Paper No. 6335

The design and construction of the Hogsmill Valley drainage scheme†

by

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Discussion

The Chairman (Mr R. le G. Hetherington, Member of Council) said that there was a reference in the Paper (§ 18) to the low dilution in effluent that discharged into the stream. Would the Authors give more information about the dilution of the effluent? Were the works in any way different from what they would have been had there been a greater dilution?

Mr N. J. Tatman (Partner, D. Balfour & Sons, Consulting Engineers) said that he had visited the works, and he had been impressed by the economy and symmetry of the layout. An unusual feature which he had noticed was the preponderance of storm-water tanks. In § 8 it was stated that additional capacity above that which was normally required had had to be made for dealing with excess storm-water from Malden and Surbiton. Why had it been necessary to have eight storm-water tanks? Could the Authors say whether that had been required from considerations of the site, the available land, or any other considerations? Were these tanks filled in series or in parallel? What was the frequency of overflow, and its relation to rainfall? This information could be obtained from the measurement flume that had been included in the outlet from the storm-water tanks. Also could the Authors give more information about the condition of the effluent from the tanks and its composition, e.g. suspended solids? Could the river board give complete details of flow in the Hogsmill River or the River Thames at the time the overflow took place? Had the Thames Conservancy stipulated any conditions for tank effluent? That was being done by a number of river boards.

92. The storm-water tanks had a design capacity of 6 hours' retention. It was accepted that tanks of that capacity were large enough to contain any but unusually severe storms without overflowing. A storm had to be of some severity to cause flow in the sewer to exceed six times dry-weather flow for 2 hours. The design capacity of 6 hours' retention was no more than a rule of thumb. Since that had no relation to the flow in the river which received the effluent from the storm tanks it was necessary to have a new approach to the design of storm-water tanks. River boards were frequently prescribing standards of effluent and, as far as could be seen, these too had little relation to the flow in the river at the time. If the theory was accepted that storm tanks were no more than impounding basins, surely more efficient designs of such tanks could be produced. If settlement was not to be the criterion, then a more realistic approach should be adopted. For size and shape, there was little virtue in the rectangular storm tank. The contents of the tank were in a state of considerable turbulence while

† Proc. Instn civ. Engrs, vol. 12, p. 269 (Mar. 1959).

they were filling, and there could be little quiescence in the tank at the time when overflow first took place. The Hogsmill tanks had a capacity of 1,747,000 gal, and would cost about £80,000, on which the loan charges would be between £4,500 and £5,000 a year. That was a large sum of money to stand idle on a site and only be brought into use at infrequent times. Could the storm tanks be incorporated in the settlement units? The combined capacity need not necessarily be the arithmetical addition of the retention times of storm and settlement tanks, but probably something less. In dry weather that would undoubtedly produce a better effluent which would impose a smaller load on the biological processes. The storm overflow could be situated between the tanks and the biological units since very little head was lost. At storm times the effluent would be that from tanks of long retention period—probably much better in quality than from normal storm tanks. The other part of the flow up to three times dry-weather flow passing to the biological units might be a little less settled at times of overflow, but then the biological units could stand an overloading of diluted sewage for a few hours without causing deterioration in the final effluent. At that time there was probably an increase in the flow in the watercourse which received the final effluent. This might have resulted in some saving in the biological units which were some of the most expensive units in the works.

93. A system should be designed in conjunction with the data and requirements of the river board which in turn should be based upon actual flows in the river and not on a rule of thumb, 6 hours, or any other theory. It would at least have the virtue of employing all the capital all the time. It might show some saving in the cost of the biological units, and it should show an all-round better result.

Dr W. W. Kay (Chairman, Hogsmill Valley Joint Sewerage Board) commented on the cordial relations which had existed between all parties concerned during the construction of the works, and expressed the Board's indebtedness to the Consulting Engineers and Contractors for the fine quality of the finished job.

Mr Kenneth Severn (Partner, Leslie Turner & Partners, Consulting Engineers) said that the most economical form of foundation and base slab for the circular tanks was that shown in Fig. 8 of the Paper for the primary sludge digestion tank—a centre base with radiating web walls to a ring foundation beam (the economical form). An alternative whereby the whole of the load would have been carried on the conical base as a raft had been rejected; it would have been necessary to extend the perimeter walls down to the hard clay strata to retain the soft clay under the higher part of the slab. To have done this would have been to introduce, owing to the bearing on the soft clay, a high ring tension in the bottom of the wall, and for that reason the scheme had been rejected.

