GOVERNMENT NOTIFICATION.—No. 335.

The following Correspondence regarding the Kowloon Water-works Gravitation Scheme was laid before the Legislative Council on the 4th instant, and is published.

By Command,

F. H. MAY,
Colonial Secretary.

Colonial Secretary's Office, Hongkong, 4th June, 1902.

(Secretary of State to Governor.)

HONGKONG. DOWNING STREET,

No. 437. *27th December*, 1901.

SIR,—I have the honour to acknowledge the receipt of your despatch No. 454 of the 31st October, submitting an improved scheme for the Kowloon Water-works and to transmit to you a copy of a report by Mr. O. CHADWICK, C.M.G., to whom the question was referred.

2. I approve this scheme being carried out in the manner suggested in Mr. CHADWICK's report.

3. I presume that the points, on which he states that he is not quite clear, can await his arrival in the Colony, for which he proposes to start soon after the middle of January.

I have the honour to be,

Sir,

Your most obedient, humble Servant,

J. CHAMBERLAIN.

Governor
Sir H. A. BLAKE, G.C.M.G.,
&c., &c., &c.

(Enclosure.)

(Mr. Chadwick to Crown Agents.)

Re HONGKONG-KOWLOON WATER SUPPLY.

7, CARTERET STREET,
WESTMINSTER, S. W.,
20th December, 1901.

GENTLEMEN,

1. I have the honour to return, herewith, the plans and papers, concerning a proposed water supply for Kowloon, and I beg to report thereon as follows:—

2. The works, now proposed, are more extensive and will afford a larger supply than those originally projected by Mr. GIBBS, and described in his report, dated 8th January, 1900. I am of opinion that the rapid increase of population, stated by the Director of Public Works, fully justifies the additional cost of the more extensive scheme.

3. I feel some difficulty in reconciling the figures, concerning the augmentation of the supply, from 590,000 to 1,575,000 gallons a day, with the plan sent home, shewing the gathering-grounds and reservoir-sites. This plan shews a total area of 415 acres, which is only about one-third more than that to be utilised, under

Available supply.

the original scheme, and obviously would not produce a nearly three-fold increase in the yield. In the report of the Director of Public Works, paragraph 12 section 2, a "Catch-water" is mentioned. This, I presume, brings in the water from some area, amounting to 400 acres, not shewn on the plan, and therefore making a total of about 800 acres. Applying to this area the Hongkong data, quoted in my report of 17th August, 1900, the available daily supply would be 1,488,000 gallons a day, an amount agreeing substantially, with that estimated by the Director of Public Works, namely, 1,575,000 gallons a day.

Reservoir capacity.

4. According to the same data, a reservoir capacity equal to 200 days' consumption, will be required to maintain the supply. The now proposed reservoir is to contain 310 millions of gallons, so that, according to Hongkong experience, it should suffice to maintain the desired supply.

Material of dam.

5. I am glad to learn that it is now proposed to construct a masonry dam. I do not consider that it would be safe to construct an earthen dam, of the height now proposed, nearly 100 feet. Indeed I hold the opinion, one shared I believe by most Engineers, that masonry (including concrete) should be preferred, whenever the conditions for its use, are reasonably favourable.

The design of dam.

6. The section of the masonry dam is judiciously designed. I have investigated the stresses, and I find that the conditions of stability, usually accepted, are fully satisfied, even when the reservoir is full to the very crest, in other words when the water-level, during a great flood is 4 feet above the cill of the waste-weir. The stresses per square foot are, speaking from memory, less than those which obtain in the case of the Taitam Dam.

Dam to be carried up to full height at once.

7. I agree with the Director of Public Works, that the dam should be carried up, at once, to the full height. The saving, due to leaving off at a lower level, will be small. The reservoir capacity, even at the full height, is by no means excessive. The crest of the dam is to serve as a road or path. By completing the dam at once, this roadway can be constructed at its final level, and will not require subsequent alteration.

Foundations.

