



Government of Bengal
Local Self-Government Department

Report of the
Drainage Outfall Committee

(Appointed by the Government of Bengal in the
Local Self-Government Department under
Resolution 1732 P. H., dated the 29th July 1931)

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Report of the Drainage Outfall Committee appointed by the Government of Bengal in the Local Self-Government Department under Resolution No. 1732 P.H., dated the 29th July 1931.

1. The Committee as constituted was composed of the following persons:—

Chairman.

The Commissioner of the Presidency Division.

Members.

Rai Shailendra Nath Banerjee Bahadur, Chief Engineer, Irrigation Department.

Mr. J. A. Stewart, M.INST.C.E., Acting Chief Engineer, Calcutta Improvement Trust.

Mr. F. C. Griffin, M.INST.C.E., M.I.E. (IND.), Chief Engineer, Public Health Department.

As thus constituted the Committee made 4 visits of inspection as follows:—

14th September 1931.—Visit to Kulti River *via* Kristopur Canal and Bhangar Khal—(Messrs. Griffin and Stewart, accompanied by Mr. A. N. Banerjee, River Surveyor to the Corporation of Calcutta).

17th September 1931.—Visit to Palmer's Bridge pumping station, Dhappa lock and Makalpota sluice—(Messrs. Griffin and Stewart, accompanied by Mr. A. N. Banerjee and Mr. P. C. Bose, Executive Engineer, Drainage, Calcutta Corporation).

22nd September 1931.—Visit to Reflux gates, Suburban storm water reservoir and Ballygunge pumping station—(Messrs. S. N. Banerjee, Griffin and Stewart, accompanied by Mr. P. C. Bose).

26th-27th September 1931.—Visit to Kulti River, Roymangal River, Gosaba, Matla River and Port Canning—(Messrs. Robertson, Griffin and Stewart, accompanied by Mr. A. N. Banerjee).

In November 1931 Mr. W. Roche, C.I.E., A.M.INST.C.E., Chief Engineer, Irrigation Department, and Mr. M. R. Atkins, B.Sc., M.INST.C.E., M.I.E. (IND.), Chief Engineer, Calcutta Improvement Trust, were made members of the Committee in place of Rai S. N. Banerjee Bahadur and Mr. J. A. Stewart. Subsequent to this change meetings were held and visits of inspection were made as follows:—

4th December 1931.—Visit to Bagjola Khal, Thakurdwari Sluice, Bamanghata lock and Bidyadhari River. (Full Committee).

8th December 1931.—Visit to Nawi Khal at Beraberi. (Messrs. Atkins and Griffin only.)

16th December 1931.—Visit to Suburban Storm Water Reservoir. (Full Committee.)

18th December 1931.—Meeting and discussion with Dr. Dey. (Full Committee.)

23rd December 1931.—Meeting and discussion with Dr. Dey. (Full Committee.)

9th January 1932.—Visit to Kulti Lock, Haruwa Gang and Nawi Khal. (Full Committee accompanied by Mr. A. N. Banerjee.)

9th January 1932.—Meeting to discuss draft of ad-interim report. (Full Committee.)

11th January 1932.—Visit to Palmer's Bridge pumping station, Town storm water reservoir, and Byntala. (Full Committee excluding Mr. Atkins who made a similar inspection on 13th March 1932.)

8th March 1932.—Meeting to discuss Mr. Griffin's proposal for reconditioning the Bidyadhari. (Full Committee.)

14th April 1932.—Meeting to discuss alternative proposals and to consider the general terms of the report to be submitted to Government. (Full Committee.)

Copies of photographs taken at the visits of inspection are attached to this report (*vide* Appendix V).

2. The terms of reference to the Committee are as follows:—

“To examine the proposals of the Calcutta Corporation for a drainage outfall, as distinct from the scheme for the revision of the internal drainage and to report to Government:—

- (1) What outfall in their opinion is the best solution of the problem;
- (2) Whether the sewage requires any form of treatment for disposal at such outfall; and
- (3) Whether they consider it desirable that their report should be submitted to some external expert or experts for opinion on either or both of these points.”

3. It may be said at the outset that the Committee have found some difficulty in dissociating Dr. Dey's outfall proposals entirely from his scheme for the revision of the internal drainage, and have found it necessary therefore in their ad-interim report to recommend that certain items of work which are included in the internal drainage scheme as sanctioned by Government should be postponed until a decision has been reached with regard to the outfall question. The works which are recommended for postponement are really in the nature of outfall works in that they affect the discharge channels from the pumping stations but not the pumping stations themselves or the high level sewers. Their postponement does not in any way debar the Corporation from proceeding with the remainder of Dr. Dey's recommendations for the revision of the internal drainage, which involve an estimated expenditure of over Rs. 55 lakhs out of his total estimate of Rs. 65 lakhs.

4. Another difficulty which has been experienced by the Committee has been the lack of detail in Dr. Dey's recommendations. The Committee fully recognize and appreciate the willingness shown

by Dr. Dey and his colleagues, Mr. A. N. Banerjee, River Surveyor, and Mr. P. C. Bose, Executive Engineer, Drainage, to assist the Committee by placing at their disposal whatever drawings and calculations were available, but the fact remains that the scheme which the Committee have been asked to examine is little more than a sketch project supplemented by a collection of records and data relating to the history and behaviour of the rivers of Western Bengal, but by very little in the way of engineering drawings and specifications. As examples of this lack of engineering detail it may be pointed out that no longitudinal sections of the proposed outfall channels from Byntala to Kulti were supplied with the scheme or were shown until they were asked for by the Committee, and that no drawings are available showing the proposed outfall sluices at Kulti or the crossing of the Bidyadhari River. Similarly no mention was made in Dr. Dey's scheme of the necessity for removing silt from the channels, although Dr. Dey admitted subsequently when questioned on this point that he proposed to remove the silt by means of a drag line excavator which was not provided for in his estimates.

