1925.

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

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Pursuant to Statute
By Command
In return to Order

Clerk of the Senate.
24th June, 1925.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

REPORT

TOGETHER WITH

MINUTES OF EVIDENCE

RELATING TO THE PROPOSED CONSTRUCTION OF

SEWAGE TREATMENT WORKS, FEDERAL CAPITAL.

Presented pursuant to Statute; ordered to be printed,

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MEMBERS OF THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

(Fourth Committee.)

The Honorable HENRY GREGORY, M.P., Chairman.

Senate.	*House of Representatives.*
Senator John Barnes.†	Arthur Blakeley, Esq., M.P.
Senator Hattil Spencer Foll.‡	Robert Cook, Esq., M.P.
Senator Patrick Joseph Lynch.†	David Sydney Jackson, Esq., M.P.
Senator John Newland.‡	George Hugh Mackay, Esq., M.P.
Senator William Plain.*	James Matthews, Esq., M.P.
Senator Matthew Reid.†	

* Ceased to be a Member of the Senate, 30th June, 1923. † Appointed 5th July, 1923. ‡ Resigned 26th June, 1923.

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EXTRACT FROM THE VOTES AND PROCEEDINGS OF THE HOUSE OF REPRESENTATIVES.

(No. 120, DATED 25TH SEPTEMBER, 1924.)

3. PUBLIC WORKS COMMITTEE—REFERENCE OF WORK—FEDERAL CAPITAL—SEWAGE TREATMENT WORKS.—Mr. Atkinson (for Minister for Works and Railways) moved, pursuant to notice, That, in accordance with the provisions of the *Commonwealth Public Works Committee Act* 1913–21, the following proposed work be referred to the Parliamentary Standing Committee on Public Works for investigation and report, viz. :—Federal Capital: Sewage Treatment Works—The construction of Treatment Works at the termination of the Main Outfall Sewer at Western Creek.

Mr. Atkinson having laid on the Table plan, &c., in connexion with the proposed work—

Debate ensued.

Question—put and passed.

LIST OF WITNESSES.

SEWAGE TREATMENT WORKS, CANBERRA.

REPORT.

The Parliamentary Standing Committee on Public Works, to which the House of Representatives referred, for investigation and report, the question of the construction of sewage treatment works, Canberra, at the termination of the Main Outfall Sewer at Western Creek, has the honour to report as follows :—

INTRODUCTORY.

1. The gravitation sewage scheme adopted for the Federal Capital involves the construction of works at the outfall to treat the sewage in order that an innocuous effluent may be obtained for discharge into the Molonglo River.

2. In 1915, the Parliamentary Standing Committee on Public Works, in submitting to Parliament its Report on the construction of a main sewer for the City of Canberra, stated :—

Paragraph 14.—"Although in the course of its investigations the Committee gathered some valuable information as to the various styles of septic tank and systems of treatment of sewage, it realizes the rapid strides being made in sanitary science, and refrains from suggesting the adoption of any particular system in view of the fact that what is considered the most up-to-date system at the present time may be superseded by a more efficient system by the time it will be necessary to erect treatment tanks at Western Creek.

The Committee, however, strongly recommends that immediately prior to the date on which it is proposed to erect treatment tanks, exhaustive inquiries be made with a view to the installation of the most up-to-date system then obtainable."

3. Since that time, methods of sewage disposal have been the subject of close investigation by experts in various parts of the world, and it is stated that the results of these experiments and the conclusions arrived at by leading authorities have been carefully reviewed by the Commonwealth engineers as recommended by this Committee before suggesting a method of treatment for the Federal Capital.

4. In order that the sewerage scheme may be in operation by the time Parliament is transferred to Canberra, it is represented that preliminary action should now be taken in respect of the treatment works, and a scheme has been formulated which is submitted for investigation.

PRESENT PROPOSAL.

5. The present proposal provides for the installation of a first unit of Sedimentation Tanks and Trickling Filters to deal with 500,000 gallons daily, being the sewage from 5,000 people plus the flushing water necessary for scouring the sewers in the initial stages. It is also intended to install a small experimental unit capable of treating the sewage of 500 people by the Activated Sludge method, so arranged that either crude sewage or settled sewage from the sedimentation tanks can be passed through it. The scheme proposed will permit of these units being increased as necessity arises to treat the sewage of 10,000 or later of 25,000 people.

ESTIMATED COST.

6. The estimated cost of the treatment works to provide for 25,000 people is £60,000, of which it is estimated that £37,000 will be expended within the next three years.

COMMITTEE'S INVESTIGATIONS.

7. The Committee visited Sydney and inspected the sewage treatment works at Folly Point, comprising a complete system of aerated tanks and also a complete system of septic tanks. Evidence was taken from the engineers of the Commonwealth Department of Works and Railways, the State Public Works Department of New South Wales, and of the Water Supply and Sewerage Board of Sydney; also from the Director of Sanitary Engineering, Commonwealth Health Department, and the Medical Officer of the Sydney Water Supply and Sewerage Board.

8. Experts carefully explained to the Committee the general theory of sewage treatment and the various devices adopted to effectually deal with the solids or sludge so that the resultant liquid or effluent shall be free from anything likely to be deleterious or obnoxious when such effluent is run into a stream or allowed to spread over land.

9. It was stated in evidence that within the last few years there has been a considerable progressive development in the treatment of sewage, although it is admitted that any work of this nature must still be regarded as experimental. There is always likely to be some uncontrollable factor, because one is dealing with unforeseen forces of nature.

10. The Departmental proposal submitted is to have a settling tank and filter bed unit with the addition of a small activated sludge unit so that the crude sewage can be turned into either unit and the effluent can also be turned either way.

This will permit of five or six different methods of working, and if at a later date it be found that one method is superior to the others, the installation can be extended on those lines without the necessity of scrapping any of the plant.

11. It was stated in evidence that before suggesting this method of treatment, the Department had had the benefit of the assistance and co-operation of Colonel Longley, of the Rockefeller Institute, who came from America to Australia at the request of the Commonwealth Government and examined the sewage problem at Canberra, and gave his advice thereon. In addition, all the technical witnesses examined expressed themselves as satisfied that the scheme proposed is the best that can be devised for Canberra in the light of present knowledge.

12. The details of the cost as submitted to the Committee are as follow :—

Diversion of Western Creek and river protection	£6,000
Preparation of site	3,000
24-in. gravity main	3,400
Screens, settling tanks, and dosing tanks	6,600
Aeration filters complete	8,500
Pump for sludge	1,200
Incinerator	100
Accommodation house for employees	500
Activated sludge tanks	1,750
Extra activated unit	1,100
Power appliances for activated sludge	750
Sludge drying beds	1,100
Contingencies	2,000
Supervision	1,000
	£37,000

and the annual cost is set down at :—

Interest on capital outlay, 6 per cent.	£2,220
Repairs, maintenance, and renewals	1,085
Wages	700
Power	265
Sludge disposal	300
	£4,570

13. On the point of provision for the future, the Committee was informed that if Canberra reaches a population of 100,000 there will be ample space at the proposed site for the extension of the treatment works. A certain amount of work done for the first installation, such as the diversion of Western Creek, the preparation of the site, the embankment to keep back the waters of the river, and the diversion of the road, will permit of the later extension of the plant at a lower proportionate cost.

14. From inquiries made from both Commonwealth and State officials, the Committee is satisfied that if the system suggested be adopted there will be no possibility of pollution of the Molonglo from the resultant effluent.

In regard to this matter, however, the Committee desires to point out that while the Commonwealth is taking great care to prevent any possible pollution of the Molonglo below the City, that river above the City still receives the surface drainage from the town of Queanbeyan. No attempt has been made to provide Queanbeyan with a sewerage system, and the Committee considers that it is imperative that every effort should be made to induce the State Government to prevent pollution from this town of the waters of the stream which flow through the centre of the Federal Capital. While Queanbeyan is unsewered there is always danger to the health of the people at Canberra.

15. In the course of evidence, it was stated that the method of aeration of the sewage in the activated sludge tanks necessitates an air compressor and an electric motor the air being forced through porous plates at the bottom of the tank. This is an expensive process, and in the case of Folly Point the cost of power works out at £288 per month. It was added that the recent view as regards activated sludge is rather tending towards the idea that the essential part of the process is not so much aeration as agitation. It is held that this can be obtained by a simpler form of agitation by means of paddles which gives the same results in the purification of the sewage at considerably less expense.

COMMITTEE'S RECOMMENDATION.

16. After careful consideration of all the evidence received, the Committee is unanimously of opinion that the proposal for the establishment of sewage treatment works at Canberra as submitted by the Department be approved. It is considered, however, that an additional activated sludge unit should be erected for the purpose of experimenting with the treatment of sewage by agitation by mechanical means in lieu of aeration.

To obtain the best results from these experimental units, the Committee is of opinion that a competent officer should be placed in charge of them to carefully collect and prepare data as to the efficiency of the respective units, so that the future treatment of sewage may be carried out on the best possible lines.

H. GREGORY,
Chairman.

Office of the Parliamentary Standing Committee on Public Works,
Federal Parliament House, Melbourne, 14th March, 1925.

MINUTES OF EVIDENCE.

(Taken at Sydney.)

THURSDAY, 6TH NOVEMBER, 1924.

Present:

Mr. GREGORY, Chairman;

Senator Reid	Mr. Jackson.
Mr. Blakeley	Mr. Mathews.
Mr. Cook	

John Norman Campbell MacTaggart, M.E., M.Inst., C.E., Acting Chief Engineer of the Water and Sewerage Board, Sydney, sworn and examined.