8. I presume that trial-pits have been sunk, along the centre line of the dam, and that the depths of foundation, shewn on the sheet of sections have been fixed in accordance with their indications. No longitudinal section of the dam is given, so I am unable to ascertain the intentions of the designers, in the matter of foundations. I am however of opinion that in getting out the foundations, stepping should be avoided. The base of the foundations. should, as far as possible, be an uniformly inclined line. Abrupt changes of level should be avoided, as far as possible, because sudden variations in depth tend to cause irregular settlement.

Waste-weir.

9. No drawing of the waste-weir has been sent to me, I am not therefore in a position to offer any opinion as to its sufficiency. The position of the waste-weir as indicated on the general plan, is satisfactory. The length of the waste-weir should be sufficient to discharge 4″ of rain, falling on the gathering-ground which contributes directly to the reservoir, plus the maximum quantity of water that the catch-water channel can convey. The latter should be provided with overflows, at points where it crosses natural drainage channels.

Draw-off arrangements.

10. The draw-off arrangements are satisfactory in principle. Some minor alterations in detail seem desirable. It is hardly necessary to go into this question at present, for the outlet apparatus will not be required, for some time to come.

Outlet-culvert.

11. It is worthy of consideration whether the sectional area of the outlet-culvert might not be increased with advantage, so as to provide water-way for the passage of rain-water during moderate floods. If, during a great flood the unfinished dam is overtopped, no great damage will result. This is one of the great merits of masonry as against earth. An earth dam, if overtopped, would be destroyed.

12. I recommend that the dam be constructed departmentally, and not by contract, so as to ensure perfect workmanship, an arrangement adopted by Mr. MANSERGH, Past President Inst. C.E., in the case of the dams for the Birmingham Water-works. At any rate, most careful supervision will be required. Competent European foremen or inspectors must supervise the work continuously. All cement should be provided by the Government. Method of construction.

13. In the case of the Taitam Dam, the late Sir ROBERT RAWLINSON, K. C. B., directed numerous small drains to be formed in the mass of the concrete behind the inner lining of masonry intended to be water-tight, in order that should any water find its way through the said lining it would flow freely away, and not accumulate in any fissure or cavity, causing an upward hydrostatic pressure, tending to reduce the stability of the structure. I consider that this would be a wise precaution. In the case of Taitam it was not however adopted, because those in charge of construction thought that the concrete would be sufficiently porous, to prevent any such prejudicial accumulation. As a matter of fact, the Taitam dam leaks considerably through the mass of the concrete. I maintain that concrete should be impervious, the interstices between the stones being completely filled with mortar. Percolation through concrete tends to its disintegration. Mr. MANSERGH informs me, that in the case of the Birmingham Dams, he is not draining the whole mass of the concrete, in the manner recommended by the late Sir ROBERT RAWLINSON, but he is taking every precaution to render the whole mass absolutely homogeneous and impervious. The only drains which he introduces are to remove the land springs, found in the excavations for the foundations, and he has also provided a single drain, at a low level, below the whole length of the dam, to remove any water which might by chance percolate through the water face, below the foundations, and this drain communicates with the out-let culvert. Drains in the mass of the dam.

14. The surface of the drainage area should be as little disturbed as possible, the natural growth of herbage should not be broken up. The main reason why the water of "Pokfolum Reservoir" is so turbid after heavy rain, is because so much bare soil is exposed, within its gathering-ground, owing to excavation for roads, and for building-sites. Drainage area not to be disturbed.

15. In conclusion, I beg to record my opinion that the project for the water-supply of Kowloon is sound and one that may be sanctioned.

I have the honour to be,

Gentlemen,

Your obedient Servant,

OSBERT CHADWICK.

(Mr. Chadwick to Colonial Secretary.)

Re NEW KOWLOON WATER WORKS.

GOVERNMENT OFFICE,

HONGKONG, 13*th May*, 1902.

SIR,—I have the honour to report that I have visited the site of the proposed works in company with the Honourable the Director of Public Works and with Mr. GIBBS, C.E. I have also inspected the Plans, and fully discussed them with the said Engineers. I beg to confirm the opinion, which I have already expressed in a report dated 20th December, 1901, to the effect that the Design is in every way satisfactory; and that the Project is one that should be carried out forthwith. Confirming previous report and approving design.