5. The Committee feel that it would be advisable at this point to dispose of a misunderstanding which has arisen in connection with a suggestion made in their ad-interim report. The suggestion in question reads as follows:—

“They, therefore, suggest for the consideration of the Corporation that the (Suburban storm water) reservoir be cleared out or abandoned in favour of a new reservoir constructed alongside the existing reservoir so as to utilize one of the existing embankments. This should be looked upon as a matter of some urgency in dealing with the sewage disposal problem.” From its place in the ad-interim report immediately after a series of paragraphs relating to the deposition of silt from the dry weather sewage it should have been clear that this paragraph embodied a suggestion for making use of the existing suburban storm water reservoir or a duplicate thereof as a settling tank for sewage solids which now pass to the outfall; but Dr. Dey evidently misunderstood the intention of the Committee, for he reported to the Corporation, according to statements which have appeared in the press, that the recommendation in question “reveals either lack of appreciation or utter disregard of the fundamental principles of hydraulics” on the part of the members of the Committee in that it shows that they have failed to see that the clearing out or re-excavation of the old reservoir would “not effect any improvement on the present rate of final disposal of Calcutta sewage, so long as the bed of the Bidyadhari remains high.” It is hardly necessary to explain that it was never the opinion of the Committee that the clearing out of the reservoir would accelerate the “rate of disposal” of the sewage. The object of the recommendation was not to improve the rate of disposal, but to give the sewage partial purification by means of a settling tank or tanks. This is urgently necessary because the Bidyadhari and connected channels are being unnecessarily fouled by the crude sewage flowing without settlement from the “storm water reservoir.”

6. The first results of the Committee's examination of Dr. Dey's outfall proposal have been reported to Government in the conclusion recorded in the first paragraph of the ad-interim report. No mention was made in the ad-interim report of Dr. Dey's proposal for discharging the storm water to the Kulti without pumping, as the Committee

considered it unnecessary at that early stage to do more than fulfil their primary obligation of reporting that the scheme was inadmissible as a whole owing to the anticipated silting up of the dry weather channel. It is only fair to Dr. Dey, however, to add that in the opinion of the Committee his storm water channel is less open to objection than his dry weather channel, in that it would rarely be called upon to work at its full capacity of 2,500 cusecs for more than a few hours at a time and would thus have opportunities of disposing of practically the whole of its contents at low tide between storms, thereby providing storage room for additional storm water during the next tide-locked period. Although workable, this method of disposing of the storm water would be unsatisfactory. Owing to the small slope in the channel and considerable tide-locking at the outfall the velocity in the channel would fall below the critical velocity for long periods. The channel would in practice be an enormously long (16 miles) storage reservoir in which the silt with which the water is heavily charged would be rapidly deposited. To maintain this long channel in efficient working order would entail heavy periodical silt clearance and consequently a high recurring charge on maintenance. The Committee cannot recommend its adoption.

7. Before leaving this question of the silting up of the proposed channels the Committee desire to call attention to the fact that the existing "pucca" sewage channel from point A (*see* Appendix I, sheet No. 2) to the Suburban storm water reservoir although constructed with a gradient of 1 in 2,500 as compared with the gradient of 1 in 10,560 (6 inches to a mile) proposed by Dr. Dey has actually silted up by more than half its original depth, as shown by the latest drawings received from the Corporation. Dr. Dey when commenting on the Committee's ad-interim report, selects this particular channel as an example of a channel which "has not silted up so as to become unworkable." Although it is true that this channel is still working, due to the fact that it is the outlet channel of sewers through which the sewage is being forced by pumps, the fact that it is cited as an example makes it obvious that the standard of "workability" which Dr. Dey is aiming at is not a very high one.

8. Having dealt with the first part of the terms of reference, namely, the examination of Dr. Dey's proposals, the Committee have now to reply to the three specific questions put to them by Government. The first question "what outfall in their opinion is the best solution of the problem?" is one which the Committee find considerable difficulty in answering in view of the very inadequate information available regarding previous outfall proposals. A very attractive scheme, more beneficial and far-reaching in its scope than any other scheme, which has been put forward throughout the Bidyadhari controversy has been outlined by Mr. Griffin in a note which is attached to this report (*vide* Appendix I). This scheme aims at restoring the Bidyadhari to its original state of activity and would have the effect of solving the drainage problem in its entirety, reducing the malaria menace, reclaiming the Salt Lakes and Jatragathi Bhil, and re-establishing navigation between Port Canning and Calcutta. Stated briefly, the scheme provides for opening up a new channel for the Bidyadhari from Bamanghatta to the Harua Gang, and diverting the Sunti and Nawi rivers and certain spill areas from the Kulti to the Bidyadhari. It also replaces the Kristopur canal by a new canal on the line of the present Central Lake Channel with a tidal link near Bamanghatta. It is, of course, impossible for this Committee to do more than give a general

opinion on a proposal of this magnitude, but they are so impressed by its apparent simplicity and feasibility, and by the promise it affords of restoring a large tract of country to healthy conditions and of opening up long discontinued lines of navigation that they desire to place it in the forefront of their recommendations. So far as the drainage of Calcutta is concerned, the scheme would operate by lowering the low tide level at the new outlet of the storm water reservoirs sufficiently to allow a maximum level of +12.50 K. D. S. to be maintained in the Town and Suburban head cuts. The provision of additional storm water pumps, and indeed of much of the storm water pumping plant of Dr. Dey's "internal drainage scheme," would then be unnecessary, and the maintenance cost of such plant would be done away with. The lowered level of the water in the Town Head Cut would permit the restoration of the system of flushing the head cut with canal water, thereby removing the nuisance of the stagnant sewage in the channel. The scheme would also provide satisfactory tidal outlets for the storm water from Maniktala *via* the existing siphons under the new Cut Canal, and an outlet for the storm water of Cossipore-Chitpore by way of the Bagjolla Khal which would be brought within the tidal range of the improved Bidyadhari. The surface drainage of five municipal areas (the three Dum Dums, Baranagore and Kamarhati) would also be improved, by reason of the improved outlet for the Bagjolla Khal. A working tidal model of the waterways and spill areas affected by the scheme has been made under Mr. Griffin's directions and may be inspected at the office of the Commissioner, Presidency Division.