1. *To the Chairman.*—I am aware of the proposal to install a sewage treatment plant 3 miles out of Canberra. For 25,000 inhabitants, it may be necessary to have the septic tank system in addition to the activated sludge system, but the activated sludge system is preferable. We have a complete system of aerated tanks at Folly Point, and also a complete system of septic tanks alongside, both in operation all day. The septic tanks were not large enough to accommodate the flow of sewage, so we erected half a dozen aerated tanks. The aerated tank system is complete without the septic system. The aerated system is the least offensive. The following is a statement showing particulars of the activated sludge plant at North Sydney outfall:—

Operations during the months of January to July, 1924:—

Average gallons of sewage treated per month ..	59,608,286
Average period of filling, hours and minutes ..	1.20
Average period of aerating, hours and minutes ..	6.40
Average period of settling, hours and minutes ..	1.00
Average period of decanting, hours and minutes, ..	1.00
Average period of aerating sludge, hours and minutes	2.00
Sludge decanted into septic tanks, cubic yards ..	3,414
Sludge sent to sea, cubic yards	Nil
Sludge formed, per million gals. of sewage, cubic yds.	58

Cost per Month.

	£	s.	d.
Labour	210	0	0
Power	288	10	11
Interest on cost of plant	80	0	0
Depreciation	50	0	0
Sludge removed to sea			
Total	£628	10	11

Gallons treated per month—59,608,286.
Units of electricity used—105,510.
Units per million gallons—1.773.
Average cost per unit—.66d.
Gallons per unit—565.
Cost per million gallons—£4 10s. 9d.
Cost of electricity—£288 10s. 11d.
Daily average through septic tanks—750,000 gallons.
Monthly average through septic tanks—23,130,857 gallons.
Daily average through activated sludge tanks—1,060,000 gals.
Monthly average through activated sludge tanks—59,608,286 gallons.
Number of persons served by septic tanks 18,975
Number of persons served by activated sludge tanks—49,000

Total number of persons—67,975

(Taken at Sydney.)

MONDAY, 10TH NOVEMBER, 1924.

Present:

Mr. GREGORY, Chairman;

Senator Barnes	Mr. Cook
Senator Reid	Mr. Jackson
Mr. Blakeley	Mr. Mathews.

Allan Gordon Gutteridge, Director of the Division of Sanitary Engineering of the Commonwealth Health Department, sworn and examined.

2. *To the Chairman.*—I am aware of the proposal that has been submitted to the Committee concerning the installation of a sewage treatment plant at Canberra. In this respect I have consulted both Mr. Hill and Mr. Connell. I have seen the plans of the proposed work. I am a graduate of the Melbourne University, Bachelor of Civil Engineering, and of Harvard University, Master of Science. In August, 1922, I was granted a scholarship by the Rockefeller Foundation, which included an eight months' course at Harvard University on water supply and the treatment of sewage, and also five months' travelling to view disposal works in America, Canada, England, and the Continent. Since my return to Australia, whilst serving with the Department of Health, I have advised municipalities throughout Australia on questions of sewerage and water supply. At present, two large plants, to our design, are being erected at Toowoomba and Ballarat. There are two systems of sewage treatment which are very nearly equal in respect to the final effluent produced. One is treatment by sedimentation, usually by tanks and filters, and the other is the activated sludge system. The trickling filter system is more expensive to install, but the maintenance is less. The activated sludge system is not so expensive to install, but the maintenance cost is heavy. A special feature of the Imhoff tank is that the sewage is actually held within the tank for a period of from 2 to 2½ hours. The principle is entirely opposite to that of the septic tank. After the sludge deposited in an Imhoff tank undergoes a proper period of digestion, there is only a slight odour from it, but no offensive smell. It makes no difference with the Imhoff tank whether the sewage is carried a long or short distance. If the sewage is septic by the time it arrives at the tank, it may give off a slight odour, but the fact of the sewage being slightly septic makes no difference in the actual operation. I have seen the plans of the proposed sewage reticulation at Canberra, and I know what size sewers are proposed to be constructed. The length of pipe through which the sewage has to travel would not make it so septic as to make the Imhoff tank unsuitable. The main system proposed at Canberra is the sedimentation tank, sometimes called the Imhoff tank, and the trickling filters. In the case of Canberra, the proposed activated sludge system will be entirely experimental. That system of treating

sewage is very costly. On the other hand, when it is found necessary to expand the plant by giving the sewage which comes from the sedimentation tank a small period of aeration, it can be applied to the trickling filters at about four times the rate than would be possible if it were not so aerated. The activated sludge system will be purely experimental, but doubtless it will be found that the annual cost of running the whole installation, when the population grows, will be less if, instead of extending the trickling filters, the activated sludge plant is used. With the ordinary septic tank, the sewage passes through a large rectangular tank and the solids deposited from the fluid decompose at the bottom. The products of decomposition rise and are taken off with the effluent. They have to be treated as well as the liquid portions of the sewage which have not been deposited. In that way the liquid which comes from the septic tank contains a large amount of decomposed organic matter. That liquid is much harder to treat than if the sewage went through a short period of detention, and the products of decomposition were not included in the effluent for treatment. The Imhoff tank consists of three long channels. The sewage goes through the channels at the top. In the ordinary septic tank the period of detention is from 15 to 24 hours, usually 24 hours. With the Imhoff tank the sewage enters on one side, goes through the channel, and leaves on the other side. The period of detention is from 2 to 2½ hours. All solids settle down through a slot into the digestion chamber below, and are there subject to anaerobic digestion without the presence of oxygen. The bacteria break down the organic compounds. The gases generated through decomposition are kept from the sewage and passed up the outside channel and escape. The slot through which the solids descend projects on one side and in that way prevents gases from decomposition getting back into the sewage. The sewage from the Imhoff tank is fresh and contains a minimum amount of organic matter. The sewage that comes to the plant consists mainly of water—99 per cent. of water—but included in it is a lot of dissolved organic matter, consisting of fine suspended matter and gross suspended matter. The gross suspended matter gives most trouble in treatment. With the Imhoff tank those gross matters are separated and treated in the digestion chamber. They cannot get back into the sewage. The gases generated in the Imhoff tank are practically inoffensive. They are not so offensive as the crude sewage, and usually cannot be noticed more than 20 to 30 feet away. There is a valve at the bottom of the Imhoff tank for the removal of sludge, and leading from the bottom of the tank is the sludge educt pipe. The sludge runs into the pipe by gravitation and is pumped up to the drying beds. The sludge, to be properly digested, remains in the digestion chamber for three months in summer and six months in winter. In America, the plants are designed for eight months' digestion to cover the winter period. The drying beds are usually about 40 feet by 80 feet, composed of sand above a gravel layer, underneath being an open-jointed tile drain. The liquid sludge, containing about 95 per cent. of water, flows on to the drying bed; the water drains away, the concentrated sludge being left on top. There is no offensive smell from it. Some people use the sludge for manure. In certain cities of America there is quite a demand for it. It is not always suitable for this purpose, because there is a high percentage of fat in it. At no time after the sludge leaves the tank is it at all offensive. With a population of 50,000, there would be no great quantity of sludge from Imhoff tanks. The usual annual allowance is from about 1 to 1½ cubic feet per capita per annum, which would mean 75,000 cubic feet at the outside. Sludge is described by some people as a very good earth, but as a very poor manure. It has practically the same value as leaf mould. The effluent from the Imhoff tank goes through a trickling filter, consisting of a bed of small stones, underdrained by a system of open-jointed tiles. The effluent is distributed evenly by rotating sprinklers. As the effluent trickles down over the stones it is acted upon by the bacteria coating the stones. These are the aerobic bacteria which operate in the presence of oxygen. The effluent, as it leaves the trickling filter by the channels underneath, flows away, and can be discharged into the sea or watercourse. The sprinklers rotate under the pressure of the liquid being distributed. The Imhoff tank is the common form of treatment in nearly all the cities of America. It is not so widely used in England, because there the septic tank is preferred. There is a lot of national pride involved in the attitude adopted by the English authorities. The Imhoff tank was first investigated by Travers, an Englishman. Imhoff made some slight improvements to the tank and pushed it harder than Travers, and it became known as the Imhoff tank. That is one reason why it is has not been so well received in England. Also, in most large English towns, a mixture of manufacturing waste goes down with the sewage, and this needs special treatment, which is not provided for in the Imhoff tank. The Imhoff tank is practically the only system used in American residential cities. Sewage, by the time it gets to the tanks, may contain some form of pollution, particularly waste from gas-works, coke-works, and steel-works, and this needs special treatment before being sent into the tanks. This waste is often disastrous to the bacteria. I am certain that the treatment of sewage at Canberra by the Imhoff tanks will be successful. The activated sludge will be an exceedingly small unit, but from it sufficient experimental data may be obtained to decide whether later on, when the plant needs expanding, it will be better to enlarge the trickling filters, or to utilize the activated sludge plant for the partial treatment of the sewage before it is passed to the trickling filters. The experimental unit of activated sludge at Canberra will be only an alternative to the trickling filter and not to the Imhoff tank. It will be for the partial treatment of sewage that comes from the Imhoff tank. When activated sludge was first started in England, it was looked upon as an alternative treatment to the use of sedimentation tanks, and not as a substitute for the trickling filter. Recent experiments in Chicago have proved that the activated sludge treatment reaches its maximum development if the sewage is first treated in the Imhoff tank, or in some form of sedimentation tank to remove all the gross solids. The effluent which remains, that is, the sewage containing dissolved matter and finely suspended matter, is then put through the activated sludge treatment, and then sometimes also on to the trickling filters for final treatment. With an experimental activated sludge plant at Canberra, the effluent from the Imhoff tank could be passed either through the trickling filters or through the activated sludge plant and then through the trickling filters. The activated sludge plant would facilitate the treatment of sewage at Canberra, because the proposed site is rather cramped for room. It is in the bed of a creek, and it cannot be extended indefinitely. If the effluent from the Imhoff tank is subjected to a short period of aeration before being put through the trickling filters it would, in all probability, be found that the trickling filters would not need to be extended for many years to come. It was originally intended to irrigate with the effluent from the termination of the outfall sewer over the country in a south easterly direction, but this would have involved pumping, and it was finally decided to establish treatment works in the bed of the Western Creek in such a position as to cause the sewage to reach the plant by gravitation and thus do away altogether with the necessity for pumping. That is the reason why it was decided to carry the sewage at a sharp angle north-west from the termination of the outfall sewer. If the plant were put in any other place but in the bed of Western Creek, pumping would have to be resorted to. In the lay-out of the plant room is left for two future extensions of the sedimentation tanks and also for an additional trickling filter bed. Even with these extensions, the plant would not be suitable for a population of 100,000. The plant was designed for 10,000 people, because that is the maximum amount of sewage needed to keep the sewer well flushed. Sufficient water has to be put through the sewer equivalent to the amount of sewage derived from 10,000 people. The proposed plant would probably be capable of treating the sewage from a population of 30,000, and if the extensions are made the plant would probably deal with 60,000 people. The activated sludge system run in conjunction with the Imhoff tank gives a continuous process. The activated sludge treatment at Folly Point is intermittent. Under the system at Folly Point the sewage enters the activated sludge tank, and is aerated. The sewage is submitted to a short period of sedimentation, and then the liquid flows out at the far end of the tank. The excess sludge that settles in the tank is used to inoculate a further batch of sewage. It is necessary to maintain a proportion of 25 per cent. of activated sludge in the tank. By allowing a short period of sedimentation after aeration, and pumping the excess sludge back into the incoming sewage, a continuous flow of sewage through the tank can be maintained. Sludge which has been activated consists of organic material on which are accumulated many hundreds of thousands of bacteria. The excess sludge with its bacteria is pumped into the incoming sewage. As the sewage comes into the tank it mixes with the 25 per cent. sludge. By that means the many millions of bacteria in the aeration chamber are maintained. The process of aeration serves to mix the sludge with the sewage, and also increases the air surface. The process will continue with from anywhere between 20 per cent. and 50 per cent. of activated sludge. Twenty per cent. has been found to be the most economic percentage. After the sewage is passed through the aeration chamber, it is submitted to a period of sedimentation. That removes not only the activated sludge, but all such particles of sewage as have not been fully acted upon. The effluent from the sedimentation tank is perfectly clear and pure. This system rivals the Imhoff tank with the trickling filter in regard to the purity of the effluent. The solids that settle down in the sedimentation tank are returned to the incoming sewage, and used again for seeding the incoming sewage with bacteria. The proportion of activated sludge gradually mounts up all the time. Once every few weeks there is an excess of sludge. This is drawn off, and either put into the Imhoff tank or got rid of in some other way. An air compressor and electric motor is necessary for aeration. At the bottom of the tank the air is forced through porous plates made of a mixture of a large proportion of sand and a small proportion of cement. At times these are clogged with fat and other materials. The loss of head through air passing through the plates should not be more than half an inch. The effluent from the Imhoff tank flows into the aeration tank and is forced to circulate. The sludge settles at the bottom, and from there it is drawn off by an air-lift pump, and returned to the inflowing sewage. The clear liquid is drawn off through the effluent pipe.

