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MADRAS RECORD OFFICE.

Government of Madras.

Public works DEPARTMENT.

G.O. No. <u>1662</u>	Press ~~Mis.~~
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Dated <u>26-5-</u>	<u>18 66.</u>

Not to be folded or roughly handled

*Proceedings of the Madras Government, Public Works Department,
26th May 1866.*

No. 600. Read the following letter from W. FRASER, Esq., C. E., Special Executive Engineer, to the Secretary to Government, Public Works Department, dated Mount Road, Madras, 7th May 1866, No. 1 :—

1. I have the honor to submit a second volume of Plans of the Madras Water Works, with a copy of the detailed estimate and a copy of the general specification, which I trust will be found satisfactory.

2. On comparing the abstract estimate now forwarded with that attached to my report it will be seen that this one exceeds the former by 590 Rupees.

This is occasioned by some alterations I made in some of the rates.

Since I sent up my report I have consulted three or four parties in Madras, who are supposed to be most familiar with the present rates of work, and they have confirmed my former opinion that the works can be executed by Native Contractors for the amount of the estimate; but I am aware that English Contractors would not take the work at these prices.

3. I regret that when you requested me to send an unbound set of plans for transmission to Calcutta, the four sets had all been bound.

I forward two coloured copies of the Index plan and section.

No. 601.

ORDER THEREON, 26th May 1866, No. 1,662.

CIVIL WORKS, No. 82.

Ordered to be recorded.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

Erd. S. T. Augustin.

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Specification for the works included in the Volume of Plans which accompanied the first Report.

1. PLANS, DIMENSIONS, &c.—The several works are delineated on the plans numbered from 1 to 31 inclusive. The details are generally shown on a scale sufficiently large to be clearly understood; but should any details have been accidentally omitted, which may fairly be supposed to form a part of such works, they are to be understood, and are to be constructed.

Should there be any difference between any portions of the works as they are drawn, and the sketches or descriptions in this specification, or any difference between the dimensions figured on the drawings and those in this specification, the latter, in both cases, are to be taken as correct; and should there be any difference between the scaling of the plan and the dimensions figured thereon, the figures are to be taken as correct.

2. SITES.—The sites of the several works are marked on the plans, but it will be competent for the Engineer to alter the sites, under the authority of Government, should he consider it advantageous to do so.

3. MATERIALS.—Unless where it is distinctly stated to the contrary, all materials are to be of the best description afforded by the locality of the works.

4. LIME.—Shell lime is generally understood to be the description used; but the Engineer in charge may permit or insist on the use of any of the stone limes, which are found at certain places along the line of works.

Whichever is used it must be supplied to the works freshly burned, as required; and when brought to the work it must on no account be left exposed to the weather, but must be either housed at once, or covered over carefully with sand.

5. SAND.—No sea sand nor sand containing any proportion of saline matter is to be used in any portion of the work; clean, sharp, river or pit sand shall alone be used; and it must be free from clay and silt.

6. CLAY.—Burned clay is to be used in the preparation of mortar and concrete or beton. It is unnecessary that it should be quite pure, as ordinary earth free from sand and silt will do. Care must be taken that it is burned only until it becomes red; when the fires must be immediately extinguished, and the clay kept covered and hot until required.

7. BRICKS.—In all cases bench-moulded bricks, of the English size, are intended. But the Engineer in charge may, in some portions of the works, allow bricks of the ordinary native manufacture to be used. All bricks irregular in shape, having a twist, or sand, or other cracks will be rejected.

8. **STONE LATERITE.**—Wherever laterite is used it must be of the dark colored and thoroughly indurated description.

The soft white description must not be used on the works, except by the special permission of the Engineer.

9. GRAVEL AND BROKEN STONES.—Wherever *gravel* is specified, dark colored, indurated, small laterite gravel is understood: and wherever *broken stone* is mentioned, angular fragments of gneiss or other hard rock, and not more than one and a quarter inches in diameter, are intended.

10. CONCRETE OF BETON.—This is to be made with lime, burned clay, sand, laterite gravel, and broken stone, in such proportion as may be directed by the Engineer.

The exact proportions will depend principally on the quality of the lime which can most readily be procured; but should shell lime or one equally pure be used, the following proportion will probably be adopted:—

Lime	...	...	...	6 Cubic feet.
Burned clay	...	...	...	10 "
Sand	...	...	...	6 "
Laterite gravel	...	...	...	6 "
Broken stones	...	...	...	4 "

—
32

This quantity will probably make one cubic yard of concrete or beton.

