

Sewage Discharge and the Mersey Estuary*

Co-operation in Technical Research

THIS handsome and well-illustrated report on the Mersey estuary, which has been issued by the Department of Scientific and Industrial Research, is an example of the working of the best English tradition of co-operation in public affairs. It exhibits the Department in a part for which it is so well equipped—which it might be more often called upon to play—that of an arbiter to determine the scientific facts for the solution of a controversial problem of great public and economic importance. It shows the various public authorities of Merseyside agreeing, in spite of a conflict of interests, to co-operate in order to obtain an independent scientific inquiry; it also shows them evincing their confidence in the Department of Scientific and Industrial Research by inviting it to undertake the investigation. The Department asked the Water Pollution Research Board to be responsible for the scheme of the investigation; so, in a typically national way, another party to the co-operative work was a body of scientific men who gave honorary service.

The problem was the effect upon the estuary of the Mersey of the discharge into it of crude sewage from the large populations of Liverpool, Birkenhead and Wallasey, among others. The volume of the estuary is very great, and matters of health and amenity were not part of the inquiry. The problem was the narrower one of the effect of this discharge of sewage on the estuary as a channel of navigation. The opinion had been put forward that the presence of sewage increased the rate of sedimentation of solid matter in the water of the estuary, and by alteration of the character of the deposit increased also the difficulty of its removal by dredging. Such a possibility led naturally to some competition of interests between the corporations responsible for the sewage discharge on one hand and the authority responsible for the navigation and conservancy of the river on the other. The data for determining whether these possibilities were actualities were not available. Accordingly representatives of the various interests, after meeting in conference in 1932, decided, with admirable judgment, to ask the Department, as has already been stated, to investigate the matter and to give an authoritative pronouncement on the scientific facts. The local

authorities and other authorities and companies concerned agreed to bear the costs of the inquiry, and agreed also that "on the issue of scientific fact the result of the investigation should be accepted as conclusive". The understanding came to was thus one which reflected great credit on all concerned, and was a signal mark of confidence in a Government Department. The agreed procedure, in the words of the preface, "might well be followed by others in dealing with controversial problems affecting many interests".

The investigation, which was begun in 1933 and lasted over a period of four years, consisted of a wide-reaching, hydrographical, chemical, and biological investigation of the effects of the discharge of crude sewage. The area to be studied embraced the navigable channels of Liverpool Bay, the tidal pool of the Upper Estuary—with a volume at high water of a spring tide of about 1,000 million cubic yards—and the Narrows which connect the two.

The Mersey Docks and Harbour Board has, since 1861, made quinquennial surveys of the capacity of the Upper Estuary, and its data show that during the period 1906–31 there was a decrease of about 52 million cubic yards. This reduction in capacity naturally led to the suggestion, already referred to, that the presence of sewage had been responsible, by bringing about a deposit of mud of such a consistency that it was not eroded by the tidal stream. In order to investigate this possibility, the records of hydrographical surveys of the Mersey made by the Mersey Docks and Harbour Board were examined, with other hydrographical data, to determine the positions and levels in the Estuary at which accretion and erosion had occurred during this period. The quantities and nature of the sewage and principal trade wastes discharged into the estuary were ascertained, the concentration of polluting substances in the estuary water under different tidal conditions was determined, and an estimate was made of the length of time spent by polluting substances in the estuary before passing out to sea. The concentration of mud and silt eroded by the tide from the bed and foreshore of the estuary and carried in suspension in the moving water was also determined.

Numerous laboratory experiments were then made to observe the effect of sewage on the rate of sedimentation of mud and silt under conditions similar to those which occur in the estuary. The factors studied included the concentration and

* Estuary of the River Mersey. The Effect of the Discharge of Crude Sewage into the Estuary of the River Mersey on the Amount and Hardness of the Deposit in the Estuary. (Department of Scientific and Industrial Research. Water Pollution Research: Technical Paper No. 7.) Pp. xvii+337+8 plates. (London: H.M. Stationery Office, 1938.) 30s. net.

state of division of the solids, the depth of water through which sedimentation occurred, the temperature and salinity of the water, and the effect of the addition of different proportions of sewage and of suspensions of bacteria derived from sewage. In some series of experiments before the rate of sedimentation of the solids was measured, samples of saline water containing mud and sewage in suspension, were stirred at different speeds, thus reproducing the conditions in the estuary, where water containing silt, mud and sewage-solids in suspension is carried to and fro by the tide.

