

1949
NEW ZEALAND

AUCKLAND DRAINAGE COMMISSION

(REPORT OF THE)

Laid on the Table of the House of Representatives by Command of His Excellency

*Commission to Inquire Into and Report Upon the Treatment and Disposal
of Sewage in the Auckland Metropolitan Drainage District*

B. C. FREYBERG, Governor-General

To ALL to whom these presents shall come and to :

Ronald Henry Quilliam, of the City of New Plymouth, New
Zealand, Barrister,

Thomas Bruce Nicol, of the City of Sydney, New South Wales,
Engineer, and

John Howard Barnett, of the City of Wellington, New Zealand,
Public Accountant,

GREETING :

WHEREAS questions have arisen as to methods of treatment and disposal of sewage arising in the Auckland Metropolitan Drainage District and the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna, and it is desirable that inquiry should be made into various methods of such treatment and disposal and into the question whether any, and, if so what, legislation is necessary or expedient in order to direct or authorize the employment of the most suitable methods :

Now therefore, I, Lieutenant-General Sir Bernard Cyril Freyberg, the Governor-General of the Dominion of New Zealand, in exercise of the powers conferred on me by the Commissions of Inquiry Act, 1908, and all other powers and authorities enabling me in this behalf, and acting by and with the advice and consent of the Executive Council, do hereby nominate, constitute, and appoint you the said

Ronald Henry Quilliam,
Thomas Bruce Nicol, and
John Howard Barnett

to be a Commission to inquire into and report upon the following matters:—

(1) What sewerage, sewage treatment, and sludge-disposal scheme is most suitable to be adopted for the Auckland Metropolitan Drainage District.

(2) Whether the utilization in the Auckland Metropolitan Drainage District of sewage by a composting or any other process is desirable in the public interest.

(3) What, if any, amendment of the Auckland Metropolitan Drainage Act, 1944, or of any other legislation, is necessary or expedient in order to direct or authorize the employment of the scheme recommended by you for adoption by the Auckland Metropolitan Drainage Board.

(4) Whether the methods of treatment and disposal of sewage at present employed for the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna are the most suitable, and if not, what alternative methods should be adopted.

(5) What, if any, legislation is necessary or expedient in order to direct or authorize the employment of any alternative method of treatment and disposal of sewage recommended by you to be employed for the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna.

(6) And, generally, upon any other matters arising out of the premises which may come to your notice in the course of your inquiries and which you may consider should be investigated in connection therewith, and upon any matters affecting the premises which you consider should be brought to the attention of the Government.

And in exercise of such powers and authorities as aforesaid, and with the like advice and consent, I do hereby appoint you, the said

Ronald Henry Quilliam

to be Chairman of the said Commission.

And for the better enabling you to carry these presents into effect you are hereby authorized and empowered to make and conduct any inquiry under these presents at such time and place as you deem expedient with power to adjourn from time to time and place to place as you think

fit, and so that these presents shall continue in force and the inquiry may at any time and place be resumed although not regularly adjourned from time to time or from place to place :

And you are hereby strictly charged and directed that you shall not at any time publish or otherwise disclose save to me in pursuance of these presents, or by my direction, the contents of any report so made or to be made by you or any evidence or information obtained by you in the exercise of the powers hereby conferred upon you except such evidence or information as is received in the course of a sitting open to the public :

And it is hereby declared that the powers hereby conferred shall be exercisable notwithstanding the absence at any time of any one of the members hereby appointed so long as the Chairman or a member deputed by the Chairman to act in his stead and one other member be present and concur in the exercise of such powers :

And it is hereby further declared that you have liberty to report your proceedings and findings under this Commission from time to time as you judge it expedient so to do :

And, using all due diligence, you are required to report to me in writing under your hands not later than the seventh day of April, one thousand nine hundred and forty-nine, your findings and opinions on the matters aforesaid, together with such recommendations as you think fit to make in respect thereof :

And, lastly, it is hereby further declared that these presents are issued under and subject to the provisions of the Commissions of Inquiry Act, 1908.

Given in Executive Council under the hand of His Excellency the Governor-General of the Dominion of New Zealand and issued under the Seal of that Dominion this 3rd day of March, 1949.

[L.S.]

M. B. HOWARD, Minister of Health.

Approved in Council—

T. J. SHERRARD,
Clerk of the Executive Council.

To His Excellency the Governor-General of the Dominion of New Zealand.

MAY IT PLEASE YOUR EXCELLENCY,—

1. We, the Commissioners appointed by Your Excellency to inquire into and report upon the treatment and disposal of sewage in the Auckland Metropolitan Drainage District, have the honour to submit our report.

2. The Commission entrusted to us directed that we should inquire into and report upon the following matters:—

- (1) What sewerage, sewage treatment, and sludge-disposal scheme is most suitable to be adopted for the Auckland Metropolitan Drainage Board.
- (2) Whether the utilization in the Auckland Metropolitan Drainage District of sewage by a composting or any other process is desirable in the public interest.
- (3) What, if any, amendment of the Auckland Metropolitan Drainage Act, 1944, or of any other legislation, is necessary or expedient in order to direct or authorize the employment of the scheme recommended by you for adoption by the Auckland Metropolitan Drainage Board.
- (4) Whether the methods of treatment and disposal of sewage at present employed for the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna are the most suitable, and if not, what alternative methods should be adopted.
- (5) What, if any, legislation is necessary or expedient in order to direct or authorize the employment of any alternative method of treatment and disposal of sewage recommended by you to be employed for the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna.
- (6) And, generally, upon any other matters arising out of the premises which may come to your notice in the course of your inquiries and which you may consider should be investigated in connection therewith, and upon any matters affecting the premises which you consider should be brought to the attention of the Government.

3. We were required by the Commission to report our findings and opinions on the aforesaid matters, together with such recommendations as we should think fit to make in respect thereof, not later than the 7th April, 1949, but by Warrants issued under the hand of Your Excellency and the Seal of the Dominion on the 7th April, 1949, the 6th May, 1949, and the 22nd June, 1949, the time was extended to the 30th June, 1949.

4. We held our first public sittings on the 7th March, 1949, and excepting for brief adjournments made from time to time at the request of persons or public bodies concerned in the matters under inquiry public sittings were held continuously until the 7th April, 1949. All such public sittings were held at Auckland.

5. Shortly after we commenced our inquiry Mr. V. R. Meredith, Crown Solicitor at Auckland, was appointed by the Government to assist the Commission generally, and we had the benefit of his assistance until the conclusion of the public sittings. We also had the assistance throughout the inquiry of counsel representing the interests principally concerned—namely, the Auckland Metropolitan Drainage Board (Mr. A. K. North, K.C., and Mr. H. J. Butler), the Auckland and Suburban Drainage League (Mr. E. J. V. Dyson, Mr. T. C. Webster, and Mr. G. T. Donne), and the Auckland Harbour Board (Mr. H. E. Barrowclough and Mr. J. D. Lethbridge)—and also of counsel representing local authorities and other public bodies, companies, and persons who were concerned with various aspects of the inquiry. In addition, representatives of several local authorities, the Federated Farmers (Auckland Branch), and other interests took part in the proceedings. We are indebted to counsel and the other representatives for their assistance.

6. During the course of our inquiry, 58 witnesses appeared and personally gave evidence before us. Counsel representing the various interests and also any persons who were present and had an interest in the inquiry were given the opportunity of putting questions to these witnesses. The oral evidence as recorded comprises 1,179 typed foolscap pages. In addition, written statements were received from various persons

which those interested had the opportunity of perusing and commenting upon and which have been considered by us. Further, there were produced to us in support of the evidence of the witnesses or of the representations and submissions made by counsel and interested bodies and persons 201 exhibits including text-books and scientific journals and articles having relation to the matters under inquiry. We desire to acknowledge the assistance given by the witnesses.

7. We must make special reference to the assistance we received from our Secretary, Mr. E. W. A. Drake, who discharged his onerous duties with outstanding ability and efficiency. We are greatly indebted to him.

8. We are grateful for the co-operation exhibited and the valuable assistance given by officers of the Health Department and other Departments throughout the inquiry.

9. We have found it convenient to divide our report into Parts, as follows:—

Part I—Introduction. (Paragraphs 10-27.)

Part II—Factors Affecting the Consideration of Sewerage and Sewage Treatment and Disposal Schemes for Auckland. (Paragraphs 28-36)—

Definition of the Drainage District. (Paragraph 29.)

Population. (Paragraph 30.)

Determination of Quantities of Sewage to be Dealt With. (Paragraph 31.)

Methods of Disposal of Sewage. (Paragraph 32.)

Disposal of Sewage by Discharge Into Water. (Paragraph 33.)

Sewage Treatment Methods. (Paragraph 34.)

Pollution of Harbour Waters. (Paragraph 35.)

Disposal of Trade Wastes. (Paragraph 36.)

Part III—Utilization of Sewage. (Paragraphs 37-47)—

General. (Paragraph 37.)

Utilization of Sludge. (Paragraph 38.)

Disposal of Digested Sludge. (Paragraph 39.)

Drainage League Proposals. (Paragraph 40.)

Value of Organic Manure. (Paragraph 41.)

Interim Report of Inter-departmental Committee on Utilization of Organic Wastes. (Paragraph 42.)

The Value of Compost. (Paragraph 43.)

Cultivation of Water Plants. (Paragraph 44.)

Composting of Municipal Garbage and Wastes. (Paragraph 45.)

Oxidation Lakes. (Paragraph 46.)

Conclusion. (Paragraph 47.)

Part IV—Sewerage and Sewage Treatment and Disposal Schemes for Auckland. (Paragraphs 48-52) —

Drainage of Central and Southern Sewerage Districts. (Paragraph 50.)

Drainage of Western and Eastern Sewerage Districts. (Paragraph 51.)

Conclusions. (Paragraph 52.)

Part V—Drainage of the North Shore. (Paragraphs 53-66) —

Drainage Act Does Not Apply. (Paragraph 53.)

Description of North Shore Sewerage Systems. (Paragraph 54.)

Existing Sewerage Systems Are Unsatisfactory. (Paragraph 55.)

Action Taken by Boroughs. (Paragraph 56.)

Scope of the Reference. (Paragraph 57.)

General Review. (Paragraph 58.)

Portions of the Waitemata County Are Affected. (Paragraph 59.)

Population of the North Shore. (Paragraph 60.)

Control of the North Shore Area. (Paragraph 61.)

Advantages of Regional Control. (Paragraph 62.)

Form of Drainage Authority. (Paragraph 63.)

Financial Position Under Unified Control. (Paragraphs 64, 65.)

Conclusions and Recommendations. (Paragraph 66.)

Part VI—Summary of Recommendations. (Paragraphs 67–71.)

Constitution and Boundaries of the Metropolitan District. (Paragraph 67.)

Sewerage and Sewage Treatment and Disposal Schemes. (Paragraph 68.)

Utilization of Sewage and Other Wastes. (Paragraph 69.)

Drainage of the North Shore. (Paragraph 70.)

Disposal of Trade Wastes. (Paragraph 71.)

PART I—INTRODUCTION

10. The planning of an adequate drainage system for the City of Auckland and the adjacent districts presents certain special problems due to a large extent to topographical features and also to certain other factors such as the very large population increase that has taken place in the area and its distribution. There are two large catchment areas having a natural drainage to the Waitemata and Manukau Harbours respectively, and there are also certain smaller areas the drainage of which is to the waters of the Hauraki Gulf situated outside the limits of the former harbour. The two harbours differ materially in certain important respects. The Waitemata Harbour is a deep-water harbour which accommodates ships of all sizes and deals with a very large volume of shipping, both overseas and coastal. It is also used as a terminus for an extensive overseas seaplane traffic. Its waters, and those of the Hauraki Gulf, are used extensively for yachting and boating and there are many popular bathing beaches and seaside holiday resorts in the harbour and gulf. The Manukau Harbour, on the other hand, has shallow waters with large areas of mud-banks at low tide, making it suitable for smaller ships only. Its waters and shores are much less used for recreational purposes than those of the Waitemata Harbour. Further, the factories and works of various industrial concerns such as fertilizer, meat, and tannery undertakings are situated on or near the shores of the harbour.

It is reasonable to expect that the future development of the district and growth of its population will be considerable and that by the year 2000 the population will amount to 600,000 people. It is, however, difficult, if not impossible, to determine with any confidence in what parts of the district the development will take place or how the population will be ultimately distributed.

11. Although the necessity for comprehensive drainage planning was recognized as long ago as the year 1878, it was not until the early years of this century that any positive action was taken. Action was then taken at the instance of the Auckland Harbour Board, which had become concerned about the practice of discharging crude sewage into the Waitemata Harbour. It is interesting to observe that although at first the problem was regarded as one affecting only the City of Auckland, before very long it came to be appreciated that the rapid increase in population of the metropolitan area necessitated the consideration of a scheme for a wider district. Accordingly, in the year 1908 the Auckland City Council arranged for a well-known London drainage expert, Mr. G. Midgley Taylor, to visit Auckland and make an investigation, and proposals made by him for a comprehensive drainage scheme for the metropolitan area were adopted. Briefly, the scheme provided for a system of intercepting sewers and an outfall at Orakei with screening before discharge. As the districts of several local authorities were affected it was necessary for the constitution of a new administrative authority, comprising representatives from the local authorities, to be empowered by statute, and this was effected by the Auckland and Suburban Drainage Act, 1908, which also gave power for the execution and operation of the required works.

12. The construction of the first part of the scheme was completed and put into operation in the year 1914, and subsequently the remainder of the scheme was carried out. By the year 1927, however, or even earlier, it became apparent that the scheme was not adequate for the requirements of the district, and the Auckland Harbour Board requested the Drainage Board to take action in order to extend the Orakei outfall sewer

and to enable treatment of the sewage to be carried out. Following this, in the year 1928 a Committee of Inquiry was appointed by the Department of Health to consider questions arising from the discharge of sewage into the Manukau Harbour as well as the Waitemata Harbour. The inclusion of the Manukau Harbour in the scope of the Committee's inquiry is significant as indicating a realization of the necessity of considering the drainage of the Auckland Isthmus as a whole. The Committee decided that there was "undoubted necessity to take in hand the question of pollution of both Waitemata and Manukau Harbours," and it recommended that there should be co-ordination of control in respect of drainage matters on the Manukau side of the isthmus similar to that brought about by the Auckland and Suburban Drainage Act, 1908, for the Waitemata side. It considered that it would be a mistake to set up a separate Board for the Manukau area, and it therefore recommended an extension of the drainage district constituted by that Act. A further recommendation was made that the Engineer to the Drainage Board should be sent overseas to investigate sewage treatment and disposal systems and problems.

13. The Drainage Board adopted this recommendation and instructed its Engineer (Mr. H. H. Watkins) to visit the United States of America, Canada, Great Britain, and other parts of Europe and Australia in order to make a full investigation of all matters relating to the administration, design, construction, and operation of drainage systems and also of the systems of treating and disposing of sewage. Mr. Watkins was engaged in this task for several months during the years 1929 and 1930, and on his return to New Zealand he prepared a comprehensive report on his investigations and also formulated proposals for sewerage and sewage treatment and disposal schemes for an extended drainage district. The report and proposals were submitted to the Drainage Board in December, 1931, and will be referred to hereafter as the 1931 proposals. The 1931 proposals provided for the extended district to be divided into two areas, a northern area comprising the Boroughs of Devonport, Takapuna, Northcote, and Birkenhead, and a southern area comprising the City of Auckland and also the districts of the other local authorities situated on the Auckland Isthmus.

The position with regard to the northern area will be dealt with in Part V of this report, which deals with the drainage of the North Shore boroughs, and it is unnecessary to make any further reference to it at this stage.

So far as the southern area was concerned, it is sufficient to state that the 1931 proposals provided for a main sewerage scheme for the isthmus with treatment-works at Motukorea (or Brown's Island), situated on the Waitemata Harbour, and an outfall in the Motukorea Channel. The proposed treatment-works included a pumping-station, plain sedimentation tanks, and sludge-drying beds at Motukorea and facilities for conveying wet sludge to the open sea.

14. It has already been mentioned that, although the action taken by the Auckland Harbour Board in the year 1927 arose from the inadequacy of the Auckland and Suburban Drainage Board's system and the outfall at Orakei, it was found advisable to give consideration as well to the pollution of the Manukau Harbour that was taking place. Pollution of the waters of the Waitemata Harbour was being caused at that time not only by the Orakei outfall, but also by outfalls from the North Shore boroughs, which were discharging crude sewage and septic-tank effluent. Pollution of the Manukau Harbour was being caused by outfalls from the sewerage systems of the Mount Roskill road districts and the boroughs of Onehunga, Otahuhu, and New Lynn, which were also discharging crude sewage or septic-tank effluent. The pollution caused by the discharge into harbour waters from the outfalls on both sides of the isthmus which have been mentioned was increased by the discharge of trade wastes into tidal waters, and of sewage from ships using the harbours, and by various other sources of pollution. It should be observed that all sources of pollution which existed in the year 1931 still exist and that not only has no effective action been taken to abate the serious nuisance caused,

but, by reason of the very large increase of population that has taken place in the interval, and also the increase of industries producing trade wastes, the extent and degree of the pollution have materially increased.

15. On receiving the 1931 proposals the Drainage Board, in addition to obtaining the approval of the Auckland Harbour Board and taking steps to have them fully considered by the local authorities affected, requested that the Committee previously referred to, which had been appointed by the Health Department in 1928, should be reassembled in order to consider them. This was done, and the Committee expressed its agreement with the proposals and stressed the need for constituting immediately the new district and thereby ensuring effective control over the whole area. It should be mentioned that the 1931 proposals met with some criticism, especially from the Auckland Yacht and Motor Boat Association. It can be readily appreciated that yachtsmen were very interested in the prevention of pollution of the waters of the Waitemata Harbour and in safeguarding from contamination the bathing beaches of the harbour and the Hauraki Gulf. Certain prominent yachtsmen had opposed Mr. Midgley Taylor's scheme, and when the 1931 proposals were published the association appointed a committee to consider them. This committee prepared a report in 1935 which was adopted by the association, the substance of which was that strong opposition was expressed to the proposals and also to any proposal that involved the discharge of sewage or sewerage effluent to the waters of the Waitemata Harbour, the contention being that the only suitable point for discharge was in the vicinity of the Manukau Heads. The criticism of the association which was repeated in evidence given before us on its behalf, will be referred to again later.

16. In the year 1935 the Drainage Board decided that it would be advisable for the 1931 proposals to be considered by independent experts, and accordingly employed Mr. G. A. Hart (formerly City Engineer of the City of Wellington) and Mr. E. F. Borrie (Sewerage Engineer of the Melbourne and Metropolitan Board of Works) for this purpose. These gentlemen visited Auckland and made a close study of the problems of the drainage of the metropolitan area. In the result they expressed general agreement with the proposals, but recommended that before any construction was commenced a comprehensive series of float observations and other tests should be made in order to verify the accuracy of the information which had been furnished to them. These observations and tests and also certain other investigations were made, and the results are shown in a report made to the Drainage Board by Mr. Watkins in March, 1937. It was considered by Mr. Watkins that his opinion as to the soundness of the 1931 proposals was confirmed by these further investigations. Considerable criticism of the sufficiency of these observations and tests was expressed to us, and this criticism will be referred to later.

17. In the year 1937 a Commission of Inquiry was appointed to report upon the advisability of altering the boundaries of the drainage district and the constitution of the Drainage Board and also upon various other matters connected therewith. This Commission in December, 1937, presented a comprehensive report which formed the basis of the legislation which was enacted in the year 1944 (the Auckland Metropolitan Drainage Act, 1944) to constitute an enlarged metropolitan drainage district and a new Drainage Board and generally to empower the execution of the 1931 proposals. We understand that the delay which took place between 1937 and 1944 was due primarily to the outbreak of the Second World War, but it appears that opposition to the proposals from the North Shore area was also a factor.

18. The Auckland Metropolitan Drainage Act, 1944 (which will be referred to throughout this report as "the Drainage Act" or "the Act"), the long title of which is "An Act to provide for the Drainage of the City of Auckland and the Suburbs thereof" repealed the Auckland and Suburban Drainage Act, 1908, and its amendments and constituted an "Auckland Metropolitan Drainage District," comprising an Inner Area and an Outer Area. The boundaries of the new district are much more

extensive than those of the old district. The Inner Area comprised the City of Auckland, the Boroughs of Mount Eden, Mount Albert, Newmarket, One Tree Hill, Onehunga, Otahuhu, and Ellerslie, the Town District of Papatoetoe, the Road Districts of Mount Roskill and Mount Wellington, the Auckland Domain and Hospital Reserve, and the island known as Motukorea or Brown's Island. The Outer Area comprised the Boroughs of New Lynn and Manurewa, the Town Districts of Glen Eden, Henderson, and Howick, and the Panmure Township Road District, those portions of the Titirangi, Waikumete, Waipareira, and Waitakerei Ridings of the Waitemata County lying within an approximate radius of nine miles from the chief post-office at Auckland, and that portion of the Manukau County lying within an approximate radius of fourteen miles from the Auckland Chief Post-office. Provision was made for altering from time to time the boundaries of the district.

The Act also constituted the Auckland Metropolitan Drainage Board, consisting of fifteen members elected by the local authorities whose districts were included in the Inner Area.

19. The following are the principal provisions of the Act which are relevant to the matters within the scope of the present inquiry :

- (1) The main sewers and drains and other works and property belonging to the Auckland Suburban Drainage Board were vested in the new Metropolitan Board, which also assumed all rights and obligations of the old Board.
- (2) The Metropolitan Board is given the sole right within the Inner Area to construct, maintain, and manage all main sewers and drains and other works, and all main sewers or drains and other works constructed by any local authority were vested in the Board subject to the payment of compensation by the Board to the local authority concerned.
- (3) The treatment-works and outfall for the district are required to be constructed on Brown's Island and the discharge of the effluent from the treatment-works into the waters surrounding the island is authorized. The construction of a submarine sewer to the island and of the outfall pipes is made subject to the approval of the Marine Department and the Auckland Harbour Board, and the Metropolitan Board is required to obtain the approval of the Harbour Board to the degree and character of purification of the effluent. With certain exceptions no sewage is allowed to be discharged from any part of the Inner Area into the waters of the Waitemata or Manukau Harbours.
- (4) For the purpose of carrying off any sewage from any part of its district within the Inner Area, a local authority is entitled to connect sewers and drains with the Board's main sewers and drains.
- (5) Subject to the approval of the appropriate local authority, the Board is empowered to construct drains for the removal of surface water and to control, alter, and improve any existing drains for that purpose, or any natural watercourse or channel.
- (6) Within the Outer Area no new main sewers or drains are allowed to be installed except by the Board, and no existing main sewers or drains may be altered or extended or any change or extensions made in any existing drainage system except with the approval of the Board.
- (7) The area outside the Metropolitan Drainage District the natural drainage of which is into the waters of either the Waitemata Harbour or the Manukau Harbour is to be regarded as within the "sphere of influence" of the Board and no drainage system for any portion of this area is to be drawn up, carried out, or maintained save with the approval and under the general supervision and control of the Board. The Boroughs of Devonport, Takapuna, Northcote, and Birkenhead are, however, expressly excluded from the sphere of influence.

- (8) The Board is given power to borrow by way of special loan such sums as are necessary for carrying out the purposes of the Act, and the local authorities of the districts within the Inner Area are liable to contribute annually such sums as may be required to meet the Board's expenditure, such contributions being assessed in proportion to the mean percentage of the rateable capital value and population of the respective districts. During the construction of the Motukorea scheme the annual cost thereof and the general administrative expenses of the Board are to be borne by all the local authorities in the Inner Area, but the annual costs of the Board's present scheme are to be borne by the local authorities of the former district of the Auckland and Suburban Drainage Board. So soon, however, as the Metropolitan Board's new main sewers are available for receiving the sewage from any local district the local authority of such local district will be liable to contribute to the whole annual cost of the Board. The local authorities of the Inner Area may pay the contribution for which they are liable out of their ordinary funds, or they may strike and collect a rate based on the rateable value of the rateable property within their respective districts, and provision is made to enable the local authorities to classify such rateable property and to levy such rates on a sliding scale according to such classification.
- (9) The Board is given power to make by-laws and also various other powers necessary for carrying out the provisions of the Act.

20. It should be mentioned, in view of the strong opposition to the Motukorea scheme which developed after the passing of the Act, that prior to its enactment the Local Bills Committee of Parliament heard evidence and received representations from interested persons and public bodies, and it would appear that the provisions of the proposed legislation were given full consideration.