96. Some concern had been felt for the effect of the heavy sulphate concentrations in the ground, and another foundation scheme had been examined, as was shown in Fig. 4 of the Paper. This comprised at the centre of the tank a 6-in. carpet of sulphate-resisting concrete with a mass concrete base of sufficient strength to resist ground-water pressure, and an 8-in. concrete surface slab. This design had not been quite so economical as that previously referred to as the economical form, but it did give a high resistance to sulphate attack, and also it gave a saving of 25 tons of steel per tank at a time when reinforcing bars were in short supply. For those reasons, it had been adopted. In the case of the sludge digestion tanks the saving had been only 8 tons, and that had been accompanied by an extra cost of £1,000 per tank. As those tanks were to be done later, it had been decided to maintain the economical form until the sulphate concentration in the ground could be more carefully determined. In fact, it had not proved to be unduly high, and the original design had been retained.

97. The eight storm-water tanks had been founded in the soft clay. They were of very heavy construction. The floor slab was 22 in. thick, and this had been done in

order to balance the uplift pressure of very high ground-water level. This heavy construction to resist the uplift from water had had a considerable bearing on the joints. Had longitudinal joints been provided, an unbalanced form would have resulted in the outside sections, because on those sections there would only be one wall on the slab, and it had been desirable to use the walls to their fullest extent to add weight to resist the uplift due to water. Therefore, only transverse joints had been provided. Two groups of four tanks had originally been planned, but the Authors had adopted four groups of two tanks. The extra cost of the side walls had been offset by the saving in the transverse mild-steel reinforcement. The smaller units had also been preferred because of the possibility of some differential settlement over the site. The bottom slabs of the tanks had been designed to slide against the resistance of the clay without the stresses caused by its resistance, together with those from bending and direct tension, exceeding 16,000 lb/sq. in. in the mild-steel reinforcement and 250 lb/sq. in. in concrete tanks. Friction resistance in the London Clay was practically nil and resistance to sliding arose from cohesion only. Sliding occurred when the principal stresses in the clay exceeded the shear strength. The pattern of those internal stresses in the soil changed with variations in the vertical load of the tank, but at the point where sliding occurred or was about to occur the horizontal stress moved towards the limiting case for sliding on a horizontal plane. It was that horizontal force which had been considered in determining the quantity of steel in the slab.

98. Prestressing had been considered at the outset. For the cylindrical tank walls it had been abandoned chiefly because of the chambers attached to the outside of the walls. It had been extremely difficult to arrange those as a later construction. It would also have been necessary to provide a free joint at the foot of the walls against the conical base but with the heavy earthfill around the walls it would have been virtually impossible to have detected any leakage at that joint. In the storm-water tanks, prestressing had shown little economy compared with mild-steel reinforcement in the bottom slab. The advantages of prestressing would have been cancelled out by the difficulties of stressing, such as providing the space for jacking and distributing the anchorage in the relatively low strength concrete.

99. The Authors had suggested in § 55 that the specified mix had been weaker than that required by the Code of Practice for liquid-retaining structures. This was not strictly accurate. The specified strength was slightly higher in the Code. The Code strength could be achieved consistently with a water/cement ratio of about 0·65. That had been considered to be too high for a water-retaining structure, and a maximum ratio of about 0·5 had been specified. In effect, that would have given a mix stronger than was required. It had been thought that the contractors should be free to vary the proportions of their materials consistent with the production of a satisfactory concrete, and the specified strengths had been varied only slightly from the Code. The result had been that the contractors had been able to employ a mix leaner than that specified by the Code, without the finished work at 12 months having a strength less than would have been reached with the Code mix.

Mr H. H. Stanbridge (General Manager, Hogsmill Valley Joint Sewerage Board) said that in February of this year, during a period of dry weather, the flow to the works averaged 7·46 m.g.d., the McGowan strength was 100, and the five-day B.O.D. was about 310, suggesting that an "average" strength sewage was being treated.

101. The volume of sewage and storm water received at the works for treatment during the year ended 31 March, 1959, averaged 8·23 m.g.d. Of that, 99%, or an average of 8·14 m.g.d., received full treatment. The detention period in the primary tanks averaged 7·1 hours and the suspended solids were reduced by 75%, from 270 to 70 p.p.m. The detention period in the activated sludge plant averaged 10·5 hours. The air used averaged 1·76 cu. ft/gal of sewage treated. The settleable solids in the mixed liquor averaged 13% (one hour settlement), and because of the high density the suspended solids in the mixed liquor averaged 3,130 p.p.m. The sludge returned was

equivalent to 67% of the sewage treated. The power consumed per million gallons of daily flow averaged 40·1 h.p. by the blowers and 6 h.p. by the pumps, a total of 46·1 h.p. The permanganate value was reduced by 76%, from 28 to 6·8 p.p.m. The five-day B.O.D. was reduced by 93%, from 132 to 9·5 p.p.m. The effluent contained on an average 16·2 p.p.m. of nitric nitrogen and as little as 8·1 p.p.m. of suspended solids.