Composition of concrete.

2. There are, however, some points concerning which some modification or reconsideration appears to be desirable. One of these concerns the composition of the Concrete.

Three qualities of Cement Concrete are specified, for different portions of the work, composed as follows:—

	Parts by Measure.		
	1st Quality.	*2nd Quality.*	*3rd Quality.*
Cement.....	1	1	1
Sand	2	2	$2\frac{1}{2}$
Broken stones	4	5	6

Now, I am of opinion that in making concrete, care should be taken to make the resultant mass thoroughly homogeneous and free from voids. To fulfil this condition, it is essential that the voids between the broken stone forming the matrix shall be entirely filled with cement mortar, and secondly that the interstices between the sand-grains shall be completely filled with cement. Most of the troubles which have occasionally been experienced in connection with concrete, are traceable to porosity. Portland cement, though practically insoluble when in solid mass, is not so when finely-divided. If water be caused to percolate through a porous mass of Portland cement and sand, the interstices between the grains not being fully filled with cement, the mass will disintegrate in time.

It has, therefore, been my practice, in case of important works like the present, not to resort to any arbitrary prescription, as to the composition of concrete; but to determine, experimentally, the percentage of voids in the matrix and in the sand, and then to fix the proportions in a scientific manner.

Determination of voids in broken stone.

3. The proportion of voids in the broken stone may be determined as follows. Take a sample of the broken-stone, and soak it in water. Then drain off all water, not actually absorbed. Take any water-tight vessel, such as a bucket or cask. Weigh it empty. Let its weight empty, or tare, be T, then fill with water, and let the weight of bucket and water be W, so that the nett weight of the contained water will be W-T. Empty out the water, and fill the bucket with stones. Weigh again, let the weight of the bucket and stones be S. Now add water, so as to fill the interstices, between the stones. Weigh again. Let the final weight (bucket, water and stones) be P. Then $\frac{P-S}{W-T}$ = Percentage of Voids.

The percentage of voids in stones, broken to approximately uniform cubes, like road-metal, is about 50%. This may however be materially reduced by using assorted sizes, the smaller particles inserting themselves between the larger masses. Having determined the actual percentage of voids, a sufficient proportion of cement mortar must be provided, to fill them, when the cement and sand are mixed and moistened ready for use, in a plastic condition.

Voids in sand.

4. The voids in the sand which is to be mixed with the cement may be determined in like manner. Usually they amount to about 33%, so that three of sand to one of cement, is about the poorest mixture that can be expected to be non-porous. It usually suffices however to determine, experimentally, the volume of plastic mortar which is formed by some given proportion of cement, sand and water. For example, take say one cubic foot of cement and two of sand. Mix with water, into a paste of proper consistency, and measure the resulting mortar in a cubic foot box. Usually two and one will give 2 to $2\frac{1}{4}$ of finished mortar. Suppose that the latter is the case, and that the percentage of voids, in the matrix, is 50%. Then the proper proportions will be $4\frac{1}{2}$: 2: 1.

The proposed mixtures may or may not fulfil the conditions of the case. This will depend upon the percentage of voids in the matrix. The first quality mortar seems likely to be homogeneous. One of cement and two of sand makes, usually, about two parts of mortar, which, with the usual voids, will suffice for 4

parts of broken stone. The second and third quality mortars seem less likely to be homogeneous. The best and only certain plan is to determine the proportions experimentally, according to the voids actually found in the matrix.

Use of red yellow earth with cement.

5. I attach so much importance to complete solidity that, if concrete proportioned as I have described, contains more cement than can be afforded, I should try the effect of adding good red earth, which is of the nature of Puzzolana. Recent experiments made in Germany, show that the addition of Puzzolana to Portland cement, improves its setting properties. Portland cement, in setting, liberates a certain proportion of hydrate of lime. When Puzzolana is present it combines forthwith, with the lime liberated, thus preventing effervescence and obviating porosity. In certain water-works in Mauritius a mixture of burned coral-lime, coral sand, red earth and a small proportion of cement, was used with success. It was also found that the addition of red earth to the cement and sand mortar, used for jointing pipes, completely obviated porosity, which was most difficult to avoid when sand alone was used. I think that it would be well worth while to experiment with various mixtures of stone, sand and cement, with and without red earth, the voids in any case being filled. If 9″ cubes, of the several samples, were made, and sent home to me at the University College, I shall be happy to have them crushed, in the testing machine, belonging to the Engineering Laboratory. The exact strength of each mixture would then be known, and it could be allotted to the part of the work for which it proves suitable.