21. Soon after the Act was passed the opposition to the Motukorea scheme increased materially and the Auckland and Suburban Drainage League was formed with the object of preventing the execution of the scheme. The league received strong support and quickly became an active organization. In particular it organized the presentation to Parliament in each of the years 1945 and 1946 of petitions. The first of the petitions was referred to the Local Bills Committee, which eventually reported that it had no recommendation to make. The object sought by the 1946 petition was the appointment of a Commission of Inquiry to inquire generally into questions concerning the conversion of sewage, garbage, and other waste materials by composting into organic fertilizers, and more particularly to examine questions connected with the use of organic manures, the relationship between the organic content of soils and their fertility, and between fertilizers and the nutritional quality of food and the incidence of sickness, and the utilization of town wastes. The New Zealand Branch of the British Medical Association supported the petition, which was recommended to Parliament for favourable consideration by the Select Committee which considered it. The scope of the petition was not limited to Auckland. The Government appointed an inter-departmental Committee to study these questions, and an interim report of this Committee was produced to us and will be referred to later.

Prior to the formation of the Drainage League and for a short time afterwards the opposition to the Board's proposals was based on the danger of pollution of the waters of the Waitemata Harbour arising, with the consequent contamination of bathing beaches and the possibility of injury to public health. It is to be observed, however, that since the year 1946 the principal ground of the opposition has been the waste involved by the failure to utilize effectively the valuable ingredients contained in sewage by the production of humus by compost-making.

22. In the meanwhile the Metropolitan Board and its staff continued to investigate the problems involved, including those connected with the disposal of trade wastes and the methods of treating and disposing of sewage.

In September, 1947, Mr. Watkins retired from the position of Engineer to the Metropolitan Board, and in January, 1948, Mr. J. P. Porter, who at that time was employed by the London County Council as the Principal Assistant in charge of design of the post-war programme of works for sewage treatment, was appointed in his place. This appointment was made on the recommendation of Mr. Peirson Frank, a former president of the Institution of Civil Engineers, and a panel of engineers nominated by the Metropolitan Board. On his appointment, Mr. Porter received instructions to investigate modern methods of sewage treatment and sludge utilization before leaving England, and he was furnished with the various reports which had been made on the drainage problems of Auckland, including those made by Mr. Watkins, and also with certain pamphlets which had been published by the Drainage League. Mr. Porter studied these documents and inspected several sewage-disposal works. In addition, he made extensive inquiries into modern methods of sewage-treatment and sludge-disposal methods and their application to Auckland. He arrived in New Zealand in May, 1948, and took up his duties on the 1st June.

23. On the 28th July, Mr. Porter submitted to the Board a report on his investigations in Great Britain and his study of the Auckland problems, and we think it will be of assistance to summarize here his principal conclusions :—

- (1) As there are several distinct catchment areas in the Metropolitan District, the provision of separate disposal works for each area should be considered.
- (2) The treatment of sewage at Motukorea appeared to be the most practical and economical method for the northern part of the isthmus.
- (3) The discharge of sewage and trade wastes from the southern part of the isthmus to Motukorea would probably involve secondary treatment to a high degree, and therefore the provision of another treatment-works on the Manukau Harbour should be considered.
- (4) Investigation should also be made into the costs and technical problems of a scheme for treating all sewage from the isthmus at a site on the Manukau Harbour.
- (5) For technical reasons it appeared to be advisable that the main scheme for the isthmus should not include provision for the sewage from the Upper Waitemata (western) part of the district, and a decision on this point was required before a scheme or schemes for the isthmus could be prepared.
- (6) Post-war costs of disposal of sludge at sea indicated the necessity of considering alternative methods of sludge disposal.
- (7) Sludge disposal by digestion air-drying and pulverization to produce organic fertilizer, which could be sold to fertilizer-compounding undertakings or used as a compost activator, appeared to be the most suitable and economical method for Auckland.
- (8) The preparation of compost from liquid sludge and town refuse would be less efficient and more expensive.
- (9) The possibilities of the cultivation of water-hyacinths for composting were too uncertain to justify the postponement of the construction of new sewers and treatment-works while experiments are carried out, but consideration should be given to the making of such experiments after the main works are completed and sewage effluent is available.
- (10) Standards of purity comparable with those to be imposed on the Metropolitan Board should be imposed on other authorities and industries discharging sewage and trade wastes to the harbours.
- (11) Methods of treatment should be designed so as to eliminate within practical limits all risks to public health from the discharge of effluents to the harbours.

The Board considered Mr. Porter's report and instructed him to make further investigations into the matters mentioned in subparagraphs (2), (3), (4), (5), and (7).

24. As a first step, Mr. Porter prepared a "Memorandum on Basic Technical Data" (dated 9th September) in which he discussed, and made proposals in connection with, the topographical features of the Metropolitan District, the estimated ultimate population of the district and its distribution, the volume of sewage for which sewers and treatment-works should be provided, the location of treatment-works, and the treatment and disposal of trade wastes. Copies of this memorandum were sent soon after its preparation to all the local authorities concerned and to certain other authorities with a request for their comments on its contents.

25. On 15th December, Mr. Porter submitted to the Board a full report on the further investigations made by him following the Board's instructions of July, 1948. This report covered all aspects of the drainage problems of the Metropolitan District, and showed the importance of the results of the investigations which had been made since the year 1946 into the quantities and quality of the trade wastes which are being discharged into sewers and harbour waters. The subject of trade wastes will be considered in a later part of this report. For the present purpose it will be sufficient to give the following brief summary of Mr. Porter's report :

- (1) The disposal of sewage on land is rejected as entirely impracticable.
- (2) Disposal to the Tasman Sea is also rejected because of the excessive cost and the loss of valuable by-products involved.
- (3) After examining five possible sites for treatment-works, those at Motukorea, Mangere Peninsula, and Southdown are considered to be practicable and the others unsuitable.
- (4) The scheme proposed by the Drainage League before the parliamentary Select Committee in 1946, which provided for a single treatment-works on the Manukau Harbour, the cultivation of water-hyacinths in an effluent lake situated above the Mangere Bridge, and the composting of the hyacinths, sewage sludge, and town and industrial wastes, is considered and rejected because of the unduly high capital and operating costs and also because it is considered that the practicability of the cultivation of water-weeds in purified sewage effluent and their harvesting is too uncertain to warrant its adoption as a main feature of a sewage-disposal scheme.
- (5) The disposal of sludge at sea under the present and the probable future conditions is considered to be likely to be more expensive than a system of full treatment by modern methods with the resulting production of a valuable fertilizer.
- (6) The method of treatment of sludge recommended (which would produce an organic fertilizer of high market value capable of being increased by the addition of potash and other mineral salts) comprises —
 - (i) Digestion in heated tanks with production of gas of high calorific value.
 - (ii) Decanting of liquid from digested sludge.
 - (iii) Air-drying of digested sludge on sand-beds.
 - (iv) Pulverization of air-dried sludge at high temperatures.

It is considered that, while the capital and operating costs would be high, they should be almost completely offset by the fuel value of the gas (to be used mainly on the works in lieu of Diesel oil) and by the sale value of the fertilizer produced.

- (7) For economic and other reasons the disposal of sludge by composting with town refuse, vacuum filtration, and other alternative processes are not recommended. It is considered that the disposal of organic town refuse is the responsibility of the municipal authorities, and that if they wish to adopt a sludge-refuse composting process they should be given the opportunity of buying dried sludge for use as an activator.

- (8) Two schemes (described as Scheme No. 1 and Scheme No. 2) are submitted with estimates of capital costs and annual charges:—

Scheme No. 1 provides for treatment of all sewage and trade wastes at Motukorea.

Scheme No. 2 provides for the treatment of sewage and trade wastes from the northern part of the isthmus at Motukorea and from the southern part at Mangere.

(These schemes will be referred to in some detail later and it is unnecessary at this stage to give further particulars concerning them.)

26. In the meanwhile in July, 1948, the Metropolitan Board was requested by the Minister of Health to suspend the prosecution of the Motukorea scheme, it having been decided to appoint a Commission of Inquiry to inquire into all questions arising in connection therewith. In March, 1949, we were appointed to make this inquiry.

27. It will be convenient if we refer here to the present metropolitan sewerage and sewage-disposal system and to the criticisms of the system and particularly of the outfall at Orakei which have been made. It was contended that the system was a failure, and this alleged failure was used as an argument against accepting the claims made by the engineers who have recommended or approved of the Brown's Island scheme. We do not think it is necessary to discuss the criticisms at any length. They appear to overlook the fact that those responsible for the planning of the system contemplated that it might be found necessary as the population of the district increased to establish treatment-works on land at Orakei. This later became impracticable. The criticisms also disregard such important considerations as the unexpectedly rapid and large population increase which has occurred and the development of the area which followed the construction of the waterfront road. It is true that by the year 1927 the system was found to be inadequate, but in our opinion it is wrong merely on that account to condemn it as a failure. Taking into consideration the conditions existing in the year 1908, we consider that those responsible for the adoption of Mr. Midgley Taylor's scheme were justified.

PART II—FACTORS AFFECTING THE CONSIDERATION OF SEWERAGE AND SEWAGE TREATMENT AND DISPOSAL SCHEMES FOR AUCKLAND

28. There are several major factors which require to be considered in order to determine what system of sewerage and sewage treatment should be adopted for the Auckland Metropolitan District, and we think that it will be convenient if we state and examine these factors before we consider the various schemes which have been proposed.

DEFINITION OF THE DRAINAGE DISTRICT

29. (1) We have referred briefly in Part I of this report to the principal topographical features of the district (paragraph 10) and also to the boundaries of the Metropolitan Drainage District which was constituted by the Drainage Act and the division of the district into an Inner and an Outer Area (paragraph 18).

(2) In the "Memorandum on Basic Technical Data" which Mr. Porter submitted to the Drainage Board in September, 1948 (see paragraph 24), he suggested that in planning sewerage-works for a large area it is advisable to divide the area into suitable catchment areas, and he accordingly took into account not only the area comprised in the Metropolitan District but also areas beyond that district, and subdivided the whole into what he considered are five natural catchment areas, which he designated "sewerage

districts." These five sewerage districts, which are referred to as the Central, Southern, Eastern, Western, and Northern Sewerage Districts, are described in the "Memorandum" and are shown in the drawing No. 1 which is attached thereto. It is unnecessary to give here the full description of the sewerage districts, but we should mention that the natural drainage of the Southern District is mainly to the Manukau Harbour (a small portion draining to the Tamaki River), and of all the others mainly to the Waitemata Harbour and the Hauraki Gulf (with a small portion to the Manukau Harbour).

(3) The evidence showed that as sewers, once they are constructed, cannot be economically enlarged, provision should be made to deal with the conditions which are likely to exist during a period of, say, forty years from the time of the completion of the sewers, and that treatment-works, on the other hand, can be enlarged from time to time as the need arises. We also agree with Mr. Porter's opinion that "it is more economical in general in a rapidly growing city to provide treatment-works which can be deemed to be 'productive works' and which can easily be extended as the need arises than to provide sewers, which are essentially partly 'non-productive,' and which must be built immediately for anticipated 'ultimate load.'" It follows that it is more economical to treat and dispose of sewage in its own catchment area than to construct a sewer to convey it to a place for treatment and disposal with sewage from another area.

(4) After inspecting the proposed sewerage districts and considering all the factors which we consider are relevant, we have come to the conclusion that the boundaries of the Metropolitan District should be altered in accordance with Mr. Porter's proposals. We are also of opinion that the Central and Southern Districts should comprise the Inner Area of the Metropolitan District, that the Eastern and Western Districts should be included in the Outer Area, and that the Northern District, while being brought within the Metropolitan District, should not be included within either the Inner Area or the Outer Area, but should occupy a special position in accordance with the recommendations which will be made later in Part V.

The areas comprising the five sewerage districts are described in general terms in paragraphs 50 (1) and 51 (1) and Part V. If our recommendations are adopted, a more exact description will be required for the amendments that will require to be made to the Drainage Act, but the general descriptions should afford a sufficient guide.

(5) We will refer later to the proposals made by Mr. Porter for the drainage of the sewerage districts.

(6) We were requested by counsel for the Metropolitan Board to recommend that the Board should have authority to divide the Inner Area into two districts for sewerage and sewage-treatment purposes. We understand that what is meant by this is that if the Board's Scheme No. 2, which is referred to in paragraph 25, is adopted, the Board should be authorized to constitute as separate sewerage districts, firstly the area the sewage from which will be dealt with at Brown's Island, and secondly the area the sewage from which will be dealt with at a site on the Manukau Harbour. It was made clear that it was not suggested that the financial provisions of the Drainage Act should be altered or that the costs of the Brown's Island and Manukau Harbour schemes should be separately borne by the respective areas served by the schemes. We have referred in subparagraph (2) above to the five sewerage districts suggested by Mr. Porter, and we have recommended that two of these districts (the Central and Southern Districts) should comprise the Inner Area of the Metropolitan District and that the Eastern and Western Districts should comprise the Outer Area. We consider also, as will be shown later, that the Northern District should constitute a separate sewerage district not forming part of either the Inner or the Outer Area. We consider that it will be convenient if the proposal made by the Metropolitan Board is carried further by subdividing the Metropolitan District into the five sewerage districts mentioned, and we accordingly recommend that this should be done and the Drainage Act amended accordingly.

POPULATION

30. (1) As has been mentioned, it is difficult and perhaps impossible to make any satisfactory estimate of the future population of the district or its distribution. Nevertheless, the attempt to do so must be made as these factors play an essential part in the planning of a sewerage system.

(2) Mr. Porter's "Memorandum on Basic Technical Data" contains tables showing in respect of the different parts of the sewerage districts (excepting the Eastern), the estimated urban area, the present population, and also his estimates, and those of the Town-planning Officer of the population in the year 2000. It is unnecessary to set out the details here, but we should mention the totals of the population estimates. They are as follows :—

					Town-planning Officer.	Mr. Porter.
Central	..	..	..	..	337,000	300,000
Southern	..	..	..	..	116,000	130,000
Western	..	..	..	..	58,000	80,000
Northern	..	..	..	..	110,000	95,000
Totals	..	..	..	..	621,000	605,000

(3) The Town-planning Officer has not submitted any estimate for the Eastern Sewerage District because he assumes that it will remain a rural area, but Mr. Porter considers that part of the district will be developed to urban standards and he estimates that the population by the year 2000 will amount to 20,000 persons.

(4) We consider that it is reasonable to assume that the population of the sewerage districts in the year 2000 will approximate the estimates given above, and that in the circumstances the differences in the estimates are not important. We also consider that the population estimates for the various parts of each sewerage district contained in Mr. Porter's "Memorandum" should be adopted as a general guide notwithstanding certain differences between the estimates.

DETERMINATION OF QUANTITIES OF SEWAGE TO BE DEALT WITH

31. (1) The quantities of sewage to be collected and disposed of by a sewerage system depend upon—

- (a) The estimated connected population.
- (b) The volume of ordinary domestic sewage contributed by each person.
- (c) The volume and quantity of trade wastes to be discharged into the sewers.
- (d) The amount of rain, storm, or ground water that enters the sewers.

(2) It is acknowledged by all sewerage engineers that the rate of discharge of domestic sewage increases as the consumption of water per head increases. The consumption of water is greater in countries where water is plentiful—*e.g.*, United States of America—and the quantities of sewage per head of population are greater, but the strength of the sewage, being more diluted, is weaker.

(3) We have already referred to the population estimates contained in Mr. Porter's "Memorandum" of September, 1948, and have stated that we consider that they should be used as a general guide.

(4) As regards the assessment of the quantity of domestic sewage discharged per head of connected population, we consider that this must be left to the Drainage Board. However, on the information now available, we agree that Mr. Porter's assessment of 50 gallons per person per day, due allowance being made for trade wastes, would appear to be reasonable. As stated above, the quantities of domestic sewage are likely to increase in the future, but as adequate provision is being made for the greater flows which always occur in wet weather there will be no difficulty in collecting and disposing of the increased future quantities.

(5) In paragraph 36 we will consider questions in connection with the disposal of trade wastes. It is obvious that as the volume of these wastes is considerable it is essential for the proper planning of a scheme that a decision should be made as to whether or not they will be discharged into the sewers. As will be shown, we have come to the conclusion that, subject to certain exceptions, trade wastes should be discharged to the sewers.

(6) The estimation of the provision to be made for rain-water, storm-water or ground-water entering sewers through surface fittings, illegal connections, or leaky sewer joints is very difficult. In wet weather it is impossible to keep these waters out of sewers and the flow increases considerably. It is the universal practice to provide overflows in sewerage systems so that the diluted sewage above a predetermined amount can be diverted to a convenient watercourse or storm-water channel, where further dilution will occur as the watercourse or channel will then be flowing nearly full. Mr. Porter proposes that provision be made for five times the average "dry weather flow" or four times the average domestic "dry weather flow" plus twice the trade waste average rate, and we consider this is a reasonable provision.

METHODS OF DISPOSAL OF SEWAGE

32. (1) There appears to be no doubt that the disposal on land of the sewage of the Auckland district is rendered impracticable by the lack of a suitable large area of reasonably level land with porous subsoil and low rainfall conditions to deal with a large volume of sewage containing strong trade wastes. It seems clear, also, that the use of the effluent from the sewage after treatment for land irrigation or for commercial and industrial purposes would be entirely uneconomic, and that it is only in areas where water is scarce or can be obtained only at high cost that this use of sewage effluent is practicable.

(2) There also appears to be no serious dispute about the impracticability because of the excessive expense involved of discharging sewage or sewage effluent into the open sea on the west coast. From an engineering point of view, disposal of sewage by this method is possible, although additional expense will be incurred in protecting the outfall sewer from disintegration of concrete material which occurs when gases are evolved from the sewage after being so long in the sewer flowing to the outfall. There is the further disadvantage that useful by-products would be lost.

(3) In the report made in 1932 by the Committee appointed by the Health Department it was stated:—

(a) "On the principle that sewage should be removed by the back entrance the proper direction to take the sewers of the Southern Area would appear to be westward to the Tasman Sea at Manukau Heads. This would involve the construction of a maximum sized outfall sewer 13 miles in length from the Whau Creek (the Western side of the district served) to Manukau Heads, and the heavy cost of such a sewer makes it extremely doubtful whether this was a practical proposition at any stage of the development of Auckland City."

(b) "From a public health point of view this project (the Committee is referring to discharge at Manukau Heads) is ideal, but we do not think it practicable from a financial point of view."

Mr. D. M. Robinson, the President of the Auckland and Suburban Drainage League, in his evidence criticized the views expressed by the Committee on the ground that its report "was based more on financial than on health considerations," and he contended that "if another scheme is ideal from the public health point of view then their acceptance of the Brown's Island scheme for 'financial considerations' is acceptance of a second best." He also contended that "the health of the community must not be endangered because of economy in sewage treatment." The latter contention is, of course, sound, but it assumes that the Brown's Island scheme will endanger public health, an assumption which, as will be shown later, is not justified. In any case, we are unable to agree with the contention that the Committee's report "was based more on financial than on health considerations."

We refer to this matter because it appeared to us that Mr. Robinson and other critics of the Brown's Island scheme held the opinion that the expense factor is of only minor importance. We consider, however, that the Committee and the engineers who have rejected the proposal for the discharge of sewage into the open sea on the ground of excessive cost were not in any way sacrificing public health considerations in the interests of economy. We think that they were satisfied on good grounds that if proper care were taken the discharge of sewage effluent into the channel near Brown's Island would be safe, and they therefore very properly rejected the more expensive proposal. A drainage authority which is entrusted with the responsibility for the expenditure of public funds, like any other similar public authority, has a duty to pay very careful consideration to the saving of unnecessary expense, and if after proper consideration it is satisfied that a method of disposing of sewage is satisfactory, it would not be entitled to reject that method for one that is more expensive.

(4) If the methods of disposal of the sewage on land or by discharge into the open sea are impracticable, we consider that it must follow that the method of discharging the effluent (after the sewage has received whatever treatment is necessary to ensure the safety of public health) into harbour waters must be adopted. We should mention that the proposals submitted to us by the Drainage League as well as those made by the Drainage Board provide for this method of disposal, and it has not been suggested to us by any one that any other method is practicable.

DISPOSAL OF SEWAGE BY DISCHARGE INTO WATER

33. (1) The commonest and usually the most economical method of disposing of sewage is to discharge it into the nearest body of water either without treatment or with sufficient treatment to remove some of the pollution. Every watercourse, lake, or other body of water receives the organic matter draining from the area tributary to it and by the processes of natural purification converts the organic matter into stable non-putrefactive matter. This change involves physical, chemical, bacteriological, and biological processes which depend upon organisms that require a supply of oxygen for their activities.

(2) Both fresh and salt water contain oxygen in solution, and if the volume of water into which sewage is discharged is sufficiently large, enough oxygen will be available to give complete purification. If, on the other hand, the volume of water is inadequate, decomposition will take place without sufficient oxygen to prevent putrefactive conditions being set up, with resulting nuisance. The conditions under which disposal of sewage by dilution can be regarded as satisfactory have been studied by previous Commissions, the most notable being the Royal Commission on Sewage Disposal (United Kingdom), which in 1912 after some fourteen years of investigation reported its conclusions as follows:—

(a) The law should be altered so that a person discharging sewage matter into a stream shall not be deemed to have committed an offence under the Rivers Pollution Prevention Act, 1876, if the sewage matter is discharged in a form which satisfies the requirements of the prescribed standard.

(b) The standard should be either the general standard or a special standard which will be higher or lower than the general standard as local circumstances require or permit.

(c) An effluent in order to comply with the general standard must not contain as discharged more than 3 parts per 100,000 of suspended matter, and with its suspended matters included must not take up at 65° F. (18.3° C.) more than 2.0 parts per 100,000 of dissolved oxygen in 5 days. This general standard should be prescribed either by statute or by order of the Central Authority and should be subject to modifications by that Authority after an interval of not less than 10 years.

(d) In fixing any special standard the dilution afforded by the stream is the chief factor to be considered. If the dilution is very low it may be necessary for the Central Authority, either on their own initiative or on application by the Rivers Board, to prescribe a specially stringent standard which should also remain in force for a period of not less than 10 years.

(e) If the dilution is very great the standard may, with the approval of the Central Authority, be relaxed or suspended altogether. Our experience leads us to think that as a general rule, if the dilution, while not falling below 150 volumes, does not exceed 300, the dissolved oxygen absorption test may be omitted and the standard for suspended solids fixed at 6 parts per 100,000. To comply with this test no treatment beyond chemical precipitation would ordinarily be needed. If the dilution while not falling below 300 volumes does not exceed 500 the standard for suspended solids may be further relaxed to 15 parts per 100,000. For this purpose tank treatment without chemicals would generally suffice if the tanks were properly worked and regularly cleansed. These relaxed standards should be subject to revision at periods to be fixed by the Central Authority and the periods should be shorter than those prescribed for the general or for the more stringent standards.

(f) With a dilution of over 500 volumes all tests might be dispensed with and crude sewage discharged subject to such conditions as to the provision of screens or detritus tanks as might appear necessary to the Central Authority.

(3) These conclusions show that where dilution is small a high standard of effluent involving a high degree of treatment is required, but where there is considerable dilution a relaxation of the standard can be made to the extent that with a dilution of over 500 volumes crude sewage can be discharged to bodies of water with only screening and removal of grit.

(4) If sewage is continuously discharged into large bodies of water, the quantity that can be so disposed of without causing any nuisance is dependent upon the rate at which oxygen is made available either by re-aeration or by replacement of the water bringing in supplies of oxygen. The main source of oxygen is from absorption from the atmosphere. The rate of re-aeration of water exposed to the atmosphere is proportional to the deficiency of dissolved oxygen in the water; it is increased by turbulence and by wave action, is greater the greater the area exposed per unit volume of water, is not greatly influenced by temperature, and is reduced by films of oil or grease on the surface.

(5) As stated above, natural purification of polluting matter is effected without nuisance if sufficient oxygen is available to permit the changes to take place without exhausting the dissolved oxygen in the water. This can be arranged for any body of water by controlling the amount of organic matter in the sewage and its oxygen demand so that the dissolved oxygen in the water will not be exhausted during the process of natural purification. Where volumes of diluting water are great, large amounts of organic matter (or suspended solids) with a greater oxygen demand (biochemical oxygen demand—B.O.D.) can be permitted in the sewage or sewage effluent.

(6) Following discussions between the Auckland Harbour Board, the Medical Officer of Health, Auckland, and the Metropolitan Drainage Board standards have been determined—

(a) For the treated sewage prior to discharge to either Waitemata or Manukau Harbours; and

(b) For the harbour waters after discharge of sewage and at certain distances from the place of discharge.

(7) The standards for the quality of the effluent from the sewage treatment works provide for—

(a) Removal of grit, sand, &c.

