

Mr. H. ROBINSON said, that in consequence of his long absence from England, he was but imperfectly acquainted with the recent works connected with the Thames, and he must, therefore, apologise for any omission which might be remarked in the Paper. His object had not been to improve the navigation, but to improve the sanitary condition of the river, by disposing innocuously of the sewage; consequently, no objections to his plan were fatal, unless it could be shown, that the evils which he might create, were of more importance than those at present existing, or that it would cost more to remedy them, than the £3,000,000, which he expected to save. His proposition was, to construct a chain of locks across the river, just above London Bridge, so as to use the piers of the bridge, as portions of the masonry of the piers of the fifteen locks; this would afford a lineal water-way of 552 feet, instead of 692 feet, as at present, and he anticipated, that the equalization of the depth of the river, would compensate for the width thus reduced. In all the lock-gates, which would be of iron, there would be ample sluice-gates, to allow of the passage of the natural current of upland water, which alone would have to pass; the tidal water being entirely kept back. The lock-gates might be worked by hydraulic power, like those of the Grimsby Docks, and the new Victoria Dock, and the cranes in many docks, both in the Metropolis and in the provinces. He proposed to maintain the water above the locks, at a level of about 12 inches below that of ordinary spring-tides, so as not to inconvenience the surface-drainage of the low districts of the Metropolis. The barges above bridge, might be towed by small steam-tugs, by which means the cost of conveyance of goods would not be more expensive, and be much more expeditious and certain, than by the present system. This plan would not at all exclude, but rather facilitate, the conveyance of the sewage, by lateral tunnels, parallel with the river, to any distance that might be judged advisable; but he considered, that no sanitary objections would exist to raising the diluted sewage matter, by means of scoop-wheels and small engine power, placed at the mouth of each existing large sewer, and thus discharging it into the river, whence it would run off through the sluices, without the possibility of return. If it was decided to have a tunnel along each shore, intercepting the mouths of all the present sewers, it could be kept constantly flushed and cleaned, by the head of water from above bridge.

The principal objection to his plan was, the reduction in the tidal capacity of the river, and the consequent danger incurred, of interfering with the scour of the ebb-tide; but to enable a correct judgment to be formed on this point, it was important to consider the amount of the reduction which would be effected. Now the tidal capacity of the river, between the mouth and Gravesend, was

17,000 millions of cubic feet, and between Gravesend and London Bridge, 4,320 millions, making a total of 21,320 millions. The whole capacity of the river above bridge, influenced by the tide, was 657,000 millions; which small proportion was yet to be decreased, by the amount of the current which would still pass during ebb-tide, amounting to 108 millions. The total reduction, therefore, would be 550 millions of cubic feet, which, deducted from a gross total of nearly 22,000 millions, would only be $2\frac{1}{2}$ per cent.

This reduction was thus of little consequence in itself, but there were other circumstances to be taken into consideration. It was feared, that if the upward progress of the tide were stopped at the bridge, the banks below would be flooded. Now, although there were good reasons for believing this fear to be groundless, still it might be useful to calculate the maximum amount of increase which it would occasion, and he had found, that the whole quantity of water now running up the river would, if accumulated below, raise the general level only 4 inches. He was, of course, aware, that the retention would not produce a general rise in the river, still as the whole quantity of water could not come in, 4 inches might be taken as the possible maximum.

But if the principle of a rise below bridge were allowed, there could be no fear of a reduction in the scour of the ebb: for not only would the water still run in and out as before, but it would be kept in that part of the river, where it was of the most use. The scour chiefly occurred towards low-tide, and considering the velocity of propagation of the tidal wave, and the comparative slowness of the current, it was probable, that the upper water, filtered through the bridges and choked by the shoals and contractions above bridge, was, practically, left behind by the ebbing tide and produced very little effect in increasing the scour. Again, nothing could be easier than to make use of the enormous reservoir, into which the upper part of the river would be transferred, for the purpose of periodically flushing, and thus producing an artificial scour, if required. Again, the experiment of Captain Washington proved, that water, with a given velocity, could only hold in suspension a given amount of silt, with which the Thames was now surcharged; it could not, therefore, effectually act as a scour, but would be more likely to deposit silt, or mud, than to take it up and carry it into the sea. But the 200 millions of cubic feet of water, which would be discharged from the dam at every tide, would be comparatively pure, and therefore, in the best condition for exerting a scouring power.

The next point for consideration was how to get rid of flood-water. Floods, whether arising from heavy falls of rain, or from the melting of snow, could always be foreseen a few hours before

they could affect the river : there would thus be time for allowing sufficient water to escape from above the dam, to permit of the river holding, without danger, the expected increased supply ; in any case, a free egress might be given by opening all the locks. Old London Bridge allowed but 300 lineal feet of water-way : this was diminished by the obstructions of water-wheels in nine of the arches, and the passage of the water was still further impeded, by the quantity of stones thrown in to secure the piers. Now the present lineal water-way was 690 feet, from which the intermediate piers of the locks would take 150, or 200 feet, leaving 500 feet, or more ; and allowing for the present depth under the arches, there would be at least three times the space allowed by the old bridge, for the passage of the tide, or about one-fourth less than the present bridge ; there would, therefore, be no fear of any great fall through the locks, if they remained open during a tide.

With regard to the general question, and the plans hitherto proposed, he looked with alarm at the intercepting schemes, and the serious results which would follow any stoppage, or giving way in the large tunnels. In a few years, the present sewers leading to the river, would not, in such case, suffice to deliver the sewage ; and considering the elective constitution of the Metropolitan Board, and the certainty, that the strictest economy would be required at their hands, there could be little doubt, that the vast annual expense now incurred for maintaining the present sewers, would no longer be deemed requisite ; the result would be, that the old sewers would not be found in a state of efficiency, at a moment when they had become absolutely necessary. Still, this risk might, perhaps, be incurred, if the intercepting plans would really effect the object proposed, but he doubted whether such would be the case ; for if all fresh sewage were stopped out of the river, the progress of cleansing, or dilution, would be very slow, and a few hours' Easterly wind would suffice to blow back the sewage, which it is proposed to discharge in a body at Woolwich, and the river would thus again become as foul as ever.

But no sanitary measures would be worth such a cost, as that contemplated, if they left untouched the great source of malaria, the mud-banks, exposed at low tide. The cases of St. Petersburg, Nizni on the Volga, and Alexandrofsky, where the cholera specially raged, proved the danger to be apprehended from such mud-banks, even without sewage matter. Too much apathy existed about this vital point. In those districts where the epidemic influence had been aided by such local circumstances, whole families had been destroyed, and even whole villages depopulated, their neighbours saving their lives only by a precipitous flight.

The influence of the Members of the Institution was, undoubtedly, great, and he would, therefore, call upon them to unite in
[1855-56. N.S.]

turning to good account the present popular excitement on the sewage question, and by expressing their approval of the scheme proposed, or of any feasible plan which might be presented, to assist in removing, what he believed to be the most deadly aid to disease, the mud-banks of a river, giving off noxious vapours under a burning sun.

Mr. VIGNOLES said, that the substance of the project appeared to be, the conversion of the upper portion of the Thames at London, from a river ebbing and flowing with the tide, into a river, flowing only in one direction, with a small uniform current. There were many grave objections to be urged against such a scheme, but the main practical point for discussion, was the mode by which it was proposed to effect the object in view. An alarming picture had been drawn of the evil results which might, possibly, attend the system of intercepting sewers; and a corresponding perspective was given of the great advantages to be derived, from the adoption of the project advocated in the Paper; but it was utterly impossible to discuss the question, unless the details were laid before the Meeting. The cost and inconvenience of constructing and upholding the proposed large intercepting sewers, could be accurately ascertained, but the expense of the proposed system of locks could no more be accurately foretold, than its effects upon the river could be foreseen.

As to the sanitary question just touched upon, he could not admit, that any fair comparison could be instituted, between a river whose mud-banks remained, for six months together, exposed to the action of the sun, and the Thames, in which the tidal flow covered the banks, twice in twenty-four hours. It was inconceivable, that any miasmatic influence should spread throughout London, by the banks of the river remaining uncovered during a portion of the interval between high and low-water; he should rather incline to the opinion, that the constant ebb and flow of the tide, causing a change and current in the atmosphere, was, on the contrary, conducive to the health of the Metropolis.

Mr. J. B. REDMAN considered the subject of the Paper replete with interest; it was a source of great regret, that the Metropolis, owing as it did, its greatness to the Thames, had done so little for the preservation of that stream.

The embankments of the lower reaches had been attributed in turn, to the Romans, the Saxons, and the Danes; their real origin being, however, only indistinctly surmised. Sir Christopher Wren, considering the work to have been of too great magnitude and difficulty for the ancient Britons, and that the Saxons were too much engaged in their continental wars to attempt it, agreed with Dugdale, that they were constructed by the Romans. Cruden, in his *History of Gravesend and the Port of*

London, referred to these opinions, but inclined to the view, that they were principally undertaken at the commencement of the twelfth century, when many of the neighbouring abbeys were founded. The commercial prosperity of London was mainly due to these works, as that of Glasgow was, to the similar modern works on the Clyde.

Mr. Redman had kept a register, which was in the Archives of the Institution,¹ of the tides at Gravesend, during the years 1842, 1843, and 1844. From the great range of tide, deduced from these observations, the importance of the embankment works was evident. The rise of tide in the Thames was generally much under-stated; taking the extreme rise and fall of spring-tides, it amounted to not less than 26 feet, and after a prevalence of North-West winds, acting on the large area of the German Ocean, the tide had ranged as high as 3 feet 7 inches above Trinity standard of high-water, fixed by the Corporation of the Trinity House, as the mean range of spring-tides; these standard marks had recently been very carefully corrected by Mr. T. M. Smith, for the Corporation of London, and were valuable references for establishing data for hydraulic works on the Thames.

The tide rose above Trinity standard,—

			Ft.	In.
On the 18th October	1841	. . .	2	3
„ 18th February	1843	. . .	3	3
„ 7th April	1844	. . .	1	3
„ 12th December	1845	. . .	3	4
„ 27th September	1847	. . .	1	6
„ 24th January	1850	. . .	3	4
„ 12th November	1852	. . .	3	7
„ 15th February	1854	. . .	3	3

These variations in the range of tide, showed the importance of the river banks, which had been preserved and governed by ancient statutes of sewers: (Temp. Hen. VIII., vide Callis.) Dagenham Breach was a notorious instance of the effects of a failure in such works, as 5,000 acres of land were then submerged.² Sufficient advantage could not, however, be taken of this rise, on account of the numerous shoals, encumbering the river, and the pernicious practice, in former times, of only dredging for gravel. Bullock's chart and section, a reduced diagram of which was exhibited, with plans, from the Report of 1845 on

¹ Vide Original Communication, No. 706; being an "Account of the new cast-iron Pier, at Milton-on-Thames, next Gravesend, &c." By J. B. Redman. The Paper and some of the Appendices were printed in the Minutes of Proceedings Inst. C. E., vol. iv. (1845) p. 222.

