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NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

Public works

DEPARTMENT

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Dated	8.1. 1878	-197.

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GOVERNMENT OF MADRAS.
PUBLIC WORKS DEPARTMENT.

8th January 1878, No. 105 W.

Buildings and Roads.

Civil Works.

Read the following papers:—

No. 73. Endorsement of the Under Secretary to Government, Financial Department, dated 26th April 1877, No. 921.

From A. McC. WEBSTER, Esq., Acting President of the Ootacamund Municipal Commission, to the Chief Secretary to Government, dated Ootacamund, 19th April 1877, No. 45.

With reference to the Proceedings of Government, dated 6th February 1877, No. 431, I have the honor to forward a plan and estimate for the improvement of the northern water-supply of Ootacamund, together with a letter from the District Engineer explaining the project, and an extract from the Proceedings of the Commissioners of this date. The estimate provides for the enlargement of the Snowden Reservoir. The subsidiary reservoirs proposed by the District Engineer and the construction of closed ducts will be estimated for hereafter.

2. Captain Morant's letter is so full that the Commissioners have nothing to add. It will be seen therefrom that in ordinary years the new reservoir at Snowden and the existing one at Marlimund will provide for the wants of 10,000 people at 20 gallons per head per diem for five months and will leave a surplus of about 24,000,000 gallons; and that in bad years there will, supposing the same consumption, be a deficit of about 25,000,000 gallons, or say 2½ months' consumption. It is however to be observed that the rate of consumption of 20 gallons per head is perhaps more than ample; and if a supply of 15 gallons per head is provided, the supply in a bad year would last for eleven months; when, however, the drainage scheme is perfected we shall require more water, so it will be necessary hereafter to construct the subsidiary reservoirs at X and Y (Plan I), and the supply of water will then be amply sufficient for all purposes.

3. The estimate does not provide for Public Works supervision, which will amount to Rupees 5,732. It is, however, very necessary that the work should be carried out by the District Engineer, as owing to the position of the reservoir nothing should be left undone to prevent any possible chance of the embankment giving way. The Commissioners will not be able to provide from their current year's budget the sum of Rupees 8,672 over and above the loan of Rupees 20,000, and I trust, therefore, that Government will be able to allow the work being carried out by the District Engineer free of charge, or that, if that is not possible, they will allow any sum which the Commissioners cannot pay during the year to lie over and to be adjusted when the completion of the water-supply and the drainage projects are passed and the proposed loan for these works is sanctioned. The present proposed increase to the water-supply is urgently needed, and the work should be pushed forward with the utmost expedition so as, if possible, to get a good supply for next year.

REFERRED to the Chief Engineer for remarks.

(By Order,)

(Signed) J. STURROCK,
Under Secretary.

No. 78-A. Endorsement of the Acting Under Secretary to Government, Financial Department, dated 29th August 1877, No. 1,655.

From A. McC. WEBSTER, Esq., Acting President of the Ootacamund Municipal Commission, to the Chief Secretary to Government, dated Ootacamund, 24th August 1877, No. 80.

In continuation of my letter of 19th April 1877, No. 45, I have the honor to forward an estimate for the completion of the water-supply project for the northern portion of Ootacamund, together with a copy of the District Engineer's letter and of the Proceedings of the Municipal Commissioners thereon; I have also the honor to forward, for the sanction of Government, an application for a loan of Rupees 1,23,692 for the completion of this portion of the work.

2. The amount of the loan applied for in my letter to Government of 25th January 1877, No. 11, as well as the work, estimates for which were submitted with my letter of 19th April, is included in the present estimate of the Commissioners and application for a loan. In the former application for a loan of Rupees 20,000 the Commissioners proposed to repay it in twenty years, but looking to the amount now required they propose to repay it in thirty years.

3. Government will observe that the Commissioners have decided to be content for the present with the improvement and enlargement of the Snowden Reservoir, leaving the construction of the additional reservoirs at X and Y on Plan No. 1 accompanying my letter of 19th April 1877 in the map for future execution should the present supply become insufficient owing to increase of population or other causes.

4. I have the honor to request that Government will be pleased to sanction the estimate and the loan, and will allow the work to be carried out by the District Engineer. The Commissioners venture to hope that Government will take into consideration the exceptional circumstances of the station, and will allow the work to be carried out by the District Engineer free of cost to the Municipality. This will reduce the cost of the work to about 1 lakh of Rupees, and the Commissioners will be enabled to spend the remaining portion of the loan in improving the southern water supply channel and in continuing the northern supply to Kandal and Woodcock Hill.

REFERRED to the Chief Engineer for remarks.

(Signed) H. B. GRIGG,
Ag. Under Secretary in charge.

No. 1,709.

THE Chief Engineer hoped ere this to have inspected personally the site of the proposed reservoir on arrival at Ootacamund with the Government. Until he is able to do so and submitted his report he recommends that no action be taken in the matter.

FORT ST. GEORGE,
21st June 1877.(Signed) E. A. FOORD, Colonel, R.E.,
Chief Engineer, P.W.D.

No. 1,709.

RETRANSMITTED to the Chief Engineer with original notes of Members.

8th September 1877.

(By Order,)
(Signed) H. B. GRIGG,
Ag. Under Secretary.

No. 216 W.

MEMORANDUM.

OOTACAMUND WATER-SUPPLY.

THE proposals which have been brought forward by the District Engineer, Nilgiris, and approved by the Municipality, embrace the provision of additional storage for the supply of the northern side of the station, and arrangements for purifying the water, with its distribution under arrangements likely to preserve its purity.

2. MARLIMUND RESERVOIR.—There is at present only one reservoir, if the small tank near Snowden House be excepted, for the storage of water for this part of the station. This is called the Marlimumd Reservoir, and was constructed about seven years ago. Generally it has filled well and has surplused; but in 1875 the depth of water on the sill of the sluice did not exceed 15 feet, and in 1876 nine feet, the depth when the reservoir is full being 19½ feet. The District Engineer estimates the contents at, in round numbers, 50 millions of gallons; but from information furnished by him two or three years ago it appears that—

The total contents are ...	7,761,000 cubic feet.
The contents below the outlet ...	324,000 "
Water available for use ...	7,437,000 "
	or 46,480,000 gallons.

The catchment basin of this reservoir is 260 acres or 0.406 of a square mile. The site is certainly much the best high level site near Ootacamund.

3. WATER-YIELD REQUIREMENTS.—To fill the Marlimumd Reservoir it is necessary that a depth of 7.88 inches should flow from the whole area of the catchment basin. The District Engineer has given a table of the monthly and annual rainfall at Ootacamund, for the years 1869 to 1876 inclusive, from which it appears that its amount was in—

Years.	Rainfall.	Rainy Days.	Average Fall of Rainy Days.	October Rainfall.	Rainy Days.	Average Fall of Rainy Days.	November Rainfall.	Rainy Days.	Average Fall of Rainy Days.
1869...	38.65	117	0.33	3.97	12	0.33	3.28	13	0.25
1870...	41.92	122	0.34	10.10	15	0.67	1.69	10	0.17
1871...	54.92	94	0.58	10.45	*	...	13.92	10	1.39
1872...	45.42	119	0.38	3.99	11	0.36	6.93	18	0.38
1873...	45.41	138	0.33	7.32	23	0.32	2.35	10	0.23
1874...	47.48	141	0.34	10.24	20	0.51	2.10	10	0.21
1875...	38.45	107	0.36	8.23	19	0.44	2.30	7	0.33
1876...	25.16	76	0.33	1.66	8	0.21	0.26	2	0.13
Average ...	337.41	914	2.99	56.06	108	2.84	32.83	80	3.09
	42.18	114	0.37	7.01	15	0.41	4.10	10	0.33

* Not stated.

The position and aspect of the catchment basin of this reservoir make the north-east monsoon rains those from which the greatest yield is obtainable, and a register of rainfall at Ootacamund, which is on the other side of the water shed, is not a very reliable criterion of the rainfall at the reservoir catchment basin, but it is the best available.

It is understood that the Municipality have a register of the water levels in the reservoir; but at present there is no series of cross sections of the tank, and conse-

quently the actual yield of the 200 acres, and the loss by evaporation and absorption, cannot be properly deduced; and indeed to enable these latter to be approximated to, it would be useful to know what water has been issued to the channel supplying the town; and of this there would seem to be no record. The District Engineer has been asked to have the requisite sections taken and a table of capacities prepared.

4. WATER-TOWER VALVES.—The water-tower valves are not as convenient as is desirable, though apparently with slight modification a fairly accurate regulation could be effected. At present the valves which are hinged at the upper edge can be regulated to somewhat more than inches of lift, and were another disc placed at the other end of the drum of the windlass, and the holes made to alternate with those now used, the difference of lift could be halved. However it will be advisable to substitute slide valves or plugs regulated by screws, and then exactly the desired discharge can readily be obtained.

5. SURPLUS CHANNEL.—The arrangements for discharge of surplus are inadequate. The capacity of the reservoir is, compared with the catchment basin, considerable; but nevertheless the tank may be full or nearly full when a heavy fall of rain occurs, and in 1871 it was in some danger. There is no escape weir at the tank, but a masonry-lined channel, 8 feet wide, starting at F.T.L., and with no bed fall, conducts the water for a considerable distance* to a series of steps or drops, the

* 292 feet.

width at the first drop being 6 feet. Thence the water is conducted by an earthen channel, altogether too small, along the hill side to a safe distance from the bund. The escape should, it is considered, be 20 feet wide with a clear overfall, and 24 feet with a channel like the present, to ensure the water level being limited to 3 feet above F.T.L. as a maximum.

6. RAINFALL REQUIRED TO FILL RESERVOIR.—It would seem that a rainfall of 12 inches in October and November are about sufficient to ensure an adequate supply to this reservoir. In 1875, a very dry year in July to September, it was about $\frac{1}{3}$ ds filled, and the rainfall in the two north-east monsoon months was 10.63 inches. The average of the eight years gives 11.11 inches.

7. ENLARGEMENT OF MARLIMUND RESERVOIR.—At a comparatively small expense the available capacity of this reservoir could be increased one-half by raising the bund and F.T.L. 6 feet. The area of the present waterspread is 597,000 square feet, and 6 feet over this would contain 3,582,000 cubic feet, so probably the total additional storage would be just about half the present capacity.

The present top width of the bund is 25 feet and might be diminished to 18 feet at the raised top level. The top of the bund is $7\frac{1}{2}$ feet above F.T.L., and the top of the raised bund should be $3 + 5$ feet above the raised F.T.L. The interior and exterior slopes above F.T.L. may be increased to 1 to 1, and if necessary the interior slope below this point may be carried down at $1\frac{1}{2}$ to 1 until the required base is obtained.

3. SNOWDON RESERVOIR.—The site of the proposed Snowden or Snowden House Reservoir is just below Snowden House on the Ootacamund side of the saddle on which that house stands. The site as regards the formation of the bund is favorable, but otherwise there is not anything in its favor.

(1).—The catchment basin is only 60 acres, so the surface yield would probably not much exceed $\frac{1}{3}$ ths of that of the Marlimund Reservoir, and if this be taken as 10 millions of cubic feet on the average, and one-third of that quantity in such a year as 1876, the water available would be in an average year ... 2,307,700 cubic feet.
in a year like 1876 ... 769,230
the intended capacity as designed is ... 3,859,800

It is therefore not probable that in ordinary year this reservoir would fill. Major Morant states that the ground above the bund site is full of springs, but it does not follow that all this spring water would go to augment the water stored in the reservoir.