(b) Reduction of suspended solids content.

(c) Removal of grease, scum, and fat.

(d) Reduction of the five-day biochemical oxygen demand.

(8) The standards for the harbour waters provide that the—

(a) Oxygen content of the waters shall not be reduced below 50 per cent. of the normal saturation quantity.

(b) Bacteriological quality of the waters shall not be below a standard which is recognized by health authorities as being safe for all recreational purposes.

(9) Limits have been set to the amount of organic matter and to the biochemical oxygen demand in the sewage effluent being discharged into the harbour waters. The permissible reduction of dissolved oxygen in the harbour waters at defined distances from the sewer outfall has been defined.

(10) Thus it will be seen that for any location of sewer outfall discharging into a body of water optimum conditions for natural purification can be obtained and the health of the public using the harbour waters can be adequately protected by setting suitable limiting standards for the sewage and for the harbour waters.

SEWAGE-TREATMENT METHODS

34. (1) It would appear to be beyond dispute that the complete purification of sewage by treatment processes is now practicable. Great advances have been made in these processes during recent years, and it has been demonstrated by their successful operations in many parts of the world that, provided sewage is given adequate treatment by processes which have been proved to be satisfactory, purity is achieved and the possibility of injury to public health eliminated.

We consider that this fact cannot be emphasized too strongly, as it is plain from the evidence that a great deal of the opposition to the Brown's Island scheme has arisen from ignorance of the efficacy of modern sewage-treatment methods.

It will be appreciated, of course, that the treatment of sewage involves extra cost and therefore that the nature and extent of the treatment will depend on the strength of the sewage and the capacity of the receiving water to complete the purification process, and also on the practicability of the utilization of sewage by-products.

(2) Treatment processes are usually classified as primary and secondary. The former includes the removal of gross solids (excreta, timber, paper, rags, and other substances) at comparatively small expense by the use of screens (which is the method at Orakei) or some other similar process. Another primary process is the removal by the use of sedimentation tanks of portion of suspended solids comprising grease, scum, and other solids which are capable of floating or settling in quiescent waters. The Board's proposals for treatment-works at Brown's Island include primary works of the kinds mentioned, and it is suggested that, depending on the quality and volume of the sewage, primary treatment may prove to be sufficient for several years.

Secondary or oxidation processes which involve higher costs will be required if they are found to be necessary in order to maintain the standards of purity which have been prescribed to ensure the prevention of pollution in the receiving waters. It is proposed that any secondary treatment required would be done by the activated-sludge process.

(3) It is important in considering methods of sewage treatment that regard be paid to the practicability of the utilization of the sewage and the economic and other benefits to be derived from the production of gas and fertilizers.

(4) As will be shown, there are many factors to be taken into account. The disposal of sludge by depositing it in the open sea, which is the method adopted in many instances, is too expensive for use at Auckland, even if the loss of the benefit of utilization of the by-products which is involved were considered to be justified. It is necessary, also, to take into account that the treatment of sewage can be carried out more efficiently and more economically when it is fresh, particularly when the sewage includes strong trade wastes. It is advisable, therefore, that the sewage should reach the treatment-works as soon as possible, and this has an influence, of course, on the selection of a site for treatment and also on the advisability of having more than one works. Again, as has been previously mentioned, whereas sewers cannot be altered without considerable expense, treatment-works can be more economically extended from time to time as may be found necessary, and this consideration must influence the decision as to the number of treatment-works that should be installed.

POLLUTION OF HARBOUR WATERS

35. (1) It cannot be disputed that the waters of both the Waitemata and the Manukau Harbours are seriously polluted and that this condition not only constitutes a danger to public health, but it also interferes with the enjoyment by the public of the valuable recreational benefits which the harbours, and particularly the Waitemata Harbour, possess.

The following extract from the evidence given by Dr. A. W. S. Thompson, the Medical Officer of Health at Auckland, shows the conditions existing in the Waitemata Harbour :—

At the present time all bathing beaches on the Waitemata from Milford to Howick inclusive are subject to pollution. The degree of impurity varies from time to time, and, in general, beaches farthest from the Orakei outfall are less heavily polluted than those which are nearer to it. All are, however, subject to occasional heavy pollution. During the past eighteen months a total of 222 samples have been taken at 23 beaches on the Waitemata, the majority (135) from Orakei, Mission Bay, and Kohimarama. Taking 100 *B. coli* per 100 c.c. as the upper limit of acceptability, 70 per cent were unsatisfactory. Fifty per cent. of samples showed heavy pollution (500 *B. coli* or more) and in 32 per cent. it was very heavy indeed (1,000 *B. coli* or more). Of 75 samples taken from 18 beaches more than a mile distant from the Orakei outfall, 48 per cent. were satisfactory, but 17 per cent. showed very heavy pollution. No beach can be regarded as safe at all times.

So far as the Manukau Harbour is concerned, the extent of the pollution is probably even greater than that existing in the Waitemata Harbour. Not only are large quantities of crude sewage and partially purified sewage discharged into the harbour, but, in addition, a large volume of wastes (in many cases of a strongly noxious nature) produced by the industries located on or near the shores are discharged without treatment into the harbour waters and pollute the waters as well as many parts of the foreshore. The waters of the Manukau are in certain respects less suitable for receiving sewage and trade wastes than are those of the Waitemata, but the much larger population on the northern side of the isthmus and the far greater use for recreational purposes made of the Waitemata Harbour and its beaches has resulted in the pollution at the Manukau receiving less attention from the public.

It has already been mentioned that the existence of this condition of pollution in the harbours has existed for many years and has become very much more serious and that, although the responsible authorities have given very full consideration to the matter and have taken action to bring about an improvement, up to the present time no alleviation has been accomplished.

(2) The pollution arises from many causes. On the Waitemata side the most important cause is the Orakei outfall, but there are also several outfalls in the North Shore area and elsewhere from which crude sewage or partially purified sewage are discharged which contribute materially to the pollution. In addition, crude sewage is deposited from the ships which use the harbour and from Harbour Board wharves and other installations. Another important source is the large number of streams and watercourses and storm-water drains which discharge into the harbour, carrying with them polluted substances of many kinds. All these sources are responsible in a greater or less degree for the pollution of the Manukau.

It is impossible to prevent the harbour waters from receiving any contaminated material, and much of it is, in any case, quickly purified by dilution. If, however, the extent of the pollution is greater than the water can safely receive, a serious nuisance is likely to arise.

(3) The Auckland Harbour Board and the Metropolitan Drainage Board have the primary responsibility for preventing the waters of the harbours from becoming polluted, but the Health Department and the Marine Department and also the various local authorities from the districts of which sewage, sewage-treatment works, effluent, and water from watercourses and storm-water drains are discharged have some share in the

responsibility. It is clear that all these authorities recognize that conditions are unsatisfactory and that there is need for remedial action to be taken. The Harbour Board has been active in the matter since the year 1927 and the Drainage Board (or its predecessor) since the year 1928. We consider that we should state that the evidence makes it clear that the authorities have appreciated their responsibilities and have earnestly sought the most satisfactory solution of the problem. The problem is, however, a difficult one and it is very important that mistakes should not be made. The Drainage Board has therefore proceeded with proper caution, and we consider that the fact that so little effective progress has been made cannot be attributed to negligence or incompetency on its part.

Disregarding the opposition of the Auckland Provincial Yacht and Motor Boat Association to the 1931 proposals (the Brown's Island scheme) and certain other opposition prior to the enactment in 1944 of the Drainage Act and taking into account only the events since the Act was passed, the main responsibility for the delay since then must rest with the Drainage League. As we have previously mentioned, the league, which was formed shortly after the Act was passed, is an active organization. We have also mentioned that whereas prior to 1944 any opposition to the Brown's Island proposals was based on the risk of injury to the public health, shortly after the formation of the league the principal ground of opposition became the contention that the proposals prevented the utilization of the sewage by composting. It is not suggested that the pollution objection was abandoned, but it did become of secondary importance in the activities of the league. This will be appreciated when it is pointed out that the Drainage League's schemes (if it were to be found that its oxidation lake and composting proposals were impracticable) for the treatment of the sewage and the disposal of the effluent are in substance no different from those of the Drainage Board, excepting that the league advocated that all the sewage should be dealt with at the Manukau Harbour.

(4) In addition to the evidence of representatives of the Harbour Board, the Drainage Board, Government Departments, the Onehunga and Otahuhu Borough Councils, and the Manukau County Council, a considerable amount of testimony on the pollution aspect of the inquiry was given by witnesses who gave evidence either as individuals or on behalf of various organizations such as the Drainage League, the Auckland Provincial Yacht and Motor Boat Association, and the Auckland Centre of the New Zealand Swimming Association. The evidence of these witnesses showed that there is a strongly and widely held view that the discharge of sewage into harbour waters, and particularly those of the Waitemata Harbour, is a menace to the health of the community, even if the sewage is treated by the activated-sludge process or any other process and that in no circumstances should it be allowed.

We were impressed by the earnestness and obvious sincerity of the witnesses who supported this view, and it was clear that they expressed opinions which are held equally earnestly and sincerely by a very large number of the residents of the Auckland district. Some, but by no means all, of these witnesses were supporters of the composting proposals, but these witnesses for the most part also appeared to hold the view that there is a risk of pollution involved in any scheme which includes provision for discharging sewage effluent into harbour waters and that that risk is a sufficient reason in itself for keeping sewage away from these waters.

In the case of some of the witnesses, the objections to the use of the Waitemata Harbour appeared to be based on æsthetic or psychological or sentimental considerations. They stressed the many benefits and privileges which the public enjoy by reason of the great beauty and natural features of the harbour and its many attractive bathing beaches and picnic resorts, and maintained, as we understood them, that even if all risk to public health were to be eliminated the use of the harbour for sewage disposal would have the effect of seriously interfering with the full use by the public of an asset of incalculable value.

We recognize that these objections are entitled to the fullest consideration. It would, of course, be most unfortunate if the benefits which following from the natural advantages of the harbour were to be prejudiced in any way, and before any sewerage scheme involving the use of the harbour is adopted the greatest possible care should undoubtedly be taken to ensure that this will not happen.

(5) We have explained in paragraph 34 that the complete purification of sewage can be erected by standard treatment processes and in paragraph 33 the purification that is brought about by dilution in water is shown. We must repeat that these are matters that cannot reasonably be doubted. We must also repeat that there exists a great deal of misconception on this subject which it is essential should be removed. It is plain that much of the criticism that has been made against the Brown's Island scheme is due to the failure to pay proper regard to the complete protection from pollution that can be effected by the use of modern, well-proved processes.

(6) In the circumstances it is surprising that, on the whole, so little attention has been paid by the critics of the Drainage Board's proposal to the possibilities of treatment processes. In several instances the critics have admittedly no knowledge at all of this subject. It is to be observed that, although the Board's proposals have been strongly criticized by the Drainage League, the expert witnesses called on behalf of the league did not suggest that it was impossible or impracticable to render innocuous the sewage proposed to be dealt with at Brown's Island. The league's consulting engineer, Mr. R. P. Worley, criticized the Board's proposals on many grounds. He contended, for example, that the proposals did not make provision for secondary treatment, and that too much reliance was placed on the effect of the primary treatment proposed. He contended, also, that Brown's Island was not large enough to cope with the population that will probably require to be served after the year 1980, assuming the sewage from the whole of the isthmus (Scheme No. 1) is dealt with there. Further, he criticized the proposals on the basis of the comparative costs of the Board's and league's proposals respectively and on various other grounds. The principal criticism made by him was, however, the unsuitability of Brown's Island for the operation of a full-scale composting scheme as advocated by the league. Mr. Worley frankly admitted that, disregarding the league's utilization scheme, the Board's proposals constitute "a very good engineering proposition," and he did not suggest in any way that, provided adequate treatment of the sewage was given, there was likely to be any danger to public health. When questioned about the standards of purity which have been prescribed by the Harbour Board and the Health Department for the waters near Brown's Island, Mr. Worley very fairly and properly said:—

I would sooner see a higher degree of purification for all sewage discharged at Brown's Island than has been fixed, but as a citizen of New Zealand I would be quite prepared to abide by the Health Department's dictum in the matter. I could not take any other attitude towards it.

(7) Mr. T. McKnight, who gave evidence on behalf of the Yacht and Motor Boat Association, admitted that he had no knowledge of sewerage engineering, but notwithstanding this handicap he advocated not only that the purification of the sewage should be "the greatest purification that is humanly possible," but also that the outfall should not be in the Waitemata Harbour at all and should be at a point in the Manukau Harbour almost at the Heads. The witness also stated that, however strong were the assurances of experts that there would be no danger of the pollution of the Waitemata Harbour, he would not be satisfied, but he subsequently modified this statement and said that if his association had an assurance from "The President of the B.M.A. or something of the sort that the stuff is not harmful and would remain harmless we could not object. The yachtsmen will certainly accept it."

(8) Similarly, Mr. W. O. Stockley, the chairman of the Auckland Centre of the New Zealand Swimming Association, stated that the centre objected "to any form of sewage discharge into the Waitemata Harbour," and in the course of his evidence he

informed the Commission that the centre has no confidence in the engineers nor in the standards of purity fixed by the Health Department and that the centre's attitude was that it was not interested in standards of purity, and the discharge of the sewage would be objectionable even if it were completely purified.

(9) In this connection it is advisable to refer at some length to the evidence of Dr. MacKenzie and the petition presented by him on behalf of the ninety-two Auckland medical practitioners. That part of the petition which has reference to the pollution reads as follows :—

We are of the opinion that further harbour disposal of sewage even following activated sludge treatment will be a menace to the health of the community especially to those engaged in boating and bathing within the Waitemata Harbour. The practice of discharging sewage into partially confined waters is out of date.

(10) It should be mentioned that the other paragraphs of the petition and a large part of the evidence of Dr. MacKenzie deal with the subject of sewage utilization which is not relevant to the matters now being considered. It should also be mentioned that Dr. MacKenzie explained that he was not giving evidence as the representative of the British Medical Association.

(11) Although the petition contains the statements that "the further harbour disposal of sewage even following sludge treatment will be a menace to the health of the community" and that "the practice of discharging sewage into partially confined waters is out of date," the only evidence adduced in support of this sweeping and (if correct) highly important proposition was that of Dr. MacKenzie. The witness made it clear, however, that the question of harbour pollution is "a matter of minor importance in comparison with the major issue of sewage utilization," although he added that "it is, however, still one of considerable importance." We are unable to reconcile these expressions with the very serious contention which the witness supported that "a serious menace to the health of the community" would arise by reason of harbour pollution. He admitted that very few of the signatories to the petition had any special knowledge of sewerage engineering. Indeed, as we understand the evidence, it is not suggested that Dr. MacKenzie or any of the signatories claim to have any special knowledge of the subject.

The witness under cross-examination agreed that if sewage receives adequate treatment he would be "perfectly happy" for it to be discharged at Brown's Island or in the Manukau Harbour. We are quite unable to reconcile this admission with the statements in the petition to which we have referred. It was also stated by the witness that he was not concerned with the standards of purity of the water near Brown's Island which have been prescribed. It was somewhat uncertain what he meant by this statement. At one stage of his evidence he stated that "these standards are laid down, but in their present form and in my experience of local-body affairs I regard those as laid down only to be disregarded." Subsequently, however, he admitted that the standards are reasonable, but he appeared to be afraid that the authorities responsible for ensuring compliance with them might be unable to accomplish this.

(12) It is surprising and, we think, significant that no medical witness or other expert attempted to show that any cases of infectious disease have arisen from infection caused by bathing on beaches of the Waitemata Harbour or the Manukau Harbour. As has been shown, it is beyond dispute that the beaches are polluted and have been so for some time. Dr. Thompson, the Medical Officer of Health at Auckland, who gave evidence on this point also informed us that he was not "aware of any evidence, or even any serious suggestion, that cases of infectious disease" have arisen from this source; and referring to the fears expressed on behalf of yachtsmen he added that he had "never heard of a single case in which it has been suggested that a yachtsman has become ill through infection acquired while sailing through these admittedly heavily contaminated waters" (that is, the waters near the present Orakei outfall).

(13) The absence of medical or other expert evidence showing that the polluted beaches have been responsible for disease is all the more significant when it is recalled that since the year 1946 Auckland and many other parts of New Zealand have suffered from a severe epidemic of poliomyelitis and suggestions have been made that the condition of the harbour waters and beaches may have contributed to the incidence of this disease in the Auckland district. Inquiries made by Dr. Thompson at the beginning of the epidemic satisfied him that none of the first fifty cases at least had been caused by infection while bathing, and he also stated that there has been no evidence since then which would suggest that any case has arisen from this cause.

(14) Dr. Thompson's evidence on these matters has not been challenged, and this fact and the omission of any reference to them by Dr. MacKenzie and in the petition of the medical practitioners must be regarded as highly significant. Dr. Thompson did not suggest that it is not possible to become infected with poliomyelitis by bathing in sewage-polluted waters, and he explained that the reason for the warning given by the Health Department at the beginning of the epidemic against bathing on the beaches was that this was regarded as a proper precaution to take against a possible cause of infection. The fact remains, however, that there is no evidence which would indicate that any case of poliomyelitis has arisen from this cause.

(15) In our opinion, Dr. MacKenzie and the signatories to the petition failed to support the contention that the discharge of sewage to the waters of the Waitemata Harbour as proposed in the Drainage Board's schemes will be a menace to the health of the community. As regards the contention that the practice of discharging sewage into partially confined waters is out of date, it is sufficient to state that no evidence at all was adduced to support the contention, and the weight of evidence given by expert witnesses is strongly opposed to it.

(16) We consider that it is necessary that we should state our opinion about the evidence of Dr. MacKenzie and the petition presented by him. It will be readily appreciated that the publication of the adverse views of medical practitioners on the subject of the pollution of harbour waters may well exert a material influence on the minds of the public, who may not understand that medical practitioners, however highly qualified they may be, are not necessarily competent to express an opinion of any value on what is, after all, a technical subject outside the ordinary scope of the experience and knowledge of a medical practitioner. We were unable to conclude from Dr. MacKenzie's evidence that he had made a sufficient study of the highly technical subjects of sewerage engineering and sewage treatment and purification processes to enable him to qualify to speak as an expert. As for the medical practitioners who signed the petition, there was no evidence whatever that they had made any study at all of these subjects. Without in any way throwing doubts on their good faith or motives, we consider it is our duty, in view of the effect the publication of their opinion may have on the public mind, to state that we think it was unfortunate that they did not attempt to justify their opinion, which, as we have said, was not only not supported by any reliable evidence, but was contrary to the weight of the expert evidence adduced before us.

(17) There is another matter about which it seems likely that there is misconception among the members of the public to which reference should be made. By section 34 (3) of the Drainage Act the Drainage Board has the obligation of obtaining from time to time the approval of the Auckland Harbour Board "as to the degree and character of purification of the effluent to be discharged" from the works to be established at Brown's Island. The section also imposes on the Board the further obligation that it "shall not discharge or permit to be discharged therefrom any effluent not conforming to the degree and character of purification for the time being approved by the said Harbour Board." In pursuance of this obligation, certain "standards of purity" have been agreed upon between the Drainage Board on the one part and the Harbour Board and

the Health Department on the other (see paragraph 33), and the evidence showed that the Harbour Board and the Health Department propose taking whatever action is found necessary to ensure that these standards will be complied with and that they will be altered if they are found to be too low or unsatisfactory in any other way.

(18) A good deal of attention was devoted to this subject at the hearing, and in particular there was considerable criticism of the adequacy of the float tests which have been carried out by the Harbour Board to determine the nature of the movement of the waters in the vicinity of Brown's Island under the influence of tides, winds, and currents. We are satisfied that the tests support the opinion that there is no reasonable possibility of any effluent which is discharged from the outfall proposed to be constructed reaching any beach within a period of four hours, and that within that period the purification of the effluent to the prescribed standards will have been completed. It should be pointed out, however, that even if it should prove from the periodical tests which must be made to ensure compliance with the standards of purity that the effluent is not being purified sufficiently rapidly by dilution, the Board will be under the obligation of providing more complete secondary treatment in order to reduce the impurity factor. It is apparent, we think, that much of the criticism of the float tests has arisen from a want of appreciation of the effects of the sun and the movement of water as purification agents.

(19) The bacteriological standards which are included in the standards of purity pay full regard, in our opinion, to the need for considering the reduction of the bacterial content of the effluent in addition to taking into account the amount of dilution obtained and the availability of dissolved oxygen in the diluting waters. There is considerable divergence in the standards which have been prescribed in the United States and other countries and it is difficult to determine what standards should be adopted. However, those prescribed for the Brown's Island area are as strict as the most conservative of the United States standards for actual bathing waters, and we consider, therefore, that there can be no doubt that they will be entirely satisfactory for samples taken from water which will be further diluted and purified before it reaches the bathing beaches.

(20) We consider, also, that there is no justification for the fears that were expressed that the Harbour Board and the Health Department may fail to insist on compliance with the prescribed standards of purity.

(21) While the Harbour Board and the Health Department have been the authorities actually concerned with the prevention of harbour pollution at Auckland, the Marine Department also has certain statutory obligations in connection with the matter, and we were informed by Mr. D. F. Hobbs, the Department's Senior Fishery Officer, who gave evidence before us on behalf of the Department, that in recent years it has taken an active interest in the subject of the reduction of pollution in harbours and in inland waters and other waters. We were also informed by Mr. Hobbs that an inter-departmental Pollution Committee, of which he is a member as the representative of the Marine Department, has recently, among other activities, conducted a fact-finding survey on the state of pollution of inland and coastal waters. The final report of this Committee was made available to us, and one of its recommendations is that a national pollution authority should be created by statute which would act as an advisory body on pollution questions. The Marine Department suggested that the inter-departmental Committee (or the statutory authority if the recommendation is given effect) should be given power to review any standards of purity that may be prescribed for the Auckland harbours. We have given careful consideration to this suggestion, which it was urged would have the advantage of placing the responsibility on an authority which would be unlikely to be affected by local pressure and which would have the benefit of the technical resources of all Government Departments. We consider, however, that there is much to be said for leaving the primary responsibility with the Auckland Harbour

Board, which has a direct interest in preventing the pollution of the harbour waters under its control. Nevertheless, in view of the interest and responsibility which the Health Department and the Marine Department have in the matter, we consider that the Harbour Board should be under a definite obligation to consult with these Departments before prescribing or altering any standards of purity. The Harbour Board has, we understand, always adopted the policy of consulting the Health Department in regard to pollution questions, and the standards of purity which have been prescribed for Brown's Island waters were adopted only after full consultation with, and with the approval of, that Department. We think that the powers of the Harbour Board will not be weakened by the imposition of a statutory obligation to consult with both the Health Department and the Marine Department, both of which are represented on the inter-departmental Committee and no doubt will be represented on any permanent authority that may be constituted. We recommend, therefore, that section 34 of the Drainage Act should be amended by providing that from time to time, before approving of the degree and character of purification of the effluent to be discharged from the outfall at Brown's Island, the Auckland Harbour Board must consult both the Health Department and the Marine Department.

(22) It will be understood, of course, that if, as we recommend, the sewage and trade wastes from the southern side of the isthmus are to be discharged into the Manukau Harbour it will be necessary for the Act to provide that the Auckland Harbour Board shall have the same control over the degree and character of purification of the effluent as it has in respect of the effluent to be discharged at Brown's Island.

(23) It will be apparent from the view we have expressed that we consider that urgent steps should be taken to alleviate and ultimately to prevent the recurrence of the serious condition of pollution now existing in the Waitemata and Manukau Harbours. It is true that there is no evidence that this condition has actually caused injury to the public health, but it would seem to be plain that it constitutes a potential menace which would necessarily become even more serious if it is allowed to continue. It will also be apparent that we are satisfied that, provided proper care is taken, all risk of danger to public health by the discharge of sewage effluent into harbour waters can be eliminated. We are also satisfied, as will be shown, that it is highly advisable, if not necessary, to use the waters of both harbours for the disposal of the effluent and that if this is done no harm will be caused to public health or to the enjoyment of the waters and beaches and pleasure resorts in the harbours. We have given full consideration to the objections on æsthetic, psychological, and sentimental grounds to the use of harbour waters for sewage-disposal purposes, but we are strongly of opinion that if these considerations are allowed to prevail the drainage problems of the Auckland district will not be satisfactorily solved and an excessive and unreasonable financial burden will be imposed on the district.

(24) In our opinion, on a consideration of all the evidence, it is clear that the opposition to the Brown's Island scheme has been unfortunate inasmuch as it has had the effect of delaying the execution of the works necessary to remedy a serious state of affairs. We should emphasize, however, that we recognize that the opponents are genuinely convinced of the soundness of their views and have been actuated by worthy motives.