Numerous samples of mud and other solid matter for examination were collected from different parts of the Upper Estuary of the Mersey and from Liverpool Bay. For comparison, samples were also collected from relatively unpolluted estuaries and marshes in Norfolk, Suffolk, Essex, Devon, Monmouth, Cheshire and Lancashire, from the Firth of Tay in Scotland, Lough Foyle in the north of Ireland, from estuaries in Eire, and from the bed of the Irish Sea. The concentration of organic matter and the principal inorganic constituents were determined by analysis, and the relative resistance of the different muds to erosion by a moving stream of water was observed.

One of the most interesting results of the investigation was the conclusion that the most likely source of new mud entering the Mersey Estuary is the bed of Liverpool Bay and of the Irish Sea. As to the quantity of suspended inorganic matter contributed by the sewage, one can calculate from the volume of daily discharge (30-40 million gallons or 180,000-240,000 cubic yards) that the quantity of *inorganic* matter discharged in a year is less than 25,000 cubic yards, that is, less than 0.0025 per cent of the capacity of the Upper Estuary. It is also to be noted that the concentration of sewage in the estuary water is not high; in the greater part it does not exceed 1 per cent by volume, and in no considerable volume of water does it exceed 5 per cent.

Another striking result obtained was that the concentration of organic matter in mud from the Mersey, usually less than 3 per cent, was *no higher* than that of samples of mud from the bed of the Irish Sea, from Liverpool Bay, and from *relatively unpolluted* estuaries, a number of which were examined. The composition of the mud, therefore, provides no evidence that sewage is responsible for its deposition.

The question of the precipitation or deposition of mud in the estuary was naturally of great interest, and one to which much attention was paid in the investigation. It was of course possible, as had been suggested, that there was some physical action between the suspended sewage and the suspended mud, leading to a co-precipitation

of material. Elaborate experiments, first with salt water and later with the addition of sewage, were therefore undertaken on the rate of sedimentation of mud from the Stanlow Bank (which includes most of the mud in the Upper Estuary), of mud from Liverpool Bay, and also of muds from various relatively unpolluted estuaries. The result observed was that the rates of sedimentation in saline water of muds from the Stanlow Bank and from the bed of Liverpool Bay were similar, and they were on the whole rather lower than those of muds from a number of unpolluted estuaries. There was thus no evidence that in water without sewage the Mersey muds precipitated more rapidly.

The observations on the effect of sewage on the rate of sedimentation were of especial interest; they indicate the importance of carrying out such studies under a wide range of conditions if erroneous conclusions are to be avoided. With small depths of fall, the addition of 5 per cent of crude sewage gave a slight but definite increase in the rate of sedimentation. When, however, the sedimentation was followed in columns of 40 ft., the sewage had no effect, although it is to be noted the concentration employed was far higher than that occurring in the estuary. The explanation appears to lie in the state of aggregation of the mud. In settling through such considerable depths as 40 ft., the mud aggregates into large clots with so high a consequent rate of settling that the effect of the sewage becomes negligible. That these conditions apply in the Mersey was shown by the observation that mud carried during the run of the tide in the estuary is generally in the form of large aggregates; similar aggregates were found for the mud carried in suspension by the water of the comparatively unpolluted estuaries of the Rivers Suir and Barrow.

The question of the ease of erosion of Mersey muds was carefully investigated and from several aspects, though, as has already been stated, the most likely source of any large quantity of new mud which may enter the Upper Estuary is the bed of Liverpool Bay and the Irish Sea. There appeared to be little erosion of mud from the surface of the banks in the Upper Estuary, since these are mostly more than 20 ft. above Liverpool Bay Datum level and so are covered only near high water when the stream velocity is low. Considerable erosion often takes place, however, from vertical faces of a mud bank exposed to the full force of the tidal stream. By the use of a suitable laboratory method the 'erodibility' of mud from different sources was compared, with the result that with Mersey mud the resistance to erosion is *slightly less* than that of mud from estuaries in Suffolk and Essex which are comparatively unpolluted.