(2).—The capacity is small compared with the height of the bund, 56 feet, as a maximum, and the depth of water, 40 feet, at the sluice. This arises from the high level of a large part of the ground within the waterspread.

Area of waterspread 220,319 square feet.
Mean depth $17\frac{1}{4}$ feet.

(3).—The cost of storage would be high, viz., Rupees ... 5,913

Per million cubic feet, even supposing the tank to fill.

The actual cost might be Rupees ... 8,000
the million cubic feet.

The Marlimund Reservoir cost Rupees ... 14,700

So the storage there was at the rate of a little under Rupees 2,000

a million cubic feet. Its capacity could be increased one-half at a cost of about 2,000 Rupees the million cubic feet.

(4).—Although it is of considerable advantage to lay 60 additional acres under contribution, this benefit would be frequently more than neutralized by the full tank level being 15 feet above the sill of the south face of the tunnel through which the Marlimund Channel runs.

The difference of aspect would be an advantage, as more water would be received from the south-west monsoon, the rainfall in which is not much less than three times that of the north-east monsoon, but spread over five months instead of two.

31-03 to 11-10.

9. OTHER SITES FOR RESERVOIRS.—There are no really good sites at a high level available. There is a site* to the west of the Marlimund Reservoir, which was inspected, and which might possibly be

* Marked W.

of use to supply Kandal and houses in that direction. The catchment basin is about 122 acres. The level of the bund site will be ascertained.

Above and to the eastward of Snowden House there are the X and Y sites mentioned in Major Morant's report; they are on extremely steep ground, and their catchment basins are 36 and 25 acres respectively. The former is on the south or Ooty side of the hills, and the latter on the north or Snowden side. The capacity of these tanks, even with high bunds, would be very small, but a considerable portion of the yield of their catchments could be conveyed to the Snowden House site, and in this way a reservoir constructed at this site might perhaps be adequately supplied. Another site marked Z is situated in the next valley to the south-east of that of the X site, and has a drainage basin of 54 acres. The water could be conveyed to the Snowden House site.

There is a site below Cinchona Villa and just where a line from the stables at Lower Norwood, at right angles to the axis of the valley, would cut the stream, at which a reservoir of some considerable capacity could be formed. The area of the catchment basin is about 307 acres, and all the water of the basin of the Snowden House site, of the X and Z sites, and of other ground would be received by it. Its adoption would entail separate filtering arrangements and distribution, but it is comparatively near the town, and the level

* Datum 200 feet below sill of lake sluice.

† The F.T.L. of Ooty lake is nearly 10 feet above sill of sluice in west bund.

‡ Letter No. 145, 18th April 1877.

of the stream at the bund site being 292.81,* as compared with Ooty lake surface 209.81,† the command would probably be sufficient.

10. WATER-SUPPLY REQUIRED.—The District Engineer in paragraph 15† notes that the Marlimund Reservoir was designed to supply 6,000 people at 30 gallons a head a day, or 180,000 gallons a day altogether. He considers it to be desirable to provide for a population of 10,000; but that with masonry conduits or pipes 20 gallons a head a day should suffice: the daily provision would then be 200,000 gallons. It is mentioned that

in London only $\frac{1}{3}$ ths of the whole delivery enters into consumption, and that in Glasgow 18 gallons out of 32 are wasted, or the wastage is rather less than in London. Major Morant thinks that the waste at Ootacamund need not be so great. Were the delivery pipes to be similar to those of the London Companies, this conclusion might be accepted, because their pipes work under considerably greater pressure than is intended in this case. Altogether, however, it would be unwise to suppose that the Ootacamund distribution arrangements will be more efficient than those existing in England after many years' experience. The issues from the reservoirs should therefore be assumed to be at least half a million of gallons a day. In ordinary seasons it is considered by the District Engineer that the reservoirs would have to store enough water for five months' consumption; but that to ensure the station against a failure of water in bad years there should be provided a storage equal to ten months' consumption. In the former case consequently the water to be available for issue from the reservoirs would be 75, and in the latter case 150 millions of gallons.

11. LOCAL DATA WANTING.—It is particularly unfortunate that reliable data, such as the Marlimund Reservoir might have furnished, are wanting as to—

(1).—The yield of a given area of ground;

(2).—The proportion between water stored in a reservoir and that available for issue after loss by absorption and evaporation.

Information on these points for the Marlimund Reservoir would have been very greatly more valuable than deductions from English experience. The loss by evaporation is dependent upon surface area; that by absorption is influenced by the nature of the bed and the depth of water. It would, it is thought, be a very favorable site at which the losses from these two causes would be less than one-third of the quantity stored. The conclusions arrived at in paragraph 18 of the District Engineer's letter appear therefore to need somewhat radical modification.

Taking, as Major Morant has done, first an ordinary year

	GALLONS*
200,000 gallons a day for 152 days	30,400,000
Wastage based on London data	45,600,000
Quantity to be issued from reservoirs	76,000,000
*Evaporation and absorption	25,335,000
Storage required	101,335,000

against 45,600,000 according to Major Morant's calculation.

Secondly in the case of a very bad year like 1876

200,000 gallons a day for 304 days	60,800,000
Wastage on London data	91,200,000
Evaporation and absorption	1,52,000,000
	50,670,000
	202,670,000

against 91,200,000 as estimated by the District Engineer.

12. WHAT THE IMPERFECT DATA AVAILABLE INDICATE.—Major Morant has been asked to obtain from the office of the Municipal Commission such registers of, and information about the Marlimund Reservoir as may be available, and to have a sufficient number of sections taken to enable a table of capacities at different levels to be drawn up. It may then be practicable to approximate more or less closely to the yield of its catchment basin in 1875 and 1876, and thus to get some data for determining what area must be laid under contribution to yield the quantity of water needed. At present there is no information available, while a deduction from the fact that the water did not rise in the reservoir higher than 9 feet above the sluice sill in 1875 would indicate that it is very improbable that a sufficient area for a ten months' supply can be found at the required level. Below the sill level the mean depth is said to be 4 feet and the contents 324,000 cubic feet. The mean depth of the tank when full is 13 feet, contents 7,761,000 "

It is probable therefore that with a depth of 9 feet out of 19 $\frac{1}{2}$ on the sill, the contents above sill level did not exceed one-third of the quantity when the tank is full, or say 2,600,000 cubic feet

and if it be assumed that the quantity drawn off in addition was 2,600,000 "

the total receipts would be 5,200,000 "

or gallons ... 32,500,000

from an area of 260 acres.

13. CATCHMENT BASINS OF OTHER SITES AND THEIR PROBABLE YIELD.—The areas of the basins of the other sites which have been suggested are—

	ACRES.	122	Fide plan.
W	36		
X	25		
Y	51		
Z	60		
Snowdon House site	307		
Below Cinchona Villa	90		
Deduct X and Z	217		
	514	say	510

If the yield be supposed to be the same in proportion it would amount to 63.75 millions of gallons, and this quantity added to that of Marlimund would be 20.25 millions. Moreover to obtain 202.670 millions for a ten months' supply the acreage of gathering ground required would be 1,621 acres or 2.53 square miles, and this is certainly no very great area in itself for the supply of a large station, though it appears to be altogether impracticable to find it, together with sites at a suitable level at which water could be stored.

14. MAJOR MORANT'S MODIFIED PROPOSALS.—Major Morant's proposals, even as somewhat modified during the recent discussions, amount to the formation of a reservoir at the Snowdon House site, and to supplementing the supply from its own basin by conducting water to it from the X Y Z basins; but, making every allowance for more favorable aspect in the case of all but Y, which much resembles that of Marlimund, the total area of drainage would be only 175 acres, and the yield would not exceed, and would probably fall short of that of the Marlimund basin. These calculations are based on no reliable or indeed ascertained data, for such data have yet to be made available; but they will suffice to indicate that there is but little chance of making provision for the supply of water to the whole station on the scale which has been proposed. When actual data, however imperfect, are given, it will be easy to show what is likely to be feasible. The Ootacamund water-supply scheme should be based on what is demonstrably probable.

15. THE WAY IN WHICH THE YIELD OF THE SNOWDON HOUSE SITE WAS ESTIMATED.—Major Morant's calculations, from which he concluded that the proposed Snowdon House Reservoir would fill more than once from the drainage of its own basin in the event of three consecutive dry years, were based, as explained by him in a demi-official note, dated the 25th September, on English experience. From the average annual rainfall one-sixth is deducted, and the remainder is taken as the average of the three driest consecutive years, 14 inches were then deducted from this quantity for evaporation and absorption (the allowance in English mountain districts) and 20 inches were found to be the depth actually draining off, the yield being 31,630,000 gallons against 24 millions, the capacity of the Snowdon House Reservoir. The area of the basin has since been found to be 60 instead of 70 acres; and the quantity corresponding to 20 inches draining off would be 27,225,000 gallons or one-eighth in excess of the capacity of the Reservoir. The depth of drainage required to fill the latter would be therefore a little over 18 inches. Now it has already been shown that 7.83 inches draining off the Marlimund basin would

suffice to fill that reservoir, and allowing for all possible difference of aspect in the case of sites a few hundred yards apart, it is certain that Marlimund Reservoir would have filled to overflowing two or three times in 1875, and have more than filled in 1876, had these deductions from English experience been applicable to the circumstances. As a fact it did not nearly fill in 1875 and did not half fill in 1876; so whatever data are to be relied on should be obtained on the spot. To this end it is desirable that rainfall should be registered at the Marlimund Reservoir which can easily be managed, and at Snowdon House, which probably can be arranged for. A knowledge, for even a short time, of the falls at these places corresponding to the falls registered at Ootacamund will be of value in determining the effect of difference of aspect and elevation.

16. REGISTERS OF SURPLUS FROM EXISTING RESERVOIRS SHOULD BE KEPT.—It may further be noticed that registers should be kept to show what the quantity of surplus discharged from the Marlimund and Dodabet Reservoirs may be, and it will be necessary to know not only the depth at the tank end of the surplus channel, which will be found from the known reading of the sole of the channel on the water tower gauge, agreeing as this does with F.T.L., but the depth also at the lower end of the horizontal part of this channel. Similarly the depths of water, or the water levels in the channels leading from these reservoirs, should be recorded at such points as will allow of the discharge being calculated. Such data are essential to the solution of the questions relating to water-supply, and their continuous record for the past six or seven years would have afforded all that would have been necessary for dealing effectively with the questions now awaiting settlement.

17. ENLARGEMENT OF MARLIMUND RESERVOIR SHOULD BE ESTIMATED FOR.—The Marlimund Reservoir has, it would seem, received more water than it could store in five years out of seven. An addition of 6 feet to its depth will enable it to retain about as much water as the proposed Snowdon House Reservoir would hold, and it is therefore recommended that this enlargement should be estimated for at once, and, if as expected the cost will be moderate, carried out at once. Its contents will then be about 11,155,500 cubic feet 62,722,000 gallons.

18. X, Y, AND Z SITES SHOULD BE FURTHER INVESTIGATED.—In the next place the X, Y, and Z sites should have sufficient sections taken to determine how far they can be utilized as reservoir sites, and what their capacities at the levels which appear to be most suitable would be. There will, it is thought, be no objection to the construction of reservoirs at these sites if it be found that storage can be effected at a reasonable cost. The X and Z sites are within the catchment basin of the site below Cinchona Villa; but the quantity of water which they will store will not, it is thought, materially affect the supply of the lower reservoir should it be deemed desirable to construct it.