9. An alternative solution of the drainage problem is described by Mr. Atkins in Appendix II to this report. Mr. Atkins' note shows by means of tidal diagrams that the high tide level of the Bidyadhari cannot rise to any appreciable extent above its present yearly average of +14.50 K. D. S., and that Dr. Dey's internal drainage scheme which delivers the sewage and storm water at Byntala at a level of +15.00 K. D. S. will do all that is necessary so long as the "meandering channel" of the Bidyadhari remains available for the reception of sewage and storm water. Mr. Atkins goes on to point out, however, that Dr. Dey does not propose to deal with the whole of the storm water which the existing low level sewers are capable of discharging. In order to remedy this defect in the internal drainage scheme Mr. Atkins suggests that sufficient additional storm water pumping plant be installed at the Palmer's Bridge pumping station to make good the deficiency. The cost of the extra pumping plant, on the basis of Dr. Dey's estimate, would be only Rs. 2½ lakhs, and the Committee consider that the Corporation would be well advised to incur this relatively slight additional expenditure in order to secure the advantage of utilizing the existing sewers to their full capacity. The Committee, however, wish to point out that this scheme simply carries on the unsatisfactory conditions of the present works, as far as outfall is concerned. These may be enumerated as follows:—

- (i) The Town Head Cut would be used as the outfall channel, and between storms would remain full of dilute sewage. The water level would continue to be so high that the channel cannot be flushed out with canal water—the arrangement provided in the original design of the Calcutta sewerage system. Consequently no improvement in the insanitary condition of the Tangra area can be effected.

- (ii) The gradual silting of the Bidyadhari would continue, with the result that the nuisance of the sewage would gradually creep further and further south, rendering the banks of that river and its continuation the Matla more and more uninhabitable.
- (iii) The question of the malaria menace of the Salt Lakes is not dealt with, and these great areas which lie so near to Calcutta are left in a derelict condition.

10. Mr. Atkins also deals in his note with the suggestion, already referred to of converting the sewage discharge channels into settling tanks, and describes how this could be effected by sub-dividing the channels into sections of different lengths which could be cleared out at regular intervals. This method he considers has certain advantages over the alternative method of diverting the channel to a new alignment when it has become fully silted up. The Committee recommend that one or other method should be adopted in order that the quantity of silt ultimately discharged at the outfall may be reduced to a minimum, but would leave it to the Corporation to select the method which suits them best.

11. While discussing the question of silt removal the Committee would like to call attention to the vague statements which have been made from time to time regarding the so-called "prohibitive" cost of sewage treatment works. It is pointed out by Mr. Griffin that the cost of the modern sewage purification plant at Bhatpara is estimated at only Rs. 3.2 per head of a population of 85,000, and that the rate per head would be less in a city of the size of Calcutta. Taking the rate at the same figure, however, and the population as 1,300,000, the cost for Calcutta would be Rs. 41.6 lakhs. Moreover, the latest experience in Europe and America tends to show that a very considerable income could be derived from the sale of gas and manure produced in the purification process. In making comparisons, however, it must be remembered that such purification works deal with the dry weather flow only, not the storm water.

12. Two other outfall proposals have been enquired into by the Committee, namely, the proposals for discharging sewage and storm water into the Hooghly, and the proposal for discharging into the Kulti by pumping. The first is dealt with in a note by Mr. Atkins contained in Appendix III and the second in a note by Mr. Roche contained in Appendix IV. The Committee are unanimously of opinion that neither proposal should be recommended for adoption having regard to the fact that Mr. Griffin's proposal for restoring the Bidyadhari would give far better ultimate results, and that Dr. Dey's internal scheme augmented by the additional pumping plant suggested by Mr. Atkins is all that is required to meet the immediate needs of the City.

13. The second question in the terms of reference has now to be considered, namely, "whether the sewage requires any form of treatment for disposal at the outfall selected." In discussing the first question it has been pointed out that it is very desirable that facilities for the preliminary settlement of suspended solids should be arranged for in connection with the internal drainage scheme. Whether any further treatment is necessary depends first upon the conditions arising from the continued discharge of partially treated sewage into the Bidyadhari in its present dying condition. If it is found that the channel of the

river becomes blocked by sewage deposits or a menace to public health in any other way, it will undoubtedly be necessary to subject the sewage to further purification. Later, assuming that Mr. Griffin's scheme is carried out, the necessity for purification will depend on whether the river in its improved condition is found capable of disposing of the sewage by dilution without nuisance to the various interests concerned. In either case it is impossible to give a complete answer to the question at the present time as the nature and extent of any such further purification cannot be decided upon except in the light of future developments.

14. As regards the third question whether it is considered desirable that this report should be submitted to some external expert or experts for opinion on either or both of the points dealt with in questions 1 and 2, the Committee consider that there is no satisfactory detailed scheme in existence which could with any advantage be submitted to an external expert. The Committee strongly recommend that Mr. Griffin's scheme be investigated at once, and that an engineer be placed on special duty without delay to work out the details of the scheme. The Committee are also of opinion that those portions of Dr. Dey's internal scheme which are affected by the modification suggested by Mr. Atkins, and by the proposal for converting the sewage channels into sewage settlement tanks should be submitted to a competent drainage engineer, preferably with local knowledge, for detailed examination. The cost of this examination would not be serious and the Committee feel that public confidence in the soundness of the internal drainage scheme as a whole would be greatly strengthened if some of its more important features were thus subjected to the scrutiny of an expert.

H. J. TWYNAM,

Commissioner, Presidency Division (Chairman).

W. ROCHE,

Chief Engineer, Irrigation Department (Member).

M. R. ATKINS,

Chief Engineer, Calcutta Improvement Trust (Member).

F. C. GRIFFIN,

Chief Engineer, Public Health Department (Member).

CALCUTTA,

The 15th May 1932.

APPENDIX I.

Note by Mr. F. C. Griffin on the possibilities of restoration of the Bidyadhari river.

In examining the records and inspecting the rivers and canals within the area, it became apparent to me at an early stage that the problem of the disposal of the Calcutta drainage was only part and parcel of a greater problem. There are other questions of vital importance which are bound up with the drainage question. The points at issue may be enumerated as follows:—

- (1) Calcutta drainage—
 - (a) Sewage disposal.
 - (b) Storm water disposal.
- (2) Malaria, and the increasing danger of the Salt Lakes from the health standpoint.
- (3) The necessity for further raising and filling in of the Salt Lakes to make room for future expansion of the city.
- (4) The general drainage of the surrounding country, including the riparian towns, and the interference with north and south drainage lines.
- (5) The Grand Trunk canal, and general navigation.

Whatever scheme is evolved now must be comprehensive, and must solve all these problems if possible.