11. Whatever proportions are used, the following mode of preparation must be adopted. If rich lime is used it may be slaked in the usual way, with just water enough to convert it into a fine powder. Should the lime possess hydraulic properties to any considerable extent it must be ground before slaking. In this case too, the process of slaking should be continued from twelve to twenty-four hours, according to the quality of the lime, and in both cases the lime must be thoroughly slaked before it is used. After slaking, the rich limes may be kept for sometime, but the poor limes must be used immediately. The slaked lime, powdered clay, and sand must then be sifted together, so that they shall be thoroughly and equally mixed in their due proportion. For this purpose the common native bamboo sieve will not answer, and must not be used; but wire lime-sieves, of the English pattern, must be provided, and used in the ordinary rocking frame.

Sufficient water is to be added, and the whole is to be turned over and thoroughly mixed, or beaten in the usual way, until a thick pasty mortar is produced, which falls from the trowel or shovel in the manner which indicates that the incorporation is complete: the laterite gravel and broken stone are then to be added, and the whole turned over until the gravel and stone are equally distributed through the mortar.

12. As soon as possible after this, the concrete is to be wheeled into its place. It is not to be thrown from a height, but to be laid in quietly, spread, and levelled to the required thickness, and then beaten down with heavy rammers. If any portions yield under the punning, fresh concrete is to be laid in and beaten down, so that when completed the surface of the concrete shall be level. In all cases the punning is to be continued until the water begins to spurt up through the surface.

Should the concrete be particularly dry when laid in, water may be sprinkled over it as it is beaten down; but great care must be taken that no more water is added at any time than is sufficient to produce a thick pasty substance.

13. If possible the whole of the concrete of any one work, or of any one part of a work, should be begun and finished within one day. If such however, be impossible, each layer of the proper thickness should be completed in one day, so that there shall be no vertical joint in any part of the work.

14. The layers of concrete laid in foundations are to fill the foundation trench from side to side, care having previously been taken to cut the trench to the exact dimensions. Should the trench, through carelessness, have been cut too

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large, it must be filled with the concrete as described above, but where the sides of the trench will not stand, or where from any other sufficient reason there would be a useless waste of material by filling in the whole trench, the sides of the concrete may be confined by any other means, and, as the layers are finished, sound earth is to be carefully packed in at the sides and well rammed down; water being used, if necessary, to make a sound, perfect job. Special care must be observed that the layers previously laid in are not disturbed.

15. Should any delay take place in building over the concrete, or in cases where it has to be carried up in layers, (as in the retaining walls of the Cortilliar dam,) it must be completely covered with bundles of straw at least fifteen to eighteen inches in thickness, and which are to be kept constantly wet until the work is finished, or the concrete is built upon.

16. MORTAR.—The mortar used in all the works is to be composed of lime, burned clay, and sand, in such proportions as the Engineer shall direct.

The ingredients are to be sifted dry, and mixed with water as described in paragraph No. 11, and particular care is to be taken that no more water is used than that necessary to form a thick strong paste.

17. EXCAVATION FOR FOUNDATION.—The excavations for foundations are to be made to the dimensions marked upon the Drawings. All unsound earth is to be removed, and replaced with such material as the Engineer may direct. If necessary the whole is to be well rammed down, until the bottom is equally hard throughout.

In no case is the building to be commenced until the Engineer has inspected and approved of the trenches.

18. PUDDLE.—The puddle must be of the best clay to be had in the locality of the works. None is to be used which is not approved of by the Engineer, and any rejected by him must be immediately removed from, or used up in some other part of the works.

The clay is to be puddled near the work, and when laid in must be puddled again and thoroughly united with the previous layer, which must be kept wet for this purpose.

19. MASON WORK AND BRICK-WORK.—Unless where otherwise shown on the Drawings, all mason and brick-work are to be built in courses horizontal and vertical in their beds and joints. the offsets of the footings are not, on any side, to exceed one-fourth the height of the course. In brick-work the total height of four courses must not exceed the height of the bricks by more than one inch. Every part of a wall must be equally soundly built, and every course must be levelled off before another is commenced, and every course in mason work, and every second course in brick-work, must be grouted with fluid mortar.