Stepping foundations.

6. In my original report, I recommended that foundations should not be stepped. I then referred to stepping in the longitudinal section of the dam. In the cross-section, at right angles to its length, stepping may, and in many cases should be resorted to.

Construction of dam — drainage of foundations.

7. It is desirable to construct a regular Drain or Culvert running along the whole of the length of the dam, at the lowest point of the foundation and located immediately behind the water-tight mass, forming the water-front or inner lining of the dam. This Drain will serve to collect and carry off any spring-water, that may be found during construction. It should have a free outlet at the lowest level possible, so that, should there be any failure to produce an absolutely water-tight junction with the soil or rock, it will effectively prevent any accumulation of water under full pressure, beneath the foundation, so as to exert a prejudicial upward pressure. If there be any other water-bearing springs or fissures, in any part of the foundation, their water should be collected and conveyed to the main drain or to the outlet channel from it, which should always be left open. If there be any leakage it is better that it should be visible and escape freely than that it should accumulate and perhaps do unseen and unknown mischief.

Drainage of superstructure of dam.

8. I trust that if the suggestions which I have made as to the composition of concrete be adopted the whole mass of the dam will be homogeneous and water-tight. Nevertheless I think that it would be a prudent precaution to provide open channels or drains, extending through the whole mass from the outer-face to within about 4 feet of the inner water-tight face. These drains might be of 3″ Chinese stoneware pipes, of the commonest quality, spaced vertically and horizontally, about ten feet apart. These pipes can do no harm, they will cost little, and they may, if any local mistake be made in construction, be the means of relieving a congestion of water, which might be prejudicial. They will, at least, afford the means of localising any leakage, should one exist. I am fully aware that the provision of drains, through the mass of a masonry dam, is not a common practice. Mr. MANSERGH is not doing so at the Birmingham water-works. But it is to be remembered that these works are being carried out in England, departmentally, and with an abundance of highly skilled supervision, and not by a Chinese contractor, and limited skilled inspection.

The outlet culvert.

9. After discussion with Messrs. CHATHAM and GIBBS, I see no reason for altering the dimensions of the outlet culvert.

The draw-off valves.

10. I am of opinion that it will be advisable to reduce the diameter of the outlet valves in the tower to 6″, providing proper taper-pieces for connection with them. With suitably-formed taper-pieces the delivery will not be appreciably reduced, and the smaller valves will be much easier to open and shut, than the large, and much less liable to breakage, in so doing. Some arrangement for closing the outlets, outside the tower, in the event of breakage, should be provided. These matters can be arranged, when the indent for the iron-work is sent in.

Venturi meters to filter-beds.

11. The drawings of the filter-beds have not yet been completed. If they are designed, on the lines of those now in use in Hongkong, they will answer well. I recommend however that each filter-bed be provided with a separate Venturimeter constructed in accordance with a special arrangement, adapted for the regulation of filtration. On my return to England I will be happy to obtain a quotation for these meters.

Large Venturi meter for registering daily consumption.

12. It would also be well to provide one large recording Venturi meter, for registering the daily consumption of water from the service-reservoir.

Measurement of flow of streams during construction.

13. It is desirable to measure the flow of the streams close below the reservoir, during construction. The arrangements should be such as to admit of accurate measurement, not only of dry weather flow, but also of moderate floods.

Probably the best arrangement would be one similar to that suggested for the measurement of the flow of Taitam stream; a large V notch for measuring small flows, and a wide square notch, for floods. It will be well also to have a self-recording water-level indicator, at each gauge.

Construction of service-reservoir.