102. A feature of the plant was that while the crude sewage contained 14·3 p.p.m. of anionic surface active agent, this was reduced to 12·6 p.p.m. in the settled sewage and to 2·1 p.p.m. in the final effluent. No difficulty with foaming was experienced.

103. The volume of sludge from the three works, which was treated in the one digestion plant, averaged 62,500 gal/day. It contained an average of 5·7% dry solids, of which 69·6% was organic and volatile matter. The detention period in the digestion plant averaged 40·7 days in the primary tanks and 24·6 days in the secondary tanks. The loading on the primary tanks averaged 0·087 lb. of dry solids per cu. ft of tank capacity per day. Only 5% of the digested sludge was withdrawn as separated water, so that the digested sludge averaged 60,100 gal/day containing 4·08% dry solids, of which 55·5% was organic and volatile matter. The reduction due to digestion was 31·6% on dry solids and 45·4% on organic and volatile matter.

104. Of the digested sludge, 44·2% was dealt with on the drying beds, and the remainder had to be discharged into temporary lagoons.

105. The gas produced, 170,000 cu. ft/day, was used in the engines or for heating the sludge. This was equivalent to 0·8 cu. ft/head/day, but the surplus gas was not metered, so that this was not the total gas production from the works, only the quantity of gas actually used.

106. At the power station, the engines operated for 98·2% of the time on sludge gas, using 14·4 cu. ft of gas per horsepower hour. Two engines were in use and they were running on about 68% full load; 8,350 units were generated per day. Of the power generated, 81·5% was used by the activated sludge plant and 6·6% by the sludge digestion plant.

Mr D. H. Hughes (Senior Engineer, J. D. and D. M. Watson, Consulting Engineers) said that he had been concerned with the design of the sludge digestion plant on the East Middlesex Main Drainage Scheme, where the figure 1·65 cu. ft/head had been adopted as the capacity, as at the Hogsmill works.

108. For the Middlesex Scheme a capacity of 1·5 cu. ft/head was needed to give approximately a month's storage, and tanks with a 30° hopper floor were used. There was evidence that, with a centre draw-off in the bottom of the hopper, grit built up in the tank, but possibly assumed an oubliette form, and then did not build up any higher because of the scouring action of further draw-off of sludge. An allowance of 10% additional capacity had been provided for the grit, thus making up the 1·65 cu. ft/head. How had the same figure been arrived at for Hogsmill?

109. The similarity between the two schemes ended there, because for secondary digestion in the Middlesex design the figure of 6 cu. ft/head had been allowed, compared with 1 cu. ft/head referred to in the Paper. Was the latter figure adequate?

110. The term "secondary digestion" was a misnomer. The operator did not want digestion in the secondary tanks, but was more concerned with the sludge cooling down so that quiescent conditions were produced for water to be drawn off. He was also concerned with having plenty of storage capacity for passing the sludge intermittently to the drying beds.

111. Were the storm tanks provided with sludge hoppers? If not, presumably the storm-water and the sludge were swept back together to the treatment plant when the tanks were emptying. That seemed to be an interesting simplification in the design of those tanks. Had it resulted in efficiency in operation?

112. Why had eight final tanks been selected? It would seem that with the flat-bottom form of design there was no particular constructional economy in having a

multiplicity of units. Four would perhaps have proved a more economical number—as for the primary tanks.

113. In § 15 the air pressure was quoted as 8 lb/sq. in., but the depth of water in the aeration tanks was 12 ft, probably about 11·5 ft over the diffusers, which was equivalent to about 5 lb/sq. in. Was there any simple explanation for the rather high pressure drop between those two figures?

114. The pumping station and the power house had an expensive form of tanking around them. There was a definite mention in the Paper that no subsoil water was found in the boreholes or met with during construction. What was the justification for the tanking?

115. In the basic design allowance had been made for increase in the *per capita* dry-weather flows from some authorities, but not from Kingston, where a figure of 56·25 g.h.d. was used for present and ultimate conditions. Why was no allowance made for increase in this case?