To understand this greater problem, the history of the area during the last 100 years must be studied. For this purpose, Mr. A. N. Banerjee's book, "History and Hydraulics of the river system near Calcutta," is very useful. From this it can be seen how the present bad condition of the Bidyadhari has been brought about by the works of man. The natural tidal flow of the river has been checked progressively by the following sequence of works:—

- (1) Construction of Cossipore lock in 1833, which cut off the connection with the Hooghly.
- (2) Construction of Dhappa lock in 1882, which further reduced tidal spill.
- (3) Construction of Bhangor canal in 1895-97, which cut off one of the main branches of the river and reduced the area draining towards the south.
- (4) Construction of the Kristipur canal in 1910.

The operations (2), (3) and (4) were each necessitated by the evil effects of the one preceding it, and were carried out in the interests of

navigation, with no consideration for the health standpoint (anti-malarial principles not having been formulated in those days), and very little consideration for the question of the life of the main river.

A scheme put forward now should as far as possible retain existing works, but where such retention militates against a successful scheme, candid admission of previous mistakes should be made, and works abandoned.

Malarial experts are united in the opinion that the Salt Lakes, if left in their present condition, are a potential source of danger to Calcutta. They recommend that if possible silt laden water should be re-introduced into the lakes, which will have the double effect of preventing mosquito breeding and of continuing the gradual raising of the low-lying areas.

Silty water can be brought into the lakes again only by a restoration of the Bidyadhari.

If the Bidyadhari were restored, the best solution would be found for the Calcutta drainage problem. For then the storm water could be again discharged by gravity at low tide, and the cost of pumping storm water would be saved. The sewage after partial treatment could be discharged at the same point.

The possibility of restoration of the Bidyadhari is therefore the main point for consideration.

That the main channel of the Bidyadhari can be dug out again by means of suction dredgers is obvious. But it is equally obvious that such digging would be a sheer waste of money unless the conditions are so re-adjusted that the river will be subsequently self-maintaining. These deltaic rivers are maintained by two forces.—(1) the flushing effect of the rain water discharge from the catchment area, and (2) the ebb and flow of tidal water into low-lying land, or "spill areas." A study of the map sheet No. 1 shews that the Bidyadhari has been reduced to its present state because the rain water from the greater part of its catchment area, and that from a good many spill areas, has been diverted to a river further east, the Kulti, or Harua Gong. In a flat country like this where the rivers are tidal, the natural line of drainage would obviously be the most direct one to the sea, *i.e.*, a north and south line. But the map shows that the Sunti and Nowi rivers, from the point where they join (near the Basirhat Railway) run east instead of south. This means that the whole of the catchment area tinted blue is discharging to the Kulti instead of the Bidyadhari. Probably also a good deal of the water from the area tinted green is also going to the Kulti. That head waters which really belong to the Bidyadhari have been diverted to the Kulti is proved by the fact that the Kulti is a vigorous river which has deepened and enlarged itself considerably in recent years. In my opinion, if the catchment and spill areas tinted blue and green, *plus* the area tinted yellow and the areas of Salt Lakes tinted brown were restored to the Bidyadhari, the river would be self-maintaining.

My suggestion is, therefore, to reconstruct the Bidyadhari on the line shown in red, and to stop the Harua Gong (or Kulti) at point B. This means cutting through the Kristopur canal at point D, and its abandonment as a canal. The navigation can, however, be provided for

by a new canal to point C, or rather, a canalisation of the present Central Lake channel.

The point C then becomes the strategic centre of the whole system. It is shown more clearly together with the connection to Calcutta on the sketch map, sheet No. 2 (scale 2"=1 mile). The existing Bhangor canal and the Bamanghata lock would be retained, and boat traffic for Calcutta would have to pass through the lock, and on to the tide way, and through the new lock to the new canal. The Calcutta drainage would then be dealt with by moving the 3 Stoney sluices X, Y and Z, to point C as shewn, thus increasing the reservoir capacity. The sweep of tidal water up and down the New Bidyadhari at point C would keep the water-way and the sluice entrances clear. The Kristopur canal would then become tidal, and would be used as a feeder of silty water into the low-lying land on either side of it. At low tide it would also provide an effective outlet for the Bagjolla khal, a thing which that khal has never had since the Kristopur canal was constructed.

This scheme also provides a solution of the Grand Trunk canal problem. In my opinion the proposal to run the canal straight eastward across the lines of drainage is a mistake, and would permanently seal the fate of the Bidyadhari. By finally preventing the re-establishment of silting in the Salt Lakes, a serious epidemic of malaria might be caused. Also, my suggestion provides a new river cutting across the Grand Trunk canal alignment, and would result in a large reduction of the capacity of the Kulti. But the New Bidyadhari would provide a steamer route, for the Sunderbans Route is connected to the Matla. There is no reason why the new lock at point C should not be made of the size proposed for the Grand Trunk canal, and by widening the existing channel and New Cut canal, the route would be completed to the proposed docks at Manicktola.

The absolute necessity for the Grand Trunk Canal does not seem to be finally proved yet, and my suggestion provides alternatives. In the first place the new canal would be made only of the width required for present country boat traffic. If the Grand Trunk canal finally became necessary, the canal could be widened. The new lock at C would be made of small size (for country boats) if the need for the Grand Trunk Canal is considered remote, or, alternatively, the lock could be built of the larger size and the canal only made to the smaller size for the time being.

The question of the Jatragathi Bhil would be dealt with by this scheme. It would be re-opened to tidal spill from the new river, either direct through a new channel, or *via* the abandoned Kristopur canal. The low-lying swamps would thus be gradually silted up, a great benefit both to the land and to the river whose tidal spill it would assist.

If this scheme were carried out successfully, it would probably not be necessary to install complete purification for Calcutta sewage for a long time. Although complete purification is doubtless the ideal to be aimed at, the partial purification which would take place in the proposed new sewage channel might be taken as sufficient for the time being. Also a more effective means for disposal of the sludge which would be settled out might be adopted as the first instalment of a purification process. The sludge might be "digested" in separate tanks

from which power gas could be collected, and the properly digested sludge would be much more useful as manure.

The difficulty of surface drainage of Manicktolla can also be overcome in a simple manner by this scheme.

The surface drainage used to discharge at the points E, F and G into the Salt Lakes. A drainage channel H, J, K could be constructed, connected to the Thakurdari sluice. The flaps shutters on this sluice could be changed over so that the sluice works in the opposite directions. Then when the Kristopur canal is tidal, water from the channel H, J, K, would pass out at low tide, and the channel becomes a low level reservoir into which the Manicktolla drainage would discharge through the existing syphons under the canal.

F. C. GRIFFIN,

Chief Engineer, Public Health Department, Bengal.