² Vide Perry's "Account of the Stopping of Dagenham Breach." London, 1721.

Tidal Harbours, well exemplified this, and the Reports of 1841, by the various officers employed by the Conservancy authorities to report on the Thames, and to lay down lines for embankment and dredging, were equally indicative of the great necessity of regulating the depth of the bed. This was felt so far back as 1793, when the necessity for improving the accommodation for the shipping, was urgently brought before the attention of the Legislature, and gave the initiative to dock enterprise. The Report of that Committee, produced in 1793, and the numerous plans and sections were, however, rendered nearly valueless, from no fixed standard being referred to; but they showed how generally it was felt, that some material improvement was pressingly required. Colonel (now Sir Frederick) Trench's designs for a quay and raised terrace, in 1825, his quarto volume of 1827, and the designs of Mr. Martin, of about the same date, gave the initiative to many other Thames embankment schemes, of the last thirty years, as well as of those for the drainage of London, and were, necessarily, very interesting. The Report of the Committee of the House of Commons, which sat in 1840, under the chairmanship of the late Sir Matthew Wood, went very closely into these two plans, as well as that of Mr. James Walker, perhaps the most practicable scheme that had been propounded.

The variations in the tides of the Thames, dependent on wind and local causes, were at all times interesting; but more especially, the phenomenon of the double tide, occasionally observed. Holinshed, in his quaint language, said:—

“For some time, the huge wind keepeth back a great part of the floudde, whereby the tide is differred, (though never altogether put by,) and sometyne, there happen three, or foure tydes in one naturall daye, whereof the unskilful do discant many things.”

Similar passages occurred in Stow and other writers. In Gough's Topography, there was given the title of a paper, published at the time of the occurrence:—

“A strange wonder, or the Cities amazement,” A.D. 1641:—describing two tides at London Bridge, within an hour and a half.

Lord Anson, in 1756, read before the Royal Society a Paper to which various logs were appended, on these variations in the tides, which he attributed to heavy gales of wind; and in the same year, Mr. Dingley also communicated a Paper on the same subject.

Griffiths' History of the Thames, 1746, gave the various authorities for the conservancy thereof by the City.¹

¹ Vide “An Essay to prove that the Jurisdiction and Conservancy of the River Thames, &c., is committed to the Lord Mayor and City of London, both in point of Right and Usage, by Prescription, Charters, Acts of Parliament, Decrees upon Hearing before the King, Letters Patents, &c. &c.” By Roger Griffiths, Water-Bailif. London, 1746.

The facilities afforded to the trade of London, like those at Liverpool, were comparatively modern. In 1660, the legal quay, 1,400 feet in length, below London Bridge, was the only accommodation for landing and bonding foreign produce in the Port of London. The formation of wet docks was not mooted till 1770, having been first established in Liverpool in 1716. In 1793, the first plan was projected for London. In 1795-6, the crowded state of the river and consequent hindrance to commerce, caused an inquiry before the House of Commons; and in 1796, when eleven thousand ships entered the port in twelve months, a navigable channel in the river, of 250 feet, was insisted on by the Legislature. The Report of May 1796, showed, that in seventy years, the trade of the port had nearly doubled, and in the quarter of a century following, the increase was proportionate; towards the end of the century, the foreign import and export values were trebled, the import tonnage was quadrupled, and the export tonnage was more than quintupled in amount. The coasting tonnage, (colliers forming more than one-half,) had correspondingly increased; the imports being nearly quintupled, and exports, more than quadrupled. In this century, the dimensions of British shipping were doubled, and the number of total entries, doubled. The attention of the Committee of 1796, was directed to the necessity of removing the colliers and timber ships, from the Pool, either into docks, or lower down the river. The objections then urged to docking timber ships,—now, (when their draught will admit of it,) almost universally so accommodated,—pointed out the fallacy of the similar opposition now made with respect to colliers; the river was shown to be ill adapted for a dock, and the practice of mooring tiers of vessels in the navigable channel, was characterised in terms, equally appropriate at the present day. In the first Report of the Select Committee on the Port of London, of June 1799, regret was expressed, that no steps had been taken for its amelioration, and it pointed out the advantages experienced by the outports, in the establishment of wet docks: the Report also recommended the immediate execution of the Isle of Dogs and Wapping plans. A succeeding Report, of July 1799, classified the various projects, without making any recommendation. The Select Committee of July 1800, referred to the consideration they had given to the Wapping (London Dock) plan, the Act for which, subsequently passed that session, removed the objections to the free use of the Greenland Dock, and provided for the future purchase of the legal quays; also to the Act, passed in the prior session, for the formation of the West India Docks; “it is,” the Committee said, “with great satisfaction, they point out these vast and expensive enterprises, as undeniable proofs of the spirit, the activity, and the wealth of the nation.”

In the year 1800, the London and West India Docks were commenced, and in 1803, the East India Docks; the Surrey Canal Dock, and the Commercial Docks, on the opposite side of the river, were subsequently formed. In 1824-5, notwithstanding the construction of the above docks, the crowded state of the river, and the urgent necessity of increasing dock room, again engaged the attention of the Legislature, when Acts were passed for Collier Docks, South London Docks, and the St. Katharine Docks; the two former were never carried into effect. In 1828, when the St. Katharine Docks were opened, the number of ships entering the port, had increased to twenty-three thousand, or more than double that towards the end of the former century; a port regulation was then made, to preserve a clear 300 feet channel, and it was legally confirmed in 1829. In 1831, a Committee of the House of Commons reported on the necessity of enforcing this regulation. In 1832, representations on the crowded state of the river, were made by many influential bodies. In 1833, stringent orders were issued by the Port Committee, to enforce the 300 feet channel, and in December of the same year, after a most laborious investigation, this width was adhered to. In 1834, a Report was made, embodying this decision. In 1835, the number of ships entering, had reached 25,365, denoting a much higher rate of increase; in this year, the preservation of the channel was urged upon the Port Committee, by memorials from the St. Katharine Dock Company, and others. In 1836, so great were the impediments, that a Select Committee of the House of Commons sat on the subject, and made similar recommendations; Captain Fisher, the Harbour Master, in a letter, in the Appendix to the Report, said he saw no remedy but compelling colliers to go into a dock, and urged the advantages of a depôt, in equalising the prices. From 1830 to 1837, various plans for Collier Docks were proposed, against which, until of late years, there had existed as great a prejudice as, formerly, against docks for general produce and timber, and probably, as well founded; the unloading of ships at less cost, than by the rude and primitive mode employed in the Pool, the greater despatch and security from danger, were all features urged in their favour. The increase in foreign imports and exports, had been in an increasing ratio for the first half of the present century, as compared with the results of last century; this applied also to the coasting trade, more especially to colliers. The foreign export tonnage was more than double, and the import foreign tonnage, treble; the coasting trade had increased in a still larger ratio, and the number of collier arrivals was trebled; the steam tonnage increase had been quite as remarkable, reaching in 1830, 73,634 tons, and in 1835, 266,684 tons, or near quadruple in five years. Mr. Hume, as examining Tidal Harbour Commissioner for 1846,

referred, in his Report, to Mr. Rowland, the Harbour Master's opinion, that after four years' additional experience, he recommended the removal of the seven sections of laden colliers, berthed in the deepest part of the river, and strongly urged, that docks should be erected for their reception. In this opinion, Mr. Hume, and the Commission generally, concurred, and so expressed themselves in their Report; the increase of steam navigation rendering necessary the widening and deepening the water-way, this change was considered imperative.

The vigorous efforts, made by all the principal outports to increase dock accommodation, were indicative of the importance attached to such works. Notwithstanding the constant increase of dock acreage at Liverpool, Birkenhead had arisen on the opposite shore, in connection with the extension of the railway system. At Hull likewise, with increased dock area, the Great Grimsby Dock had been constructed, in connection with the Lincolnshire lines on the opposite shore. The new works at Leith, Montrose, Dundee, Sunderland, Swansea, Newport, Cardiff, Southampton, &c., the extensive works in progress at Plymouth, Shoreham, &c., those projected on the Tyne, at Newcastle and Tynemouth, at King Road in the Bristol Channel, at Harwich, and elsewhere,—all testified to the desire of the outports, to keep up dock accommodation equal to the increase of freightage.

Until the commencement of the Victoria Dock, this had been by no means the case in the Port of London, although the extraordinary results of free trade, the Irish exodus, the discovery of gold-fields in Australia, the revolution in China, and other unlooked-for conditions of commerce, all directed attention to the loudly called-for increased accommodation for shipping. Apart from the steady yearly increase in the amount of foreign imports and exports for the last half century, they had, in the first six months of the year 1853, absolutely exceeded those of the like term in the former year, by 11 per cent., being a higher increase than at any period since the last war, at the close of which, from 1817 to 1818, the increase, consequent upon the opening of the ports, amounted to 23 per cent., or $11\frac{1}{2}$ per cent. for the six months. The only other parallel instance was from 1846 to 1847, when the increase was $19\frac{1}{2}$ per cent., or $9\frac{3}{4}$ per cent. for six months. Notwithstanding these unparalleled incentives to enterprise, the dock acreage of London, instead of keeping pace with the increase in freightage, had, with very slight addition, been absolutely stationary for a quarter of a century, and the two hundred acres of dock room which, in 1828, supplied the wants of a crowded port, appeared to have been considered sufficient for the ever-increasing wants of the first port of the kingdom. The existing Metropolitan Dock Companies were beginning, however, to feel the force of these

circumstances, and an expenditure of about a million was now taking place, in improving the access to the present establishments; but little or nothing would be added to the dock acreage of the port.

He had recently constructed a large wharf and tidal docks at East Greenwich, and executed the repairs of the pier at West Greenwich. The failure, originally, of the latter, was well known, and had been, rather absurdly, quoted in some of the 'blue books,' as a reason for preferring floating break-waters. The failure of the wharfrage of the Isle of Dogs, was another example of the difficulties attendant on works connected with the embankment of the Thames. The state of the accommodation for embarking and disembarking steam-boat passengers had long called for amelioration, and as far back as 1844, he had proposed the establishment of piers for this purpose, but so many obstacles had arisen from conflicting jurisdiction, as to render such a project almost impracticable. The old watermen's causeways were the source of great mischief, tending, as they did, to promote deposit along the shores, and they ought, in his opinion, to be all removed.

Mr. CHARLES PEARSON contended, that the conversion of the Thames into a partially stagnant 'cloaca' and canal, could not be executed with anything like the assumed facility, or for any reasonable sum, even if the expediency of the plan, and the efficiency of the system for raising the sewage, by mechanical means, could be admitted. Nearly the whole of the wharf property on the sides of the river would require re-arrangement, and numerous modifications must be made, which would demand a very large extra outlay, not contemplated in the plan laid before the Institution, and the commercial uses of the river would be subjected to great and inconvenient changes, all of which should be well provided for.

