remark; he observes that it will not be safe in planning sewerage for Sydney to trust too much to English practice. He (the speaker) entirely approved of that, as must every man with the least pretention to thoughtfulness. English principles—the principles of engineering science as they were taught by English professors—were applicable all over the world, for they were deduced from a right appreciation of natural laws; but English practice merely exemplified the manner in which those professors were guided by those universal principles, under the special circumstances of their work. Those circumstances were in very many respects different from ours, and the so-called separate system found with them much to recommend it. But Mr. Stayten had just considered our circumstances; and after deliberate study he had rejected the separate system, and had adopted the partially separate plan. This—unless indeed Mr. Henson was prepared to show that Mr. Stayten had not given the matter careful and intelligent consideration—course one would expect to meet with the approval of a gentleman who crowned his essay with the sentence quoted. But it did not; and in fact he falls into the very error which he points out for avoidance. His whole argument advocates the separate system—a theoretical plan which, in practice, is nowhere to be seen. He (the speaker) wished to be quite clear, and to define the sense in which he used certain expressions. By the word "sewer" then he understood a conduit to carry off liquid filth; by "drain" he meant a conduit designed to collect liquid which might be filthy but only by accident; by "separate" system he understood the exclusion from sewers of all clean water, whether that be rainfall, or water from land; and by "partially-separate" system he understood that plan by which the greater part of rainfall, surface-water, etc., was excluded from sewers, but by which a small proportion was admitted to them. Those are the meanings usually attached to the several expressions; and it was very necessary to bear them in mind, for a great deal of tedious argument would have been saved the world had they not been so often forgotten. The separate system found its chief advocates in England; they first appeared there, not less than forty years ago,

in the persons of the late Mr. J. O. Ward, and of Mr. Edwin Chadwick. Mr. Ward's aphorism was "the rainfall to the river, and the sewage to the soil." It was an excellent aphorism, sound in principle; they were to go as near to realising it as possible. What gave rise to this idea? Why, the circumstances of the country suggested it; the laws, the physical configuration, the moist and cold climate of England. Until about 1813 it was penal to turn sewage into drains; and then as population increased it was found absolutely necessary to provide for sewage, and in 1847 it was made penal, on the contrary, not to turn sewage into those drains. But the majority of the important towns of England stand on rivers; and the consequence of turning sewage into surface drains which very properly fell into the rivers, was that afterwards pure drinking water was hardly to be got. Hence the Rivers Pollution Commission and its several Reports; and thence the enactment under which it became penal to turn crude sewage into rivers—the enactment under which in fact it once more became penal to turn sewage into drains. Then, local authorities being compelled to bring their sewage to a certain degree of purity before they could get rid of it by natural channels —of the rivers—all that long and expensive series of experiments on the practical scale began, which yet are far from being concluded, to ascertain the best, speediest, and cheapest way of effecting the necessary purification. These soon showed that there were but two plans worth serious attention—precipitation and filtration; and while it was at last found that the best effluent could be got only by a combination of these two, it was learned that the filtration could be sufficiently well done by a plan which allowed of the use of the sewage as a fertiliser. Then a new problem presented itself, namely, how most money could be made out of sewage by farming, and how the heavy expenses necessarily incurred by local authorities could best be lightened. But as soon as sewage farming became a feature in the sewerage schemes of those authorities, as soon as they began to look to the farmer to lighten their expenses, the farmer became a factor in the problem, and his convenience had to be consulted. He found that he could not utilise the immense

