

## EXTRACTS AND REVIEWS.

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### ESTUARY OF THE RIVER MERSEY

#### EFFECT OF THE DISCHARGE OF SEWAGE ON THE CONSERVANCY OF THE RIVER.

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In a report issued on 25th April 1938 as Water Pollution Research Technical Paper No 7, by the Department of Scientific and Industrial Research, a detailed description is given of the results of a chemical, hydrographical and biological investigation of the effects of the discharge of crude sewage on the amount and nature of the deposits in the Estuary of the River Mersey.

For many years the possible effects on the conservancy of the Estuary of the direct discharge of sewage from a population of nearly one and a half million people has given rise to much controversy among the local interests concerned. To facilitate the passage of ocean-going ships the sea channels in Liverpool Bay have been deepened considerably by dredging, which has been carried out continuously since 1890. It had been suggested that the nature of the material deposited in these channels was so altered by the presence of sewage in the water as to increase the difficulty of dredging. Above the Narrows, on which are situated the extensive systems of docks of Liverpool and Birkenhead, is a tidal pool. The upper part of this tidal pool is navigable only at high water, and contains large areas of banks of mud and sand. The maintenance of the tidal capacity of this pool is considered to be of great importance since the water which flows into it on the flood tide and out on the ebb passes through the sea channels in Liverpool Bay and helps to maintain their depth by its scouring action. The capacity of the Upper Estuary is such that at high water of a spring tide the volume of water is about 1000 million cubic yards. During the period 1906 to 1931 the capacity decreased by approximately 52 million cubic yards and it was suggested that this was due to the presence of sewage, which had caused the deposition of mud of so glutinous a nature that it was not again eroded by the tidal streams.

In 1932 the local sanitary authorities and the authorities and companies interested in the navigation of the Estuary invited the Department of Scientific and Industrial Research to undertake an investigation into the effect of the sewage on the amount and hardness of the deposit in the Estuary and agreed to pay the whole cost of the work. In reaching this decision to co-operate in obtaining an authoritative pronouncement on the scientific facts the Merseyside Authorities and Companies set an excellent lead which might well be followed by others in dealing with controversial problems affecting many interests. The Merseyside Authorities and Companies initiated what is likely to be considered a classical investigation.

In 1933 a laboratory was set up in Liverpool and two boats, specially designed and equipped, were built for the purposes of the investigation. The investigation occupied 4 years and was made at a cost of about £ 26,000.

Records of hydrographical surveys of the Mersey made by the Mersey Docks and Harbour Board at regular intervals since 1861 were examined, with other hydrographical data, to determine the positions and levels in the Estuary at which accretion and erosion has 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 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 concentration and state of division or coagulation of the solids, depth of column of water through which sedimentation occurred, temperature, salinity of the water and addition of different proportions of sewage and of suspensions of cultures of bacteria derived from sewage. In some series of experiments samples of saline water containing mud and sewage in suspension were stirred at different speeds before the rate of sedimentation of the solids was measured, in order to reproduce the conditions which occur 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 in England, 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.

As a result of the investigation it was concluded that the most likely source of any new mud which might enter the Mersey Estuary is the bed of Liverpool Bay and the Irish Sea.

Approximately 30 to 40 million gallons (180,000 to 240,000 cubic yards) of sewage are daily discharged directly into the Estuary. The concentration of sewage in the greater part of the Estuary water does not exceed 1 per cent. by volume and in no considerable volume of water does it exceed 5 per cent. The quantity of inorganic suspended matter discharged in the sewage in a year is less than 25,000 cubic yards, or 0.0025 per cent. of the capacity of the Upper Estuary.

The concentration of organic matter in mud from the Mersey was found to be approximately the same as that in similar samples of mud from the bed of the Irish Sea, from Liverpool Bay and from the relatively unpolluted estuaries examined. Sewage, in the concentration in which it is present in the Mersey has no appreciable effect on the composition of the intertidal deposits. Mud carried in suspension in the Estuary water is in the form of comparatively large flocs and in this condition its rate of sedimentation is not affected by sewage in the concentrations present. The resistance of Mersey mud to erosion by water is about the same as that of mud of similar composition from relatively unpolluted localities and experiments showed that the resistance to erosion is not appreciably affected by sedimentation from water containing sewage in the concentration present in the Estuary of the Mersey. The extensive intertidal deposits of mud in the Upper Estuary of the Mersey are not stable but are rapidly eroded when exposed to the full strength of the tide; their relative stability during recent years has been due to the fact that they have been separated from the main channel by banks of sand so that they have not usually been exposed to rapidly moving water.

During the investigation about half a square mile of mud bank was washed away owing to a change in the position of the main channel; the volume of mud eroded was 6 to 7 million cubic yards.

Detailed examination and analysis of the records of the Mersey Docks and Harbour Board showed that there is no evidence of an increase during recent years in the difficulty of dredging in Liverpool Bay. The capacity of the Upper Estuary in 1936 was about 64 million cubic yards greater than in 1931; the capacity in 1936 was about the same as in 1871 although considerable fluctuations in capacity had occurred during this period. A reduction in capacity during the period 1906 (when the capacity was unusually high) to 1931 was due mainly to the deposition of sand in the deeper parts of the Estuary and not to the deposition of mud.

In direct answer to the terms of reference the Report states "the crude sewage discharged into the Estuary of the River Mersey has no appreciable effect on the amount and hardness of the deposits in the Estuary".

Although the discharge of sewage into tidal waters has been discussed from many stand-points in different parts of the world during recent years comparatively little information on the effect of sewage on intertidal deposits has hitherto been available. The present investigation was not concerned directly with such problems as the effect of sewage on the sanitary condition of the river and foreshores nor on fisheries but was directed solely to the study of the effect of sewage on the conservancy of the Estuary. Local authorities who discharge sewage into tidal waters and authorities responsible for the conservancy of rivers will find the results obtained and the methods used of great value in studying similar problems on other rivers. Much of the work described in the Report, particularly that dealing with the conditions affecting the rate of sedimentation of suspended solids, is also of much wider interest since sedimentation is an essential process in many methods of treatment of sewage and trade effluents, and of water for domestic supply.

The report is published by M. H. Stationery Office, London, price 30/-.

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