If the Members of the Institution would unanimously insist upon the impropriety of permitting any sewage matter to be poured into the Thames, within a certain distance of the Metropolis, the calm but confident expression of their opinion would carry conviction to the minds of the public. Let the true, scientific, and practical principles be so settled, and the public would readily supply the means for their execution. The people did not like filth and would not tolerate it in any form, nor did they like having the tax-collector's hand in their pockets too frequently; but for the sake of cleanly homes and wholesome air, they would pay handsomely, provided the matter did not savour of a job.

The next considerations were, to whom did the river belong, and who was to blame for its present condition? Though more litigation might be necessary, in order to ascertain, with the legal

precision usual in such matters, who was the owner of the Thames, still he contended, that the evidence was pretty clear, and that, if Old Father Thames could be interrogated, he would say, that though occurrences of upwards of a thousand years past were somewhat misty, his recollections were not quite obscured, and he would recall the time when the Romans under Maximus and Theodosius, aided by the tribute of the City of London, then a Roman municipium, embanked the river which divided the two great Provinces,—Britannia Prima and Flavia Cæsariensis. The government of the Port and the River remained under the municipal direction of the Londoners, until the Romans retired from the kingdom, and it was afterwards retained by the citizens, as the boundary separating the Angles, who were settled North of the Thames as far as Caithness, and the Saxons who held the country South of the line of the river.

During the Heptarchy, the Corporation governed the Thames, and Edward the Confessor established Courts of Conservancy with ample powers, secured by charter, to the Aldermen of London, whose station was recognised even before the Kings of England had being.

William the Conqueror, at his advent, exhibited considerable shrewdness, in wishing to take possession of the river, but the Corporation evinced so determined an opposition, that, desiring to be considered "friendly," as he termed it, he granted a short but comprehensive charter, confirming, in general words, all the privileges granted by Edward the Confessor. This charter, very unlike the diplomatic notes, protocols, treaties, &c., of the present day, consisted of only a few lines, but although after an interval of eight hundred years, its phraseology might appear somewhat obscure, it was, at the time, capable of being comprehended by the meanest capacity, and was completely to the purpose.

Many of the succeeding kings attempted to interfere with the government of the river, but invariably met with the same successful rebuffs from the citizens. Favourites and courtiers, then as now, the fruitful sources of all evil, were equally unsuccessful in enforcing the grants illegally made to them; until at length, in the reign of James I., the citizens actually filed an information against the Crown to establish their rights, and Sir Edward Coke, the Attorney-General, confessing the right of the Corporation, based upon immemorial usage, judgment was entered up in the Court of Exchequer; but to make assurance doubly sure, the king recognised the right and confirmed it by a Charter, which though annulled by 'Quo warranto' in the Star Chamber, was confirmed, with the other Charters granted to the City, by William III., whose plain common sense and feeling of justice, recognised the evident rights of the Corporation to continue to be the conservators

of the river which had been so long in their hands, and had been by them so ably administered.

It might have been supposed, that there could have been little or nothing to quibble about, in so plain a position ; but great was the complexity of the law, and still greater the ingenuity of legal men and courtly advisers. Possession of a property for a certain term was always assumed to confer rights of ownership, unless better rights to possession could be shown. In this case, however, the Crown laying claim, under its Royal prerogative, to the beds and banks of rivers, and the shores of the sea between high and low-water, called upon the Corporation to prove its right to the conservancy and soil of the river. The citizens naturally resisted so monstrous a claim ; they asked to have the question tried by the short and inexpensive process of the Common Law Courts, but they were introduced to the Lord Chancellor, before whom, during the last twelve years, there had been already executed more parallels, zig-zags, and other tortuous approaches and exhibitions of strategy, than before Sevastopol, without ever yet arriving at the stage of examining a single witness, or ascertaining one solitary fact.

In consequence of the removal of the old bridge in 1832, shoals were thrown up in various parts of the river, whilst the action of steamers on the water undermined the banks, and constantly stirred up the deposited impurities. The Corporation, anxious to redress these injuries and to prevent their growth, appointed a commission to examine the river and to report what measures could be taken for the purpose. The commission consisted of Mr. James Walker, then the President of the Institution, Captain Bullock, R.N., Hydrographer to the Admiralty, and the Officers of the Thames Navigation and Harbours Services.

The Report recommended the Corporation to remove certain specified shoals at a cost of £60,000, and also ;—

1st. To give encouragement to frontagers wanting more wharf room, to embank from time to time to a line set out on the plan ; thus correcting existing irregularities on the banks, and eventually approximating to one uniform line.

2nd. To encourage frontagers not wanting more wharf room, but requiring space for barges, or timber, to secure for their own use, by dwarf piling, the space lying between the plan line and the river frontage.

3rd. To charge a reasonable sum to the frontagers for the use of the ground appropriated by them, whether embanked, or piled : the sum to be fixed by arbitrators, who were to determine the value, by considering the worth of the ground appropriated, and the cost of reclaiming it.

4th. To secure, by dwarf piling, the channel of the river as laid

down on the plan, on those parts where the frontagers did not require the use of the increased embankment, or shore.

5th. To remove shoals and to excavate the bed of the river to a suitable depth, between the lines laid down on the plan by the Engineers.

6th. To erect secure and convenient steam-boat piers, in convenient places on both sides of the river.

7th. To dedicate the money produce of the embankment and steam-boat piers, towards the improvement of the river.

The Corporation adopted the recommendations in the Report, commenced the removal of one of the shoals, and granted licenses to the late Mr. Cubitt and others, to secure their property and improve the river by embankments, several miles of which were made at Battersea, Pimlico, the Isle of Dogs, and other parts. They also proposed to place the whole management of the river in a smaller committee of their own body, under the control of an Act of Parliament, and to borrow upon their own landed property £300,000, to aid the execution of the plan. This noble design had, however, been put in suspense by the Crown lawyers, who had filed an information, and obtained an injunction to stop the works. They sought to wrest the right to the soil of the river from the Corporation, and claimed to have the improvement fund as part of the hereditary revenues of the Crown, to be applied to the private uses of the Sovereign, instead of appropriating the whole fund, as the Corporation proposed, to the improvement of the river. The Corporation had strenuously resisted this; and the suit had been pending twelve years, during which time, the river had been suffering from the want of that vigorous treatment which the Corporation were disposed, under the advice of the Engineers, to have applied to it out of their own funds.

If the plan recommended by Mr. Walker and his colleagues was not a proper remedy for existing evils, a better system should be sought for at the hands of competent advisers, and it ought to be carried out by the Corporation, or the Crown, or some other authority; but the Corporation could not be expected to expend any more money, in the state of uncertainty created by the Chancery suit. They had already indorsed the bonds of the navigation fund to the extent of £150,000, the interest of which, a falling revenue was not now sufficient to pay; besides which, the Corporation had advanced above £60,000, in removing shoals and in other improvements, even whilst they were compelled to waste a large sum annually in law costs.

It was difficult to conceive how any objections could be raised to a plan so evidently for the improvement of the river and the benefit of the Metropolis, without adding to the funds, or the patronage of the Corporation, yet there was every appearance of

the suit being interminable, because in reality, the question did not relate to the Thames alone. If the claim of the Crown could be successfully maintained, it would enable the Royal Prerogative to take possession, as its apanage, of the shores of the Mersey and other rivers, and then, at the commencement of some new reign, the Crown might say, that such acquired demesnes, in addition to the Woods and Forests and other acknowledged hereditary revenues, were preferable to the civil list granted by the Representatives of the Nation, for the support of the Sovereign. This then, was only the thin end of the wedge and it was incumbent on all to aid in resisting such unjust claims.

While this apparently interminable suit was pending, he admitted, that the bed of Father Thames was being neglected and polluted, and he urged, that instead of becoming agitators against the Thames as a tidal river, and exaggerating the apprehensions of cholera on that account, the Members of the Institution might do good service by considering the case, devising sound principles of action leading to good and useful results, and enforcing upon the public, with all their power and influence, the necessity for and capability of improvement of the noble river, in conjunction with effectual means of intercepting the sewage which now polluted its once pure and pellucid stream.

DOCTOR DANIELL said, that the remarks made by the learned Solicitor of the Corporation of London might be divided into three heads:—1st, whether cholera was, or was not connected with the tidal river;—2ndly, whether the schemes for ridding the Thames of its pollution, could be carried out;—and 3rdly, the legal question, of the conflicting claims of the Crown and the Corporation to the banks of the river.

With regard to the sanitary portion of the question, he thought there could be little doubt, that the miasmatic vapours, arising from the impurities held in suspension by, or deposited upon the mud-banks, by the waters of the Thames, augmented the spread of disease. Ague was formerly the prevalent disease, but the drainage of the land of the marshy districts near the river, almost obliterated that malady; then followed fevers of various kinds, but they were diminished, or prevented, by abolishing cesspools beneath the houses, and by more rigid attention to house sewerage; then came cholera, the recurrence of which would, doubtless, be in some degree counteracted, by ameliorating the state of the banks and shoals of the river, to whose noxious vapours much of the disease of the Metropolis must be attributed, when it was considered, that about four millions of gallons of vapour were given off from it, per day. It had been proved, that the mortality was three times as great, on some parts of the coast and on the shores of muddy rivers, as in the inland districts. It was, therefore, incum-

bent upon the contending parties, to combine their forces for the execution of the works of improvement, which sanitary considerations alone so imperatively demanded.

SIR JOHN RENNIE admitted, that the facts adduced, were most important, and that the arguments in favour of the plan proposed, demanded careful consideration. There could be no doubt, that the Thames was, at present, in a very bad condition, and it had become a grave question, how it could be best improved. The plan proposed was, certainly, not in accordance with his views, and it was opposed to those of Huddart, Mylne, Telford, Rennie and other eminent Engineers, who had studied the question deeply, and who, arguing from the effect produced by somewhat similar works on smaller rivers, entertained serious doubts as to the effect of arresting the freedom of the flow of tidal water up any great estuary, or river.

It had been stated, that the filth taken out by the ebb-tide, was brought back again by the flood-tide; but he doubted whether such was the fact. The duration of the ebb-tide was in the proportion of nearly two to one, as compared with the flow; for whilst the ebb lasted about eight hours, the flood took place in four to five hours. Now assuming three miles an hour as the rate of the ebb, it would give twenty-four miles, and taking the flood at four miles an hour, the result would be 16 miles; so that the sewage would be found, after the ebb, to have been carried eight miles lower down the river. If locks were constructed, all the sedimentary matter brought down by the sewers, being no longer so well able to get away during the ebb, would soon occasion an immense accumulation above the dam; so that the means by which it was intended to make the water more clear, would have the opposite effect of rendering it more muddy. It was an ascertained fact, that the ebb-tide now acted longer, than before the removal of Old London Bridge; it appeared, therefore, contrary to reason to assert, that the sewage was not carried downwards more rapidly than had been stated, or than it would be, by the action of the current of the stream of upland water alone, without the aid of the tidal water. It was found at Lynn, that the scouring power of the ebb had been greatly augmented by the freer admission of the tidal water. It must be recollected, also, that nearly all the water for domestic purposes in the Metropolis, was now taken from points in the Thames, above the influence of the tide, and would soon be returned to the river, far below the Eastern part of the City; therefore, it became incumbent to provide for this deficiency, by the freer admission of the tidal water, to scour and carry away the inevitable deposit, from waters flowing through alluvial districts. In addition to the advantage derived from the scouring, continually effected by a tidal river, it also induced a certain change of the atmosphere at

each ebb and flow, which tended very much, in his opinion, to the improvement of health.