APPENDIX II.

Note by Mr. M. R. Atkins on discharge to the Bidyadhari.

In considering proposals for continuing to discharge the sewage and storm water into the Bidyadhari as it now exists it will be helpful, in the first place, to compare the present position with the position as it was in 1921 when Mr. Houston, who succeeded Mr. Ball Hill and preceded Mr. Wilkinson as Corporation Drainage Engineer, put up his scheme for pumping to the Bidyadhari.

At that time the maximum quantity of sewage to be pumped was estimated at 560 cusecs, and the maximum quantity of storm water at 2,440 cusecs. The highest tide level of the Bidyadhari at Bantala was taken to be +16.00 K. D. S. and provision was made to pump the whole of both sewage and storm water to this level, the pumping being done at two new pumping stations to be constructed at Bantala.

At the present time the maximum quantity of sewage to be pumped is estimated by Dr. Dey at 670 cusecs and the maximum quantity of storm water at 2,450 cusecs (figures taken from annexures 3—5 to Mr. Dey's 2nd Report) and Dr. Dey proposes by augmenting the pumping plant at Palmer's Bridge and Ballygunge Pumping Stations and installing new pumping plant at Dhappa and Topsisia to raise the whole of this sewage and storm water to such a level that it will reach a point between Bantala and Bamaughatta at the head of his proposed outfall channel to the Kulti at a level of +15.00 K. D. S. In other words he proposes by improvements and additions to what is called the "internal" drainage system, with which this Committee is not directly concerned, to carry out practically the same task as Mr. Houston set himself to accomplish in 1921, the differences being merely that Dr. Dey has slightly more sewage to pump than Mr. Houston, and delivers it at a slightly lower level, namely +15.00 K. D. S. instead of +16.00 K. D. S.

It is necessary now to see what changes have taken place in the Bidyadhari during the 11 years which have elapsed since Mr. Houston

wrote his report. Appended to this note are two diagrams showing in one case the average monthly high tide and low tide levels in the Bidyadhari from 1916 to 1930, and in the other the average yearly high tide and low tide levels over a much longer period.

It will be seen from the monthly diagram that the average tidal range at Bamanghatta was about 6 feet in 1916, 5 feet in 1921, 4 feet in 1926 and is now less than 3 feet, but that the average high tide level even in the monsoon months has varied very little in this period, and is still under +16.00 K. D. S. the level selected by Mr. Houston as the highest level to which sewage or storm water would have to be pumped. It is clear therefore that Mr. Houston was right in selecting this level so far as is shown by the experience of the last 11 years.

This is satisfactory so far as it goes, but the question naturally arises "Is it safe to assume that the average high tide level in the monsoon months will never rise above +16.00 K. D. S.?"

(*N. B.*—The difference between +15.00 K. D. S. and +16.00 K. D. S. is disregarded in this connection, seeing that the pumps to be provided in Dr. Dey's internal drainage scheme will actually be capable of raising the sewage to the higher level.)

In order to answer this question it will be helpful to refer to the other diagram, which shows the average yearly high tide level at Bamanghatta from 1903, when the Bidyadhari was in a fairly healthy condition with a depth of over 20 feet and a tidal range of 9 feet, to the present time when it has a tidal range of less than 3 feet and a bed level of +11.00 K. D. S. or higher.

Contrary to what might have been expected the average yearly high tide level over this period is found to have remained constant at about +14.25 K. D. S. In other words, in spite of the river having changed its condition from that of an active tidal river to that of a "meandering channel," to use the picturesque term which has become familiar in these reports, it remains just as available now as a means of disposing of *pumped* sewage and storm water as it always has been, and there is no reason to anticipate that its availability for this purpose will become less, seeing that the high tide level of the Bidyadhari at Bamanghatta having remained constant during the "death throes" of the river, is not likely to jump up to some new level now that the river is practically "dead."

The only other factor which would necessitate pumping to a higher level than +16.00 K. D. S., would be the silting up of the bed of the "meandering channel" by suspended solids from the sewage and storm water itself. This eventually was not regarded very seriously by the Bidyadhari Special Committee of 1924-25 as is seen from the following quotation from their Second Ad-Interim Report, written after Mr. Temple's opinion had been obtained:—

"Calcutta must always pump all her sewage and a portion of her storm water also as she has been doing from the very first and so long as she does so she can always command an outfall, for even if the Bidyadhari and the Central Lake channel were to continue to deteriorate a small channel would remain for sewage to flow when pumped into the same." It may be added that even if this small channel were to silt up to some extent it would be a comparatively simple matter to deepen

it during the dry season, and moreover the risk of silting would be much diminished by the conversion of portions of the high level channels from point A, and Dhappa into sewage settling tanks as is suggested in a later part of this note.

The next point to consider is why, if Dr. Dey's internal scheme alone is going to achieve all that is required, should it be necessary to do anything further? At first sight the answer to this question is that it is not necessary to do anything further, but examination of Dr. Dey's internal scheme reveals the fact that there is an important feature in it which has not been satisfactorily disposed of, namely, his proposal to discharge surplus storm water into the Circular and New Cut canals and into the Town Head Cut (*vide* page 6, paragraph 15 and annexure 3, paragraph B, of Dr. Dey's Second Report). Unfortunately the level of the water in these canals and in the Town Head Cut is so high that the adoption of this means of relief will not have an appreciable effect in preventing the flooding of low-lying areas in the city. Moreover it is very doubtful whether the Bengal Government will allow the Corporation to make use of the Circular and new Cut canals in this way. An alternative method, however, of overcoming this difficulty, at any rate in part, is to increase the pumping capacity at the Palmer's Bridge Pumping Station up to the limit of the capacity of the incoming sewers, which can be done at an additional cost of only Rs. 2½ lakhs as will now be shown.

The maximum capacity of the sewers discharging at Palmer's Bridge Pumping Station when running full bore with the water level in the Town Head Cut standing at +12.50 K. D. S. is given in detail in Mr. Houston's Report as follows:—

(1) Main sewer	...	47,000	C. ft. per minute.
(2) Canal Area Sewer	...	12,400	„ „
(3) Beliaghatta	„ ...	400	„ „
(4) Entally	„ ...	2,600	„ „
(5) Canal Intercepting Sewer	...	22,600	„ „
Total	...	85,000	„ „
			=1,417 Cusecs.