In this Presidency it is customary to use stone and bricks dry in building, but to use the mortar in a very fluid state. This system of working will not be permitted. Laterite stone and bricks must be thoroughly wetted, until they will absorb no more water before they are built in, and the mortar must be of the consistency of a thick paste, sufficiently strong to remain in position when spread upon a brick or stone to form a joint.

During the progress of a work, the portion on which the workmen are not engaged must be kept constantly covered with mats and wet straw, as before described in paragraph 15.

Every portion of a work or wall must be equally soundly built; and should the use of two sizes of bricks be permitted in any case, the whole of the work up to the same level must be built with bricks of the same size.

20. **CORTILLIAR DAM.**—The form and dimensions are shown on the Drawing Sheet No. 3.

The trenches for the retaining walls are to be carried down two or three feet into the stratum of clay which under-lies the sand, as shown in the Drawing.

If possible the trenches are to be excavated to the full depth and length before any of the concrete is laid in. The only difficulty in the way of accomplishing this is the quantity of water which may have to be dealt with; but it is so important that the two retaining walls should be unbroken, that this mode of construction must be adopted unless it is found to be impracticable except at a greatly increased cost. During the dry weather the quantity of water in the Cortilliar is so very small, that I believe three or four picottas, or a couple of Gwynnes' pumps, worked by a small steam engine, would suffice to keep it down.

As this dam would probably be the last work executed, the river could be bunded across above the site, and a large quantity of the water drawn off through the supply channel and into the river, by a small deep ravine which is close by. The concrete in the retaining walls is to be carried up in layers not exceeding twelve inches in height, according to the instructions under the head "concrete."

21. As much of the sand as will stand between the two retaining walls, when the trenches are excavated, may be allowed to remain; but as the walls are carried up, the space between them and the core of sand are to be filled in with layers of earth, gravel, refuse of lime, &c. The layers are to correspond in height with those of the concrete, and are to be watered and rammed down.

22. The stone work of the dam and the concrete under it are to be carried up together, the stones to be embedded in the concrete, and cemented with mortar, prepared as described in paragraph 16. According as the stone work is completed, the joints are to be raked out at least two inches in depth, and the whole must be pointed with mortar prepared as before described, with the addition of being ground fine. This pointing must be done before the work dries; but at the same time, the stones and joints must be sprinkled with water before the pointing is laid in.

23. To cover so large a work as this dam with wet straw would be very expensive, but as it is essential that it should dry very slowly, it may, as the pointing is completed, be covered with sand to a depth of two feet, which is to be kept moist for fifteen days.

24. The rough stone work at the toe of the slopes is to consist of the largest blocks that can be conveyed by ordinary means to the site. They are to be carefully laid.

25. **HEAD SLUICE.**—This work is designed to be built with laterite. The flooring, to the extent shown on the Drawings, is to be rough dressed blocks of gneiss, and the face of the recess for the gates, and the faces of the spandrel walls, so far as the gates shall slide upon them, are to be of fair dressed gneiss.

The paving is to be embedded in concrete.

The timber work is to be of teak.

26. **SUPPLY CHANNEL.**—The dimensions of the supply channel are shown on the Drawings.

There is to be a berm of five yards on each side, and at all low places the spoil must be formed with a bank at each side, rising to at least the height of the proposed bunds around Cholvaram and Red Hill lakes. The inner slope of the spoil bank is to be one to one, the outer slope may be anything the quantity of materials will allow of, but the bank must not at any place be less in section than one to one on the inner side, three feet broad on the top, and one and a half to one on the outer side.

Where the surface of the land is sufficiently high not to require the side banks, the spoil shall be disposed of as the Engineer shall direct.

27. **BRIDGES OF STONE AND BRICKS.**—The drawings of the bridges are sufficiently in detail to show clearly how they are to be built, but the following remarks are necessary. The centers are to be eased when the arches are closed, and they are to be removed altogether before any work higher than the crown of the intrados is built.

The joints in the back of the arch are to be raked out, the whole swept clean and then covered with six inches in thickness of concrete.

This must be done after the arch has settled, but before it has thoroughly dried, and the whole must be kept moist for ten or twelve days.

28. When the bridge is of stone, the work is to be carefully pointed as described in paragraph 22; only the joints need not be raked out to more than an inch in depth.

When the bridges are of brick, they may be either pointed or plastered according to the quality of the bricks. In all cases where it is decided that the brick work shall be plastered, each day's work, as it is completed, must be white-washed.

