# Editorial.

## LONDON'S WATER SUPPLY.

THE Thirtieth Annual Report of the Director of Water Examination, Metropolitan Water Board, gives the results of the Chemical and Bacteriological Examination of the London waters for the year 1935.

In the Introduction to his Report Lieutenant-Colonel Harold states that in 1933 the London water supply yielded 85·5 per cent of first-class supplies, a figure which was advanced to 95·7 per cent in the period under review, while out of a total of 280·7 million gallons no fewer than 131·6 million gallons were delivered at the remarkable standard of purity of 98·1 per cent. That this 10 per cent improvement was effected during years of unprecedented drought is considered to be no mean achievement.

Even the quality of the water terminally treated provided an improved figure of 3·2 per cent, the result of more efficient works control brought about by whole-hearted co-operation between the engineering and water examination departments. Further confirmation of this co-operation was found in the records of the Grand Junction slow sand beds, which have been raised above the 70 per cent efficiency line, this being the accepted standard of a good slow filtration station.

The Director considers that when it is realized that these results were obtained at the relatively small expenditure of £2,780 for equipment installed, including cost of the reconstruction of the Surbiton chlorinating house during 1934 and 1935, further point is given to the idea that chloramine is the "safety first" of water works practice.

The growth of the Metropolis and the development of its industrial towns gave cause for increased anxieties and necessitated stricter control of the Kent and other wells. The rapid and intense industrialization brought in its wake threats to the supplies through the influence of oil wastes. The records showed that such pollution is very difficult to control and the best course to pursue is elimination at the source.

Colonel Harold writes that "among the outstanding incidents of the year may be reckoned 'an attack of the vapours' by Queen Mary reservoir, the key reservoir of the supply, with a capacity of 6,700,000,000 gallons. The cause was climatic in origin resulting in a, sudden de-oxygenation which, fortunately, did not extend beyond the lower strata, but rendered the water unusable by reason of smell and taste." Hurried laboratory tests showed that the taste was unaffected by permanganate, but amenable to treatment by activated carbon; stocks of this were quickly made available. What might have proved a grave situation terminated happily within a few days, when the reservoir was again brought into use, following on the use of activated carbon, backed by the ingenuity of the local engineering staff.

The conditions which led up to this were as follows: There had been for some weeks a spell of warm calm weather. The plankton of the reservoir had been characterized by a considerable production of green algæ, copepods and rotifera, the last named being exceptionally numerous. From the third week of July there was a gradual falling off of plants and samples taken in August showed a complete absence of algæ; copepods and rotifers were present in enormous numbers. The peculiar weather conditions and the abundant consumers of oxygen led to the bottom layer of water being completely devoid of oxygen. This de-oxygenated condition favoured anaerobic fermentation, giving rise to marked smell and taste and was also associated with the development of a fungus, *Cladothrix dichotoma*.

The first action was to take the reservoir out of supply and draw on the Staines reservoirs. The bottom water of Queen Mary reservoir had deteriorated to a marked degree and it was feared that this might be progressive if the reservoir was allowed to stand without the circulation which has been found to be essential.

The dry feed alum plant at Kempton Park Works was used as a means of dosing with activated carbon. As soon as examination proved that the bottom layers were once more oxygenated the Queen Mary reservoir was brought back into full use.

In August there were complaints of taste and smell in the Island Barn reservoir and tests at once showed that the bottom layer was completely de-oxygenated. There was a difference of 5° C. between the temperature of the surface and bottom layers. In this case the waters were highly algal. The chief causative factors must have been climatic.

Since a difference of temperature between the surface and bottom layers will provide valuable evidence that a condition of stratification is, or is about to be, established a self-recording thermometer was installed near the outlet in Queen Mary reservoir. In the construction of new reservoirs it is intended to fit such thermometers as a standard practice. They are arranged to record temperatures from three depths.

In the Bacteriological Section of the Report it is stated that the Board have their own standard of waters on a coli basis laid down in the Thirty-Second Report of the Medical Officer of the Local Government Board in 1902-03 and accepted for the London supply by the Metropolitan Water Board and Local Government Board in 1907. With regard to the supply in service one standard of water only is approved and that is *Bacillus coli* must be absent in 100 millilitres. That is water so pure that it gives no evidence of pollution even with so small an amount as 0·00001 per cent of sewage. The Board are of opinion that the public has a right to expect and demand a water of the highest purity.

In a survey of the "Thames as a source of potable water" in last year's report it was stated that the streptococcal findings supported the coli results. The streptococcus confirmatory test has proved its value in establishing the grade of purity of swallow holes, springs and wells. From polluted wells, rivers and effluents fæcal streptococci could be isolated by direct inoculation on Conradi-Drigalski plates. In the case of rivers and good wells MacConkey's medium was more successful.