There could be little doubt also of the advantages to be derived from such shore works, as would give to the bed of the river a sufficient and uniform capacity. The propositions of Wren, Rennie, Mylne, Wyatt, Trench, Martin, Walker, and Page, all had that object in view. The experience which had been gained from the operations on the River Wear, (proposed by the Father of Sir John Rennie, in 1821,)—from those executed about the same time, on the Witham, and from others, proved that this plan had always been attended with the best results. In any case, it was most desirable, that the Government and the City should settle their differences, in order that there might be no further delay, in deciding upon and executing some definite and comprehensive plan for remedying so great an evil.

Mr. HAYWOOD thought, that the consequence of damming up the whole of the upland waters above London Bridge, would be to close permanently the mouths of the sewers and render the discharge of their contents impossible, excepting by the process of pumping. If the present high-water line of the Thames was maintained as the water level above the weir, probably one-half of the metropolitan area could not be relieved of its sewage, excepting by the agency of steam power. It would affect indeed an area a long way west of the metropolis, and he should think that at least one hundred square miles altogether would be so affected; and as pumping power must be provided, in such case, for raising the storm waters as well as the dry weather discharge,—the expense would be very great, and would, with the other objections involved in making so large a district dependent upon steam power, amount to a prohibition of the scheme.

If, in order to prevent the pumping as much as possible, high level intercepting sewers were to be built, to carry off all the waters, the cost, owing to their size, would be very great, and the scheme proposed would, with all these expensive works, result in a far larger cost being incurred, than the £3,000,000 now proposed for the scheme of sewage interception for both sides of the river.

But, supposing the difficulty of closing the sewer outlets to be got over, and the sewage to be pumped up and discharged into the river above bridge, the river would not be freed from its present state of pollution, for there would be nearly the same quantity of sewage in it, as at present. This quantity and the condition of the river had been greatly exaggerated. From popular statements, it might be imagined, that the impurities discharged into the Thames had never got below the river, but were still oscillating between London and Teddington; now, if such had been the case, the river would by this time have become nearly solid.

The fact was, that there could not be more than from sixteen to twenty days' accumulation of sewage in the river at one time, for the actual quantity in the river at one time, could be only that which was not displaced by the upland waters, which were calculated at from 70 millions to 100 millions of cubic feet per diem passing Teddington weir, and which daily displaced an equal quantity of foul water. The quantity in from sixteen to twenty days, was equal to the gross volume of water at any one time between Richmond and London Bridge. With regard to the mud-banks of the river, instead of becoming worse, they had been getting better yearly, for many years; there were now very few of them. The river water was certainly thick and impure, and as the population increased, so must its foul condition increase, unless works were undertaken to correct it; but it was proper, that the real condition should be understood when considering this subject.

His impression was, that a serious amount of deposit would take place annually, in the length of the river that was ponded up, and that it would commence from the point where the draw from the proposed locks ceased to be felt. Very little deposit would take place from the sewage, but it would arise from the river water itself, for the Thames took the drainage of about 4,000 square miles of highly-cultivated country, and in times of rain, vast quantities of clay and alluvial matters in suspension were brought down by it. In his opinion, within a month a deposit would be found, and he believed it would be from one to two feet in depth, if not more, in the first year, between London and Hammersmith, and the deposit must become a serious evil.

Whatever might have been the influence of the two rivers upon the progress of cholera, in their respective localities, as to which he could not speak, he thought no analogy could be established between the condition of the Thames and the Neva. The Thames was tidal;—the Neva was not. The Thames had but few mud-banks;—the Neva had many large ones in the dry season. At London the whole of the sewage, or nearly all, was discharged into the river;—at St. Petersburg none was. The system at St. Petersburg was very much the same as that formerly adopted in London. The inhabitants had cesspools, sometimes, but rarely, impermeable, as at Paris, at the present day; but generally permeable, as was formerly the case in London and most of the English towns, and into these cesspools all the dejections of the inhabitants were carried. The cesspools were cleansed out by nightmen, who worked under government contractors, and the soil was usually applied to the market gardens and fields in the vicinity of the city. The cleansing was generally made in the winter quarter, and the soil was at that time applied to the ground;—emptying it into the Neva was forbidden under heavy penalties.

Mr. BAZALGETTE said, it must be recollected, that cesspools were being rapidly abolished, that the additional sewage from twenty thousand houses was annually conveyed to the river, and that the pollution of the stream was now, necessarily, in the ratio of the improvement of the drainage of the Metropolis. If the sewage could be concentrated, and poured into the river above Teddington lock, some opinion might be formed of what would be the effect of the plan proposed. There could be no doubt, if the tide were dammed out at London Bridge, and the sewage pumped into the upland stream, distributed over so large an area, that the upper portion of the Thames, would become little better than a stagnant pool of accumulating filth, which would be attended with the most fatal results. He considered, that, at the present moment, the tidal action in the river was the great safeguard. The question, whether the sewage should be turned into the Thames, had been already settled by the general voice of the public, which, guided by the opinion of eminent professional men, had declared in favour of the execution of the scheme of intercepting sewers, conveying the sewage of the Metropolis to a certain distance down the river, and for carrying it still lower, if that distance was found to be insufficient.

In considering the present proposition, it must not be forgotten, that a large portion of London was below high-water mark, and that the great evil to be contended with, at present, was that the sewers were tide-locked. Now if the Thames were dammed up, and the removal of the sewage rendered dependent upon pumping, the evil would be only increased. Pumping was, at all times, objectionable, and especially so in summer. There were sixty main outlets above London Bridge, and therefore, as many pumping stations would be required. The public, who had objected to one, or two pumping establishments for sewage, far down the river, would certainly loudly protest against setting up a number of such machines in the midst of their habitations; and if it was intended to provide for raising the storm waters, the amount of pumping power would necessarily be very great, as there would not be any means of allowing the water to run off by gravitation, which was evidently the most economical system, as well as that most in accordance with common sense. If there were no reservoirs, so that a fall of 2 inches of rain in an hour, had to be pumped up, as fast as it fell, by separate stations at the mouths of the various outlets along the banks of the river, the waste of engine power would be very great, and the cost of pumping, under these circumstances, would be enormous.

Mr. GIBBS said, the proposition of making a dam across the Thames, involved serious engineering questions, not unaccompanied by engineering difficulties. The tide sometimes reached 6 feet,

and often 4 feet, higher than Trinity high-water mark : so that a dam across the river, would require that portion of the tide to be shut out ; otherwise the works would be submerged, and the navigation stopped. A dam of this description would thus, at one time, shut out the tide, and at another, retain the land water. Now the large volume of water that accumulated at Teddington lock, during the flood which occurred three years ago, showed the magnitude of the works, which would be required, under this plan, at London Bridge. Enormous tumbling bays would have to be provided, with substantial aprons below them, to prevent the degradation of the works, and the destructive effect upon the bed of the river ; and this, in a position, where the width was now only sufficient for the body of water brought up by the flow of the tide. But if the upper pool were shut out from the operation of the tide, the current below would also be stopped, for a considerable distance, and immediately against the dam, there would be dead-water. The upward passage of barges, both below and above the locks, must, therefore, be accomplished by steam-tugs, as there would not be any assistance from the tide ; the pool below being rendered nearly stagnant, and the rise being only vertical. This would involve questions of enormous magnitude, to say nothing of the neglect of the works at present in course of execution. Looking at the plan in all points of view, he thought the construction of a dam across the river, was the most serious undertaking that could be imagined ; the expense would be enormous, not only on account of the depth of the foundations, but also for the preparation of the overfall, and the advantages were, after all, more than problematical.

Another most important subject for reflection, was that in raising the water level of a river, the level of the subterranean saturation of the neighbouring districts was also raised. More than half the whole area, and one-third of the population of London, were so situated, that the water level would be entirely altered, to the evident detriment of property, upon which large sums had been expended for obtaining efficient drainage. There would be no means of draining into the river, and, in addition to the natural sewage being penned up, there would be this enormous saturation of the soil. Now all the systems of drainage proposed, had in view, as one of the sanitary conditions, the lowering of the subterranean waters, in which respect this plan was evidently retrograde. The effect which would be produced, could be easily seen, by examining the small streams which flow into the Thames : in the Wandle, for instance, the tidal level flowed up to the third mill, thus showing, that a large extent of that river would be under the influence of the dam.

As regarded the sewage, he apprehended that must be provided for, whether this dam was made, or not. It was not pretended, that

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the effective drainage of the Metropolis, would produce a perfect purification of the Thames, (for the storm waters could not be excluded,) but a mitigation of the existing evils.

He was sorry this plan had been brought forward at the present time, because he thought it was calculated to retard the greater measure, in the same way as the differences of opinion with respect to the capacity of the drains, and the districts they should pass through, had already caused much delay; and he looked upon this scheme with great mistrust, as it partook of the character of the untenable proposition of obtaining a maximum flow of water, through pipes of a minimum sectional area.

Mr. BEARDMORE corroborated the statement, that the mud in the Thames above London Bridge was decidedly decreasing: there was, practically, none, and he knew no river in England which had so little. It was difficult to get over the ankles in mud, and where it existed at all, there was rarely more than about 2 inches over the gravel shoals. But there was another fact which ought not to be lost sight of, this was that there was a strong disposition in every inlet of the Thames below bridge, such as creeks, docks, floats, and canals, to silt up with mud, which was rapidly increasing every year, not only in quantity, but also in its dirty character. The amount of mud in the docks of the Thames, collected at the rate of 6 inches per annum, and he was afraid, in many cases, it would be found to be more.

A similar work to the one proposed by the Author of the Paper, had been completed, within the last three years, on a tidal branch of the River Lee, the whole basin of which river was not more than one-sixth of the River Thames. The object in view, was not the mere purification of the river, but to connect a canal from the Thames with another canal leading into the Lee, by which the Bow River was converted into a canal; while during floods, the upland waters were let through by opening large tide-gates, by which great scour and power of cleansing was afforded. Yet even here, there had been much trouble in effecting good drainage; and although he had drained in every direction away from the river, the difficulties caused by damming up the tidal reach were not altogether removed.