Mr J. O'Neill (Deputy General Manager & Senior Chemist, Hogsmill Valley Joint Sewerage Board) said that during the operation of the works, there had been on an occasion a discharge of fly ash from the local power station. At times this had amounted to about 40,000 p.p.m. of suspended solids, and it had given considerable trouble in the desludging operations. There had been great concern about deposition in the digestion tanks. Recently there had been occasion to empty those digestion tanks, and it had been found that by drawing off the sludge from the bottom the build-up of grit in the tanks had been kept down to a minimum, and the greatest depth that had been found was less than 9 in. of accumulated grit. That was after 18 months' operation. That more or less indicated that constant withdrawal from the bottom of the digestion tank before daily additions of sludge maintained a movement of the heavy gritty material out and avoided build-up, and reduction in available capacity in the digestion.

Mr B. J. Bedford (Contracts Manager, Mears Bros (Contractors) Ltd) gave the contractor's point of view on some of the reasons why modern sewage works were so costly to build.

118. One reason he suggested was the lack of attention to detail by draughtsmen, in particular in reinforced concrete work. Often they drew out the simple mid-span sections but omitted to sketch and check the congested and more difficult ends and junctions. This occurred once in the beginning at Hogsmill. The consulting engineers immediately sent their detailer down from their Head Office to see for himself the result of his omissions. This sympathy and understanding of the constructional problems on the part of the Authors produced the spirit of co-operation and respect on the site that was an important feature of the contract.

119. Another source of what might be unnecessary expense was the method of alternate-bay construction for concrete slabs, especially where wall steel had to be left upstanding for any time causing it to rust. Specifications usually demanded the removal of rust, but Mr Bedford questioned the need for this. On the Hogsmill contract, four sets of specimens of reinforcement—one set a month old with the mill scale removed, the second 6 months old, the third 9 months old and very rusty, and the fourth 3½ years old, even rustier—had been sent to Kingston Technical College Structural Laboratory for testing. The test results showed that the non-rusty bars were the least satisfactory and no reason could be suggested for not using the 3½-year-old bars.

120. Referring again to alternate-bay construction, Mr Bedford suggested that if the bill of quantities were to include an item for construction joints and an extra over-item for this additional cost of constructing in alternate bays with limited pours, the total cost of these two items if realistically priced would be surprisingly high. He gave a graphic description of the additional operations involved with this system and said it was not surprising that the cost of labour and plant in fixing and striking stop boards,

hacking stop-ends, brushing steel, etc., could be as much as the cost of labour and plant for mixing, transporting, and placing the concrete.

121. Finally, he put three questions to the Authors—as from contractor to designer. First, did they still feel that they could not allow the use of a retarder on the stop-ends, under careful control, if cleaned down by a jet of water and air? Secondly, were they quite certain that it would not be possible to contrive a more economic design which would allow larger pours? Thirdly, were they certain that it was vital to construct on an alternate-bay system, involving, as it did, considerable extra cost, particularly on the base slabs? Had any sewage treatment works been built under modern concreting conditions of careful control and high quality but not on an alternate-bay basis and, if so, had they shown signs of failure?

Mr R. Franklin (Senior Engineer, Sir Alexander Gibb & Partners) asked whether any studies had been made of the acoustics of the power house, particularly in view of the fact that it had a barrel vaulted roof.

122a. Had the use of gas turbines been considered? If so, why had they been rejected, because they would have resulted in much lighter and simpler engine foundations?

123. At the Kingston pumping station there were horizontal flywheels for controlling surge. Would the Authors give more information on those controls, particularly the starting characteristics of the pumps?

Mr A. W. Shilston (Messrs J. D. and D. M. Watson, Consulting Engineers) said that the design of the activated sludge plant did not seem to allow for incremental loading of settled sewage, though operators were not over-enamoured with that technique. Had the introduction of that facility been considered? The idea of tapered aeration seemed to have made even less impact in this country, although there were works recently commissioned in England in which the principle was incorporated, apparently as an integral rather than an optional part of the design, by widening the diffuser spacings towards the latter part of the retention period. Had that feature been considered at Hogsmill? Could some details be given of the number and types of return sludge pumps provided? Could the rate of return sludge pumping, the provision for which seemed to be rather low, be tuned in sympathy with the incoming flow of settled sewage?

125. What intensity of aeration in terms of cu. ft of air per sq. ft of surface area could be equated to the 10/10 standards, together with the size, numbers and spacings of the air diffusers?

126. In § 27, the primary sludge digestion tanks incorporated the principle of external heat exchange and applied it in a very modern way. Could the Authors briefly describe the design philosophy, and also indicate the rating of the circulating pumps and the sludge heaters? The advantages of having sludge heaters and circulating pumps on the sides of the tank walls were apparent. On the other hand, the advantages of having such plant in a building adjacent to the digesters, together with stand-bys, were also very real from the maintenance angle.