29. **PLASTERING.**—The plastering is to consist of two coats, a rendering and floating coat.

For the rendering coat the work is to be prepared by raking out the joints as for pointing, and the surface of the work and insides of the joints must be well wet when they are swept clean.

The rendering coat may consist of the ordinary mortar described in paragraph 16, but the floating coat, though of the same materials, must be ground fine in the usual way. In preparing the mortar for plastering and pointing, the lime must be a perfect hydrate before it is used. For this purpose rich lime is to be used, and it must be kept in water, and reduced to a pasty state before it is mixed with the clay and sand.

The floating coat is to be polished in the usual way.

30. **TANK BUNDS.**—The manner in which these bunds are to be raised is shown on the cross sections.—See sheets 13, 18, and 19.

The old revetment and other stone or gravel work on the inner face are to be removed, and the old earth-work cut to the slope of one and a half to one.

The face of the new bund will consist of—

I. An outer revetment of roughly squared laterite, eighteen inches in thickness.

II. Next to this, twelve inches thick of stones and gravel, hand laid, and closely packed together, and filling up the spaces between the stones used in the revetment.

III. At the rear of this there is to be four feet in thickness of puddle, well worked in, as described in paragraph 18, and closely connected (by the use of water, &c.,) with the materials of the old bund.

The puddle wall and revetment are to be founded in the solid earth.

31. The outer slope of the old bund is to be stepped out to receive the new material, and the top of the bund is to be picked up to at least twelve inches in depth, and if it be of gravel it must be removed, and the whole thoroughly wetted before the new material is laid on. The new material is to be carried up in layers not exceeding one foot in thickness, and they are to incline towards the center, as shown on the Drawing.

32. So much of the bund as lies on the tank side of a vertical line drawn down from the center of the top of the bund, is to be formed with materials as nearly impervious to water as it is possible to get them within a reasonable distance. This portion of the bund is to be made with great care, and should the Engineer consider it necessary, water is to be used in laying the earth in. The remainder of the bund may be of materials of a looser but heavier description, such as gravel stones, &c., but the outer slope must be covered with earth to at least one foot in thickness.

PARAPET.—A low parapet wall, as shown in the Drawings, is to be built upon the revetment all along the tank bund. The parapet is to be built with mortar.

33. No material for the bund is to be excavated in the bed of the tanks without the written sanction of the Engineer, and even then the excavation is not to approach nearer than within fifty feet of the toe of the revetment.

The same distance is to be observed with regard to excavations on the other side of the bund.

34. CALINGULAHs, SLUICES, &c.—The calingulahs, irrigation sluices, and the Red Hill head sluice, call for no particular remarks.

The stone work in the calingulahs is to be laid in mortar, and pointed as described in the case of the Cortilliar dam.

For the form and dimensions of those works see the Drawings.

35. TIMBER BRIDGES.—One of these only, the foot bridge across the main channel, and forty-five feet in span, need be particularly alluded to.

Each girder is composed of two pieces of teak, fifty feet in length and six inches by six inches. They are laid parallel to each other and connected at the ends by blocks, on which they are prevented from sliding by keys of hard wood and wrought-iron straps.

The straps are to be put on hot, and when this part is finished the bottom and top pieces are to be sprung asunder in the center, to the extent shown on the Drawing; and a straining piece, six inches by six inches, inserted. A similar straining piece is to be inserted at every standard, and at the same places the top and bottom pieces are to be bolted together, as shown in detail on the Drawings. Care must be taken that the top and bottom girders are not injured. The whole work is to be built of teak.

36. DELIVERY CHANNEL TO MADRAS.—The channel to Madras is to have a berm on each side of four yards, and the spoil is to be arranged in embankments, as before described, to the height shown on the section.

37. BRIDGES AT MADRAS, &c.—The bridges proposed to be built in Madras and on the delivery channel call for no particular remarks; neither does the design for the irrigation and drainage under-tunnels.

(Signed) W. FRASER, C. E.,
Special Executive Engineer.

MADRAS,
7th May 1866.

Madras Water works

Specification for the works included
in the volume of Plans which
accompanied the first Report.

Plans, Dimensions 1st The several works are delineated on the Plans numbered from 1 to 81 inclusive. The details are generally shown on a scale sufficiently large to be clearly understood; but should any details have been accidentally omitted which may fairly be supposed to form a part of such works they are to be understood and are to be constructed.