DISPOSAL OF TRADE WASTES

36. (1) Before the location, number, and size of sewage-treatment works can be decided it is necessary to determine how the wastes (which are generally referred to as trade wastes) arising from the operations of certain industries in the district, and particularly in the Westfield - Penrose area, are to be dealt with.

Under the Drainage Board's proposals the question whether there should be one treatment-works and outfall at Motukorea or two treatment-works and outfalls, one at

Motukorea and the other in the Manukau Harbour area, depends to a large extent and perhaps solely on whether trade wastes will be discharged into the Board's sewers. If they are not to be received and dealt with by the Board, then single treatment-works at Motukorea would be adequate for the disposal of the ordinary domestic sewage for a long time to come. On the other hand, if these wastes are to be discharged into the Board's sewers, their volume and their quality require that either there should be very much more extensive treatment at a single treatment-works or that there should be a second treatment-works in the vicinity of the Manukau Harbour. It follows, therefore, that unless the Board knows whether it is to receive the trade wastes it cannot make proper plans, because the size of the sewers and of the works cannot be determined without there being available a reasonably definite estimate of the volume of sewage to be dealt with.

(2) The position with respect to the discharge of trade wastes into the waters of the Manukau Harbour is extremely unsatisfactory. For some years it has been the practice for industries of various kinds located on the shores of the Mangere Inlet to discharge their wastes, often of a most noxious kind, without any purification treatment at all into the inlet. During recent years there has been a marked increase in the number of industries in the area, and therefore a very considerable increase in the volume of wastes which are discharged into the harbour. The result has been to cause what can only be described as serious pollution of the waters of the Mangere Inlet and of the foreshores. In view of the great concern that has been expressed for many years with regard to the pollution of the Waitemata Harbour by the Orakei system and by other sources of pollution, and of the strenuous protests that have been made with regard to the proposed Motukorea scheme on the ground that pollution will occur, it is remarkable that the situation at the Mangere Inlet has not excited greater attention. The dangers arising from the pollution of the Mangere Inlet waters were, indeed, recognized by the authorities, and it would appear that the reason for the delay in remedying the trouble that has occurred has been due to the expectation that a scheme for the disposal of the sewage would be determined and the work put in hand, and that in the meantime it would be unreasonable to require the industries concerned to go to the expense involved in effecting purification.

(3) It is necessary to explain more precisely what the expression "trade wastes" embraces. It will be appreciated that it is neither necessary nor practicable for every kind of waste arising from industrial operations to be disposed of by being discharged into drains or sewers. It should be explained, therefore, that trade wastes which concern a drainage authority are limited to liquid wastes, including those containing particles of matter in suspension.

The expression "trade wastes" is not defined in the Drainage Act, but it would appear that when used in the Act it means liquid wastes which come within the above description, and in the circumstances no definition was required. In view, however, of the importance which the disposal of trade wastes has now assumed, and as, in our opinion, it is advisable to impose obligation on the undertakings which produce them, it will be necessary to define in the Act what the term "trade wastes" is intended to comprise.

The term "trade effluent" is defined in the Public Health (Drainage of Trade Premises) Act, 1937 (United Kingdom), as being "any fluid either with or without particles of matter in suspension therein which is wholly or in part produced in the course of any trade or industry carried on at trade premises." Domestic sewage is excluded. Provided that it is made clear that the expressions "trade or industry" and "trade premises" are not limited to commercial or profitmaking undertakings, but include the operations of Hospital Boards and other public authorities and Government Departments, this definition would appear to be satisfactory.

(4) A full appreciation of the importance of the trade-wastes problem, particularly at Mangere, has come to be recognized only in the last few years. Mr. Watkins, in his 1931 report, referred to the subject, but it would appear that at that time he did not recognize how much the disposal of trade wastes would in the future affect the whole sewerage scheme. It should be remembered that since 1931 there has been not only a very large increase in the population of the district, but also that there has been a very large development of those industries which produce trade wastes. The Auckland Drainage Commission of 1937 appreciated that the problem was a serious one, and it expressed the view that the situation on the Mangere Inlet was in urgent need of attention. That Commission recommended that power should be given to the Drainage Board to require industrial undertakings to install and maintain on their premises at their own expense special treatment-works, and also that the Board should have power to approve of the establishment by a group of industrial undertakings of works to deal with the wastes from their establishments. In addition, the 1937 Commission expressed the opinion that it was important to prohibit the discharge of trade wastes of any description elsewhere than into the drainage system, and that it was undesirable that any exceptions should be allowed.

(5) No provision was made in the Drainage Act in express terms to give effect to the recommendation of the 1937 Commission that industrial undertakings should be required to discharge their wastes into the Board's sewers, and whether the Act does provide for compulsion is at least open to doubt. The Drainage Board's legal advisers consider that there is no compulsion. The legal advisers of some of the industries affected hold a different view. It is unnecessary for us to endeavour to decide which of these opinions is correct, because we consider that it is essential that any doubt about the position should be removed by legislation. As regards the 1937 Commission's recommendations that the Drainage Board should have power to require pretreatment of trade wastes before they are allowed to enter the Board's drains, effect has been given to this in the Act, and we consider that this power should be preserved.

(6) When, in 1946, Mr. Rowntree was appointed as the Board's Designing Engineer, he was instructed, as a matter requiring early attention, to investigate the trade-wastes position. It is unfortunate that the Board's staff has not up to the present time included a chemist, as it seems that without the assistance of an experienced chemist it is not possible to make complete investigations. However, from Mr. Rowntree's inquiries it became apparent, even before Mr. Porter arrived in New Zealand in June, 1948, that the pollution caused by the unrestricted discharge of trade wastes into the Manukau Harbour was more serious than had been realized, and that the volume and strength of such wastes was such that the sewerage scheme provided for in the Drainage Act was likely to be affected. After Mr. Porter's arrival the investigations were continued, and before very long Mr. Porter came to the conclusion that if it were to be compulsory for all the wastes to be received and dealt with by the Board it would be necessary to alter the plans for a single treatment-works and outfall at Brown's Island. Accordingly, in November, 1948, he notified the Drainage Board and other authorities concerned that the trade-wastes problem was so great in terms of strength and volume that unless the wastes were to be excluded they must be regarded as a main consideration in connection with the location, design, and cost of treatment-works.

(7) The reason for this will be appreciated when it is explained that the investigations showed that the existing trade wastes (average summer flow) from the southern side of the isthmus amount in volume to 4,500,000 gallons per day and that the strength of most of the trade wastes is more than three times that of medium-strength domestic sewage. The effect of this is (combined with the increase in population that has taken place) that the Westfield and Penrose trade wastes contribute a further impurity load which is almost equivalent to the whole of the domestic sewage from the Inner Area of the district. If the trade wastes from the northern side of the isthmus are also taken

into account, it would appear that the impurity load is now twice that which was allowed for in 1931 for the first stage of the Motukorea scheme. Taking into account the probable population increase during the next fifty years and assuming that all trade wastes are received by the Board's sewers, the result is that if the effect of the trade wastes is considered in terms of population the Board may be required by the year 1965 to deal with sewage equivalent to that from a city without industries of approximately 700,000, and by the year 2,000 the "equivalent population" may be over 1,000,000. As the ultimate population allowed for in Mr. Watkin's original proposals was 550,000 and as no special provision was made in these proposals for trade wastes, the influence of the trade-wastes factor in the location, number, and extent of the treatment-works required will be obvious. It should be mentioned that this aspect of the problem would appear to have received little consideration on the part of the Drainage League and its technical advisers.

(8) We should explain that it was contended before us on behalf of certain of the industrial undertakings concerned that the order of reference did not empower us to consider or make any recommendations with respect to trade wastes problems. This contention was put forward rather faintly, and as we have come to the clear opinion that trade-waste matters are within the scope of the order of reference, we have considered them and have come to certain conclusions in regard to them.

(9) We have mentioned that doubts have been expressed as to whether the Drainage Act imposes an obligation to discharge trade wastes to the Board's sewerage system. We consider that it is essential that there should be compulsion, although we consider, notwithstanding the views expressed by the 1937 Drainage Commission, that in certain circumstances exemptions should be allowed. The Health Department and the Harbour Board and other authorities favour compulsion, and, in general, the industrial undertakings themselves agree. They claim, however, that they should not be put to any expense other than the expense of a certain amount of treatment on their own premises, and the fertilizer undertakings claim, in addition, that as the wastes from their works have a very low degree of impurity they should be permitted to discharge their wastes into the waters of the Manukau Harbour as they now do. The evidence with regard to the wastes from the fertilizer-works indicates that under proper control it may be quite safe for their wastes to be discharged into the harbour, but it is essential that there should be effective control.

The conclusion to which we have come is that the discharge of all "trade wastes" (to be defined in the Act) into the sewers of the Drainage Board should be compulsory, but that with the approval of the Harbour Board exemption from this obligation should be permitted to be made by the Drainage Board on such conditions as may be prescribed by the Board and approved by the Harbour Board. We consider that an undertaking should have a right of appeal against a refusal of its application for exemption and also against any of the conditions of exemption that may be prescribed by the Drainage Board, and we recommend that the Drainage Act should be amended by a provision conferring this right of appeal and applying the provisions of section 61 of the Act. We also consider that section 34 (4) of the Act should be amended so as to make it clear that it applies to trade wastes, and that section 32 (1) and its proviso should be similarly amended.

(10) Trade wastes differ considerably in their volume and in the degree of their noxiousness. In some cases no harm to the Drainage Board's operations would be caused by their being received by the Board's sewers without being previously treated so as to reduce their noxiousness. In other cases, pretreatment to a greater or less degree would be necessary, the degree being regulated by the necessity of assuring that damage to the main sewers will not be caused and that the costs of operation and maintenance per unit volume will not be unduly increased. There are also cases in which, while pretreatment would not be absolutely necessary, in default of it, extra expense would be caused

to the Board. There can be little doubt, we think, that, in general, the treatment of wastes can be more efficiently and economically carried out by the Board. Further, it would appear that in some circumstances the Board's treatment operations will actually obtain an advantage from having the use of the wastes.

Questions therefore arise as to whether there should be power to compel industrial and other undertakings—

- (a) To reduce to a prescribed standard the noxious quality of their wastes.
- (b) To bear the expense of such pretreatment.
- (c) To bear the expense caused of giving such wastes when received into the Board's sewers such further treatment as may be necessary and of finally disposing of them.

(11) The recommendation made by the Auckland Drainage Commission of 1937 that industrial undertakings should be responsible for carrying out pretreatment of trade wastes at their own expense (see subparagraph (4) above) were adopted in the Drainage Act, and it has not been suggested to us by any one that this principle is unsound or unfair and should be altered. Indeed, the principle was expressly affirmed by four meat companies which operate in the Westfield-Southdown area and produce large quantities of noxious wastes. In our opinion, this principle should be maintained.

It is perhaps doubtful whether section 27 (1) (b) of the Act empowers the Board to require an undertaking to make provision for an inspection chamber or manhole to enable samples to be taken at any time of what is passing into a sewer so that the quality of the wastes can be determined, and we recommend that this power should be expressly conferred and that the expense of making such provision should be borne by the undertaking.

(12) It should be mentioned that the meat companies referred to suggested that the Board should have authority to carry out such pretreatment itself if in any particular case the Board and the undertaking agreed that this should be done. The Board approved of this proposal. As we have stated, the treatment of wastes can, in general, be carried out more efficiently and more economically by the Board, and the Board may actually benefit by having the use of the wastes. We consider, therefore, that the Board should be given power to treat the wastes instead of this having to be done by the undertaking.

(13) The meat companies contended that, apart from rates and the cost of pretreatment carried out by the undertaking or by the Board at the request of the undertaking, they should not be under any further liability in respect of the treatment and disposal of their wastes. We understand this to mean that the expense of any treatment which the Board may find it necessary or advisable to give such wastes in addition to the pretreatment referred to above, and also the expense involved in conveying such wastes from the premises of the undertaking to the final point of disposal, should be borne solely by the Board.

(14) So far as the expense of any further special treatment is concerned, we consider that the contention of the meat companies is sound. If the Board has power to require pretreatment at the cost of the undertaking, we do not think it is necessary or reasonable to impose any further burden in respect of treatment on the undertaking. Subject to the right of appeal conferred by section 27 (1) (b) of the Drainage Act, the Board has control of the situation, and can ensure that the noxiousness of the wastes is reduced at the expense of the undertaking either by the undertaking itself or by the Board.

(15) Different considerations apply, however, in respect of the expense caused by the disposal of the volume of the wastes. We think that there is a substantial difference in this connection between ordinary domestic sewage and trade wastes. The principle upon which the liability in respect of domestic sewage is based is that it should depend on the value of the property from which the domestic sewage originates. Although this principle disregards the fact that two properties of equal value may differ materially in the use made of a sewerage system, we consider that it is the only practicable principle.

We think that the use made of the sewerage system for the disposal of trade wastes is, in substance, in the nature of an abnormal or extraordinary use of the system and that therefore different considerations apply from those which are applicable in respect of the disposal of domestic sewage. Under the Municipal Corporations Act, 1933, a local authority is empowered to distinguish between an ordinary supply of water and an extraordinary supply. Where an extraordinary amount of water is used, as in the case of many industries, the consumer may be required, and generally is required, by the local authority to make an additional payment. We think that the position with respect to sewage is analogous to that of water.

(16) If sewers are to be used for the disposal of trade wastes, larger sewers will be required and larger outfall works will also have to be installed. The result will be that extra expense will be caused by reason of the necessarily increased capital costs of construction, together with the additional annual charges in respect of such costs and of the increased maintenance and operation costs in connection with the disposal of trade wastes. We recognize, however, that the community as a whole derives benefits if trade wastes are disposed of through the sewerage system, as this method affords a valuable protection to public health, particularly by reason of the greater degree of control that can be exercised. Further, the community should share in the cost by reason of the fact that industrial undertakings will contribute to the Board's revenue by way of the rates for which they will be liable to the various local authorities which are contributing authorities under the Drainage Act.

(17) It was contended before us that to require industries to pay a special charge for the disposal of these wastes would throw a burden on those undertakings which similar undertakings in other districts are not liable to pay. It was therefore argued that to impose this burden would be inequitable so far as the industries in the Auckland district are concerned. We are unable to admit the validity of this argument. It may well be that those industries obtain special advantages from their location which similar industries in other districts do not obtain, and we consider that it would be impracticable to try to determine whether the balance of advantages is for or against local industries.

(18) Very little evidence was adduced before us to assist us in deciding how any charge to be imposed on industries for the disposal of their trade wastes should be assessed, and counsel for some of the industries affected suggested that it was probable that many industries which were not represented before the Commission may not have realized that this subject would be considered. We appreciate that this suggestion has weight. We should mention also that counsel for the Drainage Board suggested that we should do no more than lay down a general principle.

(19) We are satisfied that undertakings which produce trade wastes should be required to pay to the Drainage Board a reasonable charge for the disposal by the Board of the wastes. We recognize that the determination of the charge will involve the consideration of several factors. We have referred in subparagraph (16) above to some of these factors, but we recognize that there are others which should be taken into account. For example, as we have mentioned in subparagraph (15), the properties from which the wastes are produced have a rating liability in respect of the disposal of the domestic sewage from the properties and if, as will often be the case, it is impracticable without undue expense to separate the domestic sewage discharged to the Board's sewers from the trade wastes it would be reasonable to take this into account when fixing the charge.

(20) We consider that on the information available to us it is impossible to decide what the charges should be. We have considered the advisability of recommending that an independent tribunal should be appointed to determine them, but our opinion is that this is not necessary. Section 28 of the Drainage Act affords adequate protection to the undertakings against the imposition by the Board of arbitrary or unreasonable charges, and the general law gives additional protection.

(21) We have therefore come to the conclusion that the Board should be given power by an amendment of the Drainage Act to prescribe by by-law what charges undertakings should be required to pay for the disposal of their trade wastes. We also consider that the Board should be empowered to require an undertaking to install and maintain at its own expenses such meters or other appliances as may be required in order to measure the volume of the wastes.

(22) The next question requiring consideration is how the cost of providing the sewers necessary to convey the wastes from industries to the main sewers should be borne. We consider that where the waste can be discharged into existing local sewers which are connected with main sewers it is unnecessary to make any special provision. If, however, it is necessary for a new local sewer to be provided, the expense of this should depend on whether this sewer is to be used only for trade wastes or for trade wastes and domestic sewage combined. If the sewer is to be used for wastes only, then the cost should be borne by the Board. If, however, it is to be used for both wastes and domestic sewage, the cost should be proportioned between the Board and the local authority on an equitable basis. If an existing local sewer has to be altered to take trade wastes, the Board should bear the expense. It would be advisable, we think, for any disputes arising in connection with the cost of providing or altering local sewers to be determined by arbitration.

(23) We have given careful consideration to the question whether, pending the establishment of sewers by the Board to enable the trade wastes which are now discharged into the Manukau Harbour to be received by the Board, it is possible to take action to abate the nuisance that now exists. It will necessarily be some time before trade wastes can be discharged into any sewerage system constructed by the Board. In the meantime, however, the pollution that exists in and about the Mangere Inlet is, as we have pointed out, very serious, and we consider that it is imperative that action should be taken to effect at least an improvement. We recognize that it might be unreasonable and impracticable to require an industrial undertaking to install expensive equipment for treatment of trade wastes on their premises which, on the completion of the sewerage system, may become unnecessary or quite useless. On the other hand, there appears to be no reason why the more harmful of the wastes should not be disposed of by incineration or other suitable means without undue expense so that to some extent at least the menace to health at Mangere Inlet would be at least mitigated. We recommend that the Harbour Board and Health Department should, without delay, consider what steps can be taken to effect an improvement. It is possible that the powers possessed by them at present may not be adequate. If this is the case, additional powers should be given. We recognize that the Harbour Board and Health Department have for some years been concerned about this matter, and we understand that the only reason why effective action has not been taken before was the expectation held by them that the Drainage Board scheme would be constructed without much further delay. It seems clear, however, that, even if complete plans for a sewerage system were to be decided upon within a short time, some years must elapse before that system can be put into operation, and in the meanwhile, unless action is taken, the existing nuisance at the Mangere Inlet will continue and possibly be aggravated.

(24) In addition to action being taken to bring about an improvement pending the execution of the scheme, we think that action on the following lines could also be adopted. When a scheme is adopted it is probable that the sewers and outfall in connection with the scheme could be constructed without much delay and that the construction of treatment-works will take a longer time. We think, therefore, that the Board should ensure that the construction of the sewers and outfall is put in hand as soon as possible as well as the construction or alteration of any local sewers that may be required so that, as soon as possible, the trade wastes, even if in an untreated condition, may be discharged into the Purakau Channel. Their discharge into this channel would mitigate the serious position which exists in and near Mangere Inlet and, in addition, would bring about a substantial general improvement.

(25) We think, also, that, in order to relieve as soon as possible the existing situation at Mangere Inlet, the Board should be empowered to determine, in anticipation of the completion of the construction of the sewers and outfall, the amount and nature of treatment that will be required to be undertaken on the premises of the undertakings and to require that the installation of the necessary equipment shall be put in hand so that as soon as the sewers are ready to take the effluent the full amount of treatment can be effected. Obviously, this could be done only so far as the treatment is of the kind which will be carried out on the premises of the undertaking.

PART III—UTILIZATION OF SEWAGE

GENERAL

37. The problems connected with the utilization of sewage are in certain respects the most important of the questions with which this inquiry is concerned. It has been explained that these problems are the major interest of the Drainage League, and it will be shown that they were the basis of the petition presented to Parliament in 1946 and the cause of the Commission being appointed. It is therefore not surprising that a large proportion of the time occupied in hearing evidence and representations was devoted to this subject. The problems have special importance because the Drainage League's proposals include the application of composting processes on a scale that has not previously been attempted anywhere in the world. We were informed by Mr. Robinson, the president of the Drainage League (who is also president of the New Zealand Humic Compost Society), that "the question of utilizing sewage to compost town garbage and organic wastes is a matter of world-wide interest" and that the Drainage League's proposals have aroused international interest as well as wide interest in New Zealand.

UTILIZATION OF SLUDGE

38. (1) While it is possible to make some use of grit, paper, rags, and other similar constituents of sewage, the quantities are small and it is unnecessary for the present purpose to take them into account. The main constituent is the sludge—the material which settles as the result of sedimentation or activated-sludge treatment. This has a manurial value and contains substantial quantities of nitrogen and phosphates and some potash. When sludge is removed from the treatment plant it contains more than 90 per cent. of water, and the problem that arises is as to how practical use can be made of it.

(2) As has been shown, it is impracticable in the Auckland district to use sewage or effluent by disposing of it on land. Apart from incineration, the safest method of disposing of sewage sludge from the point of view of public health is to discharge it at a suitable place in the open sea or to convey the sludge to sea and dispose of it there. These methods are those most generally employed, but as they involve considerable expense and also the waste of useful manurial materials, increasing attention has been devoted to the possibilities of utilizing the sewage. The handling and transport of wet sludge—that is, sludge from which the water content has not been extracted or materially reduced—is expensive on account of its high water content, and this factor has an important bearing on the question of its disposal.

(3) The claims made as to the value of sludge for agricultural purposes are sometimes placed too high, and it will be useful to state the conclusion which the Agricultural Research Council of Great Britain reached in a recent consideration of the subject. It was agreed by the representatives of the Drainage League and by all the interests represented at the inquiry that the Council is a highly authoritative body and that its views have considerable weight. Its conclusions on this subject have been

published in a memorandum (A.R.C. 10011) dated 27th April, 1948, which was extensively used by both the Drainage League and the Drainage Board in support of the various submissions made by them. The conclusions are as follows :—

(a) Sewage sludge has a moderate manurial value as a source of slowly available nitrogen and phosphate. It provides very little potash. In general, the crop-producing power of sludge taken from drying-beds is much less than that of an equal weight of farmyard manure. The physical effects of sewage sludge on the soil are less pronounced and of a different kind from those of farmyard manure because sewage sludge lacks the coarse fibrous ingredients derived from straw and other plant residues.

(b) Only sludges in a comparatively dry state (less than about 50 per cent. moisture) are convenient for transport and spreading. As they must be applied at heavy rates and are sometimes difficult and unpleasant to distribute, their use must depend on economic and local considerations so that no general statement can be made on their agricultural value.

(c) Digestion improves the physical condition of sludge and the availability of its nitrogen. These improvements are still more evident when the digested sludges are shed-dried and pulverized.

(d) Certain sludges from sewages of industrial origin contain metallic and other wastes which may render their phosphate unavailable and may sometimes be harmful to crops in heavy dressings. Such sludges and also those to which iron salts have been added in the course of treatment at the sewage works should be tested on a small scale before they are used extensively.

(e) Satisfactory rotting of straw takes place in compost heaps prepared with about one and a half parts of sludge dry matter to one part of straw, provided the heap is satisfactorily wetted and aerated. Field trials have shown that such composts are better than sewage sludge alone because they supply some potash and have better physical effects on the land. Although composts of sludge and straw have proved somewhat inferior to equal quantities of farmyard manure in field trials, they provide convenient methods of adding bulky organic manures to market garden soils. Only a limited number of field experiments have been carried out on composts of sewage sludge and town refuse ; some of these have given useful results.

(f) No instance is known in which the use of sewage sludge as a manure for a crop for human consumption has led to an outbreak of typhoid or dysentery infection, but special precautions should be taken in using sludge for salad and other crops to be eaten raw. Wet sewage sludges should never be used for such crops, and sewage sludges from drying-beds only when they can be applied to the land some months before these crops are to be sown.

(4) It will also be useful to refer to a manual entitled " The Utilization of Sewage Sludge as Fertilizer " which was published in the year 1946 by the Federation of Sewage Works Associations of the United States. In this manual the use of sewage sludge in many places in the United States under many different climatic and economic conditions is reviewed, and its conclusions regarding the properties of the different kinds of sludge may be conveniently summarized as follows :—

(a) Raw primary sludge is not usually used because (i) it is odorous, (ii) it has a higher grease content than digested or activated sludge, (iii) it causes soil acidity, (iv) it may contain toxic substances from trade wastes, and (v) it is a potential carrier of pathogenic bacteria.

(b) Liquid digested sludge is seldom used in the United States and only occasionally in England.

(c) " Dewatered " digested sludge (i) has less bulk, (ii) can be applied more easily at required rates, (iii) has a minimum of odour, (iv) has a better appearance, (v) can be more easily stored, (vi) has a reduced bacteriological content with less risk of transmitting disease, (vii) has a reduced (by digestion) grease content, and (viii) is humified during digestion.