With regard to the oscillation of the tide, he could hardly attach to it too great importance: the simple flow of the Thames was, certainly, of not half the value, in cubic feet, of the oscillation of the tide. While on this subject, he would mention, that the bad state of the water in the Thames, during the past year, had been, to some extent, caused by the extraordinary drought of the two preceding years, and when Dr. Faraday wrote the often-quoted letter on the subject, he omitted to state, that he had examined the water just at the period of an extraordinarily low

neap-tide, which rose very little more than 8 feet for several successive days, and when there was stated to be a decided diminution of the 'perennial flow' of water from the strata, through which the Thames flowed. Now this diminution in the tide had given results similar to those aimed at by the Author's plan, viz., still-water. This plan did nothing towards increasing the volume of the flow in the river, which he conceived to be a primary object in any improvement: in fact, he thought it was questionable whether the Dock and Canal Companies should not be compelled to restore to the Thames, the same quantity of water which they abstracted from it. He fully agreed in the opinion, that the increased flow of a river, increased the actual vertical flow of the tide. If the ebb was lower, the flow became higher, in a certain proportion; so that, instead of the expectation of the tide flowing higher, with a bar at London Bridge, being realized, he thought, on the contrary, that the rise would not be so high. London Bridge was now the culminating point of the tide: but if a bar was placed across it, the tide would neither rise so high, nor fall so low, as at present.

Generally speaking, the only cases of the kind that he had seen, had seemed to him to involve intercepting sewers: he could, therefore, scarcely agree with those who considered it as a pumping scheme. If pumping were applied, there must be a certain number of districts, and if a pump broke down, every house in the district would be liable to be inundated. At Birkenhead, when the great estuary was to be dammed, in order to form the site of the float, the first step taken, was to form the Corporation Road Sewer, to intercept the entire sewage of Birkenhead on a frontage of two miles. Such also was the case with the Liverpool Docks, and with the Bristol Docks. In the latter case, the old river was made use of, to form the docks, and a new river constructed to drain the country. He could mention twenty other cases, where intercepting sewers formed part of the plan. Whether such a scheme could be carried out, with intercepting sewers extending from Teddington to London Bridge, was, he thought, very problematical, recollecting the vast expense, which it must, necessarily, entail.

THE REVEREND Mr. CLUTTERBUCK, through the SECRETARY, said, that assuming the proposed scheme to be carried out, it was important to know, what variation there would be in the perennial flow of the River Thames. In May last, the river was in a most filthy condition, which was, by some, attributed to the want of flood water, but, in his opinion, it was rather due to a defalcation in the 'perennial flow,' that is to say, the water due to perennial sources, and not to flood or surface water. This was easily to be accounted for, inasmuch as in the eighteen months ending April

1855, only 23·5 inches of rain had fallen, that being the average for twelve months. The perennial flow, especially in the upper districts, before the river received the larger streams flowing from the chalk, was never, in the memory of man, so much reduced. The Surveyor of the Thames Navigation had informed him, that they were enabled to open all the flood-gates of the Pangbourn lock, at one time; a fact without example in his remembrance.

The greater part of the perennial flow was derived from the chalk stratum; above Oxford, the greater portion was derived from the oolites, and the remainder, from the upper and lower green-sand, and the springs in the Oxford drift. The Cherwell, which drained the Eastern part of Oxfordshire, and which flowed through a suburb of Oxford was, at that time, (May 1855,) so reduced in volume, that it was deemed necessary to contrive a dam to flush the bed of the stream. He had never, from his own observations, known the stock of water in the chalk stratum to have been so low, nor the perennial flow of the streams issuing from it, to have been so much reduced. This cause, therefore, would suffice to account for the reduction of the volume of the Thames, on its reaching the tide.

It was difficult to anticipate what might be the effect on the perennial flow of the Thames, of the extensive agricultural land drainage, now in progress. The waters of the Ock and Thame were, in some measure, due to what might be called the back drainage of the chalk and upper green-sand. There were springs issuing from the junction of these strata with the subjacent gault clay; others, from the junction of the lower green-sand and Aylesbury or Portland oolite with the Kimmeridge clay; and again, others, from the drift overlying the Oxford clay. Now all these sources were more or less affected by agricultural land drainage. It was a well-known fact, that the character of the floods in the upper district was altered. Near Abingdon, the flood now attained its greatest height on the second, instead of the third day after heavy rain, and it was probable, that the drainage of some of the strata mentioned, might be so accelerated as prematurely to reduce the perennial flow. This, however, did not apply to the streams issuing entirely from the chalk. The following note was made in May, 1855, when the water of the Thames was in so filthy a state:—
“In the upper districts, the navigation is managed by flashes, as they are called; the water is pent up to a certain level, under certain restrictions as to mills, &c., and let down, two or three days in the week, to enable the boats to travel: could it not be contrived, that just above the tide, these waters should be so husbanded, in connexion with the flashes above, as to flush the bed of the Thames, and so, in part, abate the nuisance?”

Mr. LEACH believed, that nothing could be more mischievous to

the Thames, than to place a bar across the river at London Bridge; for the maintenance of the oscillation of the tide, up to the highest possible point, was most essential to the good condition of the river. The policy he had recommended to the Corporation of London had been to extend that principle, and they had undertaken works on the Thames, which had that object in view. Teddington lock would, in the course of a few months, have to be rebuilt, and it had been determined, that the level of the neap-tide should be the basis of operations. The cill, therefore, would be laid 8 feet deeper than at present, and the bed of the stream would be dredged out, to correspond with that level; material assistance would thus be rendered to the scour, as the tidal flow would be increased.

He also believed the maintenance of the tidal character of the river, to be most essential, in a sanitary point of view. The ebb and flow must have considerable influence upon the health of the Metropolis, as twice in each day of twenty-four hours, the whole atmosphere over the river was lifted up the full height of the tide on the flow, and again lowered on the ebb, which alone must cause considerable change of the air. If so much malaria arose from the mud-banks, how was it, that the men who worked constantly on the wharfs and on the steam-boat piers, even at Blackfriars Bridge, close to the outfall of the Fleet-ditch sewer, did not exhibit a more than average rate of mortality?

A comparison had been drawn between the tidal capacity of the Thames above London Bridge, and below Gravesend; but, in his opinion, the one had nothing to do with the other, as far as the condition of the river was concerned. He had dredged below London Bridge to deepen the berths for the tiers of vessels; after the dredging had been effected, and before the vessels had been brought into the tiers, he had known as much as 5 feet of deposit to accumulate, but as soon as the vessels were restored to their places, the scour removed it. Therefore, if the tidal flow were shut out at London Bridge, that scouring effect would be, in a great measure, lost, inasmuch as in the Pool, a great part of the scour was effected by the water which came from above London Bridge: and if that scour were excluded, a gradual accretion would take place in the Pool.

Mr. BRUNEL, V.P., could not bring his mind to the belief, that such an effect upon the atmosphere as had been described, was produced by the mere rise and fall of the tide some 10, or 15 feet, over a surface only 1,000 feet wide, nor could he subscribe to the notion, that it occasioned a current of air along the valley of the Thames. Other causes might be in operation, and certain effects produced, but he had lived, for many years, upon the banks of the Thames, and was very often upon the river, and he had never

observed any indication of a change in the direction of the wind, however light, produced by the flux and reflux of the tide. Therefore, with regard to these phenomena, it might be well first to ascertain whether they did exist, before attempting to endeavour to trace out the cause.

Mr. HAWKSHAW, V. P., directed attention to the statement of danger being apprehended, from the failure of the large intercepting sewers. Now the largest sewer that was contemplated, was only 10 feet in diameter, and the permanence of other engineering works of much more importance as to size, and presenting much greater difficulties in execution, demonstrated, that Engineers were fully capable of constructing a sewer of 10 feet diameter, and insuring a successful result. The necessity for the large size of that sewer had been contested, but it must be recollected, that the Metropolis was fast increasing in every direction, and as the drainage extended, the more rapidly would the rainfall find its way to the main sewers: it would, therefore, be less expensive to construct one new intercepting sewer, for an extensive outlying district, than to form a large number of small branches falling into the Thames. He thought the cost of the intercepting scheme would be less than the one proposed, the expense of which was stated to be £3,000,000, but no details were given from which a correct estimate could be formed. The adoption of such a plan, would be to return to a system which was now being abandoned in many towns, as in Birmingham and Coventry, for instance, where this very plan had been in operation. The streams which ran through those towns, had, till very recently, received the outlets of the sewers, but having been, from time to time, dammed up by millers, who had acquired rights upon those rivers, they had become intolerable nuisances, and it was found necessary to form intercepting sewers, such as were now proposed for London; and in this respect, those towns were far in advance of the Metropolis. He believed, that the Author's plan would not have the effect of improving the drainage; and that it would, in many respects, be highly prejudicial to the Port of London.

Sir JOHN RENNIE said, that the system of intercepting sewers had been applied at his recommendation, and carried out with success, at Kingstown Harbour, and at Ramsgate. He believed the credit of its introduction was due to Mr. Creasy, who proposed it about the year 1774; and since that period, intercepting, or catchwater drains for land drainage had frequently been applied by Rennie and others, in the Fens, and the applicability of the system to town drainage was so evident, that it was now generally adopted by all sound practitioners.

Mr. VIGNOLES remarked, that the Bristol sewers were not, properly speaking, intercepting sewers: the sewage was carried under

the float itself by a syphon. He also contested the opinion, that the tide had no influence upon the atmosphere. It was shown, by medical reports, that the miasma producing the cholera, was generated in the lower strata of the atmosphere, and that children were the first affected by it. He thought, that the change produced by a rise of tide of 20 feet, must, necessarily, have a disturbing effect on the miasmatic atoms, within that limit.

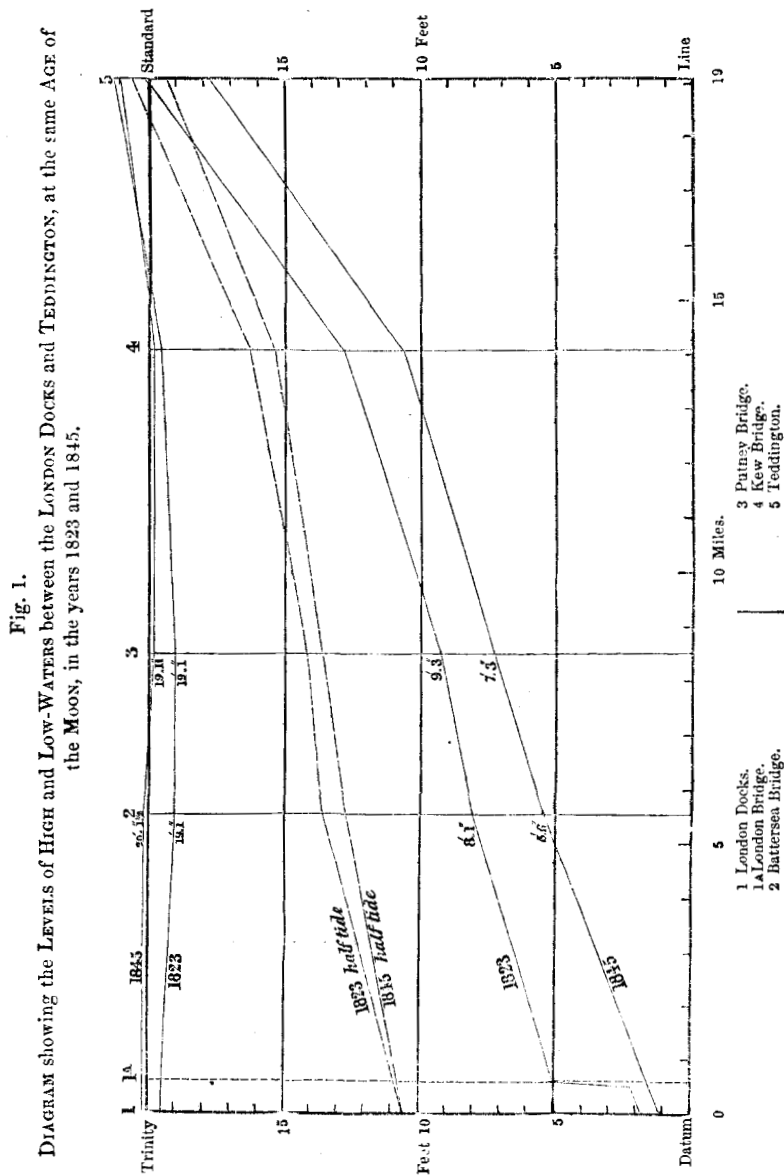
Mr. BEARDMORE said, he had prepared a diagram, (Fig. 1, page 232,) to show the alterations which had taken place in the tide, consequent upon the increased area of the Thames and the removal of Old London Bridge: the height, of course, not increasing proportionately with the fall.

