Cost of Construction of Rapid Sand Filters.—It is almost as difficult to state the comparative cost of construction of rapid sand filters as of slow sand filters. Local conditions largely govern, and it is possible and feasible to build some plants much more cheaply than others, and at the same time obtain plants which will prove as efficient as those which are more complete and ornate. A summary of the more prominent installations and their cost indicates that unless some unusual features are encountered, as in the filters at Little Falls, N.J., where the flow throughout is entirely by gravity, compelling the use of relatively expensive deep structures, or the abnormally large preliminary settling basins at Cincinnati, the cost of a rapid-filter plant, exclusive of high-lift and low-lift pumping equipment, will be about $12,000 for each million gallons daily capacity. On the basis that the water consumption is 125 gallons per capita daily, the first cost to each consumer of such a plant would be about $1.50. At 6 per cent., the interest charges on such an investment would be 9 cents per capita annually.

The above-mentioned fixed charge on the cost of construction of rapid-filter plants is materially lower than that of slow sand filter plants, as would be expected. As a general proposition, it is not usually thought necessary to build large sedimentation reservoirs in which the raw water may be first settled before the coagulating chemical is applied and the water is allowed to flow into relatively small coagulating basins. Where turbid waters are to be purified by slow sand filter plants, large sedimentation reservoirs must be provided or preliminary filters made a part of the system in order to remove the bulk of suspended matter, which would speedily clog the slow sand filters and make the cost of operation of such filters unnecessarily high. The preliminary treatment factor has a great deal to do with increasing the first cost of construction of slow sand filter plants, and, furthermore, the much greater area of filtering surface required for these filters also explains why it costs so much more to build them. It must be borne in mind, however, that all figures of cost herein given are not to be considered as strictly comparable, but only as examples of what has actually been obtained in the construction in this country of filters of the slow sand and the rapid types.

Cost of Operation and Maintenance of Rapid Sand Filters.

Range of Cost.—In the cost of operation of rapid sand filter plants the size of the plant and the quality of the raw water are the main controlling features. Privately owned works are usually operated at lower cost than are those owned by municipalities. As a general proposition, however, the total cost of operation and maintenance of rapid sand filter plants, exclusive of the interest on investment and pumping charges, ranges in this country from about $3 to $5 for each million gallons of filtered water. For some plants the cost is even less than $3, and for others it is in excess of $5 for each million gallons. The following examples will show the cost of operation of several plants in this country.

The Little Falls plant is filtering about 30,000,000 gallons daily. The charge for superintendent and labor includes the salaries of the superintendent, one filter foreman, four filter attendants, an analyst, and a boy. On a basis of a yield of 30,000,000 gallons daily, the cost of operation for each million gallons of water filtered is as follows:

Cost per Million Gallons of Water Filtered at Little Falls, N.J.

Labor	$0.80
Coagulant	1.43
Heat	.35
Power	.22
	$2.80

No itemized costs of operation of the plant at Binghamton, N.Y., are available, but it is understood that the total cost is about $6 for each million gallons of water filtered.

During 1910 the Harrisburg filters were operated at an average rate of slightly over 9,000,000 gallons a day. The cost of operation for each million gallons during 1910 was $5.31 and was divided up as follows.

Cost per Million Gallons of Water Filtered at Harrisburg, Pa., in 1910.

Labor	$2.52
Coagulant	1.06
Supplies	.28
Repairs	.38
Coal	.63
Oil and waste	.07
Laboratory	.37
	$5.31

During the year 1910, which was a representative year, the average yield of the Cincinnati rapid-filter plant was 49,000,000 gallons daily. The total cost of operation and maintenance was $4.19 for each million gallons of water filtered, the charge being made up as follows:

Cost per Million Gallons of Water Filtered at Cincinnati, Ohio, in 1910.

Supervision and attendance	$1.98
Coagulant	1.93
Repairs	.28
	$4.19

Total Cost of Rapid Sand Filtration.—It has been stated above that the average cost of rapid sand filter plants is about $12,000 for each million gallons daily capacity, which cost will include the necessary filter building, the filters, and the coagulating and filtered-water basins. At 6 per cent. this cost corresponds to a fixed charge of about $2 for each million gallons. The addition to this charge of a fairly average figure for operation and maintenance makes the total cost of filtered water by the rapid sand filter system, exclusive of pumping charges, about $6 for each million gallons. On the basis of 125 gallons per capita daily consumption, the total cost of water filtration will be, according to these figures, about 27 cents per capita per annum. This estimate is approximate and is subject to considerable variation according to the conditions in various places. It is obvious that the larger the filter plant the lower will be the cost of operation per million gallons; and also that where waters require a great deal of coagulating chemical the cost of operation will necessarily be increased in proportion.

Efficiency of Filtration.—Slow sand filters will render water clear and practically free from turbidity and will remove a material percentage, probably from 20 to 30 per cent., of the dissolved color in waters stained by decaying vegetable matter. They are not able to treat successfully and economically the very muddy waters of the central western and the southern portions of this country unless such waters are first subjected to long periods of plain sedimentation or to shorter periods if coagulants are used. Rapid sand filters are capable of treating successfully practically all kinds of water, but are particularly applicable to the treatment of waters heavily charged with suspended matter or which are highly colored. The final effluent from such filters will contain practically no residual color or turbidity. Both types of filters will ordinarily remove all but about 1 or 2 per cent. of the bacteria originally present in the raw water.