(d) The drying of digested sludge by heat is rarely attempted because of the low content of plant-food which results.

(e) Heat-dried activated sludge is the best type for agricultural use, whether used by itself or mixed with other fertilizer, because (i) it has greatly reduced bulk, (ii) it can be applied easily, especially when pulverized, (iii) it has a minimum odour, (iv) it contains more nitrogen than digested sludge, (v) it can be applied as top-dressing, (vi) it has a grease content which is greatly reduced by digestion, and (vii) it is believed to be free from harmful bacteria.

(5) The general conclusions reached as the result of the investigation and consideration of the matter by the Federation of Sewage Works Associations were as follows:—

(a) Sewage sludge is of use as a fertilizer and soil conditioner, if properly prepared and applied. Its value varies with the type of sludge.

(b) Fresh sludge is seldom used and may be troublesome because of grease content, odors, and bacterial content.

(c) Digested sludge, whether wet, air-dried, or heat-dried, appears to have application as a substitute for manure and is of about the same fertilizing value. In its wet form it must be used relatively near to the sewage treatment plant. In its air-dried form it may be worth while to transport it a short distance, perhaps 20 miles. In its heat-dried form, with a sufficient nitrogen content, it may justify a considerable haul. The nitrogen content, however, is relatively low (0.5 to 3 per cent. dry basis) as compared with heat-dried activated sludge (3 to 6 per cent. dry basis).

(d) Heat-dried activated sludge appears to have real value as a source of organic nitrogen fertilizer, whether used directly or in mixture. It is free from weed seeds, blends quickly with the soil, when applied has a slight odour for a very short period, and it can be used with safety in fertilizing practically all crops requiring nitrogen in organic form.

(e) The sewage treatment plants offering digested sludge are scattered all over the United States. The air-dried sludge is most commonly used locally within an easy distance of truck haul. Most of the plants give away this sludge; many load it free of charge.

(f) Air-dried digested sludge should preferably be disintegrated or ground to remove lumps before distributing for use. When so prepared, a charge is usually made in addition to a charge for bags.

(g) Both wet- and air-dried digested sludge should be handled like manure and plowed under as soon as practicable after distribution.

(h) It would appear that the heat drying of digested sludge depends for its success on local conditions such as the soil and the crops, and on the effort and skill of the sewage works manager in exploiting the product, as well as on its analysis. The cost of equipment and operation is a deterrent to such procedure at small plants. Most of the heat-dried digested sludge is used directly in farming or gardening. A small amount is bought in bulk by mixers. Heat-dried digested sludge can be used with safety at any reasonable time.

(i) The limited experience at Rockford, Ill., indicates that the enrichment of heat-dried digested sludge to compete with heat-dried activated sludge does not appear to be practical.

(j) Digested activated sludge apparently falls into the general digested sludge classification when judged by its analysis and use.

(k) Heat-dried activated sludge appears at present (1946) to have a ready market, which the plants at Milwaukee, Chicago and Houston are unable to satisfy. This type of sludge sells retail in bags (by the bag, ton or carload) and wholesale in bulk (carload) at a somewhat lower price, determined by the market price of its organic nitrogen and phosphoric acid contents.

(l) Heat-dried activated sludge is of value in the fertilizer and agricultural field for its organic nitrogen and phosphoric acid as well as its humus and its effect as a conditioner in mixed fertilizers. With a nitrogen content of around 4 per cent. or higher, it may justify a rail haul of 1,000 miles, more or less, in carload lots. In bags, it has been shipped 2,000 miles in limited amounts.

(m) Where organic nitrogen is required in agriculture, heat-dried activated sludge can be used with safety at any time.

(n) The cost of dewatering and heat drying activated sludge on a small scale appears to have deterred those in charge of the smaller sewage treatment plants from following this practice.

(o) With the exception of the Southern California citrus orchards, no organized handling of air-dried digested sludge from a number of adjacent plants has been found. A large number of plants, however, both large and small, have developed a market for their entire output. There is no uniformity of charge or of success in disposing of the sludge. In many small plants a knowledge of the uses for sludge appears lacking. It is hoped that this manual will fill the need for such information.

(p) Heat-dried activated sludge is the least odorous and fresh sludge the most odorous of the various sludges. The degree of odor from digested sludge may depend on the completeness of digestion. It is therefore desirable that all air-dried or fresh sludge be turned into the soil as promptly as possible.

(q) From the hygienic standpoint, heat-dried activated sludge and heat-dried digested sludge appear safe for any reasonable use in agriculture or horticulture. Digested sludge, air-dried, appears safe for such purposes if used like manure and plowed in, when preparing for a crop, and if care is taken not to apply such sludge thereafter on root crops or low-lying leafy vegetables which are eaten uncooked. Thorough digestion and air drying, as well as storage of the air-dried sludge, afford a sufficient protection of health. Up to date, no case is known of sickness traceable to the use of digested sludge or activated sludge. Most of the State health departments, however, advise that sludge (unless heat-dried) should not be used for crops which are consumed raw.

Liquid sludge from the digesters should be used with care as it may contain pathogenic organisms depending on its age. It is not so safe as air-dried digested sludge.

Fresh sludge in the form of liquid or press cake should be regarded as only one degree removed from night soil and treated as such, being used only on forage crops and then plowed in promptly after application.

(r) Under war conditions, when the demand for fertilizer material was great, unusual conditions existed which, in general, stimulated the use of all air- or heat-dried sludges. The indications are that adjustments will eventually occur, with lowered prices for all heat-dried material. For the sewage treatment plants offering air-dried material gratis, the demand should continue with increased use as the value of the material is demonstrated.

DISPOSAL OF DIGESTED SLUDGE

39. (1) In his report dated 15th December, 1948, Mr. Porter estimated that (on the assumption that trade wastes will have to be dealt with by the Drainage Board) there will be about 3,000 tons of wet sludge per week in the first few years and that ultimately the quantity may exceed 7,000 tons per week. After pointing out that the disposal of wet sludge in a sanitary manner is one of the main problems in sewage purification and that if, as is proposed, the digestion process with sludge-gas production is adopted for Auckland there will remain for disposal a considerable quantity of sludge with a water content of more than 91 per cent., he discussed (and opposed as too expensive) the carrying of the sludge to the open sea. He then referred to various other methods of disposing of digested sludge, and it will be convenient to quote his statement on these in full :—

Other methods of disposal of digested sludge are :—

(a) Pressing by machine, with sale of sludge cake for its manurial value. This process is somewhat expensive and is not now usually included in new sludge disposal works. At some works, sludge cake is heaped in the open, and ground to produce a fertilizer base. A sample of ground undigested sludge cake from Bradford is available for inspection.

(b) Elutriation, vacuum filtration, flash drying, and incineration (or grinding to produce fertilizer). This process is used by West Kent Main Sewerage Board, and by a number of American cities, and will be used at the new Colne Valley Sewage Works. It has the disadvantages of requiring large quantities of heat and chemicals, and investigations at Manchester and Sheffield have proved it to be somewhat expensive. It could only be operated in New Zealand if a regular supply of necessary chemicals could be guaranteed at a low price for many years in advance. A sample of ground digested primary sludge from West Kent is available for inspection.

• (c) Air-drying on scoria beds, covered with sand. This process involves use of considerable areas of land, but is relatively cheap to operate. Air-dried sludge has a sale value of possibly 10s. per ton, which would hardly pay for the cost of lifting and transport.

(d) Air-drying, followed by rapid grinding at high temperatures. This is the most up-to-date British process and on test has produced a good quality fertilizer, of which a sample (from West Middlesex) is available for inspection. Material of similar quality is sold commercially in Great Britain at a retail price of 25s. per cwt. The wholesale value on yearly contract should be £6 to £10 per ton. Middlesex County Council is now installing plant to produce about 4,000 tons per annum, and if satisfactory sales are obtained can produce ultimately about 20,000 tons per annum. This process is recommended for use on Motukorea, and, if satisfactory there, for use at any works which may be established at Mangere or Southdown. The amount which might be produced in 1965 is 6,000 tons per annum approximately. The annual (loan and operating) cost of sludge disposal by this method would be about £40,000. This amount would be offset by value of gas produced, about £10,000 per annum, and value of fertilizer produced, say £25,000 net per annum. In a full operational year, therefore, the income from sludge treatment would almost equal the overall cost of sludge disposal.

Notes from West Middlesex Works indicate that the final moisture content should be about 10 per cent., and that if relatively full scale oxidation is carried out the material would contain at least 3 per cent. organic nitrogen and about 2 per cent. phosphoric oxide with traces of potash and other valuable materials. The powder is in such condition that it could readily be fortified by the addition of phosphates and potash to any degree required.

(e) Composting with town wastes. In 1965, organic wastes available in Auckland would be about 15,000 tons per annum. Composts should initially contain about 1 ton wet sludge to 1 ton organic wastes. As the output of wet digested sludge will be about 70,000 tons per annum, a composting scheme depending on town and industrial wastes only, is quite impractical as a means of disposing of the Board's output of sludge, as it would leave nearly 55,000 tons per annum to be disposed of by other means.

(2) It will be noted that Mr. Porter recommended that the process of air-drying followed by rapid grinding at high temperatures should be adopted for the Brown's Island scheme, and if it is found to be satisfactory there, that the same process should be used in the southern side of the isthmus.

DRAINAGE LEAGUE PROPOSALS

40. (1) The proposals for utilizing sewage advocated by the Drainage League were explained by Mr. Worley to be as follows :—

- (a) There would be treatment-works at Southdown for the activated-sludge process.
- (b) An artificial fresh-water lake having an area of 1,869 acres would be made in the Manukau Harbour above Onehunga by replacing the Mangere Bridge with a causeway equipped with penstocks and overflow weirs discharging on the ebb tide. This lake would receive the purified effluent from secondary sedimentation tanks either direct or after passing through mechanical filters if these are required by the Health Department.
- (c) After further large-scale tests the activated sludge would be used as an activator in the manufacture of compost from garbage and other municipal and trade wastes, and in the meanwhile the sludge could be dried on drying-beds to produce sludge cake for sale to farmers.
- (d) If the large-scale tests are successful, approximately half of the lake would be used as a weed lake in which water-hyacinths or watercress would be cultivated, and harvested and added to the compost heaps. It is claimed that the water plants would extract the soluble mineral salts contained in the effluent and that the maximum amount of both organic and inorganic matter would be extracted from the sewage and other wastes and eventually returned to the soil.
- (e) In the first place the composting would be carried out by using wet sludge and garbage and other municipal and trade wastes. If the large-scale experiments in the cultivation and utilization of water weeds are successful, then use will be made of these.

(2) Mr. Worley estimated that the garbage available from the isthmus would be 49,200 tons per annum, as compared with Mr. Porter's estimate of 15,000 tons. He also considered that a minimum of 18,000 tons per annum of other organic wastes such as certain trade wastes and roadside clearings will be available. He claimed further that the whole of the sludge that would be produced would be able to be used for composting, and disagreed with Mr. Porter's contention that of the 70,000 tons of sludge that will become available only 15,000 tons could be used for composting and the remainder would have to be disposed of in some other way.

(3) The principle on which the league's composting proposals are based is concisely explained in the following extract from the evidence of Mr. Robinson :—

Practically all production from the soil finds its way into cities and towns in the form of food and industrial materials. All produce from the soil represents so much loss of soil fertility, which, unless replenished, becomes a diminishing asset, resulting, in the financial phases, in sterility and failure of production. Countries like New Zealand, which export huge quantities of primary produce, are in reality exporting their most valuable asset—soil fertility. This extracting of soil fertility must be made good; otherwise total collapse of the country's economy is inevitable. Since all organic wastes in cities and towns was originally produce of the soil, these wastes, after suitable processing, should be returned to the soil. That, in brief, is what we propose.

Until the last few years, the need to restore organic matter to the soil was not generally recognized. Even to-day there are many who, because of prejudice, ignorance, or vested interest, do not realize the vital importance of this return to the soil or, as it is commonly called, the maintenance of the organic cycle. Orthodox methods of garbage disposal have involved the expensive and wasteful practices of incineration or controlled tipping, whilst orthodox sewage disposal has usually involved pouring it through sewers into rivers, lakes, or the sea, usually polluting the receiving waters and thus endangering the health of the public using those waters for domestic water-supplies or boating, bathing, and fishing pleasures.

(4) Mr. Robinson in another part of his evidence explained the general principles of the league's proposals as follows :—

We propose that *all* organic residues from the metropolitan area be composted, and that the compost, either wet, or dried and ground, be sold as a high-grade organic fertilizer. The organic residues available in Auckland are household garbage, roadside cuttings, weeds, trades wastes, fish and

vegetable-market wastes, gorse, sawdust, shavings, &c. These would be composted, using wet sewage sludge as the animal activator: water plants grown in an oxidation lake would extract valuable salts from the effluent and the weeds would be harvested and added to the other materials in the compost heaps. The scheme to be described is for one large plant to deal with all the wastes and sewage from the metropolitan area. For our scheme we would require about 20 acres to 30 acres of reasonably flat land for the composting site and an area of about 900 acres of mud-flats for our artificial lagoon. Almost all of the work of composting would be done by machinery. Plant for this purpose is simple and relatively inexpensive. Complete units for municipal composting are made and supplied by one of the large civil engineering firms in England.

VALUE OF ORGANIC MANURE

41. (1) A considerable volume of evidence was adduced with the object of showing the value of organic manure for agricultural (including market-gardening) purposes and the need existing in New Zealand for supplementing the supplies available. The Federated Farmers (Auckland Province), Inc., was represented throughout the proceedings by Mr. S. S. Green, a farmer, who, in addition to giving evidence, took an active part in ensuring that the Commission should be fully informed on these subjects. Several other farmer witnesses also gave evidence about these matters.

(2) In general, Mr. Green and the other farmer witnesses neither supported nor criticized the league's large-scale composting proposals. Their attitude was that in order to restore and maintain the fertility of the soil, fertilizers in large quantities and at a reasonable price are urgently required. They admitted the value of artificial fertilizers, but claimed that the quantity available is not sufficient and the cost is too high, and in addition they urged that the application of organic manures is essential to ensure fertility. They were therefore in favour of the league being given the opportunity of carrying out experiments with the object of enabling the commercial practicability of its composting proposals to be fully tested.

(3) In addition to the farmer witnesses, evidence on this subject was given by other witnesses, including Professor Chapman, Professor of Botany at the Auckland University College (who made special reference to the value of humus or compost), and Dr. Cumberland, Head of the Department of Geography at the same college (who has made a special study of soil erosion in New Zealand, and whose evidence was principally directed to showing the value of humus in preventing erosion. It is not necessary to refer to the evidence of these witnesses in detail. They did not profess to have studied the practicability of large-scale composting and their evidence as to the need for organic manure and the value of humus or compost was not really disputed.

(4) Special reference should, however, be made to the evidence given by Mr. I. L. Elliott, Assistant Superintendent of the Soil Fertility Research Station at Hamilton, which is under the control of the Department of Agriculture, Dr. J. K. Dixon, Chief Chemist of the Soil Bureau of the Department of Scientific and Industrial Research, and Dr. H. E. Annett, an agricultural research chemist who is farming on his own account and is also assisting at the Soil Fertility Research Station at Hamilton.

(5) Mr. Elliott stated that New Zealand soils are characterized by inadequate supplies of phosphate, and in some areas major deficiencies of lime and potash also occur. His Department accepted as obvious the necessity for organic matter in a fertile soil, but it held the view that by the use of phosphates, clovers, and grazing animals the grassland farmer has ample means of maintaining or increasing the organic matter in his soil. While the Department would wish success to any scheme which aimed at supplying organic matter at a price and under conditions which would make it advisable to use it, it is considered by the Department that little use would be made of the product by grassland farmers. In the opinion of the witness, on the basis of experiments made by him, much larger quantities of compost would be required than of phosphate, and this would be likely to make use of compost uneconomic.

(6) Dr. Dixon, who was a member of the inter-departmental Committee referred to in paragraph 21, explained the value of compost to the soil and the importance, if compost sales are to continue, of maintaining a standard composition which would give reliable results as in the case of blood and bone. He considered that the need for organic fertilizers depended on the soil type and the use to which the soil type is put, and pointed out the influence of climate, rainfall, and good management and the introduction of good grasses and the supply of adequate lime and phosphate in resisting erosion and maintaining or building up of humus. In his opinion, compost would be most beneficial in cropping areas, and he thought it reasonable that, since the products of market gardens go to the towns, the latter should return to the former some of the lost fertility. He therefore favoured the use of sewage sludge to produce composts for cropping areas near towns, but he regarded this as an undertaking not to be lightly entered into, and he therefore supported the making of experiments by "pilot" plants.

(7) Dr. Annett, who has had a wide experience in soil-fertility research in various countries, stated that he is a firm believer in the application of all possible organic residues to the soil and in the encouragement of the use of compost. He strongly condemned, however, the criticism of inorganic fertilizers which, he stated, has been made by compost supporters, and he contended that their claims that the use of organic fertilizers results in the production of disease-free crops and animals and more healthy human beings have not been established. Dr. Annett considered that the use for farm lands of organic manures produced by composting would, in general, be uneconomic, and, like Mr. Elliott, he stressed the importance of mineral fertilizers and clover and stock manure for maintaining and building up the fertility of these lands. In his view the Drainage Board would be unwise to undertake large-scale compost-manufacture.

INTERIM REPORT OF INTER-DEPARTMENTAL COMMITTEE ON UTILIZATION OF ORGANIC WASTES

42. (1) We have referred in paragraph 21 to the interim report made by the Committee which was appointed by the Government to study questions relating to the utilization of organic wastes. The Committee comprised senior officers from the Ministry of Works, the Soil Bureau of the Department of Scientific and Industrial Research, and the Departments of Health, Agriculture, and Lands and Survey. It heard evidence and made independent investigations and studied many relevant scientific and technical publications. In view of the standing and high qualifications possessed by the members of the Committee and the importance of the matters which they investigated, we think it will be helpful if we refer to the report at some length.

(2) The report contains some immediate recommendations in connection with municipal composting experiments which will be referred to later, and also the views held by the Committee at the time the report was made on some of the matters considered. The following general conclusion was expressed :—

Much of the evidence submitted by the petitioners is considered to be either unsubstantiated or irrelevant, but nevertheless the Committee is impressed with the potential value of the materials now being wasted and considers that research will be well worth while.

(3) The Committee discussed the effects of the present methods of soil management in New Zealand on its fertility and came to the conclusion that the composting of municipal wastes would be unlikely to benefit grassland farmers, but would probably be of value to market-gardeners and orchardists.

(4) With reference to the question whether the use of artificial fertilizers has a detrimental effect on the health of plants, the report states :—

Although general statements are made attributing many present-day plant diseases to the gradual loss of humus in the soil and to the use of artificial fertilizers, no worth-while evidence has so far been placed before the Committee as regards this matter. The Committee considers that the relation of compost to plant health is of sufficient importance to warrant investigation under New Zealand conditions.

(5) In considering the contention made by Mr. D. M. Robinson that—

there is plenty of evidence that all these troubles—namely, stock losses from mammitis, contagious abortion, and tuberculosis—are deficiency diseases resulting from the consumption of deficient food given in unfertile soil,

the Committee summarized the evidence placed before it by Dr. Filmer, Director of the Animal Research Division of the Department of Agriculture, and Mr. Ward, Director of Herd Improvement, New Zealand Dairy Board. The summary showed that the available evidence does not support Mr. Robinson's contention.

(6) The Committee came to the conclusion, after studying all the evidence submitted and interrogating two of the principal witnesses, Mr. Robinson, and Sir Stanton Hicks, of the University of Adelaide, that there is no clear evidence in support of the claim that—

the incidence of disease in New Zealand such as dental caries, bone complaints, heart affections, and digestive troubles appear to be increasing, and such increasing incidence would appear to have a definite relationship to deficiencies in food occasioned by the produce of soils lacking in important constituents or deficient in humus content.

It was pointed out by the Committee as significant that although the first signatory to the petition was the New Zealand Branch of the British Medical Association (by its president), no evidence on this matter was submitted by any member of the New Zealand medical profession.

(7) As regards the possibility of any risk to plant, animal, or human health from using compost made from sewage or garbage, the Committee considered that if efficient methods are adopted there is little evidence of there being any danger.

(8) As to the manurial value of composts, the Committee, after pointing out that this will vary according to the materials used and the mode of preparation, expressed the view that there was no doubt that composts would be of great value on suitable land and that everything practicable should be done to use organic waste.

THE VALUE OF COMPOST

43. It cannot be emphasized too strongly that there was no dispute before us about the value of compost. It would appear that many supporters of the composting principle regard opposition to the Drainage League's sewerage proposals as being opposition to the value of making compost. This is obviously not the case. The contest before us was concerned with the practicability and expediency of large-scale composting being carried out by the Drainage Board as a part of its sewerage and sewage treatment and disposal operations. It was contended by the Drainage Board and other opponents of the league's scheme that the basis of the scheme was the proposal for the utilization of sewage and municipal and other wastes by composting and that the league considered that all other considerations should be subordinated to this one. The Drainage Board also claimed that its proposals made adequate provision for the utilization of sewage sludge and that it would be wrong in the present state of knowledge of the possibility of composting sludge and town and other wastes to make a sewerage scheme dependent on the utilization of the sludge by the composting method. It was not contended that the principle of composting was unsound.

In these circumstances it is unnecessary for us to examine the claims that were made as to the value of composting wastes.

In this connection we think it is advisable to refer to the application that was made by the league for the Commission to recommend that the attendance of Sir Stanton Hicks, of Adelaide, and Mr. Van Vuren, of South Africa, should be arranged in order that they might give evidence with respect to this and certain other aspects of the inquiry. After giving full and careful consideration to the matter, we were unable to agree that the attendance of these gentlemen would assist us. Eventually counsel for the league agreed so far as Mr. Van Vuren was concerned the application could not be justified,

and that it would be satisfactory if Sir Stanton Hicks were to submit a prepared statement. It was accordingly arranged that this should be done. The statement submitted has confirmed our opinion that his attendance was not necessary. It does not cover any new ground, and so far as it is concerned with the importance of soil conservation and the value of compost, as we have explained, these matters were not in dispute. So far as the statement deals with sewerage problems, we are unable to accept his opinions as authoritative.

CULTIVATION OF WATER PLANTS

44. (1) The Drainage League's proposals for the cultivation of water plants in sewage effluent which would be discharged into a lake to be constructed in the Manukau Harbour met with strong opposition. For reasons which we think it is necessary to state only briefly, we are unable to recommend that they should be adopted.

(2) It should be explained that the league appreciated that the proposals were novel and might prove to be impracticable, and it therefore made it clear that it was not asked that effect should be given to them unless after full investigations had been made it was demonstrated that they could safely be adopted.

(3) It was claimed by the league that the cultivation of water plants would have two advantages. In the first place, it was contended that if the plants were grown in sewage effluent they would extract valuable mineral salts having manurial value from the effluent which cannot otherwise be recovered. Secondly, it was claimed that when harvested the plants would have a material value in supplying the vegetable matter required for mixing with sewage sludge and garbage for composting purposes, particularly because they would contain the salts extracted from the effluent.

(4) It was admitted that the practicability of extracting the salts has never been demonstrated. It also appeared that in the treatment of sewage by the ordinary processes the larger proportion of the salts is recovered, leaving in the effluent only a small proportion, and that under the most favourable conditions it is unlikely that more than 12 per cent. would be recovered with the aid of water plants. In these circumstances we consider that the league failed to show that the growing of water plants in order to recover the mineral salts would be justified.

(5) We consider also that it was not shown that the cultivation of water plants was justified as providing organic matter for composting. Of the estimated daily summer-time harvest of 4,000 tons, only 200 tons of dry matter would become available, and having regard to the high costs involved in obtaining this quantity, the scheme would appear to be uneconomic.

(6) There were, however, even more serious objections to the proposals. Although Mr. Robinson claimed that in addition to water-hyacinths and cress there are a number of other water plants which are suitable for the purpose, most, if not all, of the evidence had reference to water-hyacinths and cress, and we will refer only to these plants. It should be observed that cress has its roots in soil and hyacinths in the water, and that if the former is grown the lake would have to be kept shallow, which would be a serious disadvantage. In fact, the practicability of growing cress for composting was not seriously pressed by the league, and we think it is clear that it would be unsuitable. Leaving out of consideration for the moment the objections to the growing of hyacinths which were made on the ground of the potential danger to health and the nuisance that might arise from the impounding in the locality proposed of a large mass of foul sewage and from the algal growths that would be encouraged to develop (which are matters that in themselves raise grave doubts) there was much evidence of great weight to support the Drainage Board's objection based on difficulties connected with the plant itself. Unless hyacinths grow profusely they would be of little use. If, however, they grew profusely there is a strong probability that they would become a pest, as has happened in other countries. It is unnecessary to traverse the evidence on this point in detail.