Should there be any difference between any portions of the works as they are drawn, and the sketches or descriptions in this Specification; or any difference between the dimensions figured on the

drawings, and those in this specification, the latter, in both cases, are to be taken as correct; and should there be any difference between the scaling of the Plan and the dimensions figured thereon the figures are to be taken as correct.

2 The sites of the several Sites works are marked on the Plans, but it will be competent for the Engineer to alter the sites, under the authority of Government, should he consider it advantageous to do so.

3 Unless where it is distinctly Materials stated to the contrary, all materials are to be of the best description afforded by the locality of the works.

4 Shell Lime is generally under: Lime stood to be the description used; but the Engineer in charge may permit or insist on the use of any of the stone limes which are found at certain places

3
along the line of works: Which ever is used it must be supplied to the works freshly burned as required; and when brought to the work it must on no account be left exposed to the weather; but must be either housed at once, or covered over carefully with sand.

Sand 5 No sea sand nor sand containing any proportion of saline matter is to be used in any portion of the work; clean, sharp, River or Pit sand shall alone be used; and it must be free from clay and silt.

Clay 6 Burned clay is to be used in the preparation of mortar and concrete or Beton: It is unnecessary that it should be quite pure; as ordinary earth free from sand and silt will do: Care must be taken that it is burned

only until it becomes red, when, the fires, must be immediately extinguished and the clay kept covered and hot until required.

In all cases Bench moulded Bricks of the English size are intended: But the Engineer in charge may, in some portions of the works, allow Bricks of the ordinary native manufacture to be used: all bricks irregular in shape, having a twist, or sand or other cracks will be rejected.

Bricks

Wherever Laterite is used it must be of the dark coloured and thoroughly indurated description:

Stone Laterite

The soft white description must not be used on the works, except by the special permission of the Engineer.

Wherever gravel is specified, Dark colored, indurated small Laterite

Gravel and Broken Stone

gravel is understood: and, whenever broken stone is mentioned, angular fragments of Gneiss or other hard rock, and not more than 1 1/4 inches in diameter, are intended.

Concrete or Beton

This is to be made with Lime, burned clay, sand, Laterite gravel, and broken stone, in such proportion as may be directed by the Engineer:

The exact proportions will depend principally on the quality of the Lime which can most readily be procured; but should shell Lime or one equally pure be used the following proportion will probably be adopted:—

Lime	6	Cubic feet
Burned clay	10	"
Sand	6	"
Laterite gravel	6	"
Broken stones	4	"
	32	

This

This quantity will probably make
one cubic yard of Concrete or Beton.

II Whatever proportions are used
the following mode of preparation must
be adopted: If Rich Lime is used
it may be slaked in the usual
way, with just water enough to
convert it into a fine powder: should
the lime possess hydraulic properties to
any considerable extent it must be
ground before slacking: In this case
too, the process of slacking should
be continued from 12 to 24 hours according
to the quality of the Lime, and in both
cases the Lime must be thoroughly
slaked before it is used:—

after slaking the Rich limes may be
kept for some time, but the poor limes
must be used immediately:—

The slaked lime, powdered clay,

7
and sand must then be sifted
together so that they shall be
thoroughly and equally mixed in
their due preparation:— For this
purpose the common native Bamboo
sieve will not answer, and must
not be used; but wire Lime sieves
of the English pattern must be provided,
and used in the ordinary Racking frame.

Sufficient water is to be added,
and the whole is to be turned over
and thoroughly mixed or beaten in
the ~~same~~ ^{usual} way until a thick pasty
mortar is produced, which falls
from the trowel or shovel in the
manner which indicates that the
incorporation is complete: the laterite
gravel and broken stone are then to be
added, and the whole turned over
until the gravel and stone are equally distributed.

through the mortar: —

12 As soon as possible after this the concrete is to be wheeled into its place. It is not to be thrown from a height, but to be laid in quietly, spread, and levelled to the required thickness, and then beaten down with heavy rammers: If any portions yield under the punning fresh concrete is to be laid in and beaten down, so that when completed the surface of the concrete shall be level: In all cases the punning is to be continued until the water begins to spurt up through the surface:

Should the concrete be particularly dry when laid in, water may be sprinkled over it as it is beaten down; but great care must be taken that no more water is added at any time than is sufficient to produce a thick pasty substance. —