Thus it would be seen, that in 1845 the tidal range between the London Docks and Teddington, had given at Battersea, 2 feet 7 inches increase of fall and 1 foot increase of rise, when compared with the tides of 1823; other places being similarly affected by the removal of obstructions in the river. The taking down of Old London Bridge alone increased the area at high-water, from 7,300 square feet to 17,600 square feet, and the spring-tide range, from 16 feet 9 inches to 19 feet 9 inches; the old bridge was a partial dam-head, and its removal was, therefore, manifestly the reverse of the plan proposed in the Paper. But independently of this, the less amount of silting and deposit, which was now allowed to accumulate, the increased dredging for ballast, and the removal of concretionary beds, commonly called 'Blackwall Rocks,' and various shoals, had all combined to produce this great alteration.

In the Philosophical Transactions for 1726, (pp. 68—71,) there was a Paper containing some tidal observations taken at Lambeth Reach, in the year 1720, from which it appeared, on comparing them with the observations of 1849, by the Metropolitan Sewers Commission, that—

		1720.	1849.
		h. m.	h. m.
The duration of Flood at Spring-tides was	. . .	3 50	5 15
„ Ebb	. . .	8 40	7 5
„ Flood at Neap-tides	. . .	4 50	6 0
„ Ebb	„ . . .	7 35	6 20

With the foregoing facts, he had before shown, that a very large increase of volume at every tide, accompanied these changes of time, and it was, therefore, evident, that a proportional increase of scour and greater difficulty of deposition on the banks must ensue. Accordingly, the tidal velocities at spring-tides, before and after the removal of London Bridge, appeared to have been:—



	First of Flood.		Last of Ebb,	
	1831. Feet per Minute.	1833. Feet per Minute.	1831. Feet per Minute.	1833. Feet per Minute.
Between Southwark and Blackfriars . .	158	174	252	295
,, Blackfriars and Waterloo . .	149	173	196	239
,, Waterloo and Westminster . .	140	150	169	191
Mean	149	166	206	242

In answer to questions from the PRESIDENT, Mr. Beardmore said, that at Westminster Bridge, the ebb now fell 3 feet 6 inches lower than in 1823. It would be desirable, that at London Bridge, there should be a free oscillation of the tide, which did not, at present, ebb very much lower than formerly, at that point of the river. The difference, indeed, between the actual level of the tides at London Bridge and Sheerness, was very small. Thus,—

The mean high-water taken at London Bridge for one month in 1849, by the Metropolitan Sewers Commission, was 1·02 feet above that of Sheerness taken in 1827-8-9;

The mean low-water at London Bridge by the same observations, was 0·598 foot below that of Sheerness;

The mean tide-level at London Bridge was 0·958 foot above that of Sheerness; and

The mean range of tide during the same periods, was 17·578 feet at London Bridge, and 14·472 feet at Sheerness.

The effect of improvement was not so much to raise the level of high-water, as to bring it down at low-water, and consequently, to lower the mean tide-level, which indicated the effects on draining into and improving a tidal river.

MR. FOWLER,—referring to a desire, that the Institution should express a decided opinion on the question of the drainage of London,—said, that such a course would be contrary to the rules of the Institution, and be open to the most serious objections. It was for the dignity and interests of the Institution, as well as for the advantage of the public, that the rule should not be infringed, even under exceptional circumstances. It had now become impossible to use the Institution for the purpose of enhancing the value of any scheme, as the discussion only expressed the individual opinions of the speakers. These were, in some cases, very valuable, and it was probable, that if an Engineer had to work out the details of a design, after it had undergone the ordeal of discussion, his views would be materially modified; this was one of the great benefits of the Society. Formal decisions of the Institution would frequently destroy good, and promote

bad undertakings, from the impossibility of avoiding premature, or imperfect evidence, or of meeting and correcting alleged statements of fact.

In the plan now laid before the Meeting, two prominent points were to be considered :—1st, The mode of providing for the sewage of the Metropolis ; and 2nd, The method of dealing with the river, and the probable effect of the proposed construction at London Bridge.

As to the first point, he did not contend, that the treating the sewage was an inherent part of the plan, but whether it would be any improvement in the existing state of things, was very doubtful. Scoop-wheels, or any other contrivance for raising sewage water into a comparatively stagnant pool, kept at a high level, would be so complicated from the numerous works, so likely to produce the worst sanitary results, so costly, (especially, if storm water was to be provided for,) but above all, so opposed to the unanimous feeling of the public, that they could not be entertained. Almost every one had now arrived at the conclusion, that by some plan, or other, the sewage of London must be intercepted and discharged into the river, at such a distance, that it could not, under any circumstances, be brought back to London by the influx of the tide. This, however, was the only point settled ; the mode of carrying it out, was still an open question. Some advocated the plan of a high-level intercepting, and low-level intercepting culvert, to economise pumping : others proposed a low-level culvert only. Another very ingenious plan had been suggested, of carrying a low-level culvert, (also to Barking,) near the high-water line, at a sufficient depth to be tunnelled, and not to disturb any foundations, so that all existing sewers might be intercepted at their mouths, and turned into the deep intercepting culvert. This plan had some solid advantages, if there were no practical difficulties in detail : it avoided any interference with streets, or existing sewers, and it had the convenience of the river for taking away accumulations in barges. These, however, were mere modifications in detail : all were founded on the principle of relieving the Thames at London from the sewage, and it was very desirable, that all new propositions should comply with this condition.

But the great question raised by the Paper, was the effect which would be produced upon the River Thames, and it would facilitate discussion to assume the work completed. First, as to the effect above bridge : a dam would, no doubt, impound a pool of comparatively pure water at the level of high-tide, and enable barges to be at all times afloat, and to lie alongside wharves, without taking the ground. It had been contended, that this pool would fill up at the rate of 2 feet per month, but such a statement was evidently an exaggeration, inasmuch as the pool would extend from

London Bridge to Teddington Lock, and would receive many small streams of pure water, such as the Wandle. There was, therefore, no reason to suppose, that the deposit of matter held in solution, would be greater than above Teddington lock, or than in the various large ponds similarly pounded up by sluices, in the Eastern districts of England. Inconveniences from this cause, would be very small, and a great many years must elapse, before any perceptible effect would be produced: assuming, of course, that the sewage was excluded.

The more obvious objections to this plan, were, 1st. The loss of the economical and convenient power of the tide:—2nd. The impossibility of storm waters getting away:—3rd. The interruption from ice, which, in such a severe winter as the last, would be from five to six weeks:—4th. The inconvenience of traffic from places above, to places below bridge, on account of the necessity of passing locks:—5th. The absorption of moisture by the sand and gravel land on each side, at a lower level than the permanently impounded water. These were, it was true, rather formidable difficulties; still, it was possible, in a great degree, to obviate them.

1st. Steam barges worked with a screw would get over the difficulty of losing the tide, and might prove quite as economical:—2nd. Storm waters might be taken away by large intercepting culverts, and be discharged below London Bridge; they might, also, correct the absorption:—3rd. The inconvenience from the ice would be very much mitigated by the use of steam for all craft.

The great question, however, was the effect below the bridge. Tidal rivers might be divided into two general classes:—1st. Those which, from the quantity and proportion of land and tidal water, and from the direction and level of their beds, preserved for themselves, by permitting the natural flux and reflux of tide, and flow of the land water, a deep channel, without any tendency to silt up. Of all English rivers, the Thames was the most perfect in these respects: every correction of the irregular shore, every removal of shoals and of fixed works in the bed, such as London Bridge, were followed by corresponding improvements in the bed of the river, and by the better tidal flow thereby induced.

2ndly. Those which were unable, if left to nature, to maintain a deep-water channel of themselves, either by reason of the small quantity of upland water, or some peculiarity in the levels or out-fall. A good example of this class was the Witham, at Boston; especially as the Grand Sluice, (erected in 1766,) was in its objects, and nearly in its circumstances, a work similar to that now proposed for the Thames. It was found, that the natural tendency of the river was to silt up with great rapidity, and except after great floods, it was impossible for vessels of more than 40 or 50 tons, to

get up to Boston, and then only at spring-tides. By impounding the land water, however, by means of the Grand Sluice, and greatly curtailing the area of the tidal channel below, by fascines and clay, the bed had been considerably deepened. The comparatively short distance to the sea had also, no doubt, been of importance in facilitating the improvement.

The Thames, on the contrary, had been able to keep its own bed, at least, since the existence of monarchy in this country; and the tendency was rather to improvement than depreciation, provided no unjust interferences were permitted. The present mean discharge of land water, was, probably, about 200,000 cubic feet per minute, at London Bridge, the smallest summer discharge, being about 50,000 cubic feet. The quantity of tidal water at spring-tides, when the sectional area at London Bridge, was about 18,000 square feet, might be calculated at 3,000,000 cubic feet, and at neap-tides, at less than half that quantity. Now at the present time, the power of the flux of this amount of tidal water through London Bridge, and reflux of the same tidal water and the land water together, were sufficient to keep the bed of the river nearly *in statu quo*.

The plan proposed would have the effect of arresting the tidal water entirely, leaving the river to depend upon the land water alone. The influence of this change on the bed of the river, would be considerable. In the first place, it would entail the necessary consequence, as at Boston, of greatly diminishing the sectional area of the river, so as to enable the diminished power of the current to keep it open. There could scarcely be any doubt of the necessity of such a work, to afford the remotest chance of the bed being preserved at a useful level: and even with this curtailment, (and to alter the banks of the Thames for 40 miles was a very serious undertaking), it would be impossible to accurately foretell the result. One thing was, however, certain, that for some distance below London Bridge, the tide would have little other than a vertical motion. On arriving at London Bridge Sluice, the stream would recoil, and run back while the water was still rising, but at Blackwall, the movement would, probably, be so trifling, that the deposit would be enormously rapid, and demand all the power of the sluices to remove. What other results would take place, it was impossible to say; but it might be anticipated, that the scour from the sluices would create a shoal, at no great distance below the locks, and this alone, was of such importance, as to almost preclude the trial of any such plan.