2A. *To Mr. Cook.*—The sludge from the activated sludge tank is a better fertilizer than is the sludge from the sedimentation or Imhoff tank. It has far more life in it. On the other hand, it will not dry so rapidly as the sludge from the Imhoff tank.

3. *To the Chairman.*—The proposed plants at Canberra could work separately or conjointly. It was first proposed to have an activated sludge system, and to install a small septic tank for the purpose of getting rid of the sludge, but the estimates as taken out by Mr. Hill and Mr. Connell were such as to make the scheme impossible under the conditions at Canberra. The success of the activated sludge plant depends on cheap power. The estimates taken out by Mr. Hill, and checked over by me, showed that the activated sludge plant would be at a distinct disadvantage on account of the cost of power. It needs approximately 40 horse-power for a population of 20,000. That is my estimate based on English practice. The air compressor has to deliver 1½ cubic feet of air for every gallon of sewage treated. There would be a 6-lb. or 7-lb. head. The proposed plant would require from about 1½ to 2 horse-power. There would be no danger of pollution or injury to health owing to the effluent gaining access to the Molonglo River, and thence to the Murrumbidgee River. I am fully satisfied on that point.

4. *To Mr. Mathews.*—The small activated sludge plant proposed at Canberra is purely experimental so as to ascertain whether the annual cost of running the whole installation cannot be reduced in later years when it becomes necessary to extend the plant. There is always a sickly odour from crude sewage. Any one standing 20 yards away from the plant would be unable to detect any odour. I know of many places in America where the site of the sewage treatment works is made a general picnic ground. Trees are planted round the works, hot water is provided free, and everything is done to encourage the people to go there. There is no disagreeable odour from the treatment.

5. *To Mr. Cook.*—If I had the opportunity to revise the proposed system of treatment of sewage at Canberra, I should not alter it. It is in every way satisfactory, and would be very hard to improve upon. It is very doubtful whether the sludge at Canberra will be of any use as manure. It is difficult to get people to take the sludge away. They might do so if it were given to them, but not if they had to pay for it. If they paid for its cartage, it would save some slight cost in disposing of it. The sludge would certainly act as a fertilizer. It is really a question of how much people will pay for it, and whether they will use the sludge in preference to artificial manure. It is all a matter of price. I know of a case in America where the sewage works manager advertised that sludge could be obtained providing it was taken away. No one took advantage of his offer. He experimented in psychology, and advertised that it could be obtained at a price of 25 cents. a load, and the people bought it. Usually there is a very poor sale for sludge.

6. *To Mr. Blakeley.*—I am not aware that experiments in sewage treatment are being carried out by the New South Wales Public Works Department. It will not be necessary to chlorinate the effluent which will be obtained at Canberra.

7. *To Senator Reid.*—The sludge is spread over sand beds. Owing to Australian conditions, it is hard to say what quantity of sludge would be obtained from a population of 10,000. There is no plant in operation in Australia from which data could be obtained, but in England and America the quantity usually averages from 1 to 1½ cubic feet of sludge per capita. The sludge is almost entirely mineralized, and contains quite an appreciable amount of nitrogen. This would be valuable for fertilizing purposes. On the other hand, there is a large amount of fat in the sludge, which, if used in quantity, would clog the land. The fatty matter does not undergo decomposition to such an extent as do other organic materials. In some places the application of large quantities of sludge have ruined land, and it had to be rested for two or three years to get the fats out of the ground. In the activated sludge system the fat is skimmed off, and treated separately. With the Imhoff tank, it goes through with the sludge. By putting the sewage first through the Imhoff tank, the fats are

got rid of before being treated in the aeration tanks. At Toronto, I saw wonderful results from fertilizing with activated sludge. All kinds of vegetables and cereals were grown. At Canberra, the sludge from the activated sludge tank could go back into the Imhoff tank, and be got rid of with the other sludge. The great trouble with activated sludge is the de-watering, but if it is put back into the sedimentation tank it will be mixed with the sludge in the sedimentation tank, and will thus dry quickly. In large tanks, such as at Milwaukee, where a tremendous amount of sludge is treated each day, the authorities can afford to install expensive machinery for de-watering the sludge, but in a small plant the expense would be too great. With the activated sludge treatment the action is aerobic. In the sedimentation tank the action is anaerobic, the bacteria being altogether different from those in the activated sludge process. It is usual to divide the bacteria into two classes, aerobic and anaerobic, although the definition is not rigid. Some aerobic bacteria can exist under anaerobic conditions, but they will not work. If returned to aerobic conditions, they revive and work.

8. *To the Chairman.*—The activated sludge plant at Folly Point was one of the first erected in the world. The system of distributing is not now the current practice. The authorities do not wish to go to the expense of redesigning the system, because soon the whole of the treatment works at Folly Point will be abolished, and the sewage now treated there will pass through the main outfall to North Head. The plant at Folly Point at present requires over 100 horse-power to treat 1,000,000 gallons of sewage per day. It is an intermittent plant. In England to-day from 35 to 45 horse-power only is required to treat 1,000,000 gallons per day, and in special instances it is less than that. By installing a different design of tank, the power consumption at Folly Point could be reduced by over 60 per cent. The cost per 1,000,000 gallons at Folly Point is £4 15s. 9d., and, under present day methods, it should not cost more than from £1 10s. to £2 per 1,000,000 gallons. By the process of sedimentation a large percentage of the organic matter in the sewage is removed, and by that means the cost is reduced still further. The effluent from an activated sludge tank, if in good working order, can discharge straight into the sea or into a river course. An activated sludge plant, unless there is competent supervision, is inclined to get out of order. Occasionally, for no apparent reason, unless owing to change in temperature, the effluent will not be quite pure, and unless the supervision is very strict, the treatment is inclined to deteriorate. That does not matter if the trickling filter is used. For a short period the trickling filter can be overloaded tremendously without injury. The trickling filter is very flexible, and acts as a safety valve. There is on the stones over which the effluent trickles a certain amount of microbic activity, which tends to purify it. The stones of which the trickling filter beds are composed are covered by a jelly consisting of millions of bacteria. The effluent trickles over the outside of these stones, and the suspended matter adheres to the bacterial film, and is acted upon by the bacteria. Also certain chemical products liberated by the action of the bacteria act on the material, which is dissolved so that the effluent which goes out from the trickling filter has been acted upon both in regard to the suspended matter and the dissolved matter. The effluent is then pure. I would not drink it, although some people state that they do so. The activated sludge treatment and the trickling filter treatment are practically identical, except that in the trickling filter the sewage is taken to the bacteria. In the activated sludge treatment the bacteria is taken to the sewage. In both cases the bacteria acts in the presence of air.

