point within the city limits from the source of water supply. The collecting system tributary to this works will eliminate the pollution of the lower Schuylkill River and will result in concentrating the sewage from over half the population of the city at one point for treatment. As the effluent of this works will be entirely below the influence of the city's water supply, the degree of treatment required need only be sufficient to prevent nuisance in the Delaware River.

It appears to be economical to construct temporarily a clarification works in the south-east district, to care for the sewage now discharged into the Delaware River below the centre of the city.