127. In § 63, on the matter of shutter arrangements, opinion generally seemed to be divided on the advantages and disadvantages of horizontal and vertical construction joints. Even in liquid-retaining structures high lifts were not unusual, and fears of segregation taking place in the concrete at the bottom of deep shutters seemed to be receding. The predominantly vertical joint arrangement had the advantage of offering a reduced length of construction joint in the structure, although properly prepared horizontal joints should not leak. What were the Authors' preferences, and what maximum height of pour could be allowed in the liquid-retaining structures?

128. With regard to the corbels for supporting the gas holder in the primary digestion tanks, had these been precast, and if so, had this facilitated materially the contractors' work?

129. In § 57, he was puzzled by the reference to expansion and contraction joints of varying spacings, both having 1/2-in. filler joints. There seemed to be some confusion as to the difference between an expansion and a contraction joint. Contraction joints in the more usually accepted sense of the term, at somewhere about 25-ft. spacings, with expansion joints every 75 ft, would have been a convenient basis for planning the joint arrangements (§ 55). This would also have allowed pours to take place between contraction joints. Alternate-bay construction, which probably increased shuttering costs if travelling forms were used, might then be dispensed with if polyvinyl chloride water stops were incorporated in the contraction joints.

130. The inference in § 73 was that the tunnel segments had been made with high aluminous cement. Had that cement been used for grouting, and if so, had any trouble been experienced through the development of high temperatures as a result?

131. On § 74, in the main heading under the Southern Region mainline railway, presumably all the timbers had been left in. Had the railway engineers stipulated that the boards be treated in any way and that the whole should be grouted up on completion?

132. The barrel vault roof in the power house appeared, from Fig. 10, to have produced a very pleasant effect. It would probably have been rather tiresome to have given the usual two or three coat plaster finish to the curved soffits, and for that reason a sprayed finish had probably been chosen. What factors had influenced the Authors in selecting "Pyroc" which had the effect rather of a sort of Tyrolean finish stucco? From Fig. 10, the floor finish in the main engine room appeared to be some form of tiling. A floor finish in such a setting had to resist wear, not be adversely affected by oil stains, and look pleasant. What floor finish had in fact been selected?

133. Mr Severn had said that the storm tanks were of a heavy construction to resist uplift. Had the use of subsoil pressure relief valves been considered in conjunction with a lighter form of structure?

Mr L. C. Held (Chief Engineer, Mears Bros (Contractors) Ltd) compared some aspects of the work at Hogsmill Valley with those at Crawley, where the sewage works had been designed by the same consulting engineers.

135. The work at Crawley had been carried out in 1957, just after the main contract was well under way at Hogsmill, and he had been lucky enough to inherit a lot of steel framed plywood-faced shutters from Hogsmill which he was able to re-use on the Crawley contract. These had had to be slightly modified but, as at Hogsmill, they had proved very successful.

136. There was an interesting point in connexion with the cost of the concrete louvered pier carrying the scraper in the primary settlement tanks. That tower at Crawley had cost about £285 (as compared with about £265 at Hogsmill). But in the secondary tanks at Crawley a single perforated steel tube had been used, costing only about £140. Would it not be preferable to use steel for all types of louvered centre piers. It might require negotiation with the manufacturers of the scraping gear, but it should be possible to persuade them.

Mr W. G. Barclay (Chief Inspector, Eastern Area, Thames Conservancy), referring to Mr Tatman's remarks, said that river boards did not like storm-water tanks, although they knew that it was necessary to have them. Nor did they like the effluent from storm tanks. There had been much discussion with Mr Calvert in the early days of the scheme about their use. Possibly one of the answers to Mr Tatman's question was that they were containers, the main object being to contain as much as possible of the storm-water. The Board had also agreed with Mr Calvert that there should be a 5-year trial period to find out how the system was working. The works had been operating now for 18 months and data were still being collected.

138. The same applied, of course, to the character of the effluent. The rate of dilution in the summer was practically nil, so that almost undiluted effluent passed down the Hogsmill River. Despite that the condition of the river was much better than before

the works came into operation. In fact, fish from the Thames now moved much further upstream in the Hogsmill River than for many years. This reflected great credit on the operation of the Hogsmill works.

139. No special standard had been specified for the works. It had been agreed that the best possible effluent should be produced for the 5-year period, during which the matter would be investigated and the standard fixed in the light of experience.

Mr M. Milne (Chief Engineer, Crawley Development Corporation) said that in § 25 of the Paper, it was mentioned that the size of the works had justified the use of methane gas for power generation.