13 If possible the whole of the concrete of any one work, or of any one part of a work, should be begun and finished within one day: If such however, be impossible each layer of the proper thickness should be completed in one day, so that there shall be

196
no vertical joint in any part of the work.
14 The layers of concrete laid in foundation are to fill the foundation trench from side to side, care having previously been taken to cut the trench to the exact dimensions: — Should the trench through carelessness have been cut too large, it must be filled with the concrete as described above; but where the sides of the trench will not stand or where from any other sufficient reason there would be a useless waste of material by filling in the whole trench the sides of the concrete may be confined by any other means, and, as the layers are finished, sound earth is to be carefully packed in at the sides and well rammed down; water being used if necessary, to make a sound perfect job: — Special care must be observed that the layers previously laid in are not disturbed. —

15. Should any delay taken place in building over the Concrete, or in cases where it has to be carried up in layers (as in the retaining walls of the Cortulliar Dam) it must be completely covered with bundles of straw at least 15 to 18 inches in thickness, and which are to be kept constantly wet until the work is finished or the Concrete is built upon.

16. The Mortar used in all the works is to be composed of Lime, burned clay, and sand in such proportions as the Engineer shall direct.

The ingredients are to be sifted dry and mixed with water as described in paragraph N^o 11, and particular

Mortar

Excavation for foundation

17. The excavations for foundations are to be made to the dimensions marked upon the Drawings: All unsound earth is to be removed and replaced with such material as the Engineer may direct: If necessary the whole is to be well rammed down until the bottom is equally hard throughout.

In no case is the building to be commenced until the Engineer has inspected and approved of the trenches.

Puddle

18. The Puddle must be of the best clay to be had in the locality

of the works: None is to be used which is not approved of by the Engineer and any rejected by him must be immediately removed from, or used up in some other part of the works.

The clay is to be puddled near the work, and when laid in must be puddled again and thoroughly united with the previous layer which must be kept wet for this purpose.

19. Unless where otherwise shown on the drawings all mason. and Brickwork are to be built in courses horizontal and vertical in their beds and joints: — the offsets of the footings are not, on any side, to exceed one fourth the height of the course. In Brickwork the total height of

Mason work
and
Brickwork

13 236
four courses must not exceed the height of the Bricks by more than one inch: — Every part of a wall must be equally soundly built, and every course must be levelled off before another is commenced, and every course in mason work, and every second course in Brickwork must be grouted with fluid mortar.

— In this Presidency it is customary to use stone and Bricks dry in building, but to use the mortar in a very fluid state: —

This system of working will not be permitted: Laterite stone and Bricks must be thoroughly wetted until they will absorb no more water before they are built in.

and the mortar must be of the consistency of a thick paste, sufficiently strong to remain in position when spread upon a brick or stone to form a joint:—

During the progress of a work the portion on which the workmen are not engaged must be kept constantly covered with mats and wet straw as before described in paragraph 15.—

Every portion of a work or wall must be equally soundly built; and should the use of two sizes of Bricks be permitted in any case, the whole of the work up to the same level, must be built with bricks of the same size.—

are shown on the Drawing sheet No 3.

The trenches for the retaining walls are to be carried down 2 or 3 feet into the stratum of clay which underlies the sands as shown in the drawing:—

If possible the trenches are to be excavated to the full depth and length before any of the Concrete is laid in. The only difficulty in the way of accomplishing this is the quantity of water which may have to be dealt with; but, it is so important that the two retaining walls should be unbroken, that this mode of construction must be adopted unless it is found to be impracticable except at a greatly

15
increased cost. During the dry weather the quantity of water in the Cortiliat is so very small that I believe 3 or 4 Picottas, or a couple of Gwynnes' Pumps, worked by a small Steam Engine, would suffice to keep it down.

As this dam would probably be the last work executed, the River could be bridged across above the site, and a large quantity of the water drawn off through the supply channel, and into the River by a small deep ravine which is close by. — The concrete in the retaining walls is to be carried up in layers not exceeding 12 inches in height according to the

17
instructions under the Head "Concrete" —

21 As much of the sand as will stand between the two retaining walls when the trenches are excavated, may be allowed to remain; but as the walls are carried up the space between them and the Core of sand are to be filled in with layers of earth, gravel, refuse of lime &c. The layers are to correspond in height with those of the concrete, and are to be watered and rammed down.