Mr. BIDDER, V. P., said, it must be admitted, that the Paper which had originated this discussion, although it had proposed a plan which was generally opposed, was not only intrinsically valuable, as assembling and recording many curious historical

facts relating to the River Thames, but was also suggestive of numerous topics of interest, and it had induced an address remarkable, not only for the humour and vivacity with which the statement had been given, of the long and close intercourse between the Corporation and the river, and the litigation now induced by the pretensions of the Government; but had even raised from his bed the venerable Genius of the stream, and induced him to disclose his griefs. It was, however, doubtful whether the confidence had been fully given; and whether, in these conversations, which had probably taken place in the "cool tranquillity of dewy eve," and under the genial influence of City hospitality, Old Father Thames had not made some remonstrance, in a tone of complaint, of sundry negligences on the part of his old friends:—such, for instance, as the utter neglect of the grand plan of Sir Christopher Wren;—the entire disregard of architectural propriety, or of uniformity of line, exhibited by the warehouses and wharfs;—the vast shoals and mud-banks on all sides;—several of the bridges in a state of jeopardy;—and that dire foe, 'vested interest,' allowed to rise up as a lion in the path, barring all improvement. The Corporation had only themselves to blame for all this; but, as it appeared, that there was such confidential communication between that plain-spoken old gentleman Father Thames, and the worthy energetic legal representative of the Corporation, it was to be hoped that, henceforth, all good plans for amelioration, would receive active support and assistance in the City, and that concessions would be granted, by the Corporation, to persons desirous of improving their water-side premises, merely on the production and approval of their plans, instead of obliging them, as at present, to obtain the sanction of their neighbours, which was, virtually, a prohibition; because every man knew that he would be obliged to follow the example of his more energetic neighbour, or he would soon find his premises at the bottom of an alley, and out of the reach of the river.

The complaints against Government interference were but too well founded, as was unfortunately felt, not only by the City, but by all who had Bills before the House, for any works on the banks of the Thames. The Bill might go on very smoothly, until it was nearly granted, when a sleek gentleman made his appearance with an application "merely for the insertion of a little clause for the protection of the rights of the Crown," which meant, that all plans should be submitted to, and be approved by various heads of 'Circumlocution' Offices; the inevitable result being, that the unlucky wight seeking a Bill, wasted his time, and then had to pay a good round sum for some imaginary right supposed to be conceded to him, for doing something which could be of no earthly use to him, or for proceeding without let, or hindrance, to some place, whither

he had no intention of, or interest in going. Now, if he was thus mulcted for the welfare of the nation, or for the benefit of our Sovereign Lady the Queen, no one would grumble very much; but when it was known, that the plunder so obtained, only went to fatten those detestable reptiles, 'the red-tape worms,' the matter was beyond endurance.

The Paper which had caused these remarks, had introduced into the discussion, the effects of the scour of tidal waters, and the changes induced by modifications of the form of estuaries and rivers; but these considerations would be better reserved for a future occasion, when, on the discussion of a Paper promised by a Member, it would be necessary to review the proceedings of 'the Little Admiralty,'—that '*imperium in imperio*,'—by which works of vast importance were unjustly and unnecessarily restricted, to the detriment of the property and the injury of the sanitary condition of the country.

As to the question of the economy, or otherwise, of the system of sewerage about to be carried into effect for the Metropolis, ample opportunity would be afforded for discussing it in detail, on the reading of a Paper, promised by a Member eminently qualified for the task, and from whom the plain truth would be obtained, as he had no party purpose to pursue,—no pot-pipes to sell,—nor any petty malice to gratify. The apt comparison, of the onslaught of the theoretical little pot-pipes, upon the common-sense, practical, large, and adequate brick sewers, to the immortal strife of Gulliver's 'big-Endians and little-Endians,' had, doubtless, been very exciting and pleasant to the amateur performers in the comedy, but it would be found to be an expensive kind of amusement for the rate-payers; and when disease again made its appearance, and found the Metropolis still unprepared, who could predict the direful consequences? He hoped, that the present Metropolitan Commissioners, who had hitherto exhibited excellent common sense in their proceedings, and in the nomination of their officers, would avoid the rocks upon which their predecessors had split; and would resist the mischievous interference of amateurs, of Government nominees, or of any persons interested in maintaining the ascendancy of any peculiar dogmas, or in the introduction, or the employment of any peculiar 'material.'

The scheme now submitted to the Meeting, was to construct at London Bridge, a dam with sluices and works, which would allow of the passage of the land waters and of the vast amount of commerce above bridge, but which would exclude the tidal waters: and by this means, the Thames was to be purified. Now, in the first place, he thought the danger of interfering with the navigation of the Thames was of such importance, that even the purifying the river could not justify the risk. Then, as to the effect of the ex-

clusion of the tidal water from above bridge, it had been shown, that the removal of Old London Bridge had sufficed to excavate the channel, and to lower the ebb nearly 5 feet in about thirty years; it was fair, therefore, to argue, that if that impediment to the free flow of the tide had never been created, the bed of the Thames would have been down at its original level,—that at which the relics of previous ages of inhabitants were now found; and also, that the construction of a more considerable impediment, would have a still more pernicious effect upon the river.

The Author seemed to think, that by excluding the tidal water, he excluded that which affected the sanitary condition of the river: but the effect would be quite the reverse. The same amount of sewage as at present, would be discharged into the river; but it would flow into stagnant water, instead of into a running stream. The land water would not flow at a greater rate than a mile a day, so that the river would be, practically, stagnant. The water might be clear to the eye, but it would be underlaid with corruption, and in hot weather, noxious gases would be continually evolved. Those who had visited Norway, could form a good opinion, of what would be the state of things above bridge, if the sewage was poured into a semi-stagnant pool. At Christiania, the water in the natural harbour, or 'Fiord,' was very deep, the rocky sides were nearly vertical, and the river running into it, was a mountain stream; but during the summer months, the exhalations of noxious gases could be seen bubbling up from the stagnant muddy deposit, and the stench was unbearable. The deaths from cholera, in that locality, were for a time, nearly 500 per week, out of a population of only about 5,000 persons; if that ratio of mortality was applied to London, how fearful would be the result! Cholera appeared to attach itself to classes, as much as to localities, and the habits of the labourers on the river and of the inhabitants in its vicinity, rendered them peculiarly susceptible of that kind of disease. In a leading Insurance Office, where the lives were well selected, there had been only one loss from cholera. There was no ground for imputing the cause of cholera to the tidal water of the Thames, especially, as in the course of this discussion, that disease had been shown to have been most virulent and fatal, in districts of the country at a distance from any tidal rivers.

He thought the injurious effects of a dam at London Bridge had been under-stated. The sluicing would, no doubt, have a great effect in its immediate vicinity, below the bridge; but it would only produce a violent scour for a short distance,—a deep hole and a bank thrown up beyond,—but the scour would not extend to Greenwich, or Blackwall. All the sewage,—for there would not be a particle less, but, on the contrary, more than at

present,—instead of being continually in motion, would be concentrated above London Bridge, in a stagnant pool, during the whole of the day, except when the sluices were in operation. But that part of the river embraced only a portion of the Metropolis: the state to which the lower part of the river would be reduced, by the construction of the proposed dam, would be fearful, and precisely in that portion of the City, where the population was most densely crowded; and it would be difficult to predict, where the consequences would stop. It took three weeks, or a month, for the matter in suspension at London, to be delivered below Gravesend, and longer in dry, than in wet seasons, as the amount of land water which came down, regulated the preponderance of the ebb above the flow. The process of land drainage, now so generally introduced, had the effect of intercepting the water in the wet season, delivering it rapidly to the streams, and leaving less in the dry season, at which period, the effects of the system would be most severely felt. Under all circumstances, therefore, he viewed this proposition with apprehension; it would have a most injurious effect upon the navigation: it would cause a large increase of expense in the lighterage of commodities upon the river, because no mechanical appliances could equal the natural power of the tide: it would render the Thames, above bridge, more injurious to health; and it would deteriorate it, below bridge, to a great extent.

Mr. RENDEL said, that the practical questions involved, were the effect upon the sanitary condition of the whole population of the Metropolis, and the effect upon the navigation of the river, above and below London Bridge. Now if it was considered desirable, that the tide should be brought as far inland as possible, there was, at once, an end of the whole question: but if that were denied, then the merits of this plan would admit of discussion. He thought, however, the opinion prevailed, that it was desirable; first, because it gave a better drainage for the land, and was thus beneficial to agriculture, and secondly, because it was beneficial to health.

If land and house drainage were generally beneficial to the health of communities, herding together in cities and towns, it must evidently be desirable to scour out the channel of the river, serving as the main land-drain, and as the eventual receptacle for the house sewage. Experience had shown, that this could only be accomplished by the free and copious admission of the tidal water, to act powerfully on the ebb, which could scarcely fall too low; just as the flow could not rise too high, or extend too far. Even if Teddington lock was removed upwards, to some position nearer to Hampton, and the river thoroughly trained to receive the tidal flow, the effects would be beneficial throughout.

Taking the proposition upon its sanitary merits, it was important to consider what would be the effect of permanently maintaining the River Thames at, say 1 foot over Trinity datum, upon the low lands of Westminster, Lambeth, Southwark and the Surrey side generally. The presumed drainage would be required not only for the sewage matter, but also for the soil; otherwise, the banks of the Thames being pervious, the whole of those districts would become extremely unhealthy. That was one difficulty as regarded the sanitary part of the question; but there was another. He did not believe, that any police regulations could prevent a certain amount of sewage from being deposited in this ponded water. The best conservancy was presumed to be maintained in docks, yet the water, from the matters thrown in, and from the sweepings of vessels and of quays, became foul and caused sedimentary deposits; and such would, undoubtedly, be the case with the Thames above bridge. It should also be remembered, that a large proportion of the mud which now accumulated on the shores of the Thames, was taken up by the water, in consequence of the disturbance occasioned by the steam-boats; and if there was a copious and long ebb, considerable quantities of the mud were carried away. If, however, the upper reach of the River was converted into a partially stagnant pool, that effect would be counteracted, and accumulation would commence, which would have a tendency to place the Thames in the same condition as the Po, and other rivers, whose beds were now considerably above the level of the land adjoining them.