It is sufficient to say that it showed that there is a grave danger that the successful cultivation of hyacinths might cause serious trouble by the blocking of drains and waterways, and by the difficulty of preventing its spreading. These dangers have been recognized by the Department of Agriculture for several years, and the Department has obtained information about the trouble that water-hyacinths have caused in other countries. Their introduction into New Zealand was therefore prohibited by the Introduction of Plants Act, 1927, and action is being taken by the appropriate authorities to prevent their propagation in New Zealand by the application to them of the provisions of the Noxious Weeds Act, 1908. The plants have caused trouble in the Whakatane district, where they are infesting and blocking canals and streams, and the efforts made to eradicate them have proved to be very difficult.

(7) We are satisfied from all the evidence that it would be most unwise to take the risks that would be involved in conducting experiments in their cultivation for composting purposes, and on this ground alone this proposal cannot be recommended. We should add that the evidence on this matter was so strong that Mr. Dyson in his final address was compelled to admit its weight, an admission which in our opinion was properly made.

COMPOSTING OF MUNICIPAL GARBAGE AND WASTES

45. (1) It is an essential part of the Drainage League's proposals that the garbage collected by the Auckland City Council and other local authorities should be conveyed to a central depot where, after removing the inorganic matter, it would be used with wet sewage sludge to make compost.

(2) The possibilities of utilizing city garbage and other wastes have in recent years attracted considerable interest and various municipalities have instituted schemes for composting these wastes. For example, in England the Boroughs of Leatherhead and Maidenhead, having populations of 26,000 and 28,000 respectively, have composted municipal wastes for several years, and in New Zealand the Borough of Dannevirke has embarked on an undertaking for the same purpose. Further, as has been mentioned, this subject was considered by the inter-departmental Committee which studied the utilization of organic wastes and which made the following recommendations:—

- (a) One or more municipalities should be encouraged to install "pilot" plants for composting organic wastes.
- (b) Arrangements should be made for the processes of these "pilot" plants to be studied experimentally.
- (c) Arrangements should also be made for the large-scale agricultural and horticultural trial of the composts produced.

The Auckland City Council is willing to conduct the experiments and the Government has granted a subsidy for the purpose. The construction of the necessary plant has not yet been completed. The results of these experiments and of other similar undertakings will, of course, be of national importance, and it is clear that many municipal authorities are showing great interest in the matter.

(3) For the purposes of this inquiry the issue appears to be a comparatively simple one. Should the Drainage Board's schemes for the sewerage of the district and for the treatment and disposal of sewage be dependent on the results of the experiments?

(4) In considering this issue it must be pointed out that under the Drainage Board's scheme provision could be made if required for the production of an air-dried digested sludge which could be used as an activator in composting, and the production of this would not seriously affect the amount of sludge available for conversion to powdered fertilizer. The Drainage League, however, contends that the composting of municipal garbage and wastes should be carried out by the Drainage Board and that all the sludge available should be used in a composting scheme, which would be on a scale which has never previously been attempted and which would include novel features.

(5) It has been shown that there is an authoritative body of opinion in favour of the use of dry sludge as against wet sludge, and it seems clear that the eminent compost authority, the late Sir Albert Howard, came to realize that the production by a sewage authority of pulverized powdered sludge which could be used as a fertilizer or as an activator in a municipal or other composting undertaking would be entirely satisfactory.

(6) Mr. A. J. Dickson, the Auckland City Engineer, gave helpful evidence on this matter. He showed that in the year 1946 the City Council's Designing Engineer, Mr. A. T. Simmons, after making investigations in England, prepared a comprehensive report which the Council used as the basis of its consideration. Mr. Dickson explained that "the composting of city refuse by major local authorities is largely an untried field" and he expressed the opinion that—

The possible end product of a sewage-treatment works should not necessarily decide an as yet unproved policy of composting refuse with sewage sludge, or whether refuse must be dealt with at the site of the sewage-works. If it were found desirable to utilize sewage sludge in this way, it would seem logical that the sludge should be treated and taken to the composting site. A process whereby the sludge is dried and powdered would appear to offer advantages, as the transport of water would be avoided.

(7) Mr. Dickson also referred to various difficulties in connection with the composting of municipal wastes such as the uncertainty as to the quantity of refuse available, the transport and sorting problems, the possibility of a nuisance being created, and the loss of the advantages derived from the present practice of "tipping" and reclaiming land. He pointed out, further, that in the composting of garbage flexibility was desirable and that this could be obtained by using pulverized activated sludge, which, if not required for composting, could be sold as a fertilizer. His final conclusion was definitely in favour of the advantages of powdered sludge.

(8) Evidence to the same effect was given by Mr. Porter, who made a special study of the subject before coming to New Zealand; and there was evidence from him, Dr. Dixon (Department of Scientific and Industrial Research), Dr. Annett, and others as to the importance and difficulty of manufacturing a compost which would be of uniform quality and not too bulky.

(9) The opinion we have formed on the matter is that it would be unwise for the Drainage Board to be concerned with the composting of municipal wastes. The utilization of these wastes is a matter of national concern. Before any large-scale use could be made by composting, much experimenting and research will have to be made. This can best be done by municipal authorities with the assistance and co-operation of the Government. All the information available indicates that powdered sludge and not wet sludge should be used in any municipal composting undertaking. The powdered sludge can be easily produced as part of the operations of the sewerage authority. It is important that the Drainage Board should be free to proceed with the construction of its sewerage and sewage-treatment works. It would be most unfortunate if the Drainage Board were to be required to make its schemes and works suitable for the execution of a composting proposal which may prove to be quite impracticable or at least inexpedient. Further, the policy of municipal composting will not be in any way prejudiced by the Drainage Board making no provision for carrying on the making of compost itself so long as proper use is made by it of the sludge with which it has to deal.

(10) In the view we take of the matter we do not feel concerned to examine here certain aspects about which much evidence was given and considerable discussion was held. We refer to such aspects as the commercial practicability of a large-scale composting scheme, the various estimates as to the amount of compost that should be produced under such a scheme, and the estimates as to the capital expenditure that would have to be made and the annual costs of operating the scheme. Owing to the many uncertain factors which exist we formed the opinion that the estimates about these matters were not reliable, and even if it had been established that the principle of large-scale composting was sound we should have been reluctant to express any definite conclusion concerning them without further evidence.

(11) Reference should be made to a method of disposing of municipal organic wastes which is used in some cities of the United States. The inorganic matter is removed at a central depot and the organic matter is ground, water being used in the process. The wet ground material is deposited in a main sewer, the result being that it is received and dealt with at the sewage-treatment works in the same way as sewage. There is insufficient evidence available to enable any satisfactory opinion to be formed as to the suitability of this process, but it would appear to be advisable that consideration should be given to it as a possible method of disposing of municipal wastes.

OXIDATION LAKES

46. (1) The construction of a lake is a necessary feature of the proposals connected with the cultivation of water plants, and as we have come to the conclusion that these proposals are impracticable, that would appear to dispose of the matter. However, the Drainage League denied that the lake proposal was dependent on the water-plants proposal, and contended that the construction of a lake for oxidation purposes is a standard method of sewage purification and is justified, without regard to its use for the growing of plants. In our opinion, it is clear that the lake proposal would not have been advocated if it had not been for the water-plant proposal, but in view of the persistence with which the advantages claimed for an oxidation lake as part of the purification processes were pressed by the league, it is necessary for us to consider whether the construction of a lake for this purpose is required or advisable.

(2) In his evidence in chief, Mr. Worley made only the following brief reference to this question :—

The power of large bodies of water held in lakes to purify themselves is well established and authorities are quoted in other evidence.

Under cross-examination, he admitted that if it should prove that the cost of constructing the lake would be greater than he estimated, he would recommend the lake only as a stage towards the final utilization of water weeds.

(3) We will refer later to the objections raised to the lake proposal, but we should mention at this point that Mr. Hugh Vickerman considered that the criticism by the Harbour Board of Mr. Worley's proposal was justified, and he suggested the construction of a smaller lake having an area of only 800 acres at a site farther away from the Onehunga wharves. Under cross-examination, Mr. Vickerman stated that in his opinion the provision of an oxidation lake (apart from the water-plants aspect) was not "absolutely necessary" but it was desirable, and he added that very few sewerage systems include an oxidation lake, and whether or not he could recommend one for Auckland would depend on circumstances. As we understood him, Mr. Vickerman had had no experience of oxidation lakes and had not given much consideration to the subject.

(4) In fact, the evidence submitted by the league in support of the oxidation-lake proposal was, in the circumstances, somewhat meagre and unsatisfactory and consisted for the most part of extracts read by Mr. Robinson from certain text-books which, in our opinion, failed to justify the adoption of the proposal for the Auckland sewerage schemes.

(5) Mr. Porter gave evidence that oxidation lakes are used by small towns and to a less extent by large towns, and that the object is to provide for final oxidation when a sufficient volume of diluting water is not available. He stated that although they are efficient for the destruction of sewage bacteria, this can be carried out equally effectively by the activated-sludge process followed by dilution in suitable bodies of water such as the harbour waters of Auckland. He also stated that experience shows that there are objectionable features, such as the risk of the lake causing offensive odours, the rapid algal growth and weed growth which takes place, and the danger of the lake becoming

a breeding-place for mosquitoes, which require serious consideration. Mr. Porter criticized the suitability of the upper Manukau Harbour as a site for an oxidation lake on account of its rocky indented shores and its irregular water depth, and he expressed the opinion that, apart from the high capital costs involved in the construction of the lake, the annual costs of keeping it clean would be very heavy. For these reasons he was opposed to the lake proposal and considered that it would be better to rely on orthodox treatment processes.

(6) The lake proposal was also opposed by the Onehunga and Otahuhu Borough Councils and the Manukau County Council on the ground that a nuisance was likely to result.

(7) The estimates of the cost of constructing the lake varied considerably. Mr. Worley's estimate was £158,100 and Mr. Hugh Vickerman's (for a smaller lake) £250,000, while that of Mr. Rowntree, the Drainage Board's Designing Engineer, was £800,000. We consider that the cost may well amount to £500,000 and the annual charges to £45,000.

(8) Mr. Worley's proposal met with strong objection from the Harbour Board, and Mr. N. L. Vickerman, the Board's Engineer, contended that "disastrous results" would follow the construction of the lake owing to the silting-up of the channel to the Onehunga Wharf. As we have mentioned, Mr. Hugh Vickerman agreed that this objection was sound and he recommended a drastic modification of the proposal. He also admitted that before his proposal is adopted it was advisable that further investigation should be made to determine whether any interference with navigation would result. We are not satisfied that even the modified proposal might not have harmful effects on the navigation facilities of the harbour. The lake proposal was also criticized on the ground that the league had failed to take into account the liability that would arise for the payment of compensation to the Harbour Board for the loss of the property and the owners of properties on the shores of the lake who would be deprived of their riparian rights.

(9) Our conclusion is that the construction of an oxidation lake should not form part of any sewerage scheme. It is, we consider, unnecessary, and the additional purification, if such were necessary, which would be obtained from a lake would be more satisfactorily and economically obtained by increasing the amount of aeration in the activated-sludge treatment.

CONCLUSION

47. Our conclusion with respect to the matter referred to in paragraph (2) of the order of reference—that is to say, whether the utilization in the Auckland Metropolitan Drainage Board District of sewage by a composting or any other process is desirable in the public interest, is as follows:—

We consider that the Drainage Board's proposals for the utilization of sewage by the production of an air-dried digested sludge which could be used either as an activator in the manufacture of compost or for conversion to a heat-dried pulverized fertilizer should be adopted.

For the reasons we have given we are unable to recommend that the sewage treatment and disposal schemes should make any provision for the adoption of the composting process. We consider, however, that in the national interests it is advisable that the recommendations of the inter-departmental Committee "that municipal authorities should be encouraged to conduct experiments in the composting of garbage and other wastes" should be given full effect.

PART IV—SEWERAGE AND SEWAGE TREATMENT AND DISPOSAL SCHEMES FOR AUCKLAND

48. Having come to the conclusion that a large-scale composting scheme for the utilization of sewage cannot be recommended and that an oxidation lake should not form part of the sewerage system, we will now consider what schemes of sewerage and sewage treatment and disposal should be adopted as the most suitable for the Auckland Metropolitan District. This matter will be considered on the basis that the boundaries of the Metropolitan District will be altered as recommended by us in paragraph 29 and that the recommendation made in paragraph 36 that the discharge of all trade wastes (subject to certain exceptions) into the sewers of the Metropolitan Board should be made compulsory is accepted.

49. Adopting the proposal made by Mr. Porter in his "Memorandum on Basic Technical Data" (see paragraph 29) for the division of an altered Metropolitan District into separate sewerage districts, we will first consider the position of the Central and Southern Districts and then deal separately with the Eastern and Western Districts. The drainage of the Northern Sewerage District will be considered in Part V.

DRAINAGE OF CENTRAL AND SOUTHERN SEWERAGE DISTRICTS

Description of Sewerage Districts

50. (1) The Central Sewerage District comprises the City of Auckland, the Boroughs of Mount Albert, Mount Eden, and Newmarket, that part of the Road District of Mount Roskill which is west of Hillsborough Road, that part of the Borough of One Tree Hill which is north of Campbell Road, that part of the Road District of Mount Wellington which is north of Panmure Road, and the Panmure Township Road District.

The Southern Sewerage District comprises the Boroughs of Onehunga, Ellerslie, Otahuhu, and Papatoetoe, that part of the Road District of Mount Roskill east of Hillsborough Road, that part of the Borough of One Tree Hill south of Campbell Road, that part of the Road District of Mount Wellington south of Panmure Road, the Mangere areas of Manukau County, and other areas adjacent to Papatoetoe, together with a considerable rural area adjoining and draining into the area described.

It will be recalled that the proposals made by Mr. Watkins and the Drainage Act provided for only one treatment-works and one outfall for the whole district and for their being located at Brown's Island. It will also be recalled that in December, 1948, Mr. Porter submitted to the Drainage Board two alternative schemes (Scheme No. 1 and Scheme No. 2).

Explanation of Scheme No. 1

(2) Scheme No. 1, which is a modification of Mr. Watkin's proposal, may be summarized as follows:—

It provides for the treatment of all sewage (including trade wastes) from the Central and Southern Districts at Brown's Island and for one outfall situated at Brown's Island. Sewage would be conveyed from the mainland at a point near West Tamaki Head either by a submarine sewer (with a pumping-station on the mainland) or by a sewer in a submarine tunnel (with a pumping-station on Motukorea) according to the conditions found to exist on the sea-bed and the engineering difficulties to be overcome. New sewers would be built from Orakei, Hillsborough (Mount Roskill), and Papatoetoe to West Tamaki Head, with small pumping-stations at Onehunga and Otahuhu. The existing Orakei tanks would be converted for use as storm-water balancing

tanks. All sewage would receive primary treatment and also secondary treatment, the extent of which would depend on whether trade wastes from the Southern District have to be dealt with. A "standby" chlorination plant for use in emergencies would be provided. An effluent-holding tank would be constructed if it were found advisable to avoid the expense of the extra secondary-treatment cost involved in the continuous discharge of effluent at all states of the tide and the effluent would be discharged on ebb tides only. The scheme assumes that for some years primary treatment might be sufficient unless the trade wastes from the Southern District are received. Sludge-treatment works to produce gas and fertilizer are included in the scheme.

Explanation of Scheme No. 2

(3) Scheme No. 2 provides for sewage (including trade wastes) from the Central District to be treated at Brown's Island and that from the Southern District at Mangere. A brief outline of the scheme is as follows:—

(a) So far as the drainage of the Central District is concerned, provision is made for the submarine sewer or tunnel from West Tamaki Point to Brown's Island and pumping-station as in Scheme No. 1, but on a reduced scale. There would be new sewers from Orakei and Pannure to West Tamaki Point and a conversion of the Orakei tanks for use as storm-water balancing tanks. All sewage would receive primary treatment and there would be a "pilot" activated-sludge plant to obtain data on which to design future developments and extensions, together with an effluent-holding tank to permit discharge on ebb tides only. There would also be an emergency chlorination plant and sludge-treatment works similar to those provided for in Scheme No. 1.

(b) For the drainage of the Southern District there would be main sewers from Hillsborough, Penrose, Mount Wellington, Otahuhu, and Papatotote to the sewage-treatment works and outfall at Mangere. Several small pumping-stations would be provided, and sewage which would reach Onehunga by gravitation would be pumped through rising mains carried on piles across the Manukau Harbour above the Mangere Bridge. Trade wastes from the freezing-works in the area would receive preliminary treatment at works situated at Southdown, and the mixed sewage and trade wastes would receive full primary treatment at Mangere and also sufficient secondary treatment to ensure that the effluent discharged into the harbour would comply with standards of purity to be prescribed. The secondary treatment would probably be the use of high-rate filters followed by the activated-sludge process. Provision is made for an effluent-holding tank so as to permit discharge to the Purakau Channel near Puketutu Island on ebb tides only. The sludge would be digested and dried and sold, or perhaps pulverized to produce an organic fertilizer as at Brown's Island.

Suggested Modification of Schemes Nos. 1 and 2

(4) (a) In the evidence given by Mr. Porter before the Commission he stated that since the preparation of his report of 15th December, 1948, he had investigated the

possibilities of an alternative site for treatment-works for the Southern District to that suggested in the report, and he expressed the opinion, in which we concur, that the requirements of a treatment-works site are as follows :

- (i) That it should be as near as possible to the main freezing-works, so enabling trade wastes to be treated while fresh.
- (ii) That it should be a gently sloping site on satisfactory geological strata. The latter requirement is desirable to minimize construction costs and difficulties.
- (iii) That it should be so placed that, if possible, a main outfall line across the Manukau Harbour near Mangere Bridge is eliminated.
- (iv) That it should have a minimum area of say, 60 acres to provide room for future expansion.
- (v) That it should not be unduly close to residential properties.

(b) Mr. Porter also stated that, having regard to these requirements, he had come to the conclusion that the most suitable site was on certain lands to the south of Favona Road Causeway at Mangere East, and he therefore proposed this site instead of the alternative sites at Mangere Peninsula and Southdown previously recommended. He pointed out that an advantage of the Favona Road site was that it would be practicable for the main collecting sewer (from Southdown to the site) and some of the sedimentation tanks and other works to be constructed in advance of the completion of the main scheme, so providing for early alleviation to some degree at least of the existing pollution of the Manukau Harbour. Mr. Porter proposed that the outfall should be in a tunnel or trench to a suitable point on the Mangere Peninsula and from there by pipe-lines on piles to an approved place in the Purakau Channel.

(c) In his evidence Mr. Porter also proposed certain alterations in the scheme for the drainage to Brown's Island. He stated that for technical reasons he thought it was advisable that the main pumping-station should be situated on the island instead of on the mainland, and he pointed out that this would involve the construction of a sewer in a submarine tunnel which would operate by gravitational flow to a deep pumping-well on the island.

(d) It will be convenient to mention here that evidence was given by Mr. C. W. Firth, Assistant Engineer of the Auckland City Waterworks and a professional geologist, as to geological matters in connection with the Board's schemes. This included an examination of the rock types and other geological features of the proposed submarine line from West Tamaki Head to Brown's Island, and of the results of the borings which have been made in connection therewith. His opinion is that, "provided it is kept below the depth of weathering, no unusual difficulty should be experienced in driving a tunnel to Motukorea in the Waitemata Series"—that is, the series of alternating sandstone and mudstone of mid-tertiary age. It would appear from the evidence that considerable investigation involving drilling over a wide area may be required before the final location of the tunnel can be determined, and that the decision should be made only following investigation by an engineering geologist, whose services should be retained during the whole of the construction period. Great care will have to be exercised in determining the level at which the tunnel is to be driven. It is not possible for us, on the information available, to make any recommendation as to the site of the tunnel, nor is it necessary that we should do so. We are satisfied, however, that, provided proper investigation is made and sound engineering construction practice is followed, there should be no difficulty in constructing a satisfactory tunnel.

(e) Mr. Porter also prepared certain other modifications of Scheme No. 1, but in the circumstances it does not appear to be necessary to refer to them.

Drainage League Schemes

(5) (a) Alternative schemes for the drainage of the Central and Southern Districts were submitted by the Drainage League. These were prepared by Mr. R. P. Worley, of Auckland, a consulting engineer who has specialized in sewerage engineering. Mr. Worley gave evidence before us in support of his proposals, and they were also supported by another consulting engineer, Mr. Hugh Vickerman, of Wellington. The latter was requested by the league to give evidence some time after the sittings of the Commission had commenced. He arrived in Auckland on the evening of the 29th March (Tuesday), and gave his evidence on Monday, 4th April. He had no knowledge whatever of Auckland's drainage problems or of the matters being considered by the Commission until he arrived in Auckland, and he admitted that he had not studied the reports made by Mr. Porter which have been referred to. Mr. Vickerman did not claim to be a sewerage expert, but he has had a very wide experience as a civil engineer. It will be obvious that he was at a serious disadvantage.

(b) Leaving out of consideration the treatment and utilization aspects, all the proposals of the Drainage League include provision for the whole of the sewage from the Central and Southern Districts to be treated at works on the southern side of the isthmus and for the effluent to be discharged into the Manukau Harbour. The following brief outline should give a sufficient explanation of the proposals.

(c) The Orakei tanks would be used as storm-water balancing tanks as proposed by Mr. Porter. There would be a main pumping-station at Orakei to elevate the sewage so that it may be discharged into a proposed new trunk sewer from Orakei to Southdown. Main sewers would be constructed to carry the sewage, including trade wastes, from Onehunga, Penrose, and Papatoetoe to Southdown as proposed in Mr. Porter's Scheme No. 2, and an additional main sewer (replacing Mr. Porter's proposed sewer from Panmure to West Tamaki Head) would be constructed from Glendowie to Southdown via Panmure. There would be treatment-works using the activated-sludge process at Southdown. If the league's proposals for an oxidation lake, the growing of water-hyacinths or other water plants, and for the composting of sludge and garbage and other municipal and trade wastes are not adopted, it is proposed that the sewage effluent would be discharged by a pipe from Southdown to the Purakau Channel on ebb tides only.

(d) It should be mentioned that although the league criticized the discharge of excess storm-water at Orakei as being insanitary, its schemes do not include any different provision for the disposal of the storm-water from that proposed by the Drainage Board. In this connection we consider that the Board's proposal is in accordance with normal sewerage-engineering practice and that the greatly diluted sewage that would flow into the harbour during periods of prolonged rainfall would not cause a nuisance.

Estimate of Costs

(6) (a) Estimates of costs for the various schemes proposed by the Drainage Board and the Drainage League respectively were given by the expert witnesses and were discussed and examined before us at considerable length. We have given careful consideration to the subject and have decided that we should not do more than make a few general observations and that no useful purpose would be served by examining the figures in detail in this report. In the first place it will, of course, be appreciated that our rejection of the oxidation lake and composting proposals has affected in many ways any consideration of the estimates. Further, it is plain that there are many uncertain and unknown factors which must have an influence on the reliability of the estimates. In addition to the effect of uncertain geological and other similar conditions, wages and other factors which affect construction costs in New Zealand and elsewhere have changed in certain respects since some of the estimates were prepared, and further changes are likely to occur before the works are executed. Again, the results of the investigations

that are still required to be made by the Drainage Board's staff may well have an important bearing, and in this connection it should be pointed out that it is doubtful whether the staff has been or is now of sufficient strength to enable reliable estimates to be prepared. We do not intend this comment to be regarded as a criticism of the accuracy of the estimates or of the staff, but it would appear to be obvious that the nature of the problems to be dealt with and the magnitude of the works that will be necessary are such as to require the employment of a large and highly competent staff, and we suggest that the Board should give early attention to the question of supplementing the staff now employed.

(b) We should mention that we consider that, on the whole, the estimates submitted by the Board are more reliable than those of the league, and it is, we think, apparent that the league's engineers have been at a serious disadvantage in not having the information and data which are held by the Board and also in not having had the same opportunities as the Board's staff have possessed of making a detailed study of the available information.

(c) On the best consideration we have been able to give to the subject, we have come to the conclusion that the scheme which we have decided to recommend for the drainage of the Central and Southern Districts will be cheaper to construct and to operate than any other scheme that has been proposed.

Scheme No. 2 Recommended

(7) (a) After careful consideration we have decided that in principle the Board's Scheme No. 2, with the modifications suggested by Mr. Porter, is the most suitable for the drainage of the Central and Southern Districts, and we recommend that it should be adopted.