22 The Stonework of the dam and the concrete under it are to be carried up together,

the stones to be ¹⁸ embedded in the concrete, and cemented with mortar prepared as described in paragraph 16. According as the stone work is completed, the joints are to be raked out at least two inches in depth and the whole must be pointed with mortar prepared as before described with the addition of being ground fine.

This Pointing must be done before the work dries; but at the same time, the stones and joints must be sprinkled with water before the pointing is laid in. —

20. To cover so large a work as this dam with wet straw would be very expensive, but as it is essential that it should dry very slowly, it may, as the pointing

Head Sluice

¹⁹ is completed, be covered with sand to a depth of 2 feet which is to be kept moist for 15 days. —

24. The rough stone work at the toe of the slopes is to consist of the largest blocks that can be conveyed by ordinary means to the site. They are to be carefully laid. —

25. This work is designed to be built with Laterite: — The flooring to the extent shown on the drawings is to be rough dressed blocks of gneiss, and the face of the recess for the gates and the faces of the Spandrell walls, so far as the gates shall slide upon them, are to be of fair dressed gneiss.

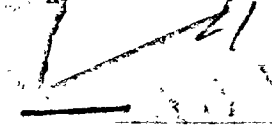
The paving is to be embedded in concrete. —

The Timber work is to be of Teak. —

26. The dimensions of the Supply channel are shown on the drawings. —

There is to be a berm of 5 yards on each side, and at all low places the spoil must be formed with a bank at each side rising to at least the height of the proposed Bunds around Cholaravaram and Red Hill Lakes. — The inner slope of the Spoil Bank is to be 1 to 1, the outer slope may be anything the quantity of materials will allow of, but the bank must not at any place be less in section than 1 to 1 on the inner side, 3 feet broad on the top and $1\frac{1}{2}$ to 1 on the outer

Bridges of
Stone and
Bricks.

side:  31/6
Where the surface of the land is sufficiently high not to require the side banks, the spoil shall be disposed of as the Engineer shall direct. —

27. The drawings of the Bridges are sufficiently in detail to show clearly how they are to be built, — but the following remarks are necessary: — The Centers are to be cased when the arches are closed, and they are to be removed altogether before any work higher than the Crown of the Introdoos is built: —

The Joints in the back of the arch are to be raked out, the whole swept clean and then covered with 6 inches in thickness of concrete. This must be done after the

2
arch has settled but before it has
thoroughly dried, and the whole must
be kept moist for 10 or 12 days.

28 When the Bridge is of
stone the work is to be carefully pointed
as described in Para: 22; only the
Joints need not be raked out to more
than an inch in depth.

When the Bridges are of Brick
they may be either pointed or Plastered
according to the quality of the Bricks:—
In all cases where it is decided that
the Brick work shall be plastered
each day's work, as it is completed,
must be white washed.

29 The plastering is to
consist of two Coats, a rendering
and floating Coat.

For the rendering Coat the work
is to be prepared by raking out the
Joints as for Pointing — and the

Plastering

Tank Bunds

23 33
Surface of the work and insides of the
Joints must be well wet when they
are swept clean.

The rendering Coat may consist
of the ordinary mortar described in
Paragraph 16, but the floating
Coat though of the same materials
must be ground fine in the usual
way. — In preparing the mortar

for Plastering and pointing the Lime
must be a perfect hydrate before
it is used: For this purpose
rich lime is to be used, and it
must be kept in water and reduced
to a paste state before it is mixed

with the clay and sand: —
The floating Coat is to be
finished in the usual way: —
30. The manner in which
these bunds are to be raised is shown

on the cross sections — See Sheets 13, 18,
and 19.

The old revetment and other
stone or gravel work on the inner
face are to be removed, and the
old earth work cut to the slope of
 $1\frac{1}{2}$ to 1.

The face of the New Bund
will consist of, —

I An outer revetment of roughly
squared Laterite, 18 inches in thickness.

II Next to this 12 inches thick of stone
and gravel, hand laid, and closely
packed together and filling up the
spaces between the stones used in
the revetment.