The witness withdrew.

Ernest Macartney de Burgh, M. Inst. C.E., Chief Engineer for Water Supply and Sewerage, New South Wales, and member and Acting Chairman of the Federal Capital Advisory Committee, sworn and examined.

9. *To the Chairman.*—I am aware of the proposal submitted to the Committee respecting the treatment of sewage at Canberra. There must be a flow of water in the main sewer equivalent to the sewage from 10,000 people, on a basis of 50 gallons per capita. If the volume of sewage is not enough to produce the proper velocity within the sewer it is necessary to add a certain volume of water. At Canberra, the plant will at first need to treat the sewage from 5,000 people, and therefore the volume of water to be added will be equivalent to the sewage. I understand that it is proposed to erect at Canberra sedimentation tanks with aerating filters. I have not erected any sedimentation tanks in New South Wales. We have been using in the country towns what is known as the septic tank with aerating filters. We are now considering altering the design and method of the treatment that we have used hitherto, with a view to including possible improvements. In New South Wales, outside of the metropolitan area, eleven large towns have been sewered, including Albury, Bathurst, Goulburn, and Lismore. At those places septic tanks with aerating filters have been installed. They have not altogether given satisfaction. The work has been performed fairly well, but we should like to improve the system. Sometimes there is an offensive odour from the tanks. The chief cause of odours of putrefaction is the failure to regulate properly the period of treatment. One of the greatest difficulties in New South Wales is to maintain the regularity of treatment from day to day, and from week to week. With the system used in New South Wales the period of flow in a sewer would not be detrimental to the treatment of the sewage because the process in the sewer would be something like that in the septic tanks, but where sedimentation (sometimes called Imhoff) tanks are used, separating the thinner liquid from the thicker, the shorter the distance to travel the better. We do not regard the distance to be travelled at Canberra as a bar to the sedimentation treatment. It is a matter more of time than of distance. I think the sedimentation tank a sound proposition, and I propose to give it a trial. It has been found effective largely in the United States of America. Colonel Longley, when in Australia, expressed his views on this subject, also Mr. Gutteridge will be able to give the Committee a great deal of information respecting sedimentation tanks. The septic tank is largely used in Great Britain. A leading expert in England—Watson, of Birmingham—is working along the lines of sedimentation and activated sludge. He has from time to time published his results. We must not suppose that the authorities in England are indifferent to this method of sewage treatment, although they may not have done as much as has been accomplished in America. I previously gave evidence regarding the outfall sewer. The proposal at that time put forward by the Commonwealth Department was to treat the sewage on the southern side of the sewer, that is further away from the Molonglo River than the outfall sewer is. The Commonwealth engineers and I myself in evidence stressed the advisability of leaving open as long as possible the decision regarding the sewage treatment works. We then considered that the matter was in a state of investigation. I had an interview with Colonel Longley, of the Rockefeller Institute, when he was here, and he suggested that we might be able to deal with the whole of the sewage on a site between the outfall and the Molonglo River, that is, on the northern side of the sewer, and in that manner dispense with pumping. He suggested the establishment to the south of the sewer of

a treatment station, with both sedimentation and activated sludge treatment for the purpose of observation. He was of the opinion that, after the results of the experiments were available, we would find that we have sufficient area to the north of the sewer to deal with the sewage by one or other of those processes without recourse to pumping. In addition, it was proposed to adopt sedimentation with filtration, that is, oxidizing filters, and as an auxiliary an activated sludge tank. There is sufficient justification to install the works on the northern side of the sewer without recourse to pumping, and to warrant the construction of the plant now under consideration by the committee. There are a number of small sedimentation tanks in use in Australia, but I do not know of any deep sedimentation or Imhoff tanks in our large townships. The system aims at reducing the sludge to a minimum. Any removal of sludge from a tank will, for the time being, give rise to odours. In small installations, if the Imhoff tank were used without an activated sludge tank, it would be necessary to use an aerating filter. It would be better to aerate the effluent before allowing it to run on to ploughed lands for absorption. The use of chlorine in the treatment would hardly deal with the odour from the effluent. Under the system proposed at Canberra, the sewage will pass first through a screening chamber to remove papers, pieces of fabric, and other heavy matters. The sewage will then flow into deep sedimentation tanks or Imhoff tanks. They will be arranged to deal with the maximum flow with a detention of from one and a half to three hours. During that period, and dependent on the nature of the sewage, a settlement takes place, and the more solid matter falls to the lower chamber of the tanks. The clearer liquid is drawn off for further treatment on the aerating bed. The difference from the plain septic tank is that with the latter a longer detention is required of the whole of the sewage, the tanks are not so deep, and have a greater area. The proposal is to distribute the clearer effluent from the tanks on to the aerating beds to bring the sewage into contact with the atmosphere for oxidization. It will filter through the beds, and should then be in a fit state to be passed into Western Creek, and ultimately to reach the Molonglo River. It is proposed to install an auxiliary activated sludge plant so that, as an alternative, the effluent from the sedimentation tank can be taken into the activated sludge tank before being put through the filters. In this way the sludge will have a further period of treatment, and thus be considerably reduced. Sewage installations are all in the experimental stage. A very important point to be remembered in regard to the Federal Capital is that we must expect an extremely diluted sewage, because there is an ample water supply, and living conditions will be good. We may expect a low percentage of solids. In manufacturing centres generally, the consumption of water per capita is very low, but at Canberra we should get a diluted sewage with a minimum of solids. I do not think it would be advisable to install at Canberra only the improved system of activated sludge, and dispense with the sedimentation tanks altogether. Without the sedimentation tanks there would be a large amount of sludge to be removed from the activated sludge installation. The activated sludge system by itself gives a very quick action, but it also gives a lot of sludge. I recommend the installation of sedimentation tanks with aerating filters. If that suffices, it will not then be necessary to force air into sewage in the activated sludge tanks. Considerable expense will thus be saved. I should think that from 30 to 40 horse-power would be required for the plant. When installed, it will be capable of use for either of the two arrangements of activated sludge, one the forcing of air into the tanks, and the other the rotating paddles, whichever is found to consume the least power for the same result. It is thought that a better result may be obtained from the use of paddles, because the area of sewage exposed to the air will be greater. The air pressure supply forces little bubbles of air through the sewage. It would be in accordance with sound practice if the proposed experimental plant were installed at Canberra. I intend to work along the same lines in country towns in New South Wales. Of course, I would be at a disadvantage in most cases, because the power facilities would not be so great as they are at Canberra, and therefore it would be almost impossible to install an auxiliary activated sludge plant in every case. I should say that a good deal of the work done in the first installation, such as the diversion of the creek, the preparation of the site, the embankment to keep back the waters of the river, and the diversion of the road, would facilitate at a minimum of cost the later extension of the plant.

10. *To Mr. Cook.*—Under this scheme there will be about 40 horse-power for every 5,000 of population. I have not gone into the details of the horse-power. The proposed scheme is in accordance with proper practice, but I do not say that it will be continued in that form for years to come. It really leads up to a determination as to future expansion. The proposed installation will serve up to 10,000 people. The effluent would be of no great value as a fertilizer, although some people think it is preferable to water. Others again prefer water. By the time the effluent is thoroughly treated, and fit to be discharged into a stream, it is very little different from water. For the purification of the effluent, I prefer a combination of the sedimentation and activated sludge systems, as is now suggested for Canberra. It is very adaptable in this case. At certain places, I would sooner use the septic tank system. I have taken steps to place upon the minutes of the Federal Capital Advisory Committee the statement that if the effluent from the filters to the gravitation aerating beds is not sufficiently pure to warrant its discharge into the Molonglo River, and thence to the Murrumbidgee, it should be further treated by the activated sludge plant or other process to bring it up to the required standard. The Commonwealth engineers concur in that view. Small towns mostly use the septic tank system, and it is generally satisfactory. Science and financial assistance will improve present methods still further.

11. *To Mr. Blakeley.*—There is very little difference in the cost of the swinging sprinklers proposed to be installed at Canberra and the stationary sprinklers at Folly Point. The stationary sprinklers are not quite so satisfactory as the others. Instead of aerating sprays, we frequently use tipping troughs, which are arranged along the filter beds. The sewage flows into them, and, when it reaches a certain quantity, the trough tips. By an automatic device the troughs can be regulated to provide an equal distribution of effluent over the beds. That practice is not followed at Folly Point. Mr. Watson, of Birmingham, uses rotating sprinklers. They are also used in Perth, Western Australia, and the results there, I am informed, have been very satisfactory. The success of the sprinklers depends to a large extent upon the attention given to stoppages. At my request, the Water Supply and Sewerage Board intends to make experiments in connexion with sewerage along the lines proposed at the Federal Capital.

12. *To Senator Reid.*—We always use aerating beds in conjunction with septic tanks. The great advantage of the activated sludge treatment is the rapid passage of the air through the sewage, thus greatly expediting the process. With activated treatment a state of oxidization might be attained in a couple of hours that would not be achieved under the other method, perhaps, in 24 or more hours. It is entirely a matter of the volume of air passed through the sewage. With activation a great volume of sewage can

be treated in a small installation. In any case either an aerating system or activated system should be used in connexion with septic tanks.

13. *To Mr. Mathews.*—To my knowledge, no royalties are attached to the system proposed for Canberra. I believe that, under the conditions at Canberra, the suggested scheme will be a success. It is, to a certain extent, experimental, but it will lead up to the adoption of the best method of treatment.