14. The service-reservoir drawings are not yet complete. It is very properly to be roofed. I have recently used roofs composed of concrete on steel girders and joists supported by cast iron stanchions, an arrangement which has usually proved more economical than masonry arches and piers. Whether this would be the case, in the present instance, I cannot say. It would however be well to get out alternative designs for the two classes of roofs. The proposed circular form lends itself to the site and naturally has the shortest length of wall, for a given capacity. I must however state that, owing to the difficulty in devising an economical covering, I have rarely found circular reservoirs economical in first cost.

Subsidiary filter-beds.

15. The principal filter-beds are to be placed near to the reservoir. It is proposed to intercept certain streams along the pipe track, between the filter-beds and the service-reservoir, and at each intake to construct a small filter-bed to filter the water of the stream, prior to its admission to the main.

I suggest the use of the Fischer Artificial Filter for these subsidiary beds. This filter consists of flattened bottles, made of porous material, composed of sand and glass, fused together. Each bottle is rectangular 3′ 3″ × 3′ 3″ × 4″. These are placed upright, in a suitable tank. A large filtering-area is provided, with relatively small floor-space. The water surrounds the filter-plate and passes through its pores, to the interior cavity, whence it is drawn off by appropriate pipes. The main advantage of the Fischer Filter, in the present case, is the ease with which it can be cleaned, and managed. A small cistern is provided at an elevation of about 10 feet, into which filtered water is pumped. The cleaning of the filter is accomplished, merely by altering the adjustment of certain valves so as to reverse the direction of the flow through the filtering material. The filtered water enters the interior cavity, passes out through the pores of the material, and forces off the adhering slime, which is then sludged out of the filtering-chamber. I have experimented on one of these filters, in connection with some very dirty water, and found that it could be cleaned with the utmost ease. I do not assert that the Fischer Filter effects better, even as good, results as well-managed sand-filtration, but I am confident that it will give better results than an ill-managed sand-filter. I fear that it will be both expensive and difficult to secure good management, in the case of small scattered filters.

16. In the cases of intakes just referred to at which filter-beds are to be provided, it would be well to provide an arrangement, by which the water of the stream is automatically intercepted during floods, so as to prevent unnecessary clogging of the filter beds. This may easily be done by constructing weirs and notches with a receiving channel, below and parallel to the crest. The channel will be so proportioned that when the stream is delivering more than a certain quantity, the cascade or apron overleaps the receiving channel. This arrangement is illustrated in works on water-supply. Interception of flood waters.

17. For the purpose of collecting statistics as to quantity of water which overflows, at the waste-weir of the reservoir, it will be well to provide means of measuring the escaping water with some accuracy. Want of such measurement has greatly reduced the value of the data recorded at Taitam. This may be done, either by constructing special gauge weirs in the overflow channel, as already described for use during construction, or by using well-constructed iron-sluices in lieu of the stop-boards with which it is now proposed to crown the waste-weir, after the first three months of the wet season. I am of opinion, that it will be a good plan, in any case to have proper iron sluices, as there is to be a bridge over the waste weir, from which they could be manipulated by means of some simple mechanism. By so doing, the stop sluices will always be to hand where required, and there will be no excuse for neglect to erect them when the time arrives for so doing. Moreover, I see no reason why these sluices should not be so contrived as to open automatically when the water rises to their upper edge. If so arranged, they might be left permanently in place. Measurement of overflow from reservoir.

To this end they should be carried on horizontal pivots, placed at one-third of their total height from their lower edge.

I have the honour to be,

Sir,

Your obedient Servant,

OSBERT CHADWICK.

GOVERNMENT NOTIFICATION.—No. 336.

The following is published for general information.

By Command,

F. H. MAY,
Colonial Secretary.

Colonial Secretary's Office, Hongkong, 6th June, 1902.

A SERVICE OF THANKSGIVING

FOR THE RESTORATION OF PEACE

within His Majesty's Dominions

will be held in St. John's Cathedral, on Sunday next, June 8th, at 11 a.m.

G. A. BUNBURY,
Acting Cathedral Chaplain.

Hongkong, 6th June, 1902.