19. POSITION OF FILTERS CAN DEPEND UPON ADEQUACY OF FUNDS TO ENCLOSE CHANNELS ABOVE ST. STEPHEN'S CHURCH.—All the water from the Marlimund Reservoir and from the X, Y, and Z sites can be brought to filters situated at any point below the Snowdon House site; and it must, it is thought, depend a good deal upon what the Commissioners can afford, at what point the filters should be placed. If money for enclosing all supply channels will be available the filters can conveniently be placed a short distance below Snowdon House. Otherwise the nearer they can be placed to St. Stephen's Church the shorter will be the length of piping necessary to maintain the purity of the water after filtration. It is desirable, if financially practicable, to enclose the water channels; but it can hardly be deemed essential. To take the channel from Marlimund Reservoir to Snowdon House tunnel for instance. There are one or two short lengths which should in any case be enclosed, because more or less liable to pollution from their proximity to dwellings and gardens, but the rest of this channel runs through clean ground, and the catch drain above it would, if properly looked after and the troughs which pass this drain water across the channel kept clear, prevent much foul water from passing. Some cross fences and frequent inspection would do the rest. The channels are certainly not in proper order, as the depths of water and velocities were found to vary greatly, which would not be the case with a channel the fall of which was equally distributed, and the waterway uniform or varied according

to the nature of the channel lining. Similarly the channel from Snowdon House to near the Church could by means of catch drains and troughs be preserved from material fouling. The cost of enclosing

Above tunnel	14,646	the channels is estimated at 21,000 Rs.,
Below do.	6,374	the interest on which at 6 per cent. is
	21,020	Rupees 1,260. Probably 300 Rupees a
		year in inspection and work would keep
		open channels in good order. Closed

channels would economize water and would be altogether more satisfactory. It is simply a matter of expense.

20. PRESENT CONSTRUCTION OF SNOWDON HOUSE RESERVOIR NOT RECOMMENDED.—The present construction of the Snowdon House Reservoir is not recommended, because the storage would be great; the drainage basin is small, and it would often necessitate passing to waste of water from the Marlimund Reservoir; for no water therefrom could be supplied to the station while that in the Snowdon House Reservoir was above 15 feet below the F.T.L. This might, as suggested by Major Morant, be remedied by closing permanently any connection between this reservoir and the tunnel and continuing a closed channel from the latter through the upper part of the bed of the latter. Then water could be conveyed to the filters from Marlimund at all times, and the reservoirs could be worked independently as might seem expedient. This arrangement does not however get rid of the cost of storage which is very high. It may ultimately be necessary to utilize this site, and nothing should be done to prejudice such future use, but until it has been demonstrated that it is not practicable to store water elsewhere more cheaply this part of the scheme may properly be held in abeyance.

21. * * * * *

22. GENERAL CONCLUSION AND DETAILS TO BE INVESTIGATED AND PLANNED.—The general conclusion arrived at by the undersigned is that storage is not likely to be available for the supply of Ootacamund with a delivered quantity of water of 20 gallons a head for 10,000 persons for ten months, and it is thought that before any complete scheme of storage and distribution is brought forward for sanction, it is desirable that it should be considered more particularly what the Municipality propose to undertake to do, and for what purposes pure water is to be supplied. The District Engineer's letter of the 1st June 1877 brings forward proposals for a certain rough division of the water-supply above St. Stephen's Church into two parts, the one to be

* 100,000 gallons.

+ 150,000 do.

carried by a high level channel to above Syll's Hotel and ultimately on to Kandal; and the other† and larger supply past the

Post Office. With these proposals estimates amounting to, in the form accepted by the Commissioners, Rupees 98,951 were submitted for enclosing the water channels and filtering the water; but these estimates evidently include only a part of the expense necessary to provide for the convenient and economical use of the water-supply. The estimates relate in fact only to a part of what may be called the principal distribution, and were so much of the work done and nothing more it would happen that by far the greater part of the supply provided at a very considerable outlay would run into the lake unused. To do much good the works contemplated will require to be supplemented at once by other works, and the following remarks will serve to indicate what are the details which have still to be planned and estimated for—

1stly.—For the supply of pure water to the bazaar: there should be service tanks or reservoirs capable of containing about three hours' supply of water, and from these pipes should run to street fountains furnished with taps from which alone water should be obtainable by the population. The number and capacity of the tanks should be fixed with reference to the population to be supplied by each, and to facilities of construction. The pipes supplying these service tanks should be capable of being closed, and it would seem to be proper to arrange for filling them every three hours, and in the intervals to furnish the supply to individual houses.

2ndly.—For detached house-supplies it will be needful that cisterns should be

• Ordinary ball cocks.

provided to be supplied by taps* which will close on the cistern becoming full. It will no, it is thought, be feasible to do without cisterns. If the pipes for the supply of individual houses are to be allowed to run so long as there may be water in the supply pipes, such house pipes must be extremely small in order to avoid great waste, and for convenience cisterns of some sort would be necessary. It will, it is thought, be much better to require cisterns in all cases to be provided, and to supply them under self-regulating cocks. The cisterns can then be placed in such positions and at such an elevation as will make the house service thoroughly effective. It is presumed that house-supply will include water for drinking, ing, baths, and stables, on which one rate would be charged. According to the class of house and the probable wants of the residents. If water for gardens or other than domestic purposes be available and supplied, a separate and additional rate would be fairly leviable, and at any rate in dry years supplies for gardens can be afforded only to a very limited extent.

3rdly.—The intended scheme of branch pipes for the supply of the detached houses and establishments has to be worked out. There must evidently be several such lines, and the cost will not be inconsiderable. If the Commissioners propose to supply the houses on the ridge commencing with Harrow on the hill and ending with Lockend, the cost will be very material, for a great length of iron piping and probably a service tank at the off-take will be necessary. If this line of houses and the higher parts of Metoocherry are not to be supplied, a considerable part of the proposed supply of the high level channel from above St. Stephen's Church will not be required, and a proportionately less quantity will need to be stored.

4thly.—Service tanks should be constructed in connection with such a system as the circumstances of Ootacamund necessitate, whenever required to meet variations of discharge; for otherwise a good deal of water must be run to waste to prevent injury to pipes from excessive pressure. Pipes may be intended to run half or three-fourths full, but if a constant supply be issued from the principal reservoirs and if a variable quantity be drawn off from the pipes as must be the case, the variations being sometimes moderate and sometimes excessive,

* A pure water reservoir below the filters would be of material assistance.

such service tanks to act as moderators* will be essential to the prevention of waste.

23. CEMENT PIPES.—The undersigned has seen some of General Morgan's cement pipes, which it is proposed to use in part as water conduits for the distribution of the pure water. On their general merits no opinion can be given in the absence of tests, but on two points an opinion may be offered—

1stly.—The cement pipes should be capable of standing a very much higher pressure than that due to a head of six feet as named in paragraph 10 of the District Engineer's letter of the 1st June, or to a head of 10 feet which Major Morant has mentioned has subsequently been suggested. Individual pipes ought to be capable of standing a pressure of at least two-thirds of an atmosphere or 21½ feet, and the pipes when joined by the saddle pieces should be water-tight under a moderate head of say 5 or 6 feet, otherwise the results of using them will not be satisfactory.

2ndly.—The interior surface of the cement pipes should be perfectly smooth; this surface as seen in the pipes at the manufactory was far too rough. A facing of cement rubbed hard would seem to be necessary.

The undersigned is of opinion that masonry or concrete, covered, channels are preferable to pipes whether of cement or earthen ware whenever the quantities of water to be carried are considerable, and the level of the water surface can be regulated so as not to rise above the sides. In those parts of the service in which off-takes whether to branch pipes or to individual houses will be numerous, iron pipes will be alone suitable. In these pipes a head will not only be unavoidable but advantageous, and at the junction of the masonry channels, cement or earthen ware pipes, and the iron piping there should be cisterns provided with means of discharging surplus so that the head of water may be strictly regulated.

24. SUMMARY.—By way of summary to the foregoing remarks it is noted—

1stly.—That the character and extent of the water-supply of Ootacamund should be determined with reference to the supply likely to be available.

2ndly.—That all available storage sites should be examined in order to settle where water can be most economically impounded, and to what total extent, taking the probable yield of the catchment basins into account.

3rdly.—That an estimate for adding about 6 feet to the depth of water in the Marlimund Reservoir should be prepared, and, if moderate, that this enlargement should be carried out as soon as possible.

4thly.—That the scheme of distribution of the water-supply, which is, as at present drawn up, both incomplete and imperfect, should be properly matured and its cost estimated.

5thly.—That the supply of pure water should, unless in excess of the demand for purposes for which pure water is necessary, be limited to those purposes. For these there is every reason to suppose it will suffice, but it will probably be altogether inadequate to supersede the present other source of supply for cleansing drains, watering gardens, &c.

6thly.—That all calculations of yield of water from different areas of catchment basin should be based upon the data which the Marlimund Reservoir will, it is supposed, afford rather than upon English precedents which are not reliable for application to Ootacamund, and which in the case of the Snowden House Reservoir site would clearly lead to disappointment. That also measures be at once taken for seeing what data the registers of water at the Marlimund Reservoir will afford, and for supplementing these by a table of capacities of that reservoir, a careful register of water levels, water issued and water discharged as surplus, and the registration of rainfall at this reservoir and if possible at Snowden House, for comparison with the registers at Ootacamund itself.

7thly.—Whenever good storage sites may be found capable of storing economically a greater quantity of water than the catchment basin would be likely to yield, probably the supply may be supplemented by catch-drains to conduct water from beyond the catchment basin proper to within its boundaries.

25. ACQUISITION OF LANDS OF GATHERING GROUNDS.—It is understood that proposals have been made for the acquisition of the catchment basins on which Ootacamund may hereafter have to depend for its water-supply, in order to secure the purity of the water. The subject is one which the undersigned is not called upon to consider further than to remark that—

1st.—If such a course be deemed imperative it is essential to concentrate storage and to make the most of each site; also to limit the pure water-supply to strictly domestic purposes.

2nd.—When valuable property occupies a part of the catchment basin, it will often be feasible and preferable to drain this so as to exclude the drainage from the reservoir, than to purchase and include the area in the basin.

26. MAJOR MORANT'S ASSISTANCE ACKNOWLEDGED.—The undersigned has to thank Major Morant for the ready assistance he has afforded. His local knowledge and acquaintance with the circumstances of the supply have enabled this report to be drawn up in a much shorter time than would otherwise have been practicable.

27. ENLARGEMENT OF DODABET RESERVOIR DESIRABLE.—It may be mentioned in conclusion that the enlargement of the Dodabet Reservoir, which is connected with the supply of the south side of Ootacamund, is certainly desirable. Its drainage basin is stated to be 184 acres, and its capacity only about 5 millions of gallons, so that it would fill with a drainage of only about 480,000 cubic feet. Its utmost possible enlargement will probably leave it still too small to store the average yield of the rainfall.

TRENCARAYCOTTAI,
22nd October 1877.

(Signed, JOHN MULLINS, Colonel, R.E.,
Chief Engineer for Irrigation.

To the Secretary to Government, Public Works Department.

No. 221 W.