14. *To the Chairman.*—No attempt has been made to provide Queanbeyan with a sewerage system. That is bound up with the question of the water supply. I hope that negotiations will shortly be finalized between the Commonwealth, the State Government, and the municipal council regarding a water supply, which must be precedent to the sewering of the town. I believe that the pan system at Queanbeyan has been improved. The Queanbeyan night-soil is not discharged into the Molonglo River. Surface water, of course, flows into the river.

15. *To Senator Reid.*—A town with 6,000 population would certainly be large enough to warrant the installation of a sewerage system.

16. *To the Chairman.*—We have installed sewerage systems in towns with from 3,000 persons upwards. A great deal depends on the situation of the town and the water supply.

17. *To Senator Reid.*—Prior to the installation of a sewerage system in a town of 6,000 inhabitants there should be for all purposes a supply of not less than 300,000 gallons of water per day.

(Taken at Sydney.)

TUESDAY, 11TH NOVEMBER, 1924.

Present:

Mr. GREGORY, Chairman;

Senator Barnes	Mr. Cook
Senator Reid	Mr. Jackson
Mr. Blakeley	Mr. Mathews.

Percy Thomas Owen, Director-General of Works, Canberra, and Member of the Federal Capital Advisory Committee, sworn and examined.

18. *To the Chairman.*—In connexion with the treatment of sewage at Canberra, the proposal is to convey the sewage by gravitation from the end of the main outfall sewer through a 24-in. pipe to the treatment works, which will comprise a sedimentation and experimental activating sludge plants. When the question of the main outfall sewer was before the committee several years ago, I put forward the view that the treatment would probably be anaerobic. The effluent would afterwards be passed through aerobic filter beds, and then discharged over the land. It was anticipated that there would be an advance in the process of treating sewage, and I suggested that the final method of treatment should be left over until the time came to install the works. Within the last couple of years there has been a development in the treatment of sewage by the activated sludge process, more particularly in regard to the drying of the sludge, which was one of the great difficulties of the system. In the meantime, I further considered what form the treatment should take. I discussed the subject with Colonel Longley, of the Rockefeller Institute. He at one time thought that we might pump the sewage to a high level, or treat it by either sedimentation or activated sludge, or a combination of both, and then gravitate the effluent over the land. But after giving the matter full consideration, he decided upon a gravitation scheme, the treatment of sewage to be by sedimentation and activated sludge in the bed of the Western Creek, just above the Molonglo River. I was asked then to give to the Federal Capital Advisory Committee my views as to what form of treatment should be adopted. I went into the question of the capital outlay and the cost of pumping. I had the assistance of the Department of Works and Railways in the preparation of drawings and estimates. As the result of our investigations, it was found that, even with a population of 3,000 or 4,000 people, water would need to be added to the sewage sufficient for 10,000 people, so as to keep the sewer properly flushed. If this were pumped, it would become a very expensive matter. Various alternatives were considered. One was gravitation, sedimentation, and filter beds without activated sludge. Another was gravitation and activated sludge. We also considered pumping effluent and using sedimentation tanks and filter beds. Another scheme considered was pumping crude sewage and using activated sludge. The schemes varied in cost from the gravitation, sedimentation, and filter bed scheme, estimated at £37,000 total capital cost, and £4,500 total annual cost, down to the pumping and activated sludge scheme estimated at £30,600 total capital outlay, and £9,190 total annual cost. Those figures were rather serious, and that point of view, combined with others, led me to recommend to the committee the adoption of a gravitation and sedimentation plant, combined with a small activated sludge unit. Estimates were carefully taken out for the pumping and other charges. The estimate of £9,190 covered interest on outlay and all working expenses, including electric current, maintenance, &c. That scheme was to pump the crude sewage, and to have an activated sludge plant at the point to which it was pumped. The scheme that I recommended to the Federal Capital Advisory Committee is the one now being considered by this committee. It will deal with a flow of 500,000 gallons per diem by means of sedimentation and trickling filter. It is also proposed to install as an accessory unit an activated sludge plant to deal with 50,000 gallons per diem. The idea of the scheme is this: I believe that, in the course of time, the activated sludge system will attain the pure condition of effluent necessary for discharge into the Molonglo River. On the other hand, to install straightway a large activated sludge plant would be fraught with danger. To ascertain the best method of dealing with the activated sludge system, it is necessary to experiment with it. In installing a sedimentation system for a comparatively small population, we shall have something tangible, and which we know will function. That unit should be installed at the commencement, and probably remain as a unit in combination with the later activated sludge process. At the same time, we ought to put in a small activated sludge plant to experiment with the sewage from that locality, and then determine which type of activated sludge plant will be most effective. Having determined that, it will be possible to increase the plant, as time goes on, for a large population, and make it either an activated sludge or sedimentation system, or a combination of both. It is now proposed to install at Canberra a sedimentation plant, really a modification of the Imhoff tank, and an activated sludge unit. Those two processes can be used with the greatest of flexibility. The Imhoff tank is a sedimentation tank. The baffles underneath vary in type. The crude sewage, after going through a roughing chamber, may be discharged into an activated sludge tank, and dealt with entirely by activated sludge. The effluent, if necessary, can be put through a filter bed before being discharged into the Molonglo River. The alternative is

to take the crude sewage through the roughing chamber and the sedimentation tanks, the effluent being passed over the filter beds and discharged, or else put through the activated sludge tank before final discharge. The sludge from the sedimentation tank is taken to a sludge collecting pit, and from there pumped on to sludge drying beds. The sludge from the activated sludge tank can be pumped from the chamber, and discharged on to the sludge drying beds. One of the great difficulties apprehended was in regard to the disposal of sludge from either sedimentation or activated sludge plants. About two years ago, a congress of municipal engineers was held in London. It was then disclosed that beds of cinder gave a quicker drying action for the sludge than any other previous method. This appears to have practically solved the sludge problem, because the sludge from the activated sludge tank is of a peculiar nature, and is very hard to dry. The estimated cost of the scheme now before the committee is £37,000 total outlay, and £4,570 total annual cost, including interest on capital. I think the estimated interest rate is 6 per cent. The annual cost of the sedimentation process alone would be £70 less, but under the combined scheme we shall gain valuable knowledge as to the type of works required for a larger population. One of the most important matters to be considered in regard to the treatment of sewage at Canberra is the purity of the effluent to be discharged into the Molonglo River, which, in turn, flows into the Murrumbidgee. The State of New South Wales is distinctly interested in this matter. My report went to the Federal Capital Advisory Committee, and was adopted. On the basis of that report, drawings have been prepared. The difference between the ordinary septic tank and the sedimentation tank is that the septic tank depends principally upon anaerobic action by bacteria which finally convert the nitrites into nitrates, thus giving plant food. The process is first by the action of anaerobic bacteria, and subsequently by aerobic bacteria. It is a bio-chemical conversion of the sewage matter into innocuous products. The sedimentation system gives a quicker settlement of the solids held in suspension in the sewage. The effluent is drawn off, but it is putrescible. It has to be put over either filter beds or sprinkling filters. The sludge in the sedimentation tank is digested. It is proposed to carry the 24-in. pipe from the end of the outfall sewer to the treatment works. Originally it was intended to pump to a higher level, and gravitate over the land. No sewage farm is proposed under this scheme, although it could be provided. If the effluent from the sedimentation or other process were innocuous, it could be distributed over an area of land. The sedimentation tank digests the sludge. Colonel Longley was averse to adopting the septic tank system, and considered that, at a place like Canberra, that system should be superseded by activated sludge or sedimentation. The Imhoff tank is extensively used in America. The septic system is mainly in use in Great Britain. I did discuss with Colonel Longley a scheme to pump the sewage, and to have a sedimentation tank, and, perhaps, a small septic tank installation. In arriving at the present proposal, I was greatly influenced by Colonel Longley, who is acknowledged throughout America to be an expert on sewage treatment.

19. *To Mr. Cook.*—The following is an extract from the letter that I addressed to the Federal Capital Advisory Committee:—

> In dealing with the question as to what system of sewage treatment should be adopted, it has been necessary to duly regard the financial factors:—
>
> A. (1) Capital outlay;
> (2) annual cost for initial population and for the development thereof so far as can be forecasted.
>
> It has, in addition, been necessary to bear in mind conditions imposed by the general locality of the treatment works.
>
> B. (1) Necessity for a satisfactory purification of such effluent as will eventually reach the Molonglo River;
> (2) disposal of sludge;
> (3) security along the Uriarra and Cotter River roads from offensive effluvia.

I have mentioned to the committee that the problem of sludge disposal has to a great extent been overcome by the modern system of drying. As far as I can learn, the effluent from the activated sludge is inoffensive and practically odourless. I have always held the opinion that anything in the nature of effluvia from sewage along the road leading to the Cotter River would be disastrous. That is one of the reasons that led me to adopt the opinion which I have expressed in the last paragraph of my letter to the Advisory Committee, reading—

> In forming my conclusions I have borne in mind that in the event of any untoward development in the early stages the sewage flow would be small, and if the effluent is such as might prejudice the condition of the Molonglo River it can be disposed of by pumping over land areas. But I also assume that eventually the effluent evolved from activated sludge can and will be made innocuous.

Why I favoured gravitation and an eventual activated sludge system, as against the septic tank or sedimentation, was with the object of obtaining a pure effluent, and of running the plant at a small annual cost. Under the present proposal there will be the least danger from offensive effluvia. It is now know that extensive oxidization renders the effluent pure. It is generally regarded that the effluent from any of these treatments is not of any great fertilizing value. It is really not much more than water. It was never proposed to put crude sewage over the land. The Royal Commissioner said that I proposed such a thing, but it is not so. The evidence is clear and definite that my proposal was to put the effluent on the land. Mr. de Burgh is quite satisfied that the proposed treatment works will not pollute the Murrumbidgee. The Burrinjuck supply is drawn from the Murrumbidgee, but the danger of pollution is negligible.