(b) In recommending the adoption of Scheme No. 2, we do not intend that the Drainage Board should be bound by the details of the scheme. As further investigations are made and the execution of the works proceeds it is probable, and perhaps certain, that it will be found to be advisable or necessary to alter details. We consider that it would be most unwise to attempt to define now precisely what any part of the works should consist of or how it should be carried out. All that we think is necessary or indeed advisable for us to do is to recommend the adoption of the general principles of the scheme.

(c) We therefore recommend that the sewage, including trade wastes, from the Central District should be conveyed to Brown's Island and after receiving adequate treatment there that it should be discharged into the channel near the island. In order to give effect to this recommendation it will be necessary for section 4 of the Auckland Metropolitan Drainage Act, 1944, to be amended so as to provide that the treatment-works and outfall for the Central District only, and not for the whole of the Metropolitan District, should be at Brown's Island.

(d) We also recommend that the sewage and trade wastes from the Southern District should be conveyed to a suitable point on or near the shores of the Manukau Harbour and discharged, after receiving adequate treatment, into the Purakau Channel.

(e) We do not think we should attempt to determine which of the sites suggested for the treatment-works is the most suitable. The site south of the Favona Road Causeway would appear to be the best, but until further investigations and surveys have been made and the necessary designs and estimates prepared it is impossible to make a decision. The Board should not be limited at this stage in the selection of a site. It may possibly find that there is a more satisfactory site than any of these proposed so far. We consider, therefore, that statutory authority should be given for the treatment-works to be established at a suitable place on or near the shores of the Manukau Harbour to be selected by the Drainage Board and approved by the Auckland Harbour Board and the Marine Department. We will refer later to the amendments of the Drainage Act that will be required if our recommendation is adopted.

(f) Our main reasons for recommending Scheme No. 2 instead of any of the other schemes are as follows :—

- (i) We consider that in the interests of public health and on financial and technical grounds the dual scheme is to be preferred.
- (ii) In the opinion of the Health Department's officers the waters of the Manukau Harbour are in certain respects not satisfactory as receiving-waters for sewage and trade wastes, and they have indicated that they may require the adoption of higher standards of purification for sewage discharged into those waters than for sewage discharged into the waters of the Waitemata Harbour. This is obviously an important factor which must be taken into account in considering whether all the sewage from the Central and Southern Districts should be discharged into the Manukau Harbour. In this connection it should also be mentioned that the opinion of the Marine Department is that two points of discharge, one at Brown's Island and the other in the Manukau Harbour, will give greater opportunity for dilution and therefore more rapid recovery. Further, the Auckland Harbour Board's Engineer considers that if all the sewage were to be discharged into the Manukau Harbour his Board would have to insist on purification to a much higher standard.
- (iii) A dual scheme is more flexible and allows greater scope for expansion.
- (iv) Under the dual scheme the pollutional load on the harbour waters is fairly evenly balanced between the two harbours.
- (v) It is inadvisable that all the sewage and trade wastes from the Central and Southern Districts should be discharged into either the Waitemata Harbour or the Manukau Harbour only. As has been shown, the risk of pollution can be eliminated if appropriate treatment processes are adopted, but the additional costs resulting from the higher standard of purification required by the Harbour Board if all the sewage from the area is treated at a single works instead of at two works can be avoided.
- (vi) If, as we have recommended, the trade wastes from the area, or a substantial portion of them, are to be received by the Board's sewers, the total quantity of sewage and its strength will be materially increased and it might become impracticable or inexpedient, owing to the future development of industries and growth of population, to have only one treatment-works and outfall.
- (vii) The natural drainage of the Northern, Eastern, and Western Districts is to the Waitemata Harbour, and with the strong probability that there will be during the next forty or fifty years a material increase in the quantities of sewage from these districts it is advisable that that harbour should not have to bear the extra burden of the sewage from the Southern District.
- (viii) It is highly probable that for several years the Waitemata Harbour will continue to receive from the Northern and Western Districts and from various other sources crude sewage or partially treated sewage, and the burden imposed on the Brown's Island works in the meanwhile should be reduced as much as possible.
- (ix) If there are two treatment-works instead of only one, the sewage from a natural drainage district will be collected, treated, and disposed of in its own drainage district and smaller main sewers will be required, thus enabling substantial economies to be made in capital costs.

- (x) The installation of a single treatment-works and outfall on either the Waitemata Harbour or the Manukau Harbour would necessitate longer sewers with consequent increased costs, by reason especially of the provision required to be made to resist the great corrosive action of stale sewage and trade wastes. Further, it is important that sewage should reach the treatment-works in as fresh a condition as possible as the treatment of fresh sewage is easier and cheaper than that of stale sewage, and if the sewage is fresh the quality of the effluent can be more readily maintained at the required standard and kept uniform.
- (xi) The Boroughs of Onehunga and Otahuhu and the County of Manukau have all approved of the principles of Scheme No. 2, subject, of course, to the effluent which will be discharged into the Manukau Harbour being of proper quality. The Engineer to the Onehunga Borough, after stating in his evidence that Scheme No. 2 was "entirely acceptable," emphasized an important consideration—namely, that the adoption of the scheme would probably relieve the serious position existing at Onehunga within a much shorter period than would be possible under Scheme No. 1.

DRAINAGE OF WESTERN AND EASTERN SEWERAGE DISTRICTS

Description of Sewerage Districts

51. (1) The Eastern Sewerage District comprises Bucklands Beach, Howick, Pakaranga, and rural lands south-east of the Panmure-Howick Road.

The Western Sewerage District comprises New Lynn, Glen Eden, Henderson, and parts of the Waitemata County between the Waitakere Hills, the Waitemata River, and the upper reaches of the Waitemata Harbour.

(2) In an earlier part of this report (paragraph 29 (4)) we have recommended that these districts should be included in the Outer Area of the Metropolitan District. Residential development in the Western District is now proceeding rapidly and proposals have been made for major harbour and industrial development at the western end of the Waitemata Harbour. Whether these proposals are adopted or not, it would appear that within a few years consideration will have to be given to the provision of main sewers for the area. Although its natural drainage is to the Waitemata Harbour, it has been suggested that it may be found expedient for the sewage to be conveyed to the system on the Manukau Harbour. The development of the Eastern District is proceeding fairly rapidly, but the provision of a sewerage system can be probably postponed for some years.

(3) We do not think it necessary or advisable at this juncture to make any recommendation with respect to a sewerage system for these districts. It seems to be accepted by the authorities interested that there is no need for action at present, and very little evidence on the subject was submitted. Section 4 of the Drainage Act makes adequate provision for the inclusion of the districts in the Inner Area of the Metropolitan District when the need arises, and we consider that it is better to postpone the determination of their sewerage systems until then. In the meanwhile, by reason of the districts being within the Outer Area, the Drainage Board will have effective control.

(4) We think it is advisable that provision should be made in the Drainage Act authorizing the Drainage Board to discharge the effluent from the treatment-works to be constructed in connection with any sewerage systems that may be adopted for the Eastern and Western Districts at such points in the Waitemata and Manukau Harbours as may be approved by the Marine Department and the Harbour Board. It follows from the opinions we have expressed that when sewerage systems for these districts are adopted it will be necessary for the effluent to be discharged into harbour waters, and it would seem to be preferable to make provision for this now rather than to wait until schemes are prepared. If this view is accepted it will, of course, be necessary to apply to the treatment-works and outfalls in connection with the systems for the Eastern and Western Districts the provisions of section 34 and such other provisions of the Act as may be required.

CONCLUSIONS

52. (1) Our conclusion with respect to the matter referred to in paragraph (1) of the order of reference—that is to say, what sewerage and sewage-treatment and sludge-disposal scheme is most suitable to be adopted for the Auckland Metropolitan Drainage District—is as follows :—

(a) *The general principles of the scheme proposed by the Drainage Board and known as Scheme No. 2, with such modifications as may be found by the Drainage Board to be expedient, should be adopted as being the most suitable sewerage and sewage-treatment and sludge-disposal scheme for those parts of the drainage district which comprise the Central and Southern Sewerage Districts.*

(b) *It is unnecessary and inadvisable to make any recommendation at present with respect to the adoption of a sewerage, sewage-treatment, and sludge-disposal scheme for the other parts of the drainage district.*

(2) With respect to the matters referred to in paragraph (3) of the order of reference—that is to say, what, if any, amendment of the Auckland Metropolitan Drainage Act, 1944, or of any other legislation is necessary or expedient in order to direct or authorize the employment of the scheme recommended by us for adoption by the Auckland Metropolitan Drainage Board—we recommend that the following amendments of the Drainage Act should be made :—

(a) *Section 34 (1) should be amended so as to provide that the treatment-works and outfall for the Central Sewerage District only (and not for the whole Metropolitan District) should be constructed at Motukorea.*

(b) *Section 34 (3) should be amended by providing that from time to time before approving of the degree and character of purification of the effluent to be discharged from the outfall at Brown's Island (and from any other outfall from which effluent is discharged into the Waitemata or Manukau Harbours) the Auckland Harbour Board must consult both the Health Department and the Marine Department.*

(c) *Section 34 (4) should be amended so as to provide that the sewage from the Central Sewerage District only (and not from the whole of the Inner Area) should be conveyed to Motukorea.*

(d) *Section 34 (6) should be amended so as to give the Drainage Board the right to reclaim land in the Manukau Harbour.*

(e) *Section 35 (1) (g) should be amended by extending the exception mentioned in the proviso (relating to the effluent from the treatment-works on Motukorea) to include the effluent from treatment-works in the Manukau Harbour.*

(f) *The Act should be amended so as to empower the Board to construct treatment-works for the Southern Sewerage District at a site or sites adjoining or near the Manukau Harbour to be selected by the Board and to discharge the effluent from such treatment-works into the waters of the Purakau Channel in the said harbour, and by applying to such treatment-works and the outfalls the provisions of section 34 and such other provisions of the Act as may be necessary.*

(g) *Section 60 (d) should be amended to make its provisions apply to the construction works for the Southern Sewerage District as well as to those for the Central Sewerage District.*

(h) *The Act should be amended so as to empower the Board to construct treatment-works for the Eastern and Western Sewerage Districts at such sites adjoining or near the Waitemata and Manukau Harbours as may be selected by the Board and to discharge the effluent from such treatment-works into the waters of the Waitemata and Manukau Harbours at such points as may be selected by the Board and approved by the Marine Department and the Harbour Board, and by applying to such treatment-works and the outfalls the provisions of section 34 and such other provisions of the Act as may be necessary.*

PART V. DRAINAGE OF THE NORTH SHORE

DRAINAGE ACT DOES NOT APPLY

53. The provisions of the Drainage Act have no application to the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna (which boroughs were referred to as a group will be hereinafter described as the North Shore boroughs). Not only were they not included in the drainage district constituted by that Act, but they were also expressly excluded from the area outside the district which was brought within the Board's "sphere of influence." This area is described in section 45 of the Act as being the area the natural drainage of which is into the waters of either the Waitemata Harbour or the Manukau Harbour, and the section provides that in respect of the area comprised in the sphere of influence the Metropolitan Board has a general supervision and control. The result is that, although the area comprising the North Shore boroughs has a natural drainage into the waters of the Waitemata Harbour, the Metropolitan Board has no jurisdiction and each borough has its separate sewerage and sewage treatment and disposal system and exercises independent control in respect of its separate system.

DESCRIPTION OF NORTH SHORE SEWERAGE SYSTEMS

54. The existing sewerage and sewage treatment and disposal systems of the North Shore boroughs may be briefly described as follows:—

(1) *Takapuna Borough*—

(a) The main portion of the system was installed in 1925-26. There are no treatment-works, but storage, in the form of long culverts, is provided to enable sewage to be discharged on the ebb tide only at two points in the Rangitoto Channel—namely, Black Rock and St. Leonard's Road. Extensions were made in 1939-40 to cope with an extension of the reticulation system. All sewage from the extended area is discharged from the St. Leonard's Road outfall. A septic tank has been constructed at the upper or Shoal Bay end of the St. Leonard's tunnel culvert. At present this culvert is used merely as an effluent pipe to convey the effluent from the septic tank to the outfall for continuous discharge at all states of the tide.

(b) The Borough Council in 1948 adopted proposals involving the abandonment of the Black Rock outfall and the provision of full treatment at the site of the Shoal Bay septic tank. It is proposed that the effluent from the treatment plant shall be discharged by the St. Leonard's outfall to the Rangitoto Channel. It is intended to take the necessary action to obtain approval of the proposals so that the work may be proceeded with at an early date.

(c) It is to be noted that the minimum staff that will be required to operate the proposed treatment plant could attend to a plant four or five times larger, and the Takapuna Borough Council has invited the other North Shore boroughs to consider joining in a scheme whereby they could use the Takapuna plant and outfall.

(2) *Devonport Borough*.—A sewerage system was first installed in the year 1899 and additions have been made from time to time. There is no method of sewage treatment, and crude sewage is discharged into harbour waters in a continuous flow from two outfalls situated at North Head and Narrow Neck Beach. The Borough Council admits that the method of disposal is unsuitable, and there can be no doubt that this admission is justified.

- (3) *Northcote Borough*.—The system, which was installed between 1923 and 1926 and serves only 250 acres out of a total area of 1,190 acres, is based on septic tanks. A storage tank to enable discharge to be made on the ebb tide only was also constructed, but this is not now in use, and there is therefore a continuous discharge from one outfall of the effluent from the septic tanks.
- (4) *Birkenhead Borough*.—A system was installed in 1936-37. It consists of a septic tank which has two chambers and a final settling-tank. The effluent is discharged to the main channel at the mouth of Chelsea Bay. The sludge is taken out to sea by barges.

EXISTING SEWERAGE SYSTEMS ARE UNSATISFACTORY

55. (1) It will be observed from the above description of the methods of sewage disposal that in each case either crude sewage or septic-tank effluent is discharged into the waters of the Waitemata Harbour and that, in effect, no method, or no adequate method, of sewage treatment is employed. Owing to the existence of several other sources of pollution of the Waitemata Harbour waters and particularly the Orakei outfall it is not possible to determine the extent to which the sewage from the North Shore area is responsible for the pollution of the waters of the Waitemata Harbour or of the bathing beaches in the North Shore area or elsewhere which the evidence of Dr. A. W. S. Thompson, the Medical Officer of Health at Auckland, shows to exist. It is sufficient, we think, to state that the evidence shows that the discharge of the sewage must contribute to this pollution to a material degree, and that in addition to the interference caused to the public in their enjoyment of the bathing beaches in the locality there is a potential menace to public health which must become progressively worse.

(2) It is recognized by the local authorities in the North Shore area, as well as by the Auckland Harbour Board, the Health Department, and the Marine Department, that the existing conditions should not be allowed to continue indefinitely, although in view of the more important problem that exists on the southern side of the harbour it is not suggested that the adoption of remedial measures demands the urgent consideration that the metropolitan area requires.

(3) In addition to the existing systems being unsatisfactory as presently contributing to the pollution of the Waitemata Harbour, it is plain, we think, that the existence of four separate independent systems is unsuitable, and that a comprehensive system for the whole North Shore area is required, together with joint control. Further reference will be made later to this aspect.

ACTION TAKEN BY BOROUGHES

56. (1) As has been mentioned, the Takapuna Borough Council in 1948 adopted proposals for the improvement of the method of disposing of sewage from the borough, including a proposal for full treatment by the activated-sludge process. The Council's Consulting Engineer, Mr. R. P. Worley, gave evidence before us, and furnished particulars of these proposals together with some estimates of cost. It is clear that if these proposals are carried into effect a material improvement will result. Indeed, provided the method of treatment proposed is carried out to a sufficient degree, it would be possible to ensure that the effluent discharged into the harbour waters would be quite safe. It has already been mentioned that the minimum staff required to operate the treatment plant could operate a plant four or five times the size of that proposed to be used, and the Takapuna Borough Council has therefore invited the other North Shore boroughs to join in a scheme for their joint use of the treatment-works and outfall.

(2) The other North Shore boroughs have not taken any steps to prepare any plans for sewerage extension or for sewage treatment or disposal. They agree that action must be taken sooner or later, and it appears to be evident that their inaction is not due to indifference, but to the realization that the only satisfactory solution of their problems is the setting-up of a drainage authority to bring about unified control and comprehensive planning for the whole area. This is also the attitude of the Waitemata County Council. It should be mentioned that the Devonport Borough Council in the year 1947, being satisfied that the only satisfactory way of dealing with its own sewerage problems and also those of the other North Shore boroughs was by the constitution of a Drainage Board for the whole of the North Shore area, took action to have a Board constituted, but it would appear that opposition on the part of the Takapuna Borough has so far prevented this from being done.

SCOPE OF THE REFERENCE

57. We consider that the second matter to be inquired into under paragraph (4) of the order of reference—namely, what alternative methods for the treatment and disposal of sewage for the North Shore boroughs should be adopted if it is considered by us that the present methods are not suitable, is not limited to an inquiry with regard to the methods of treatment and disposal for each of the four boroughs as separate authorities. If, however, this is the meaning of paragraph (4), our finding must be that any scheme of treatment and disposal which is based on a separate system for each of the North Shore boroughs is unsuitable, as we consider that it is essential that there should be one control and a comprehensive scheme for the whole of the North Shore area. In any event, even if the scope of paragraph (4) is limited in the manner mentioned above, we are of opinion that the terms of paragraph (6) of the order of reference authorize and, indeed, require us to consider the advisability of adopting a system of unified control for the North Shore area.

GENERAL REVIEW

58. We think it is necessary for a proper understanding of the problems arising in connection with the drainage of the North Shore area to consider briefly some of the efforts which have been made since the year 1928 to deal with these problems.

(1) It has been mentioned in paragraph 12 that prior to the year 1928 the Auckland Harbour Board had become concerned about the pollution of the Waitemata and Manukau Harbours which was being caused by the discharge of sewage into harbour waters and that at the request of the Harbour Board the Minister of Health appointed a Committee of Inquiry to investigate the matter. This Committee convened a conference which was attended by representatives of the Harbour Board, the Drainage Board, and the local authorities of the districts from which drainage was being discharged into harbour waters. The North Shore boroughs were represented at this conference and their representatives expressed themselves as being in favour of some form of unified control for the North Shore area. Eventually the Committee recommended that the district of the Auckland and Suburban Drainage Board should be extended, but so far as the North Shore boroughs were concerned it did not favour their inclusion in the extended district. The Committee considered that, by reason of the separation of the North Shore area from the City of Auckland and its suburbs and the different character of the drainage problems of the two areas, it was advisable that there should be a separate Drainage Board for the North Shore boroughs and that part of the Waitemata County in the vicinity of the boroughs.

(2) The proposals put forward in 1931 by Mr. Watkins (see paragraph 13) included provision for an extended district having two areas, a northern area comprising the North Shore boroughs, and a southern area comprising various districts on the southern side of the Waitemata Harbour. The proposals for the northern area were quite separate from and independent of the proposals for the southern area. It was recognized by Mr. Watkins that it was improbable that the scheme for the northern area could be proceeded with for some considerable time, but he recommended that it should be adopted as the basis for all future sewerage systems in the North Shore area.

(3) In May, 1932, Mr. Watkins' proposals were considered and tentatively approved at a conference of the local authorities affected. Three of the North Shore boroughs were represented at this conference.

(4) The 1931 proposals, including those relating to the northern area, were approved in 1932 by the Committee which had been appointed by the Minister of Health in 1928 and in 1935 by Messrs. Hart and Borrie (see paragraph 16).

(5) Matters affecting the drainage of the North Shore area were specifically excluded from the order of reference of the Commission of Inquiry which was appointed in 1937 (see paragraph 17), but notwithstanding this exclusion the Commission expressed strongly its opinion "that the provision of an adequate sewage-disposal system for this area should be undertaken in the near future," and it was recommended that the position should be investigated forthwith. The Commission did not express any opinion as to whether the North Shore area should be included in the proposed metropolitan district, but it pointed out that if it were included the local authorities concerned should have adequate representation on the Drainage Board. We consider that the views expressed by the Commission, although no definite finding on the matter was made, must be interpreted as meaning that it favoured the principle of unified control of the North Shore area.

(6) It is difficult from the evidence available for us to appreciate why it was that nothing was done to give effect to the opinions expressed by the various independent authorities in favour of the unification of drainage control for the North Shore area. There appears to have been unanimity among them so far as the general principle of unification of control was concerned, and for some time the boroughs comprised in the area were in agreement with this principle. We can understand that there may well have been room for a difference of opinion as to whether the area should come under the Metropolitan Board or whether there should be a separate Board. What we cannot understand is that some form of unified control has not yet been brought about.

PORTIONS OF THE WAITEMATA COUNTY ARE AFFECTED

59. (1) Mention must be made of certain parts of the Waitemata County which it is generally agreed must be taken into account if there is to be any combined sewerage system for the North Shore boroughs. These parts comprise:—

- (a) A large portion of the Takapuna Riding of the county generally known as the "east coast bays."

This area, which extends from Castor Bay to Torbay, is approximately five and a half miles in length and three-quarters of a mile in width and has an area of about 3,600 acres. The east coast bays are rapidly becoming, if they have not already become, a residential area. There is no sewerage or drainage system in the area.

- (b) Certain parts of the county which adjoin the boroughs of Northcote and Birkenhead, including the districts known as Glenfield and Greenhithe.

These parts, like the east coast bays, have become residential in character and have no sewerage system.

(2) It should be noted that, to the extent that the natural drainage of these portions of the Waitemata County is to the waters of the Waitemata Harbour, they come within the sphere of influence for drainage purposes of the Metropolitan Board by virtue of section 45 of the Drainage Act.

POPULATION OF THE NORTH SHORE

60. The evidence shows that the population of the North Shore area (including the parts of the Waitemata County which have been referred to) has increased materially in recent years and that it is reasonable to expect that the population will continue to increase, especially when the proposed harbour bridge has been constructed.

The following table gives particulars of the present and estimated future population and also of the areas of the districts affected. These particulars are based on information furnished by the Town-planning Officer of the Auckland Metropolitan Planning Organization and other evidence:—

	Area (Acres).	Population, 1948 (Estimated).	Population Estimate for Year 2000.
Birkenhead	3,084	4,160	15,000
Northeote	1,190	2,810	15,000
Devonport	1,100	12,300	20,000
Takapuna	2,780	11,750	30,000
East coast bays ..	3,600	4,000	30,000
Other parts of Waite- mata County ..	..	..	..
	11,754	35,020	110,000

CONTROL OF THE NORTH SHORE AREA

61. (1) After the Commission had heard some evidence about the drainage systems in the North Shore area it became evident that it would be necessary to consider whether there should be some form of unified control for the area. The local authorities concerned were therefore requested to consider certain specific questions, and a special sitting was appointed for hearing their representatives.

(2) It should be mentioned that at the opening sitting of the Commission and again on a later occasion some of the North Shore local authorities protested that there had been insufficient time allowed to enable proper consideration to be given to the issues and for the views of the North Shore boroughs to be adequately presented. While it is correct that the local authorities had only short notice prior to the commencement of the sittings of the Commission that matters concerning them were included in the order of reference, we are satisfied that in the result no prejudice was caused, and that before the Commission concluded its sittings all the local authorities had had ample time to consider the issues and to present their views. It should perhaps be pointed out in support of this opinion that the evidence showed that from time to time for several years the local authorities have been required to consider not only their separate sewerage problems, but also the advisability of there being a combined authority for the control of sewerage and drainage, and the issues contained in the order of reference did not raise any new matters.

(3) After the special sitting had been arranged the four North Shore boroughs held a conference in order to consider the questions addressed to them by the Commission, and the Chairman of the Conference (Mr. E. J. Osborne, the Mayor of Birkenhead)

appeared before the Commission and reported that certain resolutions had been adopted by the conference. The questions submitted by the Commission, together with the resolutions of the conference, are set forth below :—

Question (1).—Should there be unification of control in respect of drainage matters in the North Shore boroughs ?

Resolution : The conference resolved that it agrees that there should be unification of control in respect to drainage matters in the North Shore boroughs when the population of the respective boroughs warrants it, but in the opinion of the conference the time is not opportune for all the boroughs.

Question (2).—If there is to be unified control, should the controlling authority be the Metropolitan Drainage Board, or should some other separate Drainage Board be constituted ?

Resolution : The conference resolved :—

- (1) That it is opposed to the North Shore being brought within the jurisdiction of the Auckland Metropolitan Drainage Board.
- (2) That it is agreeable for the North Shore boroughs to be controlled by an appropriate North Shore Drainage Authority when the time is opportune.

Question (3).—Should any part of the Waitemata County, particularly that part including the eastern bays, be brought within any new district or an extension of the existing district ?