III At the rear of this there is
to be 4 feet in thickness of Puddle
Well worked in as described in
Paragraph 18, and closely connected

25
(by the use of water &c.) with the material
of the old Bund. —

The Puddle wall and Revetment
are to be founded in the solid earth: —

31 The outer slope of the Old Bund
is to be stepped out to receive the new
material, and the top of the Bund is
to be picked up to at least 12 inches
in depth — and if it be of gravel
it must be removed and the whole
thoroughly wetted before the new material
is laid on: — The new material
is to be carried up in layers, not ex-
ceeding 1 foot in thickness, and they
are to incline towards the center as
shown on the drawing. —

32. So much of the Bund as
lies on the Tank side of a vertical

line drawn down from the center of the top of the Bund, is to be formed with materials as nearly impervious to water as it is possible to get them within a reasonable distance: This portion

of the Bund is to be made with great care, and should the Engineer consider it necessary, water is to be used in laying the Earth in: — The remainder of the Bund may be of materials of a sloover but heavier description, such as gravel stones &c. — but the outer slope must be covered with Earth to at least 1 foot in thickness: —

A low parapet wall as shown Parapet in the drawings is to be built

upon the Revetment all along the Tank Bund: — The Parapet is to be built with mortar — 33 Its material for the Bund is to be excavated in the bed of the Tanks without the written sanction of the Engineer, and even then the excavation is not to approach nearer than within 50 feet of the toe of the Revetment.

The same distance is to be observed with regard to excavations on the other side of the Bund. —

Kalingulas 34 The Kalingulas, Irrigation
Sluices &c. sluices, and the Red Hill Head sluice, call for no particular remarks:

The stone work in the Kalingulas is to be laid in mortar and pointed as described

in the case of the Cortillias
Dam —

For the form and
dimensions of those works
see the Drawings. —

35 One of these only,
the Foot Bridge across the main
Channel, and 45 feet in span,
need be particularly alluded to: —

Each girder is composed of two
pieces of Teak 50 feet in length
and 6" x 6"; They are laid parallel
to each other and connected at the
ends by blocks on which they are
prevented from sliding by keys of
hard wood and wrought iron straps:

The straps are to be put on hot,
and when this part is finished,
the bottom and top pieces are to be

Timber Bridges

Delivery Channel 36 to Madras

Bridges at Madras See

sprung assunder in the center, to the
extent shown on the drawing; and
a straining piece 6" x 6" inserted:

A similar straining piece is to be
inserted at every standard, and at the
same places the top and bottom pieces
are to be bolted together as shown in
detail on the Drawings: — Care
must be taken that the top and bottom
girders are not injured: — The
whole work is to be built of Teak. —

The Channel to Madras
is to have a berm on each side of
4 yards, and the spoil is to be
arranged in Embankments as
before described to the height shown
on the section. —

37 The Bridges proposed
to be built in Madras and on the
delivery Channel Call for no

particular remarks; — Neither
does the design for the Irrigation
and drainage under Tunnels. —

Madras water works Office William Fraser & Co
Church Park, Mount Road

7th May 1866 Special Ex: Engineer

[Faint, mostly illegible handwritten text follows, appearing to be a detailed report or specification.]

13-7-906

O N 2004/18
Per 26 May 1866 L. 1862.
26th May 1866

26th May 1866

To
Colonel C. A. Orr R.E.
Secretary to Government
P.W. & E.

From
Mr. Fraser Esq. R.E.
Special C.E. Engineer

25-9-86
Copies of the
P.W. & E. and C. A. Orr R.E.

Specification for the
works included in the
Volume of Plans which
accompanied the first
Report.

Per 26 May 1866 L. 1862.

N^o 4

Madras Water works Office
Church Park, Mount Road

7th May 1866.

From

W. Fraser Esq. R.E.

Special C.E. Engineer

To

Colonel C. A. Orr R.E.

Secretary to Government

Sir,

I have the honor to submit
a second volume of Plans of the Madras
Water works, with a copy of the detailed
Estimate and a copy of the General
Specification, which I trust will be
found satisfactory.

On comparing the abstract
Estimate now forwarded with that attached
to my report it will be seen that this
one exceeds the former by 590 Rupees:

This is occasioned by some alterations
I made in some of the rates:

Since I sent up my report I have
consulted 3 or 4 parties in Madras who
are supposed to be most familiar with
the present rates of work, and they have

Confirmed my former opinion that
the works can be executed by Native
Contractors for the amount of the
Estimate; but I am aware that English
Contractors would not take the work at
these prices.

I regret that when you requested
me to send an unbound set of Plans
for transmission to Calcutta, the four
sets had all been bound.

I forward 2 Coloured Copies of
the Index Plan and Section.

I have the honour to be

Yours most Obedt Servant

William Fraser & Co

Special Exec. Engrs

Received