20. *To the Chairman.*—I am quite satisfied that if Canberra reaches a population of 100,000 there will be ample space at the proposed site for the extension of the treatment works. Electric power in bulk can be supplied at Canberra for 1½d. per unit. Mr. Connell prepared the estimates and he can give the committee definite information on this subject.

(Taken at Sydney.)

WEDNESDAY, 12TH NOVEMBER, 1924.

Present:

Mr. GREGORY, Chairman;

Senator Barnes	Mr. Cook
Senator Reid	Mr. Jackson
Mr. Blakeley	Mr. Mathews.

Henry Gustavus Connell, Chief Civil Engineer, Department of Works and Railways, sworn and examined.

21. *To the Chairman.*—In connexion with the proposed establishment of works for the treatment of sewage at Canberra, I have supervised all the designs right

from the commencement. For nine years I was Assistant Engineer with the Metropolitan Board of Works in Melbourne. For four years I was employed by shires doing drainage and sewerage work, and for the last twelve years I have been employed by the Commonwealth at different sewerage installations all over Australia. I have given special consideration to the treatment of sewage. The Works Department was the first to build an Imhoff tank in Australia. We have one at Canberra, one at Kuring-gai, and another at a hospital in Brisbane. My experience has been gained purely as an engineer controlling the plant, but, of course, in the last five years I have carefully watched the working of our installations. Any reports as to working of and results from plants go direct through me, and I am kept fully in touch with the system. We have installed Imhoff tanks in preference to septic tanks, and have found the former very satisfactory. We have had good results right from the first installation. We have had no difficulty in handling the sludge from the Imhoff tanks. The places at which we have installed the Imhoff tanks are exceptionally well situated, and there is an easy getaway for any sludge that accumulates. We have experienced no offensive smell from the sludge. In small installations we do find that some little difficulty in this respect arises no matter what care is taken. There are seasonal changes which vary the action of the treatment. To a great extent that does not apply to large installations. The proposed scheme is the best that can be devised for Canberra. It has developed out of a great number of schemes on which we spent a great deal of work during the last six months. We had the benefit of Colonel Longley's advice. He came from America to Australia at the request of the Commonwealth Government, and the final scheme has really developed from the views propounded by him. It might be interesting if I explained the development of the scheme. In the first place, when the outfall sewer was designed, twelve or thirteen years ago, it was believed that it was absolutely necessary that the sewage should be pumped from the outfall to the plant. Later investigations showed that it was possible to utilize the fall of the system for a gravitation scheme, and thus do away with pumping. The gravitation scheme was not favoured for irrigation purposes alone. At one time it was considered that the area available for gravitation from the outfall sewer was not sufficient to accommodate the population, but by utilizing later methods of treatment we now find that the area is sufficient. It was doubtful whether the area available for gravitation would be sufficient to take the ultimate capacity of the sewer. We then put forward the idea that if we could utilize gravitation and do away with pumping until the population had reached, say, 30,000, the interest saved on the initial cost would be sufficient to install a pumping plant. Later developments have now proved that we can provide for 100,000 people by gravitation. The schemes that we considered can be divided into two groups, one pumping and the other gravitation. We considered that both should be treated from a settling tank and filter aspect, and from an activated sludge aspect. There were four main schemes, pumping and gravitation, and each subdivided into tank and filter, and activated sludge. We investigated these schemes to arrive at the cost. We considered them from the aspect that the effluent obtainable from the sewage must pass the standard test as a stable effluent. Once a stable effluent is obtained, the cost is the ruling factor. We took out the initial capital cost of the schemes and capitalized them as 6 per cent. propositions. We added maintenance and running charges, and obtained the annual cost. On that basis we compared the schemes. We found that we could get a suitable effluent from either scheme. We considered whether it would be advisable to pump the crude sewage to treatment works, or to treat it first and then pump the effluent. The same result would be obtained as far as the effluent was concerned. Under the first scheme the pumps would be installed in such a way as to deal with up to 15,000 people in the early stages, but by simply extending the pumps and without altering the pumping chamber at all we could deal with 150,000 people. The next scheme was also pumping. It was first to treat the sewage in underground tanks and simply pass the effluent back to the pumps for distribution, either over filter beds or over an area of land to eventually find its way to the creek bed. In both these instances we would use two-storied sedimentation tanks of the very latest type, these giving the best results. Both these schemes were practically similar; in fact, very similar to the one that we later propounded. We adopted a type of activated sludge that we thought would be the easiest to install, and in which we could vary the supply of air as found necessary. There are various types of activated sludge, but that system is in an experimental stage at present. We adopted a type which, at that time, was in general use, consisting of the use of aerosplates. In those schemes pumping would be necessary, and the effluent would run over filter beds. Then we developed the gravitation scheme. We investigated the bed of the Western Creek, and found that, in order to adopt a gravitation scheme, we would have to divert the creek bed. We did that, and found that by having straight-out sedimentation and filtration, or aeration over sprinkling filters, we could get accommodation for 30,000 people. As a development of that, we investigated the activated sludge scheme, and found that on the same principle, without any extension, and with a very much more compact plant of activated sludge, we could deal with 120,000 people. It then became a matter of cost. For comparison purposes we went into the cost of the schemes and worked out the annual costs. In the first place, the main out-fall sewer has a minimum discharge. We must send 500,000 gallons a day through the sewer in order to keep it clean. If the sewage did not amount to that we would have to make it up with flush water. On the basis of 50 gallons a day per capita a unit would be required for 10,000 people. In comparing these schemes we took them as a 10,000 minimum unit. We found that the capital cost of the first gravitation scheme with tanks and sprinkling filters for 10,000 people would be £37,000, and the annual cost £4,500, made up of the interest on the capital, plus repairs, maintenance, renewals, &c. The next gravitation scheme was the activated sludge treatment. We found that that could be installed at a capital cost of £25,000, and an annual cost of £6,750. We then considered the pumping schemes, and found that the capital cost of a crude sewage pumping installation would be £35,000, and the annual cost £6,700. The capital cost of the sedimentation and effluent pumping scheme was found to be £42,000, the annual cost being £7,120. Thus the sedimentation tank and filter bed scheme was, in annual cost, found to be £2,000 a year less than any other scheme. In consultation with Colonel Longley, we formed the idea that we should not stick hard and fast to any particular basis, but if possible devise a scheme that would be flexible enough to perform all that was required of it, and be capable of extension on different lines at a later date. To that end it was decided to put in two units which would be interchangeable. The proposal now is to have a settling tank and filter bed unit with an activated sludge unit, so that we can turn the crude sewage into either unit or turn the effluent either way. We can get five or six different methods of working, and if at a later date we find that one method is superior to the others we can extend on those lines without having to scrap any of the plant. That is a short history of how the scheme was developed. The Imhoff tanks and filter beds will be large enough to treat the sewage from 10,000 people. In addition, we are putting in a small activated sludge unit for 500 people to experiment both with crude sewage and effluent so as to arrive at a final basis on which to conduct the ultimate plant. The activated sludge plant at Folly Point was one of the first to be installed. It was put in at a time when activated sludge was looked upon as a future development. Very little was then known about it. The intermittent working has now been practically abandoned in favour of a continuous process, which gives a better result at a cheaper rate. In addition, the tanks are of a smaller size, because of being used continuously. That has been proved by actual result. In our plans we have simply followed development. Plants of the same description have been installed as working units in a great many places. The Imhoff tank has a sludge digestion chamber. The difference between an Imhoff tank and a septic tank is simply that, in the first, the sludge is digested in a separate chamber, and, in the second, it is mixed up altogether. A clean effluent runs through an Imhoff tank. Really the same process goes on in both type of tanks, and in England the latest development, as far as sludge digestion is concerned, is to use a tank and a digestion chamber instead of the two-storied Imhoff tank. Under the English system the sludge is pumped from the septic tank into digestion chambers and left there to digest. It was found necessary to improve the Manchester septic tank installation. Instead of putting in two-storied tanks, which would have cost a great deal, the existing tanks were used in conjunction with a set of digestion tanks. There the sludge is pumped 5 miles to digestion chambers. Under our proposal our digestion chambers are on the spot. Septic tanks will develop sludge, and must be cleaned out periodically.

22. *To Senator Reid.*—The period of cleaning depends to a great extent on the quantity and quality of the sewage and the size of the tank.

23. *To Mr. Jackson.*—The cleaning depends upon how the sludge develops. We clean out some of our tanks at six-monthly periods. Other tanks run a couple of years before requiring attention. We had such a tank at Stanthorpe. It certainly should have been cleaned out before, because when examined the sludge was found to be at the top of the tank. Of course, there are different methods of treating sludge. The disposal of the sludge is the difficulty with the activated sludge system. Most of the experiments and developments now taking place deal with the accumulation of sludge. That is one reason why we have adopted sedimentation tanks and activated sludge. Sixty per cent. of the sludge in the sewage is collected in the sedimentation tanks before it goes into the activated sludge tank at all. Sludge from a two-storied tank is easily handled.