141. Ten years ago, when many works were being designed, a balance might have been found between the costs at that time and the cost of electricity. Certainly that would have applied before the war. He thought it was true to say that electricity was one of the things which had gone up by less than many other items of cost. In the light of experience, what did the Authors now think was the lower limit at which power generation using methane gas was economical.

The following contributions were received in writing.

Mr H. D. Manning (Partner, J. D. & D. M. Watson, Consulting Engineers) thought that rough calculation from figures given in the Paper and supplemented by Mr Stanbridge in discussion suggested that power generated on the works was costing between 2 and 3 pence per unit. Probably nearly twice the actual power demand could be met from methane gas produced on the works without greatly increasing the annual running costs. Would the authors agree that the particular circumstances made the Hogsmill scheme a borderline case where power generation could be justified but that, on plants where fuller use could be found for the gas generated, the economic limit might be nearer 100,000 population?

143. Could the Authors indicate the considerations which led them to install alternators and motor driven compressors rather than direct engine driven compressors? Four engine-driven alternators were provided one of which would be a standby "under peak demands". What would the position be if one engine were under routine overhaul at that time?

144. The relatively low power demand suggested that low efficiency gas turbines driving compressors direct might have proved economic owing to the great simplification of the power house, miscellaneous loads being taken from the grid. Was this considered?

145. What was the maximum rate of return of activated sludge for which provision was made?

146. In view of the permanent severance of the site by the Metropolitan Water Board pipelines and the quantity of communicating pipework and works traffic between the two parts, had consideration been given to the possibility of diverting the mains along the line of the Hogsmill stream?

147. How many men were normally employed on the works and, broadly, for what purposes?

148. Had detergent foaming been a problem and, if so, what steps had been taken to control it?

Mr R. A. Stephenson (Design Assistant, Engineer's Department, Mersey Docks and Harbour Board) noted that in § 5 the total area of the site including the existing and new works, was given as 92 acres. If it had not been for the continued operation of the existing works, could the same ultimate quantity of sewage have been treated to give an effluent of the same quality in a site of rather smaller area? Other works appeared to have catered for a rather greater number of persons per acre, but no doubt variables such as the proportion of trade effluent and quality of effluent made direct comparisons difficult.

150. It was interesting to learn from § 18 that the Hogsmill River was considered to have benefited from the effluent in that a flow was maintained in what would otherwise be a dry river-bed at certain times of the year. What aspect of the conservancy of the river derived an advantage and how was it brought about? Were there any disadvantages to offset against the gain due to the river passing through a built-up area, and were there any special circumstances applying to the Hogsmill River that might not apply to other rivers? What minimum standard of quality of effluent would be needed before any advantage could be gained? Disregarding differences in cost, where would the Authors say the balance of advantage lay between discharging the effluent direct into the Thames and into the Hogsmill River?

151. In § 25 it was remarked that there were many dwelling houses in the neighbourhood of the treatment works. How close was the nearest and how close was the nearest down-wind of the works when the wind was in the prevailing direction? Was the odour from the works tolerable at these dwellings both as to strength and character.

152. Mr Stephenson noted from Fig. 13 that the dried sludge was removed from the sludge beds to a stacking area and loading ramp. How was ultimate disposal of the sludge effected, and had composting with household refuse or any other material been considered for ultimate use as a fertilizer?

153. It must be very gratifying to know that the plant was performing so well, particularly since the capital cost appeared to be very reasonable. What useful life did the Authors expect from the treatment works and from the scheme as a whole? Might these works ultimately suffer the same fate as so many works at the end of their life in recent times and be allowed to continue functioning for many years after replacement was due on account of inadequacy of size or deterioration of condition?

Mr Calvert, in reply to the Chairman's question as to whether the works had been designed to cater for the low dilution, said that the original intention had been to discharge the effluent into the River Thames. When the works had been sanctioned by the Ministry of Housing, there had been a shortage of money in Britain, and therefore every effort had been made to save immediate capital expenditure, and the discharge into the Hogsmill River had been one means of saving money. But it had been agreed with the Ministry and with the Thames Conservancy that this consent to discharge into the Hogsmill River was a temporary consent, and the Conservancy, he thought, had reserved the right to demand in the future, if it were ever necessary, that the effluent should be discharged into the River Thames. For that reason, no special means had been adopted to get a better-than-Royal Commission standard, except perhaps that the works had been designed with a little more spare capacity than would otherwise have been the case. There was no question of a 10/10 standard, as Mr Barclay had said. The effort had been to get as good an effluent as one reasonably could, and then, in the light of experience, to decide whether it was necessary to discharge into the Thames or perhaps more economical to add some other stage of treatment. But nothing had been done at the moment and Mr Calvert thought that the Thames Conservancy were satisfied with the results that had so far been obtained. He thought that the conditions were better in the Hogsmill River than would be the case if the effluent was discharged to the Thames and the Hogsmill was virtually a dry stream in the summer. But there was that possibility, if it was ever required, of discharging into the River Thames.