volumes of combined sewage and drainage which, in that cold and moist climate, were brought to the farm by the combined system; and besides, it was found that these immense volumes of very dilute sewage could not, by the cheap processes of irrigation, be sufficiently purified. To reduce even expenses out of pocket it became necessary to reduce the volume. Hence, in towns to be newly sewered, systematic attempts began to be made to exclude drainage; so that the farms—or filter-beds—instead of receiving variable quantities of fluid often in quite unmanageable volumes, might receive a pretty constant flow of sewage of tolerably constant constitution, and so that the farmer might get a chance to raise his crops with tolerable certainty. These, in fact, were the considerations which led to the prosecution of the search for an effectual means of separating drainage from sewage; and they were considerations to a large extent not furnished by our conditions. He might be thought thus far to have referred to rainfall alone, in speaking of drainage; and, at all events, he had not specifically mentioned subsoil waters. But it was not the rainfall alone which on the combined system diluted sewage. England had not a much greater rainfall than we have; but the manner of its fall was vastly different. It fell so that the tendency was to keep the subsoil saturated; and since not all that falls finds its way into the ground, for even in England the loss by evaporation was very considerable, that saturation was there ensured by the absence of another force—that of heat. Are our circumstances then so similar to these that we should violently advocate the separate system here, merely because it has much to recommend it there? He thought not. We have —in the neighbourhood of Sydney, which was the area to be sewered—for the most part a comparatively shallow soil which overlies the sandstone and the shale; we have a country of good surface grades—consisting in part of a series of anti-clinal ridges, with ample falls to the sea; we are not environed by rivers whose waters must be kept pure; and we have a sun which sometimes we find almost too brilliant, too constantly visible. Under these circumstances we are not at all likely to be embarassed by the excessive volume of our sewage, as compared with our

cultivable area. We might safely reckon on evaporation to do much. Our climate—he did not say our soil—was more like that of Italy than that of England; and perhaps the difference might be pointed out by a reference to sewage farming as it had for very many years been successfully carried on at Milan. There no attempt was made to separate drainage from sewage. The sewers converge to an open canal called the Vettabbia, and thence the sewage was drawn off to the surface of about 4,000 acres of land arranged for broad irrigation, which for very long it had fertilised in a remarkable manner. Notwithstanding the extremely dilute character of the fluid it is actually possible from time to time to pare down the surface of several meadows—not in order to preserve the levels, but in order to sell the parings which were carted away as manure to more distant estates. We have a climate —and we are to make use of a soil—which renders the dilution of our sewage of small consequence; we are better placed in these respects than the Milanese, successful as they have been; and how much more fortunately situated are we than the people of Berlin. Yet the sewers of that city are calculated to carry a rainfall of five-sixteenths of an inch per hour, and that although every drop of it had to be raised to a vertical height of no less than 33 feet before it could run on to the several farms. He believed he had now said enough to show that the choice between the separate and the combined systems was one which must be guided by the circumstances of the place to be sewered; that, like a good many other things which here we had to decide upon for ourselves, it was not by its essential qualities absolutely good or absolutely bad; and therefore was not to be advocated in any place, merely because it had been found suitable to some other different place; and thus it happened that at Portsmouth, where the area to be sewered was in small part raised, but in a larger part was below the level of ordinary spring-tides—actually within this one area in the very birth-place of the separate system, both the separate and the combined systems were exemplified. For it was thought necessary to relieve the lower levels of the surface water running off the higher level, and therefore to the sewers of the latter all surface

waters were admitted; but as the sewage from the lower level had to be pumped, it was thought desirable to exclude as far as possible all rain-water from the sewers. That appeared to him to be a truly scientific application of principles, and to form a striking contrast to a course which involved the irreflective adoption of mere practice. It was to principles that he had thus far addressed himself; but, even at the risk of being tedious, he could not sit down without saying something upon the degree of separation which hitherto had been found practicable. He had mentioned that the separate system should not be adopted here just because it had been successfully employed elsewhere. Had it ever been unsuccessfully employed, but had it ever been found possible anywhere? He did not know of any place, at least not any place in area and population at all resembling Sydney, where it existed. But such a place might nevertheless be known, though not to him; and he would therefore repeat what was said by its advocates. The city of Winchester, sewered by Mr. Lemon, was often referred to as an example of the working of the separate system. Mr. Lemon, in speaking of the Winchester scheme at the Annual Meeting of the Association of Municipal and Sanitary Engineers held in London in 1878, said: "There is not a single gully connected with the sewers —some people called that the separate system, but it was nothing of the kind. It was impossible to prevent houses being connected with the sewers in all directions, or to prevent houses being drained into the sewers in all directions. If they carried out the separate system in its integrity they must have a double set of conduits, and that, in his opinion was an absurdity and could not be carried out." And again he said—"he is often regarded as the main advocate of this system." He had little difficulty in carrying out the separate system, and it is astonishing how that system is growing —but he has not yet been able to keep the water of back yards out of the sewers, and did not consider that practicable." So also Mr. Angel, Borough Engineer for Portsmouth said "The separate system can of course only be carried out in its general features, and not in every detail. It would be a mistake to have a duplicate set of drains to each house; backyards would