24. *To the Chairman.*—The scheme is so designed that we can either put the whole of the sewage through the Imhoff tanks or turn portion of it into the activated sludge. It is purely an experimental plant, and we are desirous of seeing how it will develop and which unit will give the best results. One of the latest activated sludge units has been installed at Houston. It comprises a settling tank and activated sludge plant. It is a gravitation scheme. The difficulty is to get rid of the sludge. The whole scheme at Canberra, with the exception of the disposal of the sludge, will be gravitation from the sewer through the tanks and settling beds. The scheme will provide straightway for 5,500 people. The tanks will be capable of accommodating 10,000 people. We want to find out the effect of the activated sludge on the effluent. It is quite possible that by the installation of another unit of activated sludge, which is allowed for in the outlay, the plant will accommodate 20,000 people. In the activated sludge tank as designed there are two sewage chambers each 17 ft. 4 in. long by 5 feet wide by 9 feet deep. It is purely an experimental tank. The cost of the gravitation scheme to provide for 5,000 people by sedimentation tanks and trickling filters, and for 500 people by activated, is as follows:—

Diversion of Western Creek and river protection	£6,000
Preparation of site	3,000
24-in. gravity main	3,400
Screens, settling tanks, and dosing tanks	6,600
Aeration filters, complete	8,500
Pump for sludge	1,200
Incinerator	100
Accommodation house for employees	500
Activated sludge tanks	1,750
Extra activated unit	1,100
Power appliances for activated sludge	750
Sludge drying beds	1,100
Contingencies	2,000
Supervision	1,000
	£37,000

ANNUAL COST.

Interest on capital cost, 6 per cent.	£2,220
Repairs, maintenance, and renewals	1,085
Wages	700
Power	265
Sludge disposal	300
	£4,570

By the use of sedimentation tanks and activated sludge at Canberra we can treat the sewage from 10,000 people. A larger population could be accommodated by simply moving the dam a little further down the creek. From this plant we could get an absolutely stable effluent, but by the use of a special plant we could oxidize the effluent to a greater extent. We have not consulted the State Government authorities in regard to the discharge of effluent, but I do not think there would be the slightest objection from them. Mr. de Burgh, the State authority, has not raised any objection to the discharge of effluent as proposed. The quantity of sludge accumulated at the end of five years will depend entirely upon the number of people at Canberra. With 5,000 people we might get 300 yards annually. I do not anticipate any great use of the sludge for manure. It could be used for grading and filling in park lands in and around the city. It would be exceptionally good material for that purpose. I believe it has a special value for manurial purposes. The latest development in sewage treatment is a combination of the settling tank and activated sludge processes.

25. *To Mr. Blakeley.*—The digestion chamber is at the bottom of the Imhoff tank, and in this instance it will have an eight months' capacity. We do not expect to have eight months' sludge in it, but that is a safety basis. We do not expect to keep the sludge under treatment more than three or four months. It will be drawn off from the bottom when required. The slope of the floor of the tank is in accordance with accepted practice. As a matter of fact, we have kept it a little on the steep side to aid gravitation.

26. *To Senator Reid.*—The Imhoff tank is specially made for digesting sludge. There are different methods of separating the solids from the liquids, but the latest development, so far as the tank itself is concerned, is the quick settling of the solids, which are allowed to digest, and the separate treatment of the liquids. Different types of tanks have been made, but they all follow that line of development. The incoming sewage enters the Imhoff tank, and as the rate of discharge through the tank is slow, the solids settle and do not remain in the same chamber as the incoming liquid. They lodge in the bottom digestion chamber, and a projecting edge prevents the gases from the solids interfering with the incoming liquid. We expect to treat the effluent from the tank by activated sludge

or acrating beds. That method is at present being followed elsewhere. There is no doubt that further developments will be made on those lines. Any improvements must be on the line of the oxidization of the sewage. To bring about improvements at Canberra would only mean the extension of the plant. The principle of the treatment is not experimental, but the actual type of tank or the way in which the sewage will be treated is experimental. The activated sludge tank is in the greatest state of development.

27. *To Mr. Cook.*—I have had no experience of sewage treatment works outside Australia, except through reading and discussion, but my information has been satisfactory. I constantly travel up and down Australia, and I keep in touch with sewage and treatment works in the different States. Some of the installations in small towns are satisfactory, but others are not. The success of every sewage system depends to a great extent upon supervision and care. Any offensive effluent is due purely and simply to the method by which it is oxidized. A method which may be satisfactory in one town may not be satisfactory in another. Provided the engineer in charge of a plant is a capable man, there is no reason why it should not be successful. The sludge is a fertilizer, but I do not think it has a commercial value. It is quite good for park land filling and gardens.

28. *To the Chairman.*—It is estimated that the cost of electric power will be 1½d. per unit.

29. *To Senator Barnes.*—I have inspected the sewage farm in Melbourne on many occasions. Crude sewage is there used for irrigation purposes. Never in my experience have I seen a tank of any description that does not accumulate sludge. One tank may be slower in accumulation than another, but they all have to be cleaned out at some period.

The witness withdrew.

Edward Sutherland Stokes, Medical Officer to the Metropolitan Board of Water Supply and Sewerage, Sydney, sworn and examined.

30. *To the Chairman.*—For the last twenty years I have been in touch with the sewage treatment works conducted by the Board of Water Supply and Sewerage, Sydney. A decision as to the best system of treatment rests largely upon local surroundings. Providing an outfall could be obtained at a reasonable cost and the point of discharge was such that the danger of washing sewage back on to the beach was obviated, the best method of disposing of sewage would be to discharge it into the sea. If the locality was so situated that a suitable area of land were available, probably disposal by land treatment would be satisfactory. I have inspected the system adopted in Melbourne. It is a very effective method of getting rid of sewage. Adelaide has a system of land treatment which, I understand, served its purpose in the early days. I am now informed that owing to the growth of the city the system is not fulfilling its requirements. At times, in the outskirts of Melbourne, there is an offensive effluvia, due to the open conduit system, but that is apart from what I had in mind as to the means of disposing of sewage. That effluvia is caused by the long carriage of sewage in an open carrier. The sewage decomposes and is septic when it reaches the outfall. I am keeping in mind two distinct things—one, the carriage of sewage to the outfall, and the other the treatment of sewage when it reaches the outfall. The length of time before sewage becomes septic depends, to some extent, upon the locality and the climate. In a hot climate sewage would become septic sooner than in a cool climate. I do not think that sewage would become offensive because of travelling 8 miles. I understand that land treatment is out of the question at Canberra. Therefore, one has to inquire what is the best of the other methods of sewage treatment. One might approach that problem from the stand-point of the degree of purification aimed at, and that would depend on the means available for disposing of the effluent. If the system discharges a large volume of well-aerated water, having a long flow after it leaves the place of treatment, then the effluent can be purified to a less degree than if it were discharged into a sluggish stream in which the water is not well aerated. At works such as our treatment works in Sydney, where a large body of water flows into the harbour, the volume being enormous and the water fully aerated, we can afford, without creating any nuisance, to allow the effluent to be discharged not so well purified as the effluent to be discharged into a stream used for drinking purposes or running past a town a few miles further down. As it is necessary to have the purest form of effluent at Canberra, perhaps we can put aside chemical precipitation which, although giving good results, is not regarded as an up-to-date method. Associated with the chemical precipitation is a lot of difficulties. The modern tendency is rather to adopt what is known as biological methods. We take advantage of the elements that exist in nature for converting the noxious organic matter in sewage into harmless compounds. These agencies exist normally in sewage. Biological methods aim at using these agencies to their full extent, so that all such organic material is removed from the water. I think that can be done, but the usual installations cannot be depended upon at all times to carry out this process to its full extent. One might install the biological process for the treatment of sewage with the best of intents. It might be operated and good results obtained, but there are factors operating that at times upset the process and it becomes sick. That might happen in any biological installation at any time. I cannot tell exactly what the factors are, but we know from observations extending over a long period that installations get sick.

31. *To Mr. Mathews.*—I do not think that the abnormal use of disinfectants would upset the installation. I have experimented by using varying amounts of disinfectants, and found that the amount of disinfectant necessary to be added to upset the working of the installation is far in excess of the proportion that could possibly go into a sewer from a hospital. The conditions of life for the microbes may be wrong. Some species may overgrow others. During the period of sickness, which is only a short period, the effluent will not be good.

32. *To Mr. Blakeley.*—I cannot give any particulars of such cases. It is a phenomenon we notice from time to time. We find that works are off colour one month and next month operate satisfactorily. The period of sickness may be caused through continuous dry weather, when the sewage becomes concentrated and the flow smaller in volume. But when flushed by rain the installations improve again. I do not know that that factor has operated on every occasion that installations have become sick.