155. Mr Tatman had raised the question of the storm-water tanks, and he thought that Mr Tatman was probably aware that there was a Committee of the Ministry of Housing at present sitting to investigate this question of storm-water treatment. Mr Calvert agreed that there was a case for adopting a better method of design than a "rule of thumb" of 6 hours' flow. There were some cases where more storm capacity was required and others where less would certainly do. He did not, however, entirely agree with Mr Tatman that it would be an advantage to add the storm-water tanks to the settlement tanks and use them continuously in dry weather. One of the big disadvantages of that proposal would be that under dry-weather conditions there would be very little improvement in the tank effluent, and at the same time there would be a larger number

of tanks to de-sludge and keep in operation, thereby adding to the cost of operation of the works.

156. Referring to the storm tanks, Mr Hughes had quite rightly pointed out that there was no sludge hopper. There was a channel along the inlet end to the tanks which collected the whole contents of the tank which were returned for full treatment. Of course, all designers had their own individual ideas, but Mr Calvert felt it was an advantage to return the whole contents for treatment through the works. It saved trouble in separating the storm-water sludge from the supernatant liquid, and at the same time probably gave a thicker sludge from the primary tanks than it would be possible to get from the storm tanks themselves.

157. With regard to the number of final tanks, Mr Calvert considered it important to get the activated sludge back quickly into the aeration tanks, and if the diameter was too big, especially with flat floors, the time might be increased to such an extent that the return activated sludge might possibly become septic. Therefore, with the larger number of tanks, the natural result was that the diameter was smaller and the activated sludge was returned more quickly.

158. Mr Hughes had also pointed out that there was no allowance for increase in Kingston, and that, of course, depended on the density of population of the various areas. Kingston was virtually built up, and it was not expected that there would be an appreciable increase in population; also there was a large quantity of water infiltration into the sewers, so that even if there was an increase in domestic water consumption it would be a very small increase on the total flow of sewage, which was already between 50 and 56 g.h.d.

159. Mr Bedford and Mr Held had spoken from the contractor's point of view. Although they had made some criticisms, he thought they would agree that the relations on the site, both at Hogsmill and at Crawley, had been very happy. On alternate bays, Mr Calvert's experience was that if one invited tenders with or without alternate bay construction, there was very little difference, whereas if one invited tenders without alternate bay construction and then asked for it to be included, there was an enormous difference!

160. He accepted Mr Bedford's comments on steel, but as also with vibration, it was necessary to allow for the fact that the quality of the contractor to be employed was not known at the time of drawing-up a specification.

161. Mr Franklin had asked about gas turbines. These had been considered, but it had been felt that the experience of them was hardly sufficient to justify their inclusion on a sewage works of this size; at this stage of their development there was perhaps more case for their inclusion in power-station work, where generation of power was the prime objective, whereas at Hogsmill it was secondary. He believed that they were being included now, but he thought that if they had included them at Hogsmill, it would have been about the first case on sewage works. They had felt that they did not want to be too experimental.

162. Mr Franklin's reference to noise in the power house and the barrel-vault roof was related to Mr Shilston's question in § 132. One reason for using Pyroc had been its rough surface, which it had been hoped would reduce noise more than it had done. Care had been taken to silence the incoming air, which was often a very noisy feature on compressors, but it was still undesirably noisy. He believed that the horizontal flywheels on the Kingston pumps were about the first case where these had been used in such work, and the Authors would give more details about them later.

163. When installing power generation (§ 140) at Crawley, the Authors had come to the conclusion that about 50,000 people was about the minimum for which it could be justified. He agreed that the cost of electric power had gone up far less than the corresponding figure for labour, which he thought was more critical to the capital cost of the engines. Labour charges had far more significance than the cost of electricity *pro rata*, and he was quite sure that at that moment a figure higher than 50,000 would be the critical one. It might perhaps be nearer to 100,000.