MEMORANDUM

From a communication just received from the District Engineer, Nilgiris, it appears that the cost of the Marlborough Reservoir, as given in the memorandum, No. 216 W, dated 22nd October 1877, does not include certain items which ought to have been added to the sum therein named, and that the cost or expenditure stands thus—

	PA.
Marlinton Dam	
Escape weir, &c.	11,680
Masonry drop, &c.	2,120
	1,120
Total	17,920

ENGINEERS AND ARCHT.
 CIVIL WORKS.
 ★
 COL. OF ENG'G
 PUBLIC WORKS.

Memo of Papers sent to the Financial
 Department with GO 91^o/105W
 dated 8th January 1878 —

5 Plans —

- 1 Extract from Proceedings of a Meeting
of the Colacacund Municipal Comm^y
held on the 19 April 1877
- 1 Table of Annual Annual Rainfall

5 Estimates

C/110-8395

- 1 application for loan.
- 1 Special Meeting of Municipal
Comm^y held on the 7 June 77
- 1 Notice —
- 1 Minutes of Special Meeting of
the City Municipality - 7 June 77
- 1 Estimates & Specifications
for Water supply
Filters, Culverts & piping

1 Memo for orders : (Cn^o 8747)

Office note...

To E.W.

Ootacamund water supply

I have read the paper and
am writing to the D.C. to
tell him on what points in-
formation is required so
that he may leave the
subject ready for discussion when
it is up which I hope to do within
a fortnight

I think in the mean time
there should be a disposal
of this kind

The paper "As the Chief Engineer
P.W.D cannot conveniently
to visit Ootacamund at present
the paper will be referred to
the Chief Eng. for I will after
such further discussion with
the District Engineer as may
be necessary will report to Govt
on the proposed Snowdon Reservoir
and on the northern section of
the supply of Ootacamund
Yours faithfully
E.W.

Ootacamund.

25th September 1877.

My dear Colonel.

I am very glad indeed
that Government have asked you to
give an opinion on the proposed
Snowdon Reservoir, and I am very
much obliged to you, amidst all your
other pressing work, for entering so fully
into the subject. I need hardly say
that I will with pleasure do all in
my power to supplement the informa-
tion according to your Memorandum.
In the mean while, I trust you will

allow me to offer a few remarks:-

No information can be gathered from the working of the Marlborough Reservoir, I am sorry to say. No water-levels in this Reservoir have ever been registered: the tank has never been contoured. I can obtain the drainage area of its basin, but its yield of water I can only state from English experience (say Breckenridge Tables). In the same way no record has been kept of the issue of the water from the tank. And even if such a record was available

it would, I fear, be of little use, because the imperceptible and incalculable waste of the water which has percolated through the bottom and sides of the open channel in which it runs to the town has been very great, and because, on account of its muddy dirty state, very few persons have taken the water.

I should have stated the gathering ground of the proposed Snowdon Reservoir. It was not altogether an oversight. I did not

state it chiefly because, the Broadmoor
Reservoir is intended to be not only
an impounding but also a service
reservoir, receiving accessions to its
natural supply from the Martine-
mund and X and Y reservoirs.

I find its drainage area or
catchment basin is 70 acres in
extent. It appears from the rainfall
table which accompanied my report
that in Octacumund
annual.

the average rainfall is 41 inches.
the wettest annual rainfall is 55 inches (1871).
the driest annual rainfall is 26 inches (1876).

According to English experience,
these figures should be

40 $\frac{1}{2}$ inches average

53 $\frac{5}{6}$ " wettest

27 $\frac{1}{6}$ " driest

thus showing that the figures are suf-
ficiently close to justify comparing
English experience with Octacumund
practice.

According to Hawkeley,
Broadmoor and others $\frac{1}{6}$ th is deduc-
ed from the average annual rain-
fall; this gives $41 - 6\frac{5}{6} = 34\frac{1}{6}$
or say 34 inches: and this figure is
by them taken as the average of the
three driest consecutive years.

Deducting from this latter figure
14 inches for evaporation and
absorption (the allowance in English
mountain districts) we obtain 34
- 14 = 20 inches. The available
annual rainfall is thus 20 inches.
Beardmore (1862 edition) page 61 table
16 gives discharge for 20 inches
in gallons per diem per acre of
gathering ground at 1238 gallons,
or 451,870 gallons per annum
per acre of gathering ground. The
Snowdon Reservoir has 70 acres of

gathering ground; hence the available
annual rainfall to fill it will amount
to 31,630,900 gallons. Its capacity
is equivalent to 24 millions of gallons,
above pipe level. It will therefore,
be more than once filled ^{annually} during
an average of three consecutive
driest years. But while filling
the supply will be also drawn off,
so that a margin is not inadvi-
sable nor will it result in waste.
The site of the proposed Snowdon
Dam might be taken lower down
the stream. It would then improve

more water. But the dam would be higher and with all its works much more costly.

The idea of increasing the supply of water by catch drains seems a most excellent one. It occurred to me, and I intended providing for it in Reservoirs X and Y. It might easily be applied to the Snowden Reservoir. These catch drains would, I fear, bring down large quantities of silt, just as they always do in our road catch

drains. Perhaps this evil might be prevented or in a great measure mitigated by catch pits or by arrangements so that very heavy storm floods should not wholly discharge into the Reservoir.

I am having all the levels reduced to the one datum you mention, viz. 100 feet below the sill of the Lake sluice. I will also have a section taken down the proposed Reservoir valley from Snowden House.

Could you kindly return me all
the Plans so that I may add to
them the new datum.

The construction of the Snowden
Reservoir with its F. T. L. - 15 feet
above sill of Merliamund tunnel
is not, I admit, a convenient
arrangement. I adopted it in order
to make the proposed reservoir as
large as possible. If its F. T. L.
was limited to the level of the sill
of the Snowden tunnel its capacity
would be, very considerably reduced

and it would then be a question
whether it was worth constructing so
small a reservoir there at all.

I have written to the
Commissioner about General
Morgan's compensation. I believe
there will be no difficulty on
that point.

With regard to the flushing
of sewers in the Staines town I
think that could best be done
by turning the main supply of
the Lake into them through a
culvert starting from some point

near Charing Cross: this was Major
Tulloch's idea... Dr. Gordon propo=
=ses in the report he is now writing
to Government on this town that
the main Native Bazaar be removed
to Kandal. If that was done a
dry earth system of conservancy
would in my humble opinion be
the best: but if water for flushing
the Kandal drains was required
I think a Reservoir could best be
formed in the valley just below
"Sandrock"; the water though impure,

would do for that purpose.

I would much like to
discuss with you the Subject of
your para 11. In order to do
so respectfully would it not be
well for Government to put in
your hands my second report
and plans and estimates regarding
the piping of the channels and
filtering the water of the North Supply?

With regard to the
maximum flood discharge, and
width of waste weir I now give,

you the following calculations:

I made the waste weir of the
Snowdon Reservoir of the same
width as that of the Dodaletta
Reservoir, although its drainage
area is not nearly as large. I

hope the following calculations are
correct and will satisfy you.

I find from the Records of the
Commissioner's Office and of myself
now that the following are the
heaviest falls of rain in 24 hours:

From Engineer's Office Records	From Commissioner's Office Records
in 1871	} on two consecutive days of 1871
wettest year	
{ 4.59	} = responding
{ 5.55	
	5.30

I think we should be quite safe if
we took a maximum fall of 6
inches in 6 hours. According
to Beardmore's Table 15 page 60
this would give, off 70 Acres, a
discharge of 4235 cubic feet
per minute. Now turning to
his table 2 page 34 a waste

weir 15 feet wide running only
1½ feet deep will discharge
5897.10 cubic feet per minute.
Our waste weir is 5 feet high to
crest of dam. It might safely
I suppose run 2 feet deep. It
is hence amply sufficient, if these
calculations are right.

The site of the proposed
dam is a good one. The bed
of the reservoir not the site of the
dam abounds with springs.

Voluntarily to the Commission on the part of the

14
I do not think any drainage
of the site of the dam will be found
necessary; but it could easily
be done if you consider it advi-
sable.

I have written these re-
marks in the hope that you
will kindly give me your opinion
on them. I am very glad
you are coming up here to
discuss the project on the spot.
Believe me,

8.

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1

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1

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1

0

1

0

1

0

1

0

1

0

Yours truly
J. H. H. H.

Memorandum by the Chief Engineer
for Irrigation No 216 W dated
22nd October 1877

FOR ORDERS.

Edmund D. Coll. R.

Fort St George } Secy to Govt PWD
October 1877 }

It is to be noted
that for the purpose
of special primary
attention to the suggested
extension of the Marli
: and reservoir
It seems the most
logical project.
The extension of the
system. but reservoir
It also receives

Special attention.

These of Col. McKinnon
remarks sh^d. be
commended to the
careful consid^r of the
H^{on}. It is evident that
the applicⁿ for a loan
sh^d. be premature.

I think these papers
 shd. be sent to H. G. the
 Govt. Dir. he is at
 Ottawa. H. G. 2/11/22

S.F.S. 2.11.77. Paper please
all the news
above. Hope to know

11/11/11 11/11/11

I have the honor
to acknowledge the receipt
of your letter of the 11th
inst. and in reply to inform
you that the same has been
forwarded to the proper
authorities for their consideration.