Resolution : The conference resolved that it agrees to the east coast bays area of the Waitemata County coming under the control of a unified form of authority when it is deemed advisable.

(4) The attitude of the North Shore boroughs towards these questions was again explained to the Commission towards the conclusion of its sittings when submissions were made by Mr. Baxter as counsel for the boroughs of Birkenhead, Devonport, and Northcote, and by Mr. Guineven, the Mayor of Takapuna. In addition, Mr. Pearn, the Mayor of Northcote, made certain representations.

(5) The submissions made by Mr. Baxter may be summarized as follows :—

- (a) The time is not opportune for a single drainage authority to be constituted to carry out the construction of a drainage and sewerage scheme for the North Shore.
- (b) An authority should, however, be constituted now for the purpose of planning a comprehensive scheme for the area and of supervising and controlling drainage and sewerage in the area.
- (c) The constitution of this authority and the definition of its functions, together with any incidental matters, should be decided as soon as possible by either a specially appointed Commission of Inquiry or by the Local Government Commission.
- (d) For the following reasons the North Shore area should not be brought under the jurisdiction of the Metropolitan Drainage Board, namely—

(i) Any drainage and sewerage scheme for the North Shore must necessarily be entirely separate from and independent of any scheme required for any other area, as the problems involved are entirely different.

(ii) There is no community of interest between the North Shore area and the Metropolitan District and it is necessary or highly advisable that any scheme for the North Shore should be designed and formulated by an authority which is concerned only with North Shore problems.

(iii) As the Metropolitan Board has serious problems affecting the district on the south side of the Waitemata Harbour which require urgent attention, it will not be able to give proper attention to the problems of the North Shore area, which must necessarily be regarded by the Board as of only secondary importance.

(iv) The representation on the Metropolitan Board which it would be practicable to give to the North Shore area must necessarily be ineffective to enable North Shore problems and interests to be adequately and properly protected.

(6) The final submissions made by the Mayor of Takapuna were substantially in agreement with those made by Mr. Baxter, excepting that he contended that the authority to be set up now should not be merely a planning and controlling body, but one having power to carry out at once improvements to the Takapuna system. The Takapuna Borough Council, it was explained, wishes to avoid any further delay in the execution of the scheme of improvement which has been adopted.

(7) The final submissions of the Mayor of Northcote were also in substantial agreement with that made by Mr. Baxter and were summarized by him as follows :—

- (a) The North Shore area should be constituted as a separate drainage district.
- (b) The question of setting up a Drainage Board should be deferred for five years, unless two or more boroughs request earlier consideration.
- (c) Failing the setting-up of a Board, the local authorities in the district should be required by law to have a joint scheme planned for future progressive development of sewage-disposal works.

(8) Evidence presented on behalf of the Waitemata County Council showed that the Council considers that there should be a separate drainage district for the North Shore boroughs and those parts of the county which have been previously described. The Council is, however, concerned lest an onerous burden should be imposed on its ratepayers before the population is large enough to bear it, and it therefore suggested that until the county areas are reticulated with a water-supply they should form part of the Metropolitan Board's Outer Area and that until the Council requests that there should be connection with a sewerage system there should be no financial liability on the county areas. Finally the Council contended that there should be a separate drainage authority for the North Shore area unless the method adopted of disposing of sewage from the area is connected with the disposal system for the area on the south side of the harbour—*i.e.*, the Brown's Island scheme—in which case the area should come under the jurisdiction of the Metropolitan Board.

ADVANTAGES OF REGIONAL CONTROL

62. (1) We consider that, in general, there should be regional control of drainage and sewerage and that it is a mistaken policy for the separate local authorities in a district to have independent systems when by combination a comprehensive scheme can be employed.

(2) There are many advantages to be obtained from combination. Administration expenses are reduced. The authorities responsible for the maintenance of public health and the prevention of pollution from sewage disposal can exercise more effective control if there is only one drainage authority. Further, modern methods of sewage treatment and disposal require the services of highly skilled and trained sewerage engineers and chemists and other specialists. These are required not only for designing and constructing a system, but also for efficiently operating it. We consider that a drainage authority comprising several local authorities is much more likely to be able to employ a highly skilled staff than would the individual members.

(3) This opinion as to the advantages of unified control is supported by the authorities responsible for the control of the Waitemata Harbour—namely, the Auckland Harbour Board, the Health Department, and the Marine Department. We were informed that the Harbour Board policy is that the North Shore area should be under one sewerage authority and that it would prefer that that authority should be the same authority as is responsible for the district south of the Waitemata Harbour—namely, the Metropolitan Board. Dr. Maclean, of the Health Department, pointed out that the North Shore boroughs are at present discharging into the Waitemata Harbour or Rangitoto Channel either crude sewage or septic-tank effluent, and he expressed the opinion that the resulting pollution has to a large extent been overshadowed by the effect of the greater quantity of sewage discharged from the Orakei outfall. He stated that the Health Department considered that as soon as the Orakei outfall ceases to function it is very desirable that the situation at the North Shore should be remedied, and while the Department would be satisfied provided the sewage receives adequate treatment, it is considered that combined treatment in one undertaking would make for greater efficiency and reduced cost. Mr. D. F. Hobbs, the Senior Fishery Officer of the Marine Department, who gave evidence on behalf of the Department, agreed with the view that it was preferable that there should be unified control of sewage disposal.

(4) It will be observed that all the North Shore boroughs and the Waitemata County Council support the principle of unified control for the area, but they are all opposed to the area being brought under the jurisdiction of the Metropolitan Board (subject to the reservation made by the County Council).

(5) We have already explained that Mr. Watkins recommended the adoption of this principle, and his proposals were approved by the Committee appointed by the Minister of Health and also by Messrs. Hart and Borrie and by the 1937 Commission of Inquiry. Both Mr. Porter, the present Chief Engineer to the Board (who gave evidence on this part of the inquiry in his private capacity as a resident and ratepayer of the Waitemata County), and Mr. R. P. Worley, Consulting Engineer to the Takapuna and Birkenhead Boroughs, were in favour of unified control.

(6) It would appear that there is a fear on the part of the North Shore local authorities, or, at any rate, some of them, that if the North Shore area is brought under one authority at the present time, and especially if that authority is the Metropolitan Board, there is a risk that an elaborate scheme involving an unreasonable financial burden on the area will be undertaken. We consider that there is no justification for this fear. It was realized by Mr. Watkins and by the Drainage Board when the 1931 proposals were formulated that it would not be practicable or advisable to carry out the North Shore part of the proposals for some years. If a separate drainage authority is constituted, the local authorities should be able to ensure that a scheme beyond their resources is not adopted. Even if the North Shore area is added to the Metropolitan District and brought under the Metropolitan Board, it is, in our opinion, highly improbable that the Board would undertake a scheme which the local authorities oppose and cannot reasonably finance, especially if, as we think should be provided, they are required to bear the expense without assistance from the other parts of the district. It should be observed that Mr. Porter holds the opinion that there should be delay in undertaking a comprehensive scheme until the area is capable of bearing the expense, and we consider that this opinion is sound and should prevail.

(7) We consider that the North Shore boroughs and the portions of the Waitemata County previously referred to should be combined into one area for drainage purposes.

FORM OF DRAINAGE AUTHORITY

63. (1) If the principal of unified control is accepted, it becomes necessary to consider whether there should be a separate drainage authority for the North Shore area or whether the area should be brought under the jurisdiction of the Metropolitan Board.

(2) As has been explained, the four North Shore boroughs and the Waitemata County Council are all opposed to being brought under the Metropolitan Board, and ask that a separate Board should be constituted. We have stated the reasons put forward in support of their contention. We are not overlooking the proposal made by the County Council that if the sewage from the area is to be treated and disposed of at Brown's Island the Board should be the controlling authority. It has never been suggested, however, that this course should be adopted, and it would appear to be quite impracticable.

(3) We have given full consideration to these reasons, but we have come to the conclusion that they should not be allowed to prevail and that the area should be brought within the Metropolitan District and under the control of the Metropolitan Board, with adequate representation on that Board of the local authorities affected. We have also come to the conclusion that the area should not form part of either the Inner Area or the Outer Area of the Metropolitan District, but should be constituted a separate sewerage district.

(4) We consider that it is important in the interests of the North Shore area, as well as in those of the Metropolitan District as a whole, that there should be no division of control in drainage matters. Further, we consider material economies in administration expenses can be effected by avoiding the setting-up of a separate Board. The most important factor, however, in favour of the incorporation of the North Shore area in the Metropolitan District is the great advantage that will follow from that area having the benefit of the experience and skill of the Metropolitan Board and its technical staff. Modern methods of sewage treatment and disposal require the services of highly skilled and experienced engineers, chemists, and other technical staff. These are required for designing and constructing the necessary works, but, in addition, it is necessary to maintain a skilled and experienced staff to operate the works efficiently. Even if the comparatively small area and population comprising the North Shore area were able to bear the financial burden of employing the competent staff required, there would be no justification for the duplication of expense that must necessarily result. The North Shore area should not be deprived of the advantages that must follow from being able to make use of the experience and knowledge that will be possessed by the Metropolitan Board and its staff.

(5) We recognize that the local authorities in the North Shore area genuinely feel that their interest will be subordinated to those of the rest of the district, but we consider that their fears are groundless. It has not been suggested by any local authority which in 1944 was brought within the extended Metropolitan District that its inclusion has resulted or is likely to result in any prejudice to the ratepayers or residents of the district of the local authority. If the views of the North Shore local authorities are sound, it might have been expected that they could be supported by referring to the situation of other parts of the Metropolitan District.

(6) It follows, of course, that if the North Shore area is to be included in the Metropolitan District the local authorities in the area must have adequate representation on the Metropolitan Board. None of the North Shore local authorities made any representations on this question, and the information available to us is, we consider, insufficient for the proper determination of what is clearly a very important matter. The only satisfactory course is, we think, that there should be a special inquiry by a competent authority which should hear evidence and representations not only from local authorities in the North Shore area, but also from those included in the existing Metropolitan District. In the circumstances we have decided that we should not make a positive recommendation with respect to the representation which the local authorities in the North Shore area should have on the Metropolitan Board, but that we should recommend that for the purpose of determining this question there should be a special inquiry by the Local Government Commission.

FINANCIAL POSITION UNDER UNIFIED CONTROL

64. (1) While we consider that the North Shore area should be brought under the jurisdiction of the Metropolitan Board, we think that the costs of constructing, operating, and maintaining systems of sewerage and sewage treatment and disposal for the North Shore area should be kept separate from the costs of systems in other parts of the district and that on the one hand the North Shore area should be under no liability for the costs of such other systems, and on the other hand that the other parts of the district should not be liable for the costs of the North Shore systems.

(2) Our reasons for this opinion are as follows: It is clear that there will be no connection between any comprehensive North Shore drainage system and the drainage system of any other part of the district. While we consider that this factor does not justify the constitution of a separate drainage authority, we think that it does justify and, indeed, require the complete separation of financial liabilities. There is not, in our opinion, any sound reason why the North Shore area should be called upon to contribute to the costs of draining any other area. Nor is there any reason why any other area should be required to contribute to the costs of drainage of the North Shore area. We consider that our opinion in this connection is supported by the probability that the construction of any large-scale sewerage and sewage treatment and disposal works for the North Shore area will not be undertaken for several years. We should mention also that all the boroughs were strongly in favour of the complete separation of financial liabilities.

65. The information required to enable us to recommend any detailed scheme of sewerage and sewage treatment and disposal for the North Shore area has not been submitted to us, but we consider that this is not material and that it is unnecessary and probably inadvisable for any detailed recommendations to be made at this juncture. In our opinion, the matter requiring immediate attention is the inclusion of the North Shore area in the Metropolitan District and the bringing of the area within the jurisdiction of the Metropolitan Board. When these things have been done the Board should formulate a comprehensive scheme suitable for the requirements of the area with plans for the progressive execution of the scheme.

CONCLUSIONS AND RECOMMENDATIONS

66. We set out below our conclusions and recommendations with respect to the matters comprised within paragraphs (4) and (5) of the order of reference:—

(1) *The methods of treatment and disposal of sewage at present employed for the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna are not the most suitable.*

(2) *It is unnecessary and inadvisable to make any recommendations at present for the adoption of alternative methods for the treatment and disposal of sewage from the said boroughs.*

(3) *The said boroughs, together with certain parts of the Waitemata County (as described in paragraph 59), should be constituted by an amendment of the Drainage Act a combined sewerage district which will be hereinafter referred to as the Northern Sewerage District.*

(4) *The area comprised within the Northern Sewerage District should, by an amendment of the Drainage Act, be added to the Metropolitan Drainage District constituted by section 3 of the Act.*

(5) *The Northern Sewerage District should not form part of either the Inner Area or the Outer Area of the Metropolitan District.*

(6) *Provision should be made by an amendment of the Drainage Act for the said boroughs and the Waitemata County to be given equitable representation on the Drainage Board constituted by section 5 of the Act.*

(7) *In order to determine the representation that the said boroughs and the Waitemata County should have on the Drainage Board, a special inquiry should be held by the Local Government Commission.*

(8) *Appropriate amendments of the Drainage Act should be made to provide that—*

- (a) *The Metropolitan Drainage Board should be given the sole right within the Northern Sewerage District to construct, maintain, and manage all main sewers and drains, pumping-stations, storage tanks, outfalls, and treatment-works for sewage (compare section 32 (1) of the Act).*
 - (b) *The said Board should be required as soon as conveniently practicable to provide for the sewage from the Northern Sewerage District to be conveyed to a suitable place and there treated and discharged (compare section 34 (4) of the Act).*
 - (c) *Where any main sewer or drain, pumping-station, storage tank, septic tank, or outfall has been constructed within the Northern Sewerage District by any local authority, the same should be taken over by and vested in the said Board at such price and upon such terms and conditions as may be agreed upon between the said Board and such local authority or, in the event of their being unable to agree, as may be settled by arbitration under the Arbitration Act, 1908 (compare section 32 (2) of the Act).*
 - (d) *The said Board should be empowered to construct, maintain, and operate within the Northern Sewerage District all such main sewers, main drains, pumping-stations, storage tanks, outfalls, treatment-works, and other works and things as may, in the opinion of the Board, be advisable for the efficient drainage of the Northern Sewerage District (compare section 33 of the Act).*
 - (e) *The said Board should be empowered to discharge the effluent from any treatment works constructed by the Board into the waters of the Waitemata Harbour or the Hauraki Gulf (compare section 34 (1) of the Act).*
 - (f) *The construction of any outfall pipes should be subject to the precedent approval of the Marine Department and of the Auckland Harbour Board as to location, depth, and other details of construction (compare section 34 (2) of the Act).*
 - (g) *The said Board should be required from time to time to obtain the approval of the Auckland Harbour Board as to the degree and character of purification of the effluent to be discharged from the said works to the waters of the Waitemata Harbour or Hauraki Gulf, and should be restrained from discharging or permitting to be discharged therefrom any effluent not conforming to the degree and character of purification for the time being approved by the Harbour Board (compare section 34 (3) of the Act).*
 - (h) *The discharge of sewage from any portion of the Northern Sewerage District into the waters of the Waitemata Harbour or the Hauraki Gulf except through the main sewers of the said Board should be prohibited, but any existing drains should be allowed to continue to discharge sewage until the Board has completed provision for conveying such sewage to its treatment-works, and this provision should not apply to any discharge from storm-water overflow chambers forming part of the drainage system of any local authority (compare section 34 (4) of the Act).*
- (9) *Provision should also be made by appropriate amendments of the Drainage Act that—*
- (a) *A separate account shall be kept by the said Board of all property held by the Board and of all liabilities incurred, and also of all moneys received or disbursed by the Board in respect of the Northern Sewerage District, including the amounts paid by the Board to the local authorities in accordance with subparagraph (8) (c) above and all liabilities assumed by the Board thereunder.*

- (b) *The Northern Sewerage District shall be liable only for contributions required for—*
 (i) *The capital, operating, and maintenance costs and charges in respect of the sewerage system and sewage treatment and disposal works for the Northern Sewerage District (including an equitable charge for the services of the said Board's staff).*
 (ii) *An equitable annual contribution towards the general administration expenses of the Board (compare section 4 (4) (b) of the Act)*
 (c) *The property and funds of the Board, other than the property and funds included in the Northern Sewerage District separate account, shall not be liable for any obligations incurred in respect of the Northern Sewerage District.*
 (d) *The said Board is empowered to raise a loan for an authorized purpose for the benefit of the Northern Sewerage District or any defined part or parts thereof (compare section 56 (4) of the Act).*
 (10) *The Drainage Act should also be amended by applying to the Northern Sewerage District such of the provisions of sections 58 to 62 (inclusive) and 64, 65, and 66 as are applicable and by replacing such of them as are not applicable.*

PART VI—SUMMARY OF PRINCIPAL RECOMMENDATIONS

CONSTITUTION AND BOUNDARIES OF THE METROPOLITAN DISTRICT

67. (1) The boundaries of the Metropolitan District should be extended by an amendment of the Drainage Act so as to comprise the areas included in the Central, Southern, Eastern, Western, and Northern Sewerage Districts referred to in paragraph 29 (2). (Paragraphs 29 (4), 50 (1), 51 (1), and Part V.)
 (2) The extended Metropolitan District should be sub-divided into five sewerage districts—namely, the Central, Southern, Eastern, Western, and Northern Sewerage Districts—and the Drainage Act should be amended accordingly. (Paragraph 29 (6).)
 (3) The boundaries of such sewerage district should be as described in general terms in paragraphs 50 (1), 51 (1), and Part V.
 (4) The Drainage Act should be amended so as to provide for the Central and Southern Districts to constitute the Inner Area of the Metropolitan District and the Eastern and Western Districts the Outer Area. (Paragraph 29 (4).)
 (5) The Northern District should be constituted by an appropriate amendment of the Drainage Act as a separate district within the Metropolitan District not forming part of either the Inner or Outer Area. (Paragraph 63 (3).)
 (6) Section 45 (2) of the Drainage Act should be repealed.

SEWERAGE AND SEWAGE TREATMENT AND DISPOSAL SCHEMES

68. (1) The general principles of the scheme proposed by the Drainage Board and referred to as Scheme No. 2, with such modifications as may be found expedient, should be adopted as the most suitable sewerage and sewage treatment and disposal scheme for that part of the Metropolitan District which is comprised within the Central and Southern Sewerage Districts. (Paragraph 52 (1).)
 (2) It is unnecessary and inadvisable to make any recommendation at present with respect to the adoption of a sewerage and sewage treatment and disposal scheme for the other parts of the Metropolitan District. (Paragraphs 52, 65, and 66 (2).)
 (3) The Drainage Act should be amended so as to provide that treatment-works for the Central Sewerage District should be constructed on Motukorea and treatment-works for the Southern Sewerage District at a site or sites adjoining or near the Manukau Harbour to be selected by the Drainage Board and that the effluent from such treatment-works may be discharged into the waters surrounding Motukorea and into the Purakau Channel respectively.
 (4) The Drainage Act should also be amended as recommended in paragraph 52 (2).

UTILIZATION OF SEWAGE AND OTHER WASTES

69. (1) The Drainage League's proposal for the cultivation of water plants in a lake to be made in the Manukau Harbour and into which the effluent from the sewage of the Central and Southern Districts would be discharged is considered to be inadvisable. (Paragraph 44.)

(2) The Drainage League's proposal that the sewerage and sewage treatment and disposal scheme for the Metropolitan District should make provision for the composting by the drainage authority of municipal garbage and other wastes is considered to be inadvisable. (Paragraph 45 (9).)

(3) The Drainage Board's proposals for the utilization of sewage by the production of an air-dried digested sludge which could be used either as an activator in the manufacture of compost or for conversion to a heat-dried pulverized fertilizer should be adopted. (Paragraph 47.)

DRAINAGE OF THE NORTH SHORE

70. (1) The methods of treatment and disposal of sewage at present employed for the Boroughs of Northcote, Birkenhead, Devonport, and Takapuna are not the most suitable. (Paragraph 66 (1).)

(2) It is unnecessary and inadvisable to make any recommendation at present for the adoption of alternative methods for the treatment and disposal of sewage from the said boroughs. (Paragraph 66 (2).)

(3) The said boroughs, together with those parts of the Waitemata County described in paragraph 59, should be constituted a separate sewerage district (Northern Sewerage District) which should be added to the Metropolitan District but which should not form part of either the Inner or the Outer Area. (Paragraph 66 (3), (4), and (5).)

(4) Provision should be made for the said boroughs and the Waitemata County to be given equitable representation on the Drainage Board, and for this purpose a special inquiry should be held by the Local Government Commission. (Paragraph 66 (6) and (7).)

(5) Amendments of the Drainage Act as set out in paragraph 66 should be made in order to give effect to the foregoing recommendations.

DISPOSAL OF TRADE WASTES

71. (1) The term "trade wastes" should be defined by an amendment to the Drainage Act. (Paragraph 36 (3).)

(2) The Drainage Act should be amended by an express provision that the discharge of trade wastes into the Drainage Board's sewers is compulsory, with a provision that the Drainage Board shall have power to grant exemptions on such conditions as may be prescribed by the Board and approved by the Harbour Board. Provision should also be made for a right of appeal against a refusal to grant exemption or against any condition prescribed by the Board. (Paragraph 36 (9).)

(3) Sections 34 (4) and 32 (1) of the Act should be amended by extending the meaning of the expression "sewage" to include trade wastes. (Paragraph 36 (9).)

(4) Undertakings which produce trade wastes should be responsible for carrying out the treatment of such wastes at their own expense. (Paragraph 36 (11).)

(5) The Act should be amended by conferring on the Drainage Board the power to require an undertaking to make provision for an inspection chamber or manhole at its own expense to enable samples of the wastes to be taken. (Paragraph 36 (11).)

(6) The Act should be amended by conferring on the Drainage Board the power to treat wastes at the expense of the undertaking instead of requiring the undertaking to carry out the treatment. (Paragraph 36 (12).)

(7) Undertakings producing trade wastes should not be required to contribute to the cost of any further special treatment carried out by the Drainage Board after the Board's requirements for pretreatment have been complied with. (Paragraph 36 (14).)

(8) Undertakings producing trade wastes should be required to pay a reasonable charge for the disposal by the Board of trade wastes, and the Drainage Act should be amended by empowering the Board to prescribe by by-law the charge that should be paid. (Paragraph 36 (19) and (21).)

(9) The Drainage Board should have power to require the undertaking to install and maintain at its own expense such meters or other appliances as may be required to measure the volume of trade wastes. (Paragraph 36 (21).)

(10) The cost of providing a new local sewer for conveying trade wastes only should be borne by the Drainage Board. (Paragraph 36 (22).)

(11) The cost of providing a new local sewer for conveying trade wastes and domestic sewage should be apportioned between the Drainage Board and the local authority on an equitable basis. (Paragraph 36 (22).)

(12) The cost of altering a local sewer to take trade wastes should be borne by the Drainage Board. (Paragraph 36 (22).)

(13) Action should be taken by the Auckland Harbour Board and the Health Department without delay to alleviate the nuisance caused by the present methods of discharging trade wastes into the Manukau Harbour. (Paragraph 36 (23).)

(14) In order to alleviate the nuisance caused by the present methods of discharging trade wastes into the Manukau Harbour, the construction of the main and local sewers and outfall for the Southern District should be carried out as soon as possible so as to enable trade wastes to be discharged into the Purakau Channel. (Paragraph 36 (24).)

(15) The Board should have power to require undertakings producing trade wastes to install treatment equipment prior to the construction of the sewers and outfall for the drainage of the Southern District. (Paragraph 36 (25).)

CONCLUSION

72. (1) We consider that it is advisable to emphasize that, in our opinion, it is highly important that the Drainage Board should be able to proceed immediately with the execution of its schemes for the drainage of the district. We have endeavoured to show that the need for the provision of an adequate drainage system is imperative and that it is unfortunate that the commencement of the work should have been so long delayed. We are satisfied that the opposition to the Board's proposals has arisen primarily from ignorance of modern sewage-engineering principles and practice and from misconceptions with regard to what modern proved methods of sewage treatment and disposal can accomplish.

(2) We have the honour to return herewith the Commission with which Your Excellency was pleased to favour us.

(3) We have the honour, in obedience to the Commission entrusted to us, to submit for the consideration of Your Excellency this our report, which has been unanimously adopted.

Given under our hands and seals

[L.S.]

RONALD H. QUILLIAM, Chairman.

[L.S.]

T. B. NICOL } Members.

[L.S.]

J. H. BARNETT }

Dated this 24th day of June, one thousand nine hundred and forty-nine (1949).

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