Dr. Dey assumes, according to Annexure 3 of his Second Report, that only 1,000 cusecs out of this total of 1,417 cusecs will actually reach the Pumping Station, and of this 1,000 cusecs he proposes to pump only 800 cusecs, leaving the remaining 200 cusecs to escape into the Head Cut when the pumps are mastered and the water in the sump rises to level of that in the Head Cut. The reason why he expects only 1,000 cusecs of storm water to reach the Pumping Station and to be discharged in this way is presumably that owing to the water level in the Head Cut being considerably higher than +12.50 K. D. S. the hydraulic gradient governing the discharge of the sewers will be much flatter than the gradients of the sewers themselves. Now this hydraulic gradient can be steepened and brought into conformity with the gradients of the sewers by lowering the water level in the sump by the simple expedient of pumping into the Head Cut the additional 617 cusecs which make up the maximum discharging capacity of the sewers.

Hence the problem reduces itself to that of providing additional pumping plant of sufficient capacity to lift 617 cusecs of storm water from the level +12.50 K. D. S. to the level of the Head Cut, which may be assumed to be about +17.50 K. D. S. at the most.

The engine horse power require for this operation, to follow Dr. Dey's method of calculation, would be $\frac{617 \times 60 \times 62.5 \times 5 \times 100}{33,000 \times 75} = 417$ H.P.

As the other new storm water pumping units at this station are to be Dissel units of 300 H. P. each it is suggested that two more of these units be supplied at Dr. Dey's estimated cost of Rs. 90,000 per unit. This would give an additional cost of Rs. 1,80,000 for pumping plant and say Rs. 70,000 for alterations to the building, etc., or a total additional cost of Rs. 2½ lakhs to be added to Dr. Dey's estimate of Rs. 65 lakhs, a very small addition when it is considered that it will have the effect of enabling the sewers to discharge full bore at all times as they were originally intended to do.

Another matter which has been mentioned in an earlier paragraph of this note is the suggestion that portions of the high level channels from point A and Dhappa should be converted into sewage settling tanks. This is in fact an elaboration of the recommendation made by the Committee in its Ad-Interim Report to the effect that the existing Suburban Storm Water Reservoir should be cleared out or duplicated in order to intercept some of the silt which now passes to the outfall. The present suggestion is merely that portions of the two high level channels should be left kutcha, deepened and widened out and divided into sections by having earthen bunds placed across them at selected intervals for the purpose of localizing the deposition of silt and sludge and enabling those sections which collect the larger quantities to be cleared out more frequently than the other sections. The tops of the bunds would be sufficiently below water level to allow the sewage to pass over them without serious loss of head and would be protected against scour by masonry pitching. A floating scum board would be fitted also at the up-stream side of each bund to hold back the scum in each section.

It is anticipated that the sections at the inlet ends of the channels will silt up more rapidly than those at the outlet ends and may have to be cleared out every year or every second year, while those at the outlet ends may not require clearing more often than once in every 5 years. During sludge clearance, which will take place during the dry season only, the sewage flow can be temporarily diverted into the storm water channels running alongside.

It should not be necessary to increase the estimate of Rs. 65 lakhs in order to provide for these settling tanks as the sum of Rs. 5.7 lakhs already provided to meet the cost of pucca high level "Guiding Channels" from point A to Bantala and from Dhappa to Makalpota should be sufficient to cover the cost of enlarging and sub-dividing portions of the channels in the way described.

The method of dividing the channels into sections is preferred to the alternative method of diverting the channels to new alignments when they have become fully silted up for the following reasons:—

- (1) The silting up process will not take place uniformly and there will always be doubt as to whether the channel is sufficiently silted up to need diversion.

- (2) The channel will become less and less efficient as the time for diversion draws near.
- (3) Expenditure will be incurred at irregular intervals instead of annually or biennially and there will be considerable difficulty in getting the money voted with the result that the channel will not be diverted when required.

The small scale plan accompanying this note gives a general idea of the relative positions of the pumping stations, settling tanks and outlets into the Bidyadhari Channel.

M. R. ATKINS,

Chief Engineer, Calcutta Improvement Trust.

APPENDIX III.

Note by Mr. M. R. Atkins on discharge to the Hooghly.

Discharge to the Hooghly appears to have been first suggested by Messrs. Rendel, the Consulting Engineers who were called in to report on Mr. Clark's drainage scheme of 1853, which still forms the basis of the Calcutta drainage system. Messrs. Rendel's proposals, however, were turned down very decisively by the then Municipal Commissioners who pronounced them to be not only uneconomical but impracticable.

The next mention of a Hooghly Outfall occurs, according to Mr. C. C. Chatterjee's "Brief History of the Calcutta Drainage Works," in a note on the "Deterioration of the Bidyadhari River" written by Mr. C. Addams-Williams in 1912-13. Mr. Addams-Williams, discussing the possibility of a new drainage system becoming necessary writes "A large quantity of sewage and storm water is discharged from the Municipality during the year into the Bidyadhari, and when this closes up expensive works will have to be undertaken, either to extend the outfall channel and sluices to some river further east, or to introduce a new system of treatment of the sewage. The storm water can be diverted to the Hooghly at probably a considerable expense, but this cannot be done with the sewage." It is not clear why Mr. Addams-Williams did not then contemplate the possibility of discharging the sewage into the Hooghly as well as the storm water but probably he ruled out the idea as leading to inevitable pollution of the river.

Mr. Ball Hill, the Corporation Drainage Engineer, apparently had no scruples about discharging crude sewage into the Hooghly for he put up proposals in 1914 for discharging both sewage and storm water without treatment into the Hooghly at Akra at a total estimated cost of Rs. 182 lakhs. This project was put forward again as one of the possible alternatives by Mr. Houston in 1921, but was not further investigated as the Corporation at that time was considering Mr. Houston's much less expensive proposal for pumping into the Bidyadhari.