usually drain into sewers, but for the most part roofs can be drained into road channels or surface drains. About 90 per cent. of surface waters can be diverted without causing difficulties of details." Professor Robinson, an eminent authority on all matters of sewage, says of the separate system: "Its advantages appear chiefly where sewage is disposed of by irrigation, and where it is absolutely necessary to lift sewage by pumping. For irrigation it appears desirable to have sewage as concentrated as possible; but when pumping is unnecessary dilution within certain limits is not detrimental. A duplicate system involves greater cost; it would also exclude from the sewers street and road washings, which are unfit to be admitted to streams, and it would also prevent natural flushing." Some of these objections have but little force here. As he (the speaker) said before, we are not in danger of fouling streams from which drinking water might be taken; and it would, in his opinion, be a mistake to consider our extended road surfaces from just the same standpoint as the less extensive road surfaces in England must be regarded from. With proper catchpits intervening, there could be no objection to the passage to the Harbour of such surface water. He could not conclude without repeating the following lines from Mr. Denton's invaluable work:—"If," he says, "we recognise, as we certainly ought, a difference between towns situated in districts of rapid inclinations, impervious surfaces, and heavy rainfalls, and those where the reverse conditions prevail, it will be considered advisable to admit into the sewers of the former only such rains as fall on the back parts of dwellings on impervious surfaces so situated that there would be a difficulty in connecting them with any system of surface drainage, and on those streets and courts which from their position collect refuse almost as foul as sewage itself. In the latter, having flat inclinations, porous surfaces, and smaller rainfalls, it is better to admit such additional quantity as may be advantageously turned to account in flushing." To which of these sets of conditions was ours most like? The conclusion drawn from these statements was that the separate system is a practical impossibility, however

desirable it might be shown to be on theoretical grounds. Whenever an author speaks of the "separate system," you may find that he is speaking loosely, and that, in fact, he means the partially separate system. The difficulty was, in fact, a purely practical difficulty; and although it was inadvisable, for a hundred different reasons, to admit all waters to sewers, it was not possible to exclude all. As for subsoil waters, unless you are prepared to lay iron pipe sewers with gas-tight joints, you cannot entirely keep them out except by laying in the same excavation a special drain for them. This it was often necessary to do in the case of pipe sewers, but not so necessary in the case of main sewers, while as for rain water, although the greater part could easily be excluded, the exigencies of house building rendered it simply impossible to keep the whole of it out. In the latter case, there was the difficulty which arose under the general heading of error of experiment. The separate system required a double set of conduits, and a double set of yard gullies. Besides the very great expense of the former, there thus arose an intolerable confusion beneath the soil of the two sets of pipes; and in the very few places where they had been laid it had been found, by practical experience, that even authorised workmen inevitably confused the two, and from time to time connected the sewers of houses with the drains and *vice versâ*. Then, in respect to the two yard gullies, you import into the elaborate scheme the domestic servant, and place it entirely at his mercy; for wherever yards slope towards houses there the two must be side by side, and wherever yards are already formed they are so graded that any gully to take their water must be placed next to the present gullies, unless you are prepared to cause all the yards to be re-laid. He drew illustrations on other points from several different parts of the world; but on this he need not go further than our own Surry Hills. Why did not Mr. Trevor Jones, who supports Mr. Henson's views, detail to the Association his own experience of the working of the separate system, as instituted by himself at Surry Hills. For, Mr. Jones, with the courage of his opinions, has initiated the separate system in this city; and he (Dr. Thompson) would