The first thing I
 did was to go to
 the bank and get
 some money out of
 my account. I had
 about \$100 left.
 Then I went to the
 post office and got
 some stamps. I had
 about 10 left.
 Then I went to the
 grocery store and got
 some food. I had
 about \$5 left.
 Then I went to the
 drug store and got
 some medicine. I had
 about \$2 left.
 Then I went to the
 hardware store and got
 some tools. I had
 about \$1 left.
 Then I went to the
 clothing store and got
 some clothes. I had
 about \$1 left.
 Then I went to the
 furniture store and got
 some furniture. I had
 about \$1 left.
 Then I went to the
 electronics store and got
 some electronics. I had
 about \$1 left.
 Then I went to the
 bookstore and got
 some books. I had
 about \$1 left.
 Then I went to the
 toy store and got
 some toys. I had
 about \$1 left.
 Then I went to the
 pet store and got
 some pets. I had
 about \$1 left.
 Then I went to the
 garden center and got
 some plants. I had
 about \$1 left.
 Then I went to the
 car wash and got
 my car washed. I had
 about \$1 left.
 Then I went to the
 gas station and got
 some gas. I had
 about \$1 left.
 Then I went to the
 laundry and got
 my clothes washed. I had
 about \$1 left.
 Then I went to the
 hair salon and got
 my hair cut. I had
 about \$1 left.
 Then I went to the
 dentist and got
 my teeth checked. I had
 about \$1 left.
 Then I went to the
 doctor and got
 my blood pressure checked. I had
 about \$1 left.
 Then I went to the
 pharmacist and got
 my prescription filled. I had
 about \$1 left.
 Then I went to the
 florist and got
 some flowers. I had
 about \$1 left.
 Then I went to the
 bakery and got
 some bread. I had
 about \$1 left.
 Then I went to the
 butcher and got
 some meat. I had
 about \$1 left.
 Then I went to the
 fish market and got
 some fish. I had
 about \$1 left.
 Then I went to the
 vegetable market and got
 some vegetables. I had
 about \$1 left.
 Then I went to the
 fruit market and got
 some fruit. I had
 about \$1 left.
 Then I went to the
 cheese shop and got
 some cheese. I had
 about \$1 left.
 Then I went to the
 deli and got
 some sandwiches. I had
 about \$1 left.
 Then I went to the
 ice cream parlor and got
 some ice cream. I had
 about \$1 left.
 Then I went to the
 candy store and got
 some candy. I had
 about \$1 left.
 Then I went to the
 chocolate shop and got
 some chocolate. I had
 about \$1 left.
 Then I went to the
 nut shop and got
 some nuts. I had
 about \$1 left.
 Then I went to the
 seed store and got
 some seeds. I had
 about \$1 left.
 Then I went to the
 fertilizer store and got
 some fertilizer. I had
 about \$1 left.
 Then I went to the
 pest control company and got
 my house treated. I had
 about \$1 left.
 Then I went to the
 lawn care company and got
 my lawn mowed. I had
 about \$1 left.
 Then I went to the
 gutter cleaning company and got
 my gutters cleaned. I had
 about \$1 left.
 Then I went to the
 window washing company and got
 my windows washed. I had
 about \$1 left.
 Then I went to the
 roof repair company and got
 my roof repaired. I had
 about \$1 left.
 Then I went to the
 plumbing company and got
 my pipes fixed. I had
 about \$1 left.
 Then I went to the
 electrician and got
 my wires fixed. I had
 about \$1 left.
 Then I went to the
 HVAC company and got
 my furnace serviced. I had
 about \$1 left.
 Then I went to the
 painting company and got
 my walls painted. I had
 about \$1 left.
 Then I went to the
 landscaping company and got
 my yard landscaped. I had
 about \$1 left.
 Then I went to the
 pool maintenance company and got
 my pool maintained. I had
 about \$1 left.
 Then I went to the
 car detailing company and got
 my car detailed. I had
 about \$1 left.
 Then I went to the
 home inspection company and got
 my house inspected. I had
 about \$1 left.
 Then I went to the
 real estate agent and got
 my house sold. I had
 about \$1 left.
 Then I went to the
 mortgage lender and got
 my mortgage paid off. I had
 about \$1 left.
 Then I went to the
 insurance company and got
 my policy renewed. I had
 about \$1 left.
 Then I went to the
 tax preparer and got
 my taxes done. I had
 about \$1 left.
 Then I went to the
 accountant and got
 my books balanced. I had
 about \$1 left.
 Then I went to the
 lawyer and got
 my will updated. I had
 about \$1 left.
 Then I went to the
 therapist and got
 my session. I had
 about \$1 left.
 Then I went to the
 yoga studio and got
 my class. I had
 about \$1 left.
 Then I went to the
 gym and got
 my workout. I had
 about \$1 left.
 Then I went to the
 dance studio and got
 my lesson. I had
 about \$1 left.
 Then I went to the
 art studio and got
 my painting. I had
 about \$1 left.
 Then I went to the
 pottery wheel and got
 my bowl. I had
 about \$1 left.
 Then I went to the
 wood shop and got
 my table. I had
 about \$1 left.
 Then I went to the
 metal shop and got
 my sculpture. I had
 about \$1 left.
 Then I went to the
 jewelry maker and got
 my ring. I had
 about \$1 left.
 Then I went to the
 watchmaker and got
 my watch. I had
 about \$1 left.
 Then I went to the
 optician and got
 my glasses. I had
 about \$1 left.
 Then I went to the
 audiologist and got
 my hearing aid. I had
 about \$1 left.
 Then I went to the
 prosthetist and got
 my cane. I had
 about \$1 left.
 Then I went to the
 orthodontist and got
 my braces. I had
 about \$1 left.
 Then I went to the
 dermatologist and got
 my skin treatment. I had
 about \$1 left.
 Then I went to the
 allergist and got
 my allergy test. I had
 about \$1 left.
 Then I went to the
 endocrinologist and got
 my blood sugar checked. I had
 about \$1 left.
 Then I went to the
 nephrologist and got
 my kidney function checked. I had
 about \$1 left.
 Then I went to the
 gastroenterologist and got
 my stomach checked. I had
 about \$1 left.
 Then I went to the
 pulmonologist and got
 my lungs checked. I had
 about \$1 left.
 Then I went to the
 cardiologist and got
 my heart checked. I had
 about \$1 left.
 Then I went to the
 neurologist and got
 my brain checked. I had
 about \$1 left.
 Then I went to the
 psychiatrist and got
 my mind checked. I had
 about \$1 left.
 Then I went to the
 psychologist and got
 my soul checked. I had
 about \$1 left.
 Then I went to the
 life coach and got
 my future checked. I had
 about \$1 left.
 Then I went to the
 spiritual healer and got
 my spirit checked. I had
 about \$1 left.
 Then I went to the
 tarot reader and got
 my cards checked. I had
 about \$1 left.
 Then I went to the
 fortune teller and got
 my fate checked. I had
 about \$1 left.
 Then I went to the
 palm reader and got
 my lines checked. I had
 about \$1 left.
 Then I went to the
 crystal ball seer and got
 my vision checked. I had
 about \$1 left.
 Then I went to the
 clairvoyant and got
 my intuition checked. I had
 about \$1 left.
 Then I went to the
 medium and got
 my message checked. I had
 about \$1 left.
 Then I went to the
 psychic and got
 my power checked. I had
 about \$1 left.
 Then I went to the
 witch and got
 my magic checked. I had
 about \$1 left.
 Then I went to the
 wizard and got
 my spells checked. I had
 about \$1 left.
 Then I went to the
 sorcerer and got
 my potions checked. I had
 about \$1 left.
 Then I went to the
 mage and got
 my enchantments checked. I had
 about \$1 left.
 Then I went to the
 druid and got
 my blessings checked. I had
 about \$1 left.
 Then I went to the
 shaman and got
 my rituals checked. I had
 about \$1 left.
 Then I went to the
 priest and got
 my prayers checked. I had
 about \$1 left.
 Then I went to the
 nun and got
 my vows checked. I had
 about \$1 left.
 Then I went to the
 monk and got
 my meditation checked. I had
 about \$1 left.
 Then I went to the
 yogi and got
 my asanas checked. I had
 about \$1 left.
 Then I went to the
 dancer and got
 my moves checked. I had
 about \$1 left.
 Then I went to the
 artist and got
 my creations checked. I had
 about \$1 left.
 Then I went to the
 potter and got
 my wheels checked. I had
 about \$1 left.
 Then I went to the
 carpenter and got
 my joints checked. I had
 about \$1 left.
 Then I went to the
 blacksmith and got
 my hammers checked. I had
 about \$1 left.
 Then I went to the
 jeweler and got
 my stones checked. I had
 about \$1 left.
 Then I went to the
 watchmaker and got
 my gears checked. I had
 about \$1 left.
 Then I went to the
 optician and got
 my lenses checked. I had
 about \$1 left.
 Then I went to the
 audiologist and got
 my speakers checked. I had
 about \$1 left.
 Then I went to the
 prosthetist and got
 my canes checked. I had
 about \$1 left.
 Then I went to the
 orthodontist and got
 my brackets checked. I had
 about \$1 left.
 Then I went to the
 dermatologist and got
 my creams checked. I had
 about \$1 left.
 Then I went to the
 allergist and got
 my shots checked. I had
 about \$1 left.
 Then I went to the
 endocrinologist and got
 my needles checked. I had
 about \$1 left.
 Then I went to the
 nephrologist and got
 my filters checked. I had
 about \$1 left.
 Then I went to the
 gastroenterologist and got
 my scopes checked. I had
 about \$1 left.
 Then I went to the
 pulmonologist and got
 my masks checked. I had
 about \$1 left.
 Then I went to the
 cardiologist and got
 my pills checked. I had
 about \$1 left.
 Then I went to the
 neurologist and got
 my wires checked. I had

I think the only
 way to find out
 what is best for
 the people is to
 let them know
 what is going on
 and let them
 decide for
 themselves.

I am looking at the
 good of the world
 with the same eye
 as the children of men
 who are the people
 of the world.

Newton County, Va.
 Commissioned & sworn
 before me on the 1st day of
 June 1864.
 John H. H. H.
 The said John H. H.
 is entitled to supply
 and at an high level
 sufficient to maintain
 himself and all other
 family -
 The undersigned
 has signed and
 attested to the same
 and will be sworn to
 before me on the
 1st day of June 1864
 at the place of the
 said John H. H.
 and it is my duty to
 record the same
 at the place of the
 said John H. H.
 with the same

FOR ORDERS.

No 221-IV.

Memorandum

From a communication just received from the District Engineer Neilgherrie, it appears that the cost of the Marlumund Reservoir, as given in the Memorandum No. 216W dated 22^d October 1877, does not include certain items which ought to have been added to the sum therein named, and that the cost or expenditure stands thus, -

Marlumund Dam	Rupess	14,683
Escape weir	"	2120
Masonry drop	"	1120
		<u>Total Rupess 17,920</u>

It is mentioned moreover that convicts were employed in raising the Dam free of all charges except Police guards, and the supply pipes under the dam were obtained cost free from the Wellington Barracks. Possibly then the cost of this reservoir should be assumed to be Rupess 20,000 when comparing it with

Camp at
Marandapully
28th October 1877

Voluntarily Colonel R.R.
Chief Engineer for Irrigation

To The Secretary to Government, P. W. D.

~~Circulated in
Continuation of the
Memorandum by
the Chief Engineer for
Irrigation No 216 W
dated 22 October, circu-
lated on the 31 Octo~~

GA7
1/11

I have passed on the
address. 970?

Dated 28 } Oct. 1877
Sept. 31 }
1877 }
H. 224-57

Marlborough Record. -
Stirling District. - News.
mentioning the cost of the -
including certain items under
the cost as given in the
News. - 216-71 of 22 Dec.

Circulated

No 276 W

Memorandum

Ootacamund water supply

Enders. 19

The proposals which have been brought forward by the District Engineer Nilgiris, and approved by the Municipality, embrace the provision of additional storage for the supply of the Northern side of the station, and arrangements for purifying the water, with its distribution under arrangements likely to preserve its purity.

Marlimund Reservoir.

2 . There is at present only one Reservoir, if the small tank near Snowden House be excepted, for the storage of water for this part of the station. This is called the Marlimund reservoir, and was constructed about 7 years ago. Generally it has

has filled well and has surplused,
 but in 1875 the depth of water on the
 sill of the sluice did not exceed 15
 feet, and in 1876 9 feet, the depth
 when the reservoir is full being $19\frac{1}{4}$
 feet. The District Engineer estimates
 the contents at, in round numbers, 50
 millions of gallons, but from in-
 formation furnished by him 2 or 3
 years ago it appears that
 the total contents are 7,761,000 cubic feet.
 " contents below the outlet 324,000 do.....
 water available for use 7,437,000 do.....

Information
 given by
 Municipal
 Overseer.

or 46,480,000 gallons.

The catchment basin of this reservoir
 is 260 acres or 0.406 of a square mile.

The site is certainly much the best
 high level site near Otacamund.