Then with regard to the navigation; the time required for passing the traffic of the Thames, through the locks, would act as a serious impediment to commerce, particularly as the barges generally came up through the Pool in fleets, with the flowing tide. Again; the passenger steamers, which now afforded the greatest relief to the overcrowded thoroughfares of the Metropolis, would be injuriously arrested, by the obligation of transshipping their passengers at the locks, for they could not wait to take their turn with the barges. The Thames, instead of being blocked up, ought to be maintained in a state of still greater efficiency for the purposes of navigation, and future Engineers would, probably, have to consider, how it could be improved as a great arterial thoroughfare. Looking to the effects of this plan below bridge, could any one, for a moment, maintain, that this part of the river ought to be made narrower and more shallow, in the face of the increasing demand for space in the Pool, the greater number of vessels, and the larger dimensions now given to them?

The case of the River Clyde, at Glasgow, should be carefully examined, when considering any measure for the *régime* of the Thames. The Clyde had become a vast tidal canal, mainly kept
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open by constant dredging, and the wash caused by the steamers ; but it would never do to reduce the Thames to such a condition. No reasoning from the effect of the sluices at Boston, could apply, for the two cases were utterly dissimilar. He concluded, that the plan proposed in the Paper, was not tenable, either in a commercial, a sanitary, or an engineering point of view.

Mr. J. B. REDMAN remarked, that the plan was retrogressive, as an engineering proposition, negative, as a sanitary one, and opposed to the received opinions on river and tidal harbour conservancy, for the trade of London had, undoubtedly, been fostered by the flow and ebb of the tide. It had been assumed, that the effect below bridge would be, to raise the level of high-water. But the comparison of tidal area so low as the mouth of the Thames was unfair, giving, as it did, only $2\frac{1}{2}$ per cent., as the abstraction above bridge ; the estimate of 4 inches, added to 3 feet 8 inches lift of tide above Trinity standard, would be 4 feet above that level, and it must be borne in mind, that the water at many of the dock-entrances, quays and wharfs, was only equal to, and at others, even less than that height. It was probable, on the contrary, that there would be no increased lift ; but it was very certain, that below bridge, there would be an increased deposit from the absence of tidal scour, and that similar results might be expected above bridge. It was proposed, that the water above bridge should be kept at 12 inches below Trinity standard, so as to allow of surface drainage, but he did not see how, in the meanwhile, the sewage was to be disposed of.

It was no argument in favour of the plan, that the mud-banks exposed at low-water, (which ought to be embanked or removed,) would be covered, and that the wharfs and bridges would no longer be undermined ; such had been the results in all improved rivers, where, as at Glasgow on the Clyde, and other places, by removing weirs, starlings of old bridges, &c., the tidal flow and ebb had been increased, to which circumstance, the great extension of the trade of such ports was mainly due. Three great undertakings were necessary to improve the river :—

1st. To divert the drainage and sewage, and discharge it so low down, that, whether deprived of noxious parts and utilized, or not, it should not return. The different plans for effecting this object, had been sufficiently dwelt upon : he would, therefore, state his opinion, that the points of discharge should not be higher than Barking Creek, or Plumstead Marshes, and that no pumping for handling, or transferring sewage, should be used, except at the outfalls.

2nd. To regulate the low-water *régime*, by removing the shoals below London Bridge : the material extracted would find a ready sale, or might be used in embankments. Sufficient attention had

not, in his opinion, been paid to the great lift of tide, or to the fall at low-water, which was about 8 inches per mile.

3rd. To construct from London Bridge to Vauxhall, a solid embankment, with dwarf-piled recesses to form lie-byes for barges, the action of which was well exemplified at Messrs. Calvert's Brewery, just above London Bridge on the Middlesex side; to dredge the channel and to raise the material behind embankments. From £6,000 to £8,000 had been spent on leasehold property, in the construction of Mowleins' wharf and tidal docks at East Greenwich, which proved, that a proper system of embankment and recesses with tidal docks, was profitable. This embankment was carried out to the line of the adjoining wharfs, and the outworks, up to the line laid down by the City, to the latter of which the proprietors were bound hereafter to advance, if the adjacent frontage above and below, should be extended to that point. The material dredged out for the ships' berths, was used for the embankment: and the tidal docks were provided with self-acting scouring reservoirs.

Two other subsidiary improvements were also requisite:—

1st. The removal, by Act of Parliament, if necessary, of all watermen's causeways, now that the wherry had become obsolete. They acted in the same way as jetties, constructed on the shores of rivers, for the reclamation of mud lands. Below Gravesend, a local accumulation of 12 inches, had taken place in four years, owing to the customs' jetty: and the New Tavern Bridge, a military landing-place, which, in 1800, was 6 to 7 feet above the mud, was now 4 feet below it.

2ndly. The establishment of steam-boat piers. The difficulty attending the construction of landing-places was enormous; nearly £100,000 had been invested in two piers at Gravesend, by Act of Parliament, and with the sanction of the City, yet every hotel-keeper was permitted to run out a floating-pier. A similar investment had been made at Greenwich, and a floating-pier had been immediately constructed alongside. He had proposed in 1846, a plan for establishing piers above bridge, but the Admiralty, the Woods and Forests, the City, and other Boards had to be consulted, and the project, like many subsequent ones, was abandoned.

London had not quadrupled her foreign imports, or quintupled her exports in a century, but from the circumstances of being situated on a free tidal estuary; and Liverpool, which now exceeded London in her foreign tonnage, and in the size of her ships, owed her prosperity to an increased lift of tide of 10 feet. The proposed plan was antagonistic to such conservative influences. The best works were those which assisted, rather than those which attempted to control Nature. He considered, that

any proposition to stem the natural tide, would be most baneful to the continued prosperity of the Metropolis.

CAPTAIN W. S. MOORSOM, through the SECRETARY, called attention to a statement of the plan which he had proposed, in 1849, for the drainage of the Metropolis, and which plan embraced the following main features :—

First,—in principle,—To provide main outfalls for receiving all the filth of the Metropolis, now poured into the river Thames :—

To discharge all surplus sewage and drainage, clear of any influence on the health or comfort of the Metropolis :—

To effect this, without disturbing, to any material extent, the present outfalls :—

To provide ample means of storage against times of heavy rain or flood :—

To raise a revenue, by the operation of the plan, which should relieve the public from all expense attending it :—and finally,

To separate, and improve more immediately, the drainage of Southwark and Lambeth.

Secondly,—in detail,—To apply iron as a material, in all cases where speed and exact work were required, so as to entail the least possible amount of inconvenience on the public :—

To avoid all unnecessary interference with property, by carrying on the works in the tide-way :—

To reduce the principal works to simple forms and positions, so that the whole should become an aggregate of work of ordinary engineering character, capable of execution in nine months :—

To form the several parts of the work, so that they might be readily cleansed or repaired :—and

To arrange the design, so that, if desired, a practical trial might be made of one, or more portions, at a moderate expense, before entering upon the entire measure.

He estimated the cost of these works,—for the North side of the river, at £745,873,—and for the South side, at £696,643,—giving a total of £1,442,516.

Mr. H. ROBINSON said, in reply, that no injury would be done by occasional excessive tides ; because the dam might be so constructed, as not to diminish the water-way through the bridge, and if it were found impossible to save the lower districts from being flooded, if such tides were dammed out, the gates could, on any emergency, be opened, and a passage given to the same quantity of water as at present. It was no proof that the sewage would be always travelling downwards, because a float would be a certain distance lower, at each successive tide ; the cases were not analog-

ous, because the sewage was always rapidly mixing with the water around. This mixing was accelerated by the tide running up at the sides, whilst it was still running down in the middle, by every Easterly wind causing an upward surface current against the tide, and by the wave carried by every steamer. That sewage was accumulating, and mounting the river, was shown by the water being now foul at Richmond, although it was pure, a few years ago, at Putney; and he considered, that the tidal action could never stop, or remove an evil, of which it had not been able to prevent the increase. It was admitted, that the mud-banks, in some places, were shifting, owing to the scour which the removal of Old London Bridge had caused, but this effect would cease, when the channel had been thus sufficiently deepened.

Sewage matter was nearly all soluble, and he proposed, not that it should be ponded up, as had been erroneously imagined, but that it should always be running away. No fear need be entertained of its settling, or even remaining in the river, as the actual solid matter would be about 30 tons per day, falling into 20 millions of tons of pure water. But he believed, that the amount to be raised, had been much exaggerated; it was deduced from a Report to the Commissioners of Sewers, that the low-level sewers, (from which alone the sewage was proposed to be pumped up,) discharged a maximum of 18,000 cubic feet per minute, and this amount was stated to require ten pumping stations on each side of the river, with an aggregate of 300 horse-power. As to the loss of the propelling power of the flood-tide, that was a commercial question, and a statement, given from observation, showed, that the amount of traffic was now, comparatively small.

With regard to the engineering features of the case, he did not call in question, the principles laid down by the eminent authorities who had taken part in the discussion. He admitted the tendency of the upper part of the river to silt up, but his position was, that the absence of the material would prevent that effect being produced, as anything passing at Teddington, would soon settle, and could be easily removed,—the banks, or bottom would no longer be carried down by the slow current,—and when much was brought in by drainage after rains, the same cause would give the velocity of current required for removing it. It appeared to be conceded, that there would be no danger of an additional rise of tide below bridge, and no speaker had, apparently, anticipated danger to the mouth of the river, from the small reduction of tidal current. He believed, that little danger need be apprehended of injury to the Pool, both on account of the comparative purity of the water, and the artificial scour of the stream issuing from the dam, for the value of a scour was only great at, or near a low-tide, when the same amount would pass as at present, but which

amount could be doubled, if required, for the last hour of the ebb. The question of the future drainage of the low lands was, no doubt, important, but he contended, that, as it was proposed to maintain the water level below the surface of the ground, instead of permitting it to rise above, as at present, and to dam out the frequent extra high-tides which flooded those districts, a real good would be effected in this respect.

He admitted, that his views had been somewhat modified, by the deliberate opinions of so many older and more experienced Members of the profession; and if he ventured to retain faith in the efficacy of the proposed plan, it was, because full weight had not been given to various modifying circumstances, peculiar to the case. The subject was, undoubtedly, one of the most interesting which could come under discussion; he hoped, therefore, that a candid consideration would be given to the arguments adduced in favour of the plan, and he believed the result would be, the conviction, (though his views might not be at once admitted,) that at least there were two sides to this important question.

Mr. R. STEPHENSON, M.P.,—President,—said, it must be admitted, that the Author's reply had done great credit, both to his head and heart; and if he had not met with many supporters, he must have made friends, by the openness of his statements, and the straightforward manner with which he had met and argued all the contested points, during the protracted and interesting discussion.

January 29, February 5, and 12, 1856.

ROBERT STEPHENSON, M.P., President,
in the Chair.

The discussion upon the Paper, No. 938, "On the Past and Present Condition of the River Thames," by MR. H. ROBINSON, having been resumed, was continued throughout these Meetings to the exclusion of any other subject.

At the Meeting of February 5, the following Candidates were balloted for, and duly elected:—JAMES ATKINSON LONGRIDGE, as a Member; ROBERT RICHARD ARNTZ, JAMES EGLESON ANDERSON GWYNNE, JOHN HAMILTON, JUN., THOMAS GEORGE SOUTH, and JOHN YOUNG, as Associates.