like to be informed whether it was not the case that in the district mentioned there were to be found in back yards two gullies, and whether it was not the case that those two gullies were confused in the manner he had just suggested, so that although the houses referred to were sewered, sewage from them not infrequently still found its way by the drain to the road gutter. The drift of his argument was—first, to show that the separate system had been advocated in England to meet that country's special requirements; secondly, that our circumstances differed from those to an extent and in a manner which rendered it unnecessary seriously to consider the separate system here; thirdly, that the separate system was deemed by the best practical authorities to be impossible of execution, and, as a matter of fact, was nowhere carried out, or, at most, in no city at all resembling ours in the matters of area and population; and lastly, that the partially separate system was both practicable, economical, and wise. But then, the partially separate system was what Mr. Stayten had adopted. "About 90 per cent. of surface water may be diverted without causing difficulties of detail," says Mr. Angel. Well, Mr. Stayten proposes to divert exactly that amount over a part of his area, and over the rest he thinks—and he (the speaker) saw no reason to suppose him wrong—that he could divert 85 per cent. In short, Mr. Stayten had adopted the approved practice.

Mr. Shellshear said that proper provision for the removal of storm water was as essential for the public health as the removal of filth, and he hoped that some of the members would give their views, embodied in papers, to the Association on some future occasion; and he instanced the reckless style in which suburban lands, in some cases, are cut up into allotments and built upon.

Mr. Poole was sorry that he had not heard the original paper which had given rise to the discussion. He wished to call the attention of the Association to the desirableness of establishing sewage farms; about three years ago he made an inspection of the sewage farm at Birmingham, England, and the site, which was originally a pure river-bed, was admirably adapted for filtering; but he found at the time of his visit about fifteen inches of matter

resting upon it. The point which he wished to bring under their notice was, that a yearly increase, to a certain extent easily computable, would act as a check upon the original properties, and filtering beds on this farm would in time cease to filter at all; and would become stagnant marshes, and the system would eventually have to be exchanged for a costly and difficult system.

Mr. Henson, in replying to the discussion on the paper, said he should mainly confine his remarks to the question of separation of sewage from rain water. Mr. Cowdery's remarks consisted chiefly of adverse criticisms on the report, and he regretted that he (the speaker) did not propose a rival scheme. In his paper he had indicated the lines upon which a more perfect scheme could be carried out—further he could not go, as he could afford neither the time nor the expense. Reference was made to the annual cost of the scheme as proposed in the report. The rate therein stated, 5·12 pence in the £ per annum for a 60 years period, is based upon the estimated cost of the three systems, and did not cover the cost of the subsidiary sewers. The rate for each system should have been stated separately. As the Northern system discharged into the main Bondi outlet it was likely that part of the expense of that work would be chargeable thereto, and when it was added to the cost of the subsidiary sewers, the necessary rate for the area comprised in the Northern system would be nearly double that mentioned above. He quite agreed with Mr. Shellshear in his remarks about the necessity for improving the storm water channels. This work was in a large measure independent of the sewage work, and the immediate construction thereof would largely mitigate the evils now experienced through the stagnation of house drainage in the irregular beds of the creeks, etc. He was glad to say that the recommendation of the report, in regard to the treatment of watercourses, were in accordance with the views expressed by him in the paper on "The Sanitary Aspect of the Site of the Metropolis and its Environs," which he had the honour of reading before you in May of last year. Dr. Thompson alluded to the successful working of the existing syphon at Cook's River, and thought that it fully justified the adoption of the syphons recommended in the