3 To fill the Marlimund reserv-
 -voir it is necessary that a
 depth of 7.88 inches should
 flow from the whole area of
 the catchment basin. The District

Water yield re-
 -quirements.
 260 acres = 11,325,600 sq. ft.
 $\frac{7,437,000}{11,325,600} = .6567$ feet
 = 7.88 inches

Engineer

Engineer has given a table of the
 monthly and annual rain fall at
 Otacamund, for the years 1869 to 1876
 inclusive, from which it appears that
 its amount was in,

~~year Rain fall. Rainy days. Average fall in rainy days. October Rain fall. Rainy days. Average fall in rainy days.~~
~~1869 38.65 117 0.33~~

year	Rain fall	Rainy days	Average fall of rainy days	October Rain fall	Rainy days	Average fall of rainy days	Novem-ber rain fall	Rainy days	Average fall of rainy days	
1869	38.65	117	0.33	3.97	12	0.33	3.28	13	0.25	
1870	41.92	122	0.34	10.10	15	0.67	1.69	10	0.17	
1871	54.92	94	0.58	10.45	*	—	13.92	10	1.39	* not stated
1872	45.42	119	0.38	3.99	11	0.36	6.93	18	0.38	
1873	45.41	138	0.33	7.32	23	0.32	2.35	10	0.23	
1874	47.48	141	0.34	10.24	20	0.51	2.10	10	0.21	
1875	38.45	107	0.36	8.33	19	0.44	2.30	7	0.33	
1876	25.16	76	0.33	1.66	8	0.21	0.26	2	0.13	
	337.41	914	2.99	56.06	108	2.84	32.83	80	3.09	
Average	42.18	114	0.37	7.01	15	0.41	4.10	10	0.38	

The position and aspect of the catch-
 -ment basin of this reservoir make
 the N. E. monsoon rains those from
 which the greatest yield is obtain-
 -able, and a register of rain fall
 at Otacamund, which is on the other
 side

side of the water shed, is not a very reliable criterion of the rainfall at the reservoir catchment basin, but it is the best available.

It is understood that the Municipality have a register of the water levels in the reservoir; but at present there is no series of cross sections of the tank, and consequently the actual yield of the 260 acres, and the loss by evaporation and absorption, cannot be properly deduced, and indeed to enable these latter to be approximated to, it would be useful to know what water has been issued to the channel supplying the town, and of this there would seem to be no record. The District Engineer has been asked to have the requisite sections taken and a table of capacities prepared.

The water tower valves are not as convenient as is desirable though

Water tower
valves.

though apparently with slight modification a fairly accurate regulation could be effected. At present the valves which are hinged at the upper edge can be regulated to somewhat more than inches of lift, and were another disc placed at the other end of the drum of the windlafs, and the holes made to alternate with those now used, the difference of lift could be halved. However it will be advisable to substitute slide valves or plugs regulated by screws, and then exactly the desired discharge can readily be obtained.

Surplus chan. 5
inlet.

The arrangements for discharge of surplus are inadequate. The capacity of the reservoir is, compared with the catchment basin, considerable, but nevertheless the tank may be full or nearly full when

a heavy fall of rain occurs, and in 1871 it was in some danger. - There is no escape weir at the tank, but a masonry lined channel, 8 feet wide, starting at F.T.L. and with no bed fall, conducts the water for a considerable distance to a series of steps or drops, the width at the first drop being 6 feet. Thence the water is conducted by an earthen channel, altogether too small, along the hill side to a safe distance from the bund. The escape should, it is considered, be 20 feet wide with a clear over fall, and 24 feet with a channel like the present, to ensure the water level being limited to 3 feet above F.T.L. as a maximum. x 272 feet

6 It would seem that a rainfall of 12 inches in October and November are about sufficient to ensure an adequate supply to this reservoir. In 1875, a very dry year in July to September. Rainfall required to fill reservoir

Enlargement of Marlumund reservoir.

September, it was about $\frac{2}{3}$ filled, and the rainfall in the two N.E. monsoon months was 10.63 inches. The average of the 8 years gives 11.11 inches. - At a comparatively small expense the available capacity of this reservoir could be increased one half by raising the bund and F.T.L. 6 feet. The area of the present water-spread is 597,000 square feet and 6 feet over this would contain 3,582,000 cubic feet, so probably the total additional storage would be just about half the present capacity.

The present top width of the bund is 25 feet and might be diminished to 18 feet at the raised top level. The top of the bund is $7\frac{1}{2}$ feet above F.T.L., and the top of the raised bund should be $3 + 5$ feet ^{above the raised F.T.L.}. The interior and exterior slopes above F.T.L. may be increased to 1 to 1, and if necessary the interior slope below this point may be carried down at $1\frac{1}{2}$ to 1 until the required base is obtained.

8. The site of the proposed Snowdon or Snowdon House reservoir is just below Snowdon House on the Oota.

camund side of the saddle on which that house stands. The site as regards the formation of the bund is favourable, but otherwise there is not any thing in its favour.

(1) The catchment basin is only 60 acres, so the surface yield would probably not much exceed $\frac{6}{26}$ of that of the Marlimund reservoir, and if this be taken as 10 millions of cubic feet on the average, and one third of that quantity in such a year as 1876, the water available would be

in an average year	2,307,700 Cub. Ft.
in a year like 1876	769,230 —
the intended capacity as designed is	3,859,860 —

It is therefore not probable that in ordinary year this reservoir would fill. Major Morant states that the ground above the bund site is full

area of water spread 220,319 sq. feet. —
mean depth $17\frac{1}{2}$ feet. —

full of springs, but it does not follow that all this spring water would go to augment the water stored in the reservoir.

(2) the capacity is small compared with the height of the bund, 56 feet, as a maximum, and the depth of water, 40 feet, at the sluice. This arises from the high level of a large part of the ground within the waterspread.

(3) the cost of storage would be high viz Rupees — 594.3

per million cubic feet, even supposing the tank to fill. The actual cost might be — 8000 Rupees the million cubic feet.

The Marlimund reservoir cost Rupees — 14,700

so the storage there was at the rate of a little under Rupees — 2,000 a million cubic feet. Its capacity could be increased one half at a cost of about 2,000 Rupees the million cubic feet.

(4) Although it is of considerable advantage to lay 60 additional acres under

under contribution this benefit would be frequently more than neutralized by the full tank level being 15 feet above the sill of the South face of the tunnel through which the Marlimund channel runs.

The difference of aspect would be an advantage as more water would be received from the South West monsoon, the rain fall in which is not much less than 3 times that of the North East monsoon, but spread over 5 months instead of 2.

There are no really good sites at a high level available. There is a site to the West of the Marlimund reservoir, which was inspected, and which might possibly be of use to supply Kandal and houses in that direction. The catchment basin is about 122 acres. The level of the bund site will be ascertained.

Above and to the Eastward of Snowdon House there are the X and Y sites mentioned in Major Morant's report; they are

Other site
for reservoir
marked

are on extremely steep ground, and their catchment basins are 36 and 25 acres respectively. The former is on the South or Ooty side of the hills and the latter on the North or Snowdon side. The capacity of these tanks even with high bunds would be very small, but a considerable portion of the field of their catchments could be conveyed to the Snowdon House site, and in this way a reservoir constructed at this site might perhaps be adequately supplied. Another site marked Z is situated in the next valley to the South East of that of the X site, and has a drainage basin of 54 acres. The water could be conveyed to the Snowdon House site.

There is a site below Kinchona villa and just where a line from the stables at Lower Norwood, at right angles to the axis of the valley, would cut the stream, at which a reservoir of some considerable capacity could be

be formed. The area of the catchment basin is about 307 acres, and all the water of the basin of the Snowdon House site, of the X and Z sites, and of other ground would be received by it. Its adoption would entail separate filtering arrangements and distribution, but it is comparatively near the town, and the level of the stream at the bund site being 292.81 as compared with Ooty lake surface 289.81, the command would probably be sufficient.

10 The District Engineer in para 15 notes that the Marlumund reservoir was designed to supply 6000 people at 30 gal. a head a day, or 180,000 gallons a day altogether. He considers it to be desirable to provide for a population of 10,000, but that with masonry conduits or pipes 20 gallons a head a day should suffice; the daily provision would then be 200,000 gallons. It is mentioned that in

* Datum
feet below
sill of Lake
shrine

the F.T.L. of
Ooty Lake is
nearly 10 feet
above sill of
shrine in
bund.

Water supply
required
Letter No 146
18th April 1897

in London only $\frac{2}{5}$ of the whole delivered enters into consumption, and that in Glasgow 18 gallons out of 32 are wasted or the wastage is rather less than in London. Major Morant thinks that the waste at Ootacamund need not be so great. Were the delivery pipes to be similar to those of the London Companies, this conclusion might be accepted because their pipes work under considerably greater pressure than is intended in this case. Altogether however it would be unwise to suppose that the Ootacamund distribution arrangements will be more efficient than those existing in England after many years experience. The issues from the reservoirs should therefore be assumed to be at least half a million of gallons a day. In ordinary seasons it is considered by the District Engineer that the reservoirs would be able to store enough water for 5 months consumption

consumption, but that to ensure the station against a failure of water in bad years there should be provided a storage equal to 10 months' consumption. In the former case consequently the water to be available for issue from the reservoirs would be 75, and in the latter case 150 millions of gallons.

It is particularly unfortunate that reliable data, such as the Marlumund reservoir might have furnished, are wanting as to;

Local Data wanting

- (1) the yield of a given area of ground;
- (2) the proportion between water stored in a reservoir and that available for issue after loss by absorption and evaporation.

Information on these points for the Marlumund reservoir would have been very greatly more valuable than deductions from English experience. The loss by evaporation is dependent upon surface area; that by absorption

absorption is influenced by the nature of the bed and the depth of water. It would, it is thought, be a very favourable site at which the losses from these two causes would be less than one third of the quantity stored. The conclusions arrived at in para 18 of the District Engineer's letter appear therefore to need somewhat radical modification;

Taking as Major Morant has done first an ordinary year;

	Gallons.
200,000 gallons a day for 152 days	30,400,000
wastage based on London data	<u>45,600,000</u>

Quantity to be issued from Reservoirs	—	76,000,000
---------------------------------------	---	------------

Evaporation and absorption	—	<u>25,335,000</u>
----------------------------	---	-------------------

Storage required	—	101,335,000
------------------	---	-------------

against 45,600,000 according to Major Morant's calculation.

Secondly in the case of a very bad year like 1876;

200,000 gallons a day for 304 days	60,800,000	
wastage on London data	—	<u>91,200,000</u>

152,000,000

Evaporation and absorption.....

152,000,000

50,670,000

202,670,000

against 91,200,000 as estimated by the District Engineers.

12 Major Morant has been asked to obtain from the office of the Municipal Commission such registers

What
imperfect
data as
available

of; and information about the Marlborough reservoir as may be available, and to have a sufficient number of sections taken to enable a table of capacities at different levels to be drawn up.

It may then be practicable to approximate more or less closely to the yield of its catchment basin in 1875 and 1876, and thus to get some data for determining what area must be laid under contribution to yield the quantity of water needed. At present there is no information available, while a deduction from the fact that the water

water did not rise in the reservoir higher than 9 feet above the sluice sill in 1875 would indicate that it is very improbable that a sufficient area for a 10 months' supply can be found at the required level. Below the sill level the mean depth is said to be 4 feet and the con-

tents ————— 324,000 C.Ft.

The mean depth of the tank when full is 13 feet, contents 7,761,000 —

It is probable therefore that with a depth of 9 feet out of 19½ on the sill, the contents above sill level did not exceed one third of the quantity when the tank is full or say 2,600,000 C.Ft. and if it be assumed that the quantity drawn off in addition was ————— 2,600,000 —

the total receipts would be 5,200,000 —

or gallons..... 32,500,000

from an area of 260 acres.

13 The areas of the basins of the other sites which have been suggested are

W.	122 acres	Catchment basins of sites and their prod. yield.
X	36 "	
Y	25 "	
Z	54 "	
Snowdon House site	60 "	

Below Cinchona villa 307
 Deduct X and Z ——— 90 217
 514 say 510

If the yield be supposed to be the same in proportion it would amount to 63.75 millions of gallons, and this quantity added to that of Marlimumd would be 96.25 "

Moreover to obtain 202.670 millions for a 10 months supply the acreage of gathering ground required would be 1621 acres or 2.53 square miles and this is certainly no very great area in itself for the supply of a large station

station, though it appears to be altogether impracticable to find it, together with sites at a suitable level at which water could be stored.