The data of dredging operations point in the same direction as studies of mud erosion. Dredging of the sea channels in Liverpool Bay has been carried on since 1880 and records of the operations are available. Those of two dredgers for the period 1909–35 were examined in detail, but the returns gave no evidence of any increase in the difficulty of dredging during those years.

With regard to the changes in capacity of the Upper Estuary, the report accepts the values put forward by the Mersey Docks and Harbour Board. The surveys by the Board show that between 1871 and 1886 the capacity rose by 48 million cubic yards, that is, by 5 per cent. Between 1886 and 1891 it declined by 5.5 per cent of the former value, but rose again in 1906; between that year and 1926 there was a loss of 5.2 per cent. The survey of 1936 shows an increase of capacity over 1931, the decrease on the 1906 value being only 4 per cent. The capacity was approximately the same in 1936 as in 1871, 1891 and 1916, so that the changes do not indicate any regular decrease in capacity with time, such as would be expected from a gradually increasing discharge of sewage.

Finally, results most illuminating for the points at issue were obtained by a consideration of the losses of capacity at different *horizontal* levels, and also of the distribution of mud and of sand. Half the loss of capacity was due to deposits below the level of Liverpool Bay Datum (L.B.D.), and only about 10 per cent to deposits above a level of 20 ft. above L.B.D. Mud, however, is found almost

entirely on banks of a height greater than 20 ft. above L.B.D.; banks of lower height are comprised almost entirely of sand. It is thus plain that reduction of capacity does not coincide with the present distribution of *mud* banks.

From the report, it is thus evident that the answer to the question proposed needs no balancing of conflicting evidence. Converging lines of testimony have been drawn from (a) the amount of inorganic matter brought into the estuary from sewage, (b) the concentration of organic matter in the mud, (c) the effect of sewage upon the composition and rate of sedimentation of mud in the condition of suspension in which it is found in the water of the estuary, (d) the resistance to erosion of mud from the Mersey in comparison with that of muds from relatively unpolluted estuaries, (e) a comparison of the reduction of capacity in different parts of the estuary with the distribution of mud and sand. All these give an unequivocal negative to the question as to whether the discharge of crude sewage has had any effect on the amount and hardness of the deposit in the estuary.

This study of the Mersey estuary should long stand as a classic one in the field of applied science, not only for the width and scope of the investigation but also for the decisiveness of its results and the civic importance of its findings. Its origin makes it a shining example to other public authorities who may similarly find themselves faced with controversial problems which can be solved by scientific analysis.

The Hebrew Technical Institute, Haifa*

THE Hebrew Technical Institute in Haifa is the centre of technical training and research for the young Jewish community in Palestine. Hebrew is the language of instruction, but the college is open to all, making no distinction of race or creed; and a few Palestine Arabs have availed themselves of this opportunity. The curriculum is extensive, and includes courses leading to university degrees in the technical college proper (500 students), a trade school for training skilled artisans and foremen (250 pupils), special vocational training classes for refugees, courses for agricultural workers, and evening classes. At present there are about a thousand students altogether; examinations are held under the supervision, and with the help of, the Palestine Government. The Institute was

founded about thirty years ago; but, owing to the Great War, did not begin its academic work until 1924. Its progress offers an opportunity for the study of the effect of colonization on the development of an educational institution.

Colonization in Palestine does not mean the establishment of foreign trading stations on the coast-line, but the building up of a new national life in all its branches and with all its implications, in a limited area, and under the pressure of thousands of families from the countries of middle and eastern Europe forced to immigrate for economic, social or political reasons. The Jews left Palestine about two thousand years ago and can only return in larger numbers if, both in agriculture and in industry, they make the utmost use of the advances of pure and applied science. Owing to social prejudices and to legal restrictions imposed upon them by the people among whom they lived, the Jews were, for many centuries,

* A booklet "The Hebrew Technical Institute, Haifa; Its Achievements and its Aims (Haifa, 1938)" has just been published and will be sent, free of charge, on application to the Secretary of the Institute, P.O.B. 910, Haifa (Palestine), or to the Hon. Sec. of the Auxiliary Group of the H.T.I., (Mrs.) B. Buckman, 21 Willow Road, London, N.W.3.