The *Clostridium welchii* test did not follow the coli index as closely as the fæcal streptococcus. The best results were obtained by heating the samples to 80° C. and incubation at 37° C. in litmus milk; under these conditions a better correlation with the coli and streptococcus results was obtained.

A source of anxiety was a minute green copper-resistant flagellate alga, a species of *Chlamydomonas*, which appeared in May. Like the motile Oscillatoria this organism has the power of penetrating sand filters, even when they are yielding a first-class filtrate. Treatment with cupri-chloramine proved effective, providing complete protection to Hornsey, although the New River was olive-green in colour. Though it was effective against the vegetative forms, the *zygotes* with the contained spores were resistant to all treatment; they passed into the Stoke Newington reservoir, where subsequent treatment failed to eliminate them. Colonel Harold writes that "Professor Fritsch the eminent algologist, associated these outbursts with earthen banks, and it is certainly significant that the three outbreaks recorded during the past twenty years have all occurred in the New River which has a puddled bed. There would also appear every necessity for strictly limiting the work on this conduit during the summer to the necessary repairs and weed cutting. The use of the river for the transportation of even the cuttings of the grass verges should be strongly opposed."

In the Biological Section it is pointed out that the plankton of a river differs very markedly from that of a lake. In the Board's undertakings river water is impounded in reservoirs; the result is a complete change in the plankton. Thames water taken from the Laleham intake may contain a sparse collection of diatoms and only a few crustacea, while the waters in Queen Mary reservoir are coloured green with Eudorina and contain thousands of rotifers and crustacea per litre. Viewed from the point of view of algal control, it would be considered better to use the raw Thames water, but reservoirs are necessary to provide reserves for periods of drought and storage decreases the number of bacteria and improves the chemical constitution. Some species of alga give more trouble than others; Tabellaria and Asterionella may cause tastes; the small Cyclotella passes through primary and tends to clog the secondary beds. Oscillatoria also passes through filters. This species gives rise to trouble as it cannot be sedimented by alum and tends to accumulate on the surface in masses.

There may be great differences in the flora of reservoirs obtaining their water from the same source. In order to avoid algal growth it is important to have good circulation through the reservoir. In any new reservoir the position of the inlet and outlet will have to be carefully planned so as to keep a large body of the water on the move.

Observations extending over many years have shown that there are commonly two periods of great plankton production; the one in the spring, the other in the autumn. The spring maximum is due almost entirely to several species of diatoms of which Cyclotella, Stephanodiscus, Asterionella, Melosira, and Synedra are mentioned. The autumnal maximum may be due to diatoms, but blue-green algæ such as oscillatoria, as well as such green algæ as Eudorina and yellow-green Trebonema may often surpass the diatoms in abundance.

Supplies of vital inorganic salts may be markedly reduced following such algal outbursts. It is suggested that the concentration of nitrates, phosphates, and silicates may fall so low as to be a limiting factor.

Variations in the silica content of the Board's water may cause trouble to consumers employing softening processes. The bulk of these employ the "base exchange" method in which sodium alumino-silicate is one of the constituents. When there is a deficiency of silica in the water disintegration and loss of the softening agent occur and replacement of this material may entail an expenditure of several thousands of pounds annually. A few measurements made last year suggest that the periods when trouble is experienced with softening correspond with those when there is great production of diatoms which, being enclosed in a frustule of silica, make heavy demands on the existing supply.

The Board's records show that the amounts of available nitrogen have a regular seasonal fluctuation. The values are highest in the winter and early spring. It has been found that the concentration of oxidized nitrogen in Queen Mary reservoir, where plankton is high, is regularly lower than in the Thames, where plankton is not so rich, and the suggestion is made that the lower value in the reservoir is due in part at least to the greater demands made upon the nitrogen by the plants. When a regular dose of copper sulphate was used at the intake of Queen Mary reservoir there was a decrease in algæ and an increase in the concentration of oxidized nitrogen.

In the Walton reservoir the concentration of oxidized nitrogen is high, and judged by resistance to filtration and the general works experience it is free from excessive algal growths.

In the control of algal growths chloramine and cuprichloramine have been found to be very efficacious. In the older copper sulphate method of treatment data as to the necessary lethal concentrations for individual species are available. In order to obtain similar data for cuprichloramine experiments were commenced in 1934 and have been continued in 1935. As it is difficult to determine by macroscopic and microscopic examination when death of the species has occurred, endeavours are being made to cultivate planktonic algæ under laboratory conditions, using methods similar to those employed in bacteriological cultural technique. It is thought that the cultivation of algæ *in vitro* will also enable observations to be made on the inorganic foodstuffs used by the algæ and the influence of light on their growth.