Major Morant's proposals, even as somewhat modified during the recent discussions, amount to the formation of a reservoir at the Snowdon House site, and to supplementing the supply from its own basin by conducting water to it from the X.Y.Z. basins, but making every allowance for more favourable aspect in the case of all but Y, which much resembles that of Marlimumd, the total area of drainage would be only 175 acres and the yield would not exceed, and would probably fall short of that of the Marlimumd basin. These calculations are based on no reliable

reliable or indeed ascertained data, for such data have yet to be made available, but they will suffice to indicate that there is but little chance of making provision for the supply of water to the whole station on the scale which has been proposed. When actual data, however imperfect, are given, it will be easy to show what is likely to be feasible. The Otacamund water supply scheme should be based on what is demonstrably probable.

15. Major Morant's calculations, from which he concluded that the proposed Snowden House reservoir would fill more than once from the drainage of its own basin in the event of 3 consecutive dry years, were based, as explained by him in a demi official note dated the 25th September, on English experience.

The way in which the yield of Snowden site was estimated.

From the average annual rainfall one sixth is deducted, and the remainder is taken as the average of the three driest consecutive years. 14 inches were then deducted from this quantity for evaporation and absorption (the allowance in English mountain Districts) and 20 inches were found to be the depth actually draining off, the yield being 31,630,900 gallons against 24 millions, the capacity of the Snowden House reservoir. The area of the basin has since been found to be 60 instead of 70 acres, and the quantity corresponding to 20 inches draining off would therefore be 27,225,000 gallons or one eighth in excess of the capacity of the reservoir. The depth of drainage required to fill the latter would be therefore a little under 18 inches. Now it has already been shown that 7.88 inches draining off the

the Marlumund basin would suffice to fill that reservoir, and allowing for all possible difference of aspect in the case of sites a few hundred yards apart, it is certain that Marlumund reservoir would have filled to overflowing 2 or 3 times in 1875, and have more than filled in 1876, had these deductions from English experience been applicable to the circumstances. As a fact it did not nearly fill in 1875 and did not half fill in 1876; so whatever data are to be relied on should be obtained on the spot. To this end it is desirable that rainfall should be registered at the Marlumund reservoir which can easily be managed, and at Snowden houses, which probably can be arranged for. A knowledge, for even a short time, of the falls at these places corresponding to the falls

falls registered at Ootacamund will be of value in determining the effect of difference of aspect and elevation.

Registers of 16
surplus from
existing re-
servoirs should
be kept.

It may further be noticed that registers should be kept to show what the quantity of surplus discharged from the Marlumund and Dodabet reservoirs may be, and it will be necessary to know not only the depth at the tank end of the surplus channel, which will be found from the known reading of the sole of the channel on the water tower gauge, agreeing as this does with F.T.L., but the depth also at the lower end of the horizontal part of this channel. Similarly the depths of water, or the water levels in the channels leading from these reservoirs, should be recorded at such points as will allow of the discharge being calculated.

calculated. Such data are essential to the solution of the questions relating to water supply, and their continuous record for the past 6 or 7 years would have afforded all that would have been necessary for dealing effectively with the questions now awaiting settlement.

17 The Marlumund reservoir has, it would seem, received more water than it could store in 5 years out of 7. An addition of 6 feet to its depth will enable it to retain about as much water as the proposed Snowden House reservoir would hold, and it is therefore recommended that this enlargement should be estimated for at once, and, if as expected the cost will be moderate, carried out at once. Its contents will then be about — 11,555,500 cubic feet or 62,722,000 gallons

Enlargement of Marlumund reservoir should be estimated

X.Y. and Z sites should be further investigated.

18

In the next place the X.Y. and Z sites should have sufficient sections taken to determine how far they can be utilized as reservoir sites, and what their capacities at the levels which appear to be most suitable would be. There will, it is thought, be no objection to the construction of reservoirs at these sites if it be found that storage can be effected at a reasonable cost.

The X and Z sites are within the catchment basin of the site below Cinchona villa, but the quantity of water which they will store will not, it is thought, materially affect the supply of the lower reservoir should it be deemed desirable to construct it.

Position of fil. 19. All the water from the Marlumund reservoir and from the X.Y. and Z sites can be brought to filters situated above St. Stephen's Church.

situated at any point below the Snow-
don House site; and it must, it is thought,
depend a good deal upon what the
Commissioners can afford, at what
point the filters should be placed.
If money for enclosing all supply
channels will be available the fil-
ters can conveniently be placed a
short distance below Snowdon House.
Otherwise the nearer they can be
placed to St. Stephen's Church the
shorter will be the length of piping
necessary to maintain the purity of the
water after filtration. It is de-
sirable, if financially practicable,
to enclose the water channels, but
it can hardly be deemed essential.
To take the channel from Marlborough
reservoir to Snowdon House tunnel
for instance. There are one or two
short lengths which should in
any case be enclosed because more
or less liable to pollution from their
proximity to dwellings and gardens.

but the rest of this channel runs
through clean ground, and the
catch-drain above it would, if pro-
perly looked after and the troughs
which pass this drain water across
the channel kept clear, prevent
much fouling. Some cross fences
and frequent inspection would do
the rest. The channel is certainly
not in proper order as the depths
of water and velocities were found
to vary greatly, which would not
be the case with a channel the
fall of which was equally distri-
buted, and the water-way uniform
or varied according to the nature
of the channel lining. Similarly
the channel from Snowdon House
to near the church could by means
of catch drains and troughs be
preserved from material fouling.

Above tunnel 314,646
= net
Below do 6371
21020
The cost of enclosing the channels
is estimated at 21,000 Rupees the
interest on which at 6 per cent is

Rupees 1260. Probably 360 Rupees a year in inspection and work would keep open channels in good order. Closed channels would economize water and would be altogether more satisfactory. It is simply a matter of expense.

20 The present construction of the Snowdon House reservoir is not recommended because the cost of storage would be great; the drainage basin is small, and it would often necessitate the pouring to waste of water from the Marlumund reservoir for no water therefrom could be supplied to the station while that in the Snowdon House reservoir was above 15 feet below the F.T.L. This might, as suggested by Major Morant, be remedied by closing permanently any connection between this reservoir and the tunnel and continuing a closed channel from the latter through the upper

Present construction of Snowdon House reservoir recommended

upper part of the bed of the latter. Then water could be conveyed to the filters from Marlumund at all times, and the reservoirs could be worked independently as might seem expedient. This arrangement does not however get rid of the cost of storage which is very high. It may ultimately be necessary to utilize this site, and nothing should be done to prejudice such future use, but until it has been demonstrated that it is not practicable to store water elsewhere more cheaply this part of the scheme may properly be held in abeyance.

Site for reser. 21
-voir below Cin-
chona villa
promises con-
siderable ca-
pacity

From a few sections which Major Morant had taken of the site below Cinchona villa it appears probable that this site would allow of water being stored economically and that a F.T.L. of 350 would give

gives a fair capacity with a moderate height of bund. This water surface would be 150 feet above the sill of the Gaty lake sluice, or about 140 feet above the surface of the lake, and the Reservoir sluice sill would be at about 295 or 85 feet above the lake surface, so the command of the bazaar would probably be sufficient. As a reservoir for drinking water this site might not be suitable, as it would probably not be worth while to establish separate filters for cleansing it, but for washing and similar purposes it would do very well, and it is a site which, whether from this comparatively large catchment basin or from its probable capacity which has been roughly estimated at 14 millions of cubic feet or $87\frac{1}{2}$ millions of gallons, it will be worth while to examine more completely, as in the dearth of good sites for storage it is likely

* 200

at the bottom 10 feet lake

General con-
clusion and
details to be in-
vestigated and
planned.

likely to be wanted sooner or later.

22 The general conclusion arrived at by the undersigned is that storage is not likely to be available for the supply of Ootacamund with a delivered quantity of water of 20 gallons a head for 10,000 persons for 10 months, and it is thought that before any complete scheme of storage and distribution is brought forward for sanction it is desirable that it should be considered more particularly what the Municipality propose to undertake to do, and for what purposes pure water is to be supplied. The District Engineer's letter of the 1st June 1877 brings forward proposals for a certain rough division of the water supply above St. Stephen's Church into two parts, the one to be carried by a high level channel to above Sylke's Hotel and ultimately on to Kandal, and the other

* 100,000 gallons.

* 150,000 do.

and

and larger supply past the Post office.
With these proposals estimates amount-
ing to, in the form accepted by
the Commissioners, Rupees 98,954 were
submitted for enclosing the water
channels and filtering the water,
but these estimates evidently in-
clude only a part of the expense
necessary to provide for the conve-
nient and economical use of the water
supply. The estimates relate in fact
only to a part of what may be called
the principal distribution, and were
so much of the work done and nothing
more it would happen that by far
the greater part of the supply provided
at a very considerable outlay would
run into the Lake unused. To do much
good the works contemplated will
require to be supplemented at once
by other works, and the following re-
marks will serve to indicate what
are the details which have still to be
planned

planned and estimated for..

1st for the supply of pure water to the
bazaar: there should be service
tanks or reservoirs capable of
containing about 3 hours sup-
ply of water, and from these
pipes should run to street
fountains furnished with taps
from which alone water should
be obtainable by the population.
The number and capacity of the
tanks should be fixed with re-
ference to the population to be
supplied by each, and to facili-
ties of construction. The pipes
supplying these service tanks
should be capable of being
closed, and it would seem to be
proper to arrange for filling them
every 3 hours, and in the intervals
to furnish the supply to individual
houses.

2nd For detached houses supplies it
will be needful that cisterns should
be provided to be supplied by taps
which..

ordinary ball
cocks.

which will close on the cisterns be-
-coming full. It will not it is
thought be feasible to do without
cisterns. If the pipes for the sup-
-ply of individual houses are to be
allowed to run so long as there may
be water in the supply, pipes such
house pipes must be extremely small
in order to avoid great waste, and
for convenience cisterns of some sort
would be necessary. It will, it is
thought, be much better to require
cisterns in all cases to be provided,
and to supply them under self-
regulating cocks. The cisterns can
then be placed in such positions
and at such an elevation as will
make the house service thoroughly
effective. It is presumed that house
supply will include water for drink-
-ing, cooking, baths, and stables,
on which one rate would be charged
according to the class of house and
the probable wants of the residents.

13

U
If water for gardens or other than
domestic purposes be available
and supplied, a separate and ad-
-ditional rate would be fairly levi-
-able, and at any rate in dry years
supplies for gardens can be afford-
-ed ^{only} to a very limited extent.

3^d the intended scheme of branch
pipes for the supply of the de-
-tached houses and establish-
-ments has to be worked out. There
must evidently be several such
lines and the cost will not be
inconsiderable. If the Commission-
-ers propose to supply the houses
on the ridge commencing with
Harrow on the Hill and ending
with ~~Lock~~end, the cost will be
very material, for a great length
of iron piping and probably a
service tank at the off-take will
be necessary. If this line of houses
and the higher parts of Metoochen
are not to be supplied, a consi-
-derable

considerable part of the proposed supply of the high level channel from above St. Stephen's church will not be required, and a proportionately less quantity will, as need, be stored.