The Authors, in additional joint reply, said that the size of the storm tanks (§ 91) was limited partly by foundation conditions and partly by the economics of scraper gear, hence the eight tanks. The tanks were filled in pairs and in series, and this available storage capacity was a point in favour of separate storm tanks as opposed to an increase in the size of the sedimentation tanks. Until March 1959 the tanks overflowed on fourteen occasions only, and the overflow was only 1·05% of the total flow to the works. The suspended solids in the effluent had varied from 51 to 158 p.p.m.

165. Mr Severn had pointed out (§ 99) an error in terminology; the reference in § 55 should have been to a "leaner" not a "weaker" mix. A strength of 4,000 lb/sq. in. had been achieved by careful grading of the mix and a water/cement ratio not greater than 0·49.

166. In further reply to Mr Hughes, the air pressure quoted in the Paper was the maximum available at the blowers to allow for clogging of the diffusers, but had not yet been required in operation. The tanking was justified by the low-lying site and the possibility of surface-water accumulating around the structures.

167. The flywheels on the Kingston pumps driven by slip-ring motors had no influence on the starters, which were of the standard rotor resistance type; but the actual starting was naturally slower. The required inertia of the flywheels to prevent shock had been calculated by Mr Hugh Lupton on behalf of the manufacturers and amounted to 1,200 lb-ft^2 and 600 lb-ft^2 for the large and small pumps respectively, but as a margin figures of 1,500 and 900 lb-ft^2 had been adopted. The flywheels on the large pumps were 32½ in. in dia. and weighed 788 lb., and on the small pumps were 34 in. and weighed 1,145 lb.

168. Mr Shilston had asked for further details of the return/sludge pumps: they were vertical-spindle unchokeable centrifugal pumps, two of 475 g.p.m. and three of 950 g.p.m. capacity. The rate of sludge return was adjusted manually. The air diffusers consisted of 7-in.-dia. domes at 9-in. centres, but the intensity of aeration could not be related to a 10/10 standard, since this was not contemplated. On thin walls the height of concrete pours had been limited to 4 ft, but up to 6 ft had been allowed in thicker walls; no leakage was experienced if the construction joints were properly prepared. The corbels on the walls of the digestion tanks were actually formed of mild-steel brackets bolted to the concrete after completion of the concrete construction. With regard to the expansion and contraction joints, in view of the varying shape and size of the different structures, it had been decided to standardize on a joint with water-stop, which served for both purposes. Portland cement had been used for grouting behind the tunnel segments, and in the heading under the railway all the timber had been left in with no treatment, but the whole heading had been grouted. Pyroc was used in the powerhouse largely because of its heat-insulating properties. The floor finish was of semi-vitreous clay tiles.

169. In reply to Mr Held, although the capital cost of a steel central-distribution box was less than one in concrete, the maintenance cost was higher and the life shorter. Therefore, there was little to choose between them.

170. Alternators had been included because in the Authors' view they gave greater flexibility, and could cope better with the situation envisaged by Mr Manning. If two engines were out of commission simultaneously it would be necessary to reduce the demand—probably by reducing the air supply. The scheme had been designed for 50% d.w.f. as return sludge, but at the present time about 67% was returned, since full load on the works had not been reached. It was doubtful whether diverting the M.W.B. mains would have been economical in view of their number and size; in any case, the transfer of the land from the M.W.B. would have caused complications. The operation of the works was under the control of the General Manager, who would report on the men employed when the regular establishment was fixed after the works had settled down.

171. Mr Manning's question on foaming had been answered by Mr Stanbridge in § 102.

172. Mr Stephenson's questions on the relative merits of discharge to the Hogsmill

or the Thames raised some very interesting questions which could not be precisely answered. A dry river-bed tended to become a refuse dump, and from the point of view of general appearance a channel which had to be provided for storm flows looked better if it did not dry up. On the other hand, this benefit was lost if the quality of the effluent was not sufficiently high to prevent unsightly growths in the river itself. But there was a special circumstance in the Hogsmill in that the discharge was relatively near to its confluence with the Thames. The cardinal principle of effluent disposal was to obtain as much dilution as possible; therefore, discharge to the Thames was to be preferred. On the question of area, the total necessary would have been less if the existing works had not been kept in operation; but it would not have released the whole area, for it would not be possible to dispense with the sludge-drying beds on those works. For the disposal of the sludge, composting had not been considered economical or feasible, since it would have involved a complete reorganization of the local authorities' refuse-disposal arrangements. Although properties were almost adjacent to the site, there had been no serious complaints of nuisance.

173. The Authors had no doubt that the works would outlast the Ministry loan period, but the time when they should be replaced and the danger of their being maintained in operation though obsolete was a question of maintenance, repair, and policy. all of which were decided by the Board and not by the Consulting Engineers.