The Calcutta Sewage and Storm Water Disposal Committee of 1921-23 was so confident of being able to improve the Bidyadhari by means of an artificial spill reservoir that it gave but scanty consideration to the

question of a Hooghly Outfall. It did, however, arrange for a series of float experiments to be carried out in the Hooghly and recorded its conclusions from the results of those experiments in the following general terms:—

“It appears from the float experiments that the outfall for the dry weather sewage would require to be a considerable distance below Calcutta, the sewage would have to receive sufficient treatment to prevent any nuisance being caused on the banks of the river, whilst the storm water would need sufficient settlement to prevent the discharge into the river of suspended matter which may be deposited on the bed and cause obstructions in the river.” Mr. G. Bransby-Williams who was a member of the Committee, wrote a little more definitely in an appendix to the report as follows:—

“There is no particular difficulty in devising a scheme for pumping into the Hooghly except its cost, and that both sewage and storm water might have to be treated to some extent, the former to conform to such standards as the Port Commissioners might insist upon as regards the amount of suspended matter. And the latter to produce such an effluent as might with safety be discharged into the river having regard to the place of discharge and the dilution.” It is interesting to note that the float experiment carried out at the instigation of the Committee indicate that sewage discharged at Akra on the last of the ebb tide might be carried as far up the river as Baranagar before the tide begins to ebb again.

The proposal to treat the sewage and discharge the effluent into the Hooghly was investigated by Mr. Wilkinson but we have no comprehensive record of his conclusions beyond a scheme for disconnecting the sewers west of Tolly's Nullah from the Ballygunge Pumping Station and diverting them by means of a main outfall sewer running from east to west to a point in the neighbourhood of the Monikhali outfall near Akra where the sewage, combined with that of Garden Reach, would be treated by some modern process, preferably by the activated sludge system, and discharged into the Hooghly at all states of the tide. The cost of this scheme, without the subsidiary sewers, was estimated at Rs. 44 lakhs.

Mr. A. N. Banerjee, late of the Bengal Irrigation Department, River Surveyor to the Corporation of Calcutta, pronounces against a Hooghly outfall in his “History and Hydraulics of the River System near Calcutta.” If an outfall to the Hooghly were unavoidable, he would select Mayapur or Roypur as the point of discharge as he considers Akra to be too near the City, but he points out that the proximity of the Rupnarain and Damodar outfalls causes abnormally high low tide levels in this reach of the Hooghly, which would have the effect of prolonging the tide-locked periods.

Dr. Dey is evidently not in favour of a Hooghly outfall as he dismisses the whole matter in summary fashion in his first report in the following words:—“The outfall of Calcutta cannot be changed to the Hooghly without either remodelling the whole of the internal drainage system of the City, which is impracticable, or carrying the entire sewage and storm water of Calcutta from point A westward and pumping same after treatment into the Hooghly at a prohibitive cost. The ground slopes away from the river at a steep grade. Moreover, the intake and offtake stations should not be situated in the same river, specially when it is a tidal one. The idea of pumping the sewage into

the Hooghly must therefore be definitely abandoned." Dr. Dey's arguments are not so convincing as they might have been if they had been supported by facts and figures showing what the "prohibitive cost" of treatment and pumping to the Hooghly would be, and why the intake and outfall stations should not be situated on the same river, but it certainly seems, judging from the opinions of the several Engineers quoted above and from a superficial survey of the obvious difficulties, engineering, psychological, and financial which would have to be overcome in diverting the whole of the sewage and storm water of Calcutta to the Hooghly that this alternative is not one which will commend itself strongly to the Bengal Government, the Port Commissioners or the Calcutta Corporation.

M. R. ATKINS,

Chief Engineer, Calcutta Improvement Trust.

APPENDIX IV.

Note by Mr. W. Roche on discharge to the Kulti with pumping.

1. As requested at the meeting of the Outfall Committee on 14th April I submit a revised note on the effect of the combining Dr. Dey's outfall scheme with pumping at the outfall at Kulti.

2. I will take the storm water channel first. On page 12 of the printed papers containing Dr. Dey's explanatory note on the estimate for the outfall scheme, in paragraph (1) (a), the following particulars are given of the design of the storm water channel:—

Length—16 miles.

Water depth at full supply—9.0 feet.

Bed level at Kulti—1.00 K. D. S.

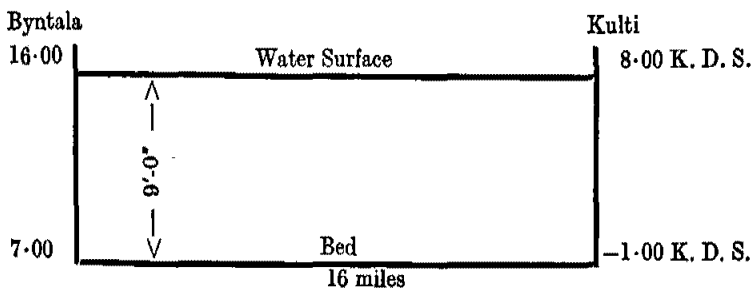
Bed slope—0.5 ft. per mile.

Bed level at head (Byntala)—7.00 K. D. S.

Bed width—120 ft.

Discharge (paragraph 6)—2,500 cusecs.

The following diagram represents the bed and water surface of this channel:—



Point A is 20 miles from Kulti or 4 miles further west.

If the same slope is continued upwards along the channel the water surface levels would be:—

At point A 18.00 K. D. S.

At Palmer's Bridge 18.5 K. D. S.

3. I cannot find anywhere in Dr. Dey's original report or in his note of 22nd December 1931, any reference to the water level in the storm water channel at which the storm water in the sewers has a free outfall but it certainly would appear that a water surface level of 18.00 K. D. S. is too high to allow a free outfall of storm water from the sewers, at point A.

4. On page 8 of Mr. Ball Hill's report he states:—"It may be seen from Messrs. Hughes and Kimber's joint report April 1896 that.....the top water level at the outfall at Palmer's Bridge to allow the sewers a free flow should not rise above 12.50 K. D. S." On page 9 of the same report Mr. Ball Hill states:—"In order to admit of the storm water at Palmer's Bridge not rising above 12.50 it will not be safe to allow the top water level at Byntala to be above 11.50 K. D. S." If we accept 11.5 K. D. S. as the maximum water level at Byntala which will allow of free outfall of the storm water sewers and allow for a channel with a slope of 0.5 ft. per mile from there to Kulti (16 miles) the water surface level at Kulti would be 3.5 K. D. S.

5. This channel has to cross the Bidyadhari. Though the latter river has deteriorated it is still an outlet for drainage in the monsoon and could not be allowed to be blocked by the storm water channel. It would therefore be necessary to syphon the storm water channel under the Bidyadhari. Even if such a large syphon as 6 pipes of 8 ft. diameter is allowed for, the loss of head through the syphon would be 1.4 ft. We may, however, accept that the loss of head through the syphon could be reduced to 1.0 ft. The effect of the syphon crossing would therefore be to reduce the water surface level in the storm water channel at Kulti to 2.5 K. D. S.