33. *To Senator Reid.*—I do not think that the quality of the water supply would affect the installation. The usual method of biological treatment involves a certain preliminary settlement in the tank through which the sewage runs slowly. The best known form of tank is the septic tank, through which the flow is on a 24-hours' basis. The capacity of tank is such as will hold 24 hours' flow, and the sewage takes approximately 24 hours to go through. There are other modifications of that system in which the sewage will take perhaps 10 or 12 hours. In one case the flow is reduced to 2 or 3 hours. The septic tank is most widely used and gives satisfactory results. Later modifications of the septic tank, especially the Imhoff tank, have come into vogue very much of late years, and although I have had no practical experience of Imhoff tanks, still I have looked into the matter closely, and they seem to present certain advantages over the septic tank. They are designed to separate, as far as possible, the sludge

from the sewage flowing into the tank, allowing the sludge to deposit at the bottom of the tank and remain undisturbed, so that after a period of time it can be thoroughly digested, leaving a residue practically odourless. Another important object is aimed at, namely, that the sewage going through the Imhoff tank in two or three hours would not have the same opportunity to become septic and odorous as it would in a longer period up to 24 hours in a septic tank. These two points seem to be of distinct advantage, and if we were increasing the installation in Sydney, I should feel disposed to recommend the installation of Imhoff tanks in place of septic tanks. I think better results would be obtained Possibly, I am curious to see how they would operate. Under any circumstances, I do not think the results would be worse, and I think that one would be quite justified in recommending Imhoff tanks. We operate our septic tanks in Sydney for the most part to obviate a necessity that has been rather stressed in other places, that is, removing the contents of the tanks from time to time. Our septic tanks are rather in excess of 24 hours' flow, and even at places where they have only a 24 hours' flow, we operate them to obviate the necessity for frequent cleansing. We do it in this way. Our tanks are all built in multiples, so that we can use one or more separately. In large installations there is at least one tank standing idle for a period of from 3 to 6 months. The tank thrown idle is the one containing the most solid matter. We find at the end of that period that the solid matter is practically all digested and has disappeared. The tank is then thrown into operation again, and another tank is thrown out of cycle. In this way we obviate the necessity of removing the contents of the tanks. That system has been adopted for some years with good results. The system of sludge digestion has been used in late years. In many places the sludge is deliberately removed from septic tanks and sedimentation tanks and placed in digestion tanks, where it is held for several months until the organic matter is dissolved. This applies to installations where the flow through the tanks is less than 24 hours. This sludge would contain 98 per cent. or 99 per cent. of water. The undigested matter at the end of the period of digestion is practically nothing, less than 1 per cent. of the total volume of the sludge in the first place. Sludge digestion tanks need not be cleaned out for many years, because the accumulation of sludge is small. They will run a long time without handling. We have run septic tanks for 13 years without cleaning them out. The working was quite satisfactory, and therefore we did not touch the tanks. We cleaned them out more from curiosity than anything else.

34. *To the Chairman.*—That is the first stage in the biological system. The second stage is carried out in filters. There are two forms of filter—contact and percolating. At present the former are not being constructed, as they are not economical, treating only about half the amount per unit as the percolating filters. This form of filter requires no consideration at this stage, because it is out-of-date. We are, therefore, reduced to the consideration of the percolating filter. This gives quite good results, and as a rule can be depended upon for fairly constant work, although it does have sick periods. It is liable from time to time to discharge a large amount of suspended matter which has been deposited upon the filtering material. A certain amount of suspended matter is carried through from the preliminary treatment works on to the percolating filter. That material becomes deposited on stones or material used for filtering, and builds up a deposit upon those particles. This deposit is in the form of a jelly, and collects all kinds of organisms, which are regarded as factors in causing purification. From time to time this material dies a natural death, and is cast off. Therefore, we have in the effluent a lot of suspended matter from the percolating filter. This material is termed a humus, because it is largely of a vegetable character. It is quite inodorous and harmless. At times humus tanks are put in to arrest this material before the final discharge of the effluent. They are put in as an emergency or safeguard to prevent any suspended material getting out from the treatment works. The second stage—the filtering stage—is an oxidization process. The organic matter that has been broken up in the first stage is oxidized in the second stage. That oxidization results in the formation of nitrates from the organic substances of the sewage. Nitrate is food readily available for plant life. If the effluent is well oxidized, or the greater proportion of the organic nitrogen oxidized to nitrate and well aerated, it can be discharged with perfect safety almost into any stream, and the purification can be regarded as all that is necessary. The effluent is loaded with organisms, and cannot be accepted as coming up to the standard of drinking water. A further stage of refining is required under certain circumstances to kill these organisms. That is a process of sterilization. In places this is done by the addition of chlorine in some form or other to the effluent. The addition of a small amount of chlorine will kill all organisms. At Canberra it does not seem necessary to go to that stage of refinement. All that would be aimed at would be a good degree of chemical purification. I cannot see why that degree of purification should not be obtained at Canberra by adopting the biological process of Imhoff tanks and percolating filters, and possibly a little sedimentation after going through the percolating filters. The last-mentioned may not be necessary, but it would be advisable to have it there in the case of suspended matter getting through. By having a place where the flow can be arrested the humus, which settles very rapidly, can be got rid of. It does not decompose like the organic matter in sewage. The material is only vegetable matter, and quite harmless. It will go to the bottom, and cause no nuisance.

35. *To Senator Reid.*—The growth of mixed organisms on the stones never becomes offensive. They are natural agencies provided by nature for the purification of sewage, and they find a suitable place to grow on the stones. They also find a suitable food in the sewage, and luxuriate there.

36. *To the Chairman.*—The rotary sprinklers proposed at Canberra would be much better than the fixed sprinkler at present operating at Folly Point. The mechanical system is the more effective method of distribution. The installation of Imhoff tanks with sprinkling filters, proposed at Canberra, will certainly give satisfactory results. The system commends itself to me. The recent view as regards the activated sludge is rather tending towards the idea that the essential part of the process is not aeration at all, and that the air simply acts as an agitator. It is believed that agitation can be obtained by a simpler method giving the same results in the purification of the sewage. Work of this nature was carried out at Sheffield, in England, where the sewage was driven along by a series of paddle-wheels which effected the agitation. The results there have shown that an equally pure effluent can be obtained by agitation without air as by agitation with air, and that the air supplied by the ordinary activated sludge is more than is required for the oxidization of the organic matter. The sewage is passed up and down a long race by paddle-wheels. The race is 700 feet long, so that the sewage is agitated for quite a long period. A more recent innovation is a cylindrical basin on which is a mechanically-driven screw operating over the central partition of the basin. The sewage is driven down the central chamber and up between the central and the outer walls. There is a continuous passage of the whole of the sewage while the process is being carried on. There is an arrangement at the side for a kind of inner wall where sedimentation takes place and the clear effluent runs off

at the side. I have not seen it in operation, but it appeals to me as a very simple method of agitation, and were I experimenting I should try the mechanical process in preference to ordinary aeration. I do not think it would really be an experiment. I am told by engineers that agitation by air is the most expensive form of agitation. The power cost at Folly Point is heavy, and, in addition, a large staff is necessary to look after the machines. I might mention that Mr. Gutteridge has detailed plans of the latest form of agitation. If I were remodelling the plant at Folly Point I should adopt the activated sludge. We are working in a very limited area there, and the population is right around the works. The people are very susceptible to smells. We could conduct the activated sludge treatment there without any smell at all. We can purify the sewage in a period of eight hours to a degree which I am satisfied is higher than that obtained by any biological installation. We can discharge a thoroughly purified effluent into the harbour. Even if the activated sludge system were more expensive I should recommend it for the reasons mentioned. From my experience I find that smells for most installations are only intermittent.

37. *To Senator Reid.*—The quantities of oxidization at the various stages of treatment have been thoroughly worked out. With mechanical agitators the air dissolved at the surface would give sufficient oxidization. The absorption of oxygen by water from the air takes place on the surface and by breaking up the sewage with air bubbles a larger surface of air is obtained. The results of agitation have proved that there is quite sufficient oxygen obtained from the air to give satisfactory results.

38. *To Mr. Blakeley.*—I was not referring to the disposal of sludge at Folly Point when I spoke about tanks not being cleaned out for thirteen years. The septic tanks at Folly Point have been installed approximately 25 years. They were cleaned out from time to time up to the last four or five years, and I do not think that we have touched them since. The engineers made a point of cleaning them every one or two years, but it was thought unnecessary. We agreed to leave them alone to see what would happen, and nothing has happened.

39. *To the Chairman.*—At Folly Point we are working the tanks only 8 hours during the 24 hours. We are taking the bulk of the sewage to the activated sludge plant. When the flow is heavy we take the extra flow to the septic tanks, in which the sewage gets a longer period of digestion.

40. *To Mr. Blakeley.*—It would not be possible to dissolve the 1 per cent. of sludge remaining after digestion, because it would probably be composed of sand. The organic matter becomes digested and leaves a residue that is called humus, practically the same as decayed leaves. It is slow of digestion by ordinary methods. Humus is really good earth, but not so much of a manure. It has the property of keeping land moist. If chlorine were added to the effluent at Canberra not more than 1 part of chlorine to 1,000,000 parts of effluent would be required. The chlorine would be used up by organic matter. The chlorine would not travel for any distance.

41. *To Senator Reid.*—The reason why paper in the sewage is separated from the solids is that paper greatly accentuates the formation of scum in the septic tanks. In every septic tank a scum is formed on the surface. By examining the matter I found that it consisted very largely of pieces of paper built up in layers with a certain amount of organic matter between them. The result was that the scum gradually rose out of the water and a lot of organic matter was carried out of the reach of the agencies which cause it to dissolve, and as the scum became higher it became thicker. At times we have had the scum as thick as 4 or 5 feet. In one instance the scum and the sludge met, and there was no liquid in the tank at all. To obviate that we decided to screen out as much paper as possible from the crude sewage. Since then we have had no trouble with excessive building up of scum in the tanks. The paper is very indigestible. It consists mostly of newspaper, which is the most indigestible of all.

42. *To Mr. Mathews.*—I do not think that one could point to any particular system and say that it was perfect. Any work of this nature must be experimental, although some engineers like to believe otherwise. There is an experimental element in every sewage plant installed, because of dealing with factors over which there is no absolute control, those factors being the unforeseen forces of nature.

43. *To Mr. Cook.*—These processes are slowed up by cold weather, but I do not think the effect is very material, because in places which experience absolute freezing winter conditions, the biological process operates, and the results are reasonably satisfactory. The temperature of the sewage is never that of the air. In the winter it is warmer than the air, and in the summer colder than the air. The chemical process going on generates a certain heat. The biological process has been found to be satisfactory even in extremes of heat and cold. I do not think that there will be any ground for complaint from the State authorities respecting the pollution of the Murrumbidgee River. If raw sewage were put into the Molonglo to the extent of half a million gallons a day, there would be no opportunity of it polluting the Murrumbidgee.

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