6. If we allow for a very large sluice at Kulti say 12 openings of 8' x 6' or 576 sq. ft. of waterway the head necessary to discharge 2,500 cusecs through the sluice would be 0.5 ft.

7. A storm water channel carrying 2,500 cusecs starting with a water surface level of 11.5 at Byntala would therefore only have a free discharge at Kulti as long as water level in the Kulti was not higher than 2.00 K. D. S. In Table No. 8 accompanying Dr. Dey's letter No. S.—1872 of 22nd December 1931, the average low water level at Kulti from June to October is given as follows:—

1930	...	4' 6" K. D. S.
1931	...	4' 4" K. D. S.

It will therefore be seen that throughout the rains when the storm water channel would be required to function the lowest water level in the river would on an average be 2.5 ft. higher than the level of free discharge in the channel so that even at average low water level the water at the tail of the channel would be headed up 2.0 ft. The channel therefore never could empty itself by gravity.

8. The water in the channel could of course be allowed to head up in the storm water channel up to 10.5 K. D. S. The capacity in the

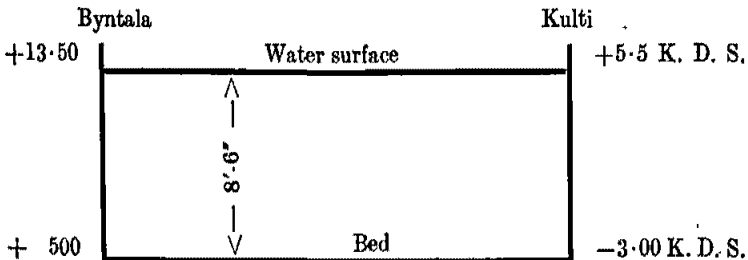
headed up portion of the channel would hold a volume equivalent to the discharge (2,500 cusecs) running for about $4\frac{1}{2}$ hours. With the storm water channel headed up to 10.5 K. D. S. and water in the Kulti at 4.5 K. D. S. (average low water level) the sluice would discharge at the rate of 8,490 cusecs. From tidal curves of the Kulti it appears that the rate of rise from low water is about 1 ft. per half hour. The discharge through the sluice is constantly reducing as water level in the storm water channel falls and water in the Kulti rises. I have made an approximate calculation which shows that the headed up water would be reduced back to 4.5 K. D. S. in under two tides. We may take it therefore that such a storm water channel would store the storm water run-off for $4\frac{1}{2}$ hours and would empty itself back to average low tide level in 24 hours. The channel, however, would have many obvious disadvantages. It would have to have very high banks capable of allowing the water at the tail head up to about 16 feet depth, the channel when not functioning would contain stagnant water from its tail up to Byntala and the velocity would be so low when storm water did flow in it that silt would be rapidly deposited.

9. A storm water channel as proposed by Dr. Dey with water surface level 16.00 K. D. S. at Byntala would also work on similar lines and would be subject to similar disabilities. The main objection would be low velocity and rapid silting of the channel. To maintain a suitable water slope in the storm water channel such as would prevent silting it would be necessary to resort to pumping at Kulti. In the channel proposed by Dr. Dey it would apparently also be necessary to pump at the head to attain a water surface level of 16.00 K. D. S. at Byntala.

10. I will now consider the Dry Weather Flow Channel. In paragraph (1) (b) of the explanatory note on the outfall estimate Dr. Dey gave the following particulars of the channel:—

- Bed width—16 feet.
- Water depth (at full supply)—8.5 feet.
- Bed level at Kulti—3.00 K. D. S.
- Length—16 miles.
- Discharge (paragraph 6)—600 cusecs.

The following diagram represents the proposed channel:—



Subsequently in Annexure II to his note of 22nd December 1931 Dr. Dey showed the Dry Weather Flow channel with a water surface level of 15.00 K. D. S. at Byntala bed levels remaining as originally proposed. As Dr. Dey himself remarks the design is not good for

uniform velocity. The water surface is not parallel to the bed of the channel. The Committee have already pointed out to Dr. Dey that his assumption of a uniform water slope in the channel when water is headed up at the outfall is incorrect. If the channel is to carry the solid matters of the sewage a uniform slope without reduction of velocity at the outfall is essential.

11. Starting with a water surface level of 13.5 at Byntala and allowing a slope of 0.5 feet per mile in the 16 miles to Kulti the water surface level at Kulti would be 5.50 K. D. S. but we will have to allow 1 ft. loss of head in the channel at the Bidyadhari syphon as in the storm water channel which reduces the water surface level at Kulti to 4.50 K. D. S.

12. Allowing 3 sluices 8' x 6' or 144 sq. feet area of sluice a head of 0.5 feet is necessary to discharge 600 cusecs through the sluices. There will therefore be a free discharge without heading up in the channel only as long as tide level at Kulti is at 4.00 K. D. S. or below it. From Table No. 8 accompanying Dr. Dey's letter of 22nd December 1931 it will be seen that the average low tide level at Kulti throughout the year in 1930 was 3.7 (say 3.5 feet) K. D. S. The channel would therefore only have a full free discharge by gravity while the tide rose from 3.5 to 4.0 and discharge without heading up in the channel would cease when the tide rose to 4.5 K. D. S. From an examination of tidal curves at Kulti I find that the tide rises from low water at about an average of 1 ft. per half-hour. In half an hour after low tide it would therefore be necessary to pump the whole of the sewage discharge. A similar period of free discharge would be available on the falling tide so the total period of free discharge would be one hour per tide. For the balance or for about 22 hours out of the 24 complete pumping of 600 cusecs would be necessary. The period of free discharge is so short that it may almost be neglected, in other words the discharge of the Dry Weather Flow channel would practically have to be pumped continuously up to a maximum lift of about 11 feet at high tide. An outfall to Kulti therefore would not avoid having to pump the whole of the Dry Weather Flow.

13. The lack of fall from Calcutta to the Kulti Outfall in my opinion renders any sewage outfall to the Kulti impossible without pumping. It is obvious that Mr. Ball Hill found the same difficulty even in his scheme as he allowed a slope of only 1 in 20,000 or 0.026 ft. per mile in his outfall channel. A channel carrying sewage with this slope would obviously deposit its solid matters in the channel and require constant clearance.

W. ROCHE,

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