Service tanks should be constructed in connection with such a system as the circumstances of Ootacamund necessitate, whenever required to meet variations of discharge, for otherwise a good deal of water must be run to waste to prevent injury to pipes from excessive pressure. Pipes may be intended to run half or three fourths full, but if a constant supply be issued from the principal reservoir and if a variable quantity be drawn off from the pipes as must be the case, the variations being sometimes moderate and sometimes excessive, such service tanks to act as moderators will be essential

cement
pipes.

essential to the prevention of waste.

23 The undersigned has seen some of General Morgan's cement pipes, which it is proposed to use in part as water conduits for the distribution of the pure water. On their general merits no opinion can be given in the absence of test but on two points an opinion may be offered:-

1st the cement pipes should be capable of standing a very much higher pressure than that due to a head of 6 feet as named in para 10 of the District Engineer's letter of the 1st June, or to a head of 10 feet which Major Morant has mentioned has subsequently been suggested. Individual pipes ought to be capable of standing a pressure of at least two-thirds of an atmosphere or $2\frac{1}{3}$ feet, and the pipes when joined by the saddle pieces should be water tight under a moderate head of say 5 or 6 feet, otherwise the results of using them

x a pure
reservoir
the filters
be of material

them will not be satisfactory.

2^d the interior surface of the cement pipes should be perfectly smooth; this surface as seen in the pipes at the manufactory was far too rough. A facing of cement rubbed hard would seem to be necessary.

The undersigned is of opinion that masonry or concrete, covered, channels are preferable to pipes whether of cement or earthen ware whenever the quantities of water to be carried are considerable, and the level of the water surface can be regulated so as not to rise above the sides. In those parts of the service in which off-takes whether to branch pipes or to individual houses will be numerous, iron pipes will be alone suitable. In these pipes a head will not only be unavoidable but advantageous, and at the junction of the masonry channels, cement or earthen ware pipes, and the iron piping there should be cisterns provided with

means

44
means of discharging surplus so that the head of water may be strictly regulated.

summary 24 By way of summary to the foregoing remarks it is noted;

1st That the character and extent of the water supply of Otacamund should be determined with reference to the supply likely to be available.

2^d That all available storage sites should be examined in order to settle where water can be most economically impounded, and to what total extent, taking the probable yield of the catchment basins into account.

3^d That an estimate for adding about 6 feet to the depth of water in the Marlumund Reservoir should be prepared, and if moderate, that this enlargement should be carried out as soon as possible.

4th that the scheme of distribution of the water supply, which is, as at present drawn up, both incomplete and imperfect, should be properly matured.

matured and its cost estimated.

5th that the supply of pure water should, unless in excess of the demand for purposes for which pure water is necessary, be limited to those purposes. For these there is every reason to suppose it will suffice, but it will probably be altogether inadequate to supersede the present other sources of supply for cleansing drains, watering gardens &c.

6th that all calculations of yield of water from different areas of catchment basin should be based upon the data which the Marlumund reservoir will, it is supposed, afford rather than upon English precedents which are not reliable for application to Otacamund, and which in the case of the Snowdon House Reservoir site would clearly lead to disappointment. That also measures be at once taken for seeing what data the registers of water at the Marlumund reservoir will afford, and for supplementing these by a table

table of capacities of that reservoir, a careful register of water levels, water issued and water discharged as surplus, and the registration of rainfall at this reservoir and if possible at Snowdon House, for comparison with the registers at Otacamund itself.

7th Whenever good storage sites may be found capable of storing economically a greater quantity of water than the catchment basin would be likely to yield, probably the supply may be supplemented by catch-drains to conduct water from beyond the catchment basin proper to within its boundaries.

Requisition 25. It is understood that proposals have been made for the acquisition of the catchment basins on which Otacamund may hereafter have to depend for its water supply, in order to secure the purity of the water. The subject is one which the undersigned is not called upon

to consider further than to remark that,

1st if such a course be deemed imperative, it is essential to concentrate storage and to make the most of each site; also to limit the pure water supply to strictly domestic purposes.

2nd When valuable property occupies a part of the catchment basin, it will often be feasible and preferable to drain this so as to exclude the drainage from the reservoir, than to purchase and include the area in the basin.

26. The undersigned has to thank Major Morant for the ready assistance he has afforded. His local knowledge and acquaintance with the circumstances of the supply have enabled this report to be drawn up in a much shorter time than would otherwise have been practicable.

27 It may be mentioned in conclusion that the enlargement of the Dodabet Reservoir, which is connected

Major Morant's assistance acknowledged

Enlargement of Dodabet Reservoir desirable

Camp at Thencarai station
22nd October 1877

with the supply of the South side of Dodabet is certainly desirable. Its drainage basin is stated to be 184 acres, and its capacity only about 480,000 Cub. Ft. 3 millions of gallons, so that it would fill with a drainage of only about $\frac{5}{7}$ of an inch. Its utmost possible enlargement will probably leave it still too small to store the average yield of the rain-fall.

W. H. Mullins Colonel R.E.
Chief Engineer for Irrigation

To The Secretary to Government

1877.

From
The Chief Engineer for the

Dated 22 3 Oct 1877
Recd. 26 3

No 216 N

5 Plans & Estimate

sent to Finl Dep
with GO-10511-21

Ostacammund Water

- Algiers District. - Present

reporting on the proposals for

- connection with the Suverdon

for the better supply of the

port of Ostacammund.

R.C.S-1-75

Ar 31-10-R5-1-78

47 60 P.W.D.
No 1709.

Letter from the President Ostacammund
Municipality No 45 dated 19th April 1877
referred to the Chief Engineer for his
remarks with endorsement in the Financial
Department No 921 dated 26th April 1877.

The Chief Engineer hoped ere
this to have inspected personally the site
of the proposed reservoir on arrival at
Ostacammund with the Government. Until
he is able to do so, and submitted his
report he recommends that no action be
taken in the matter.

Fort St. George
21 June 1877

Edmond Colonel R.E.

Chief Eng^r P.W.D.

To The Chief Secretary
with papers returned.

16 1783

Retransmitted to the Chief Engineer with
original notes of members.

In order

Sep 9th 1877

Speci
S. Under Sec.

Subd 21st June 1877
See 22nd June 1877
13 pages

Chief Engineer

Chief Engineer

Recd to Finl
Dept with G. L. 1878
W of S. Janry 1878

Chs 4336/77

R-5-1-78.
R-5-1-78
R-5-1-77.

No 80

Ottawa Municipal Commission Office
24 August 1877

From

A. M. F. Corbeter Esq.
Acting President, Municipal
Commission, Ottawa

To

The Chief Secretary
to Government,
Fort Saint George.

Sir,

Received of 19 April 1877, No 45, Have the
Chief Engineer
Ottawa - is
in line 17/8/77

In continuation of my letter
of 19 April 1877, No 45, I have the
honor to forward an Estimate for
the completion of the water supply
project for the northern portion of
Ottawa, together with a copy
of the District Engineer's letter, and
of the proceedings of the Municipal
Commission thereon. I have also
the honor to forward for the sanction
of Government an Application for
a loan of \$236,920 for the
completion of this portion of the work.

2. The amount of the loan
applied for in my letter to Government
of 25 January 1877, as well as
the loan, Estimate for which, were
submitted with my letter of 19th
April is included in the present
Estimate of the Commission and
application for a loan. In the
former Application for a loan
of \$20,000, the Commission were
proposed to repay it in 20 years,
but looking to the amount now
required they propose to repay it
in 30 years.

3. Government will observe that
the Commissioners have decided
to be content for the present with
the improvement ^{and supply} of the existing
reservoirs, leaving the construction
of the additional reservoir at
X & Y on Plan ^{of 1906 & 1907} as the
map for future operations. Should
the present supply become insuff-
-ficient owing to increase of popula-
tion or other causes.

4. I have the honor to request that
Government will be pleased to
sanction the estimate and the loan,
and will allow the loan to be carried
out by the District Engineer. -
The Commissioners desire to hope
that Government will take into
consideration the exceptional circum-
stances of the Station, and will
allow the loan to be carried out
by the District Engineer free of
cost to the Municipality. This
will reduce the cost of the loan
to about 1 lac of Rupees, and
the Commissioners will be enabled
to spend the remaining portion
of the loan in improving the
Southern Water Supply Channel
and in continuing the Northern
Supply to Kundab and Kundab
Hill.

I have the honor to be
Sir

Yours truly O. S. S. S. S.

M. M. M. M.

Acting President
Municipal Commission

No. 80. Jul (1877) 145
From

The President
Municipal Comm
Ottawa

To

The Chief Secy
to Government
Fort Saint George

Dated 24 Aug 1877
Recd 27

Encl. 6.7

(Recd 27)
File 100
with 50

Water Project. 1877

Submissions for
Examination of
present and future
for the completion
of the water supply
of the Province
to the Chief Secy
to Government
for a
Report to the Chief
Engineer for remarks

25/8/77

22 July
G. W. D. J. S. J.

P. C. S. 1-78.
C. 31-10 R. S. 1-78

No. 145

From

A. M. Webster Esq
Acting President
Ottawa Municipal Comm

To

The Chief Secretary
to Government
Fort Saint George

Sir,
With reference to the Proceedings
of Government dated 6 February 1877
I have the honor to forward a plan
and Estimate for the improvement
of the Northern Water Supply of
Ottawa together with a
letter from the District Engineer
explaining the project, and an
extract from the Proceedings of
the Commissioners of that date,
the Estimate provides for the
enlargement of the Enslaved
Reservoir. The subsidiary reservoir
proposed by the District Engineer,
and the construction of conduits
will be estimated for hereafter.
2. Captain Morant's letter is so
full that the Commissioners have
nothing to add. It will be seen
therefore that in ordinary years
the new reservoir at Enslaved
and the existing one at Millstream
will provide for the wants of 1000
people at 25 gallons per head per
diem for 365 months and will
have a surplus of about 24,000,000
gallons, and that in bad years
there will, supposing the same
consumption

Consumption, be a deficit of about
25,000,000 gallons or say 2 1/2 months
consumption. It is however to be
observed that the rate of consump-
tion of 20 gallons per head is
perhaps more than ample, and
if a supply of 15 gallons per head
is provided, the supply in a bad
year would last for 11 months,
when however the Drainage Scheme
is perfected we shall require more
water, so it will be necessary
hereafter to construct the Subiding
reservoir at K and G (Plan I)
and the supply of water will then
be amply sufficient for all purposes.

3. The Estimate does not
provide for Public Works Expen-
diture which will amount to
Rs 5700. It is however very
necessary that the works should
be carried out by the District
Engineers, as owing to the position
of the Province nothing should
be left undone to prevent any
possible chance of the Embank-
ment giving way. The
Commissioners will not be
able to provide from their
current year's Budget the sum
of Rs 5700, over and above the
loan of Rs. 20,000, and I trust
therefore that Government
will be able to allow the work
being carried out by the District
Engineers free of charge, or that
if that is not possible they
will allow any sum which the
Commissioners

Commissioners cannot pay
during the year to be over and to
be deposited when the completion
of the water supply, and the
Drainage projects are passed,
and the proposed loan for these
works is sanctioned. The present
provision made to the water supply is
urgently needed, and the work
should be pushed forward with
the utmost expedition, so as if
possible to get a good supply
for next year.

I have the honor to be
Sir
Yours Most Obedt Servt

M. M. W. W. W.
of President
M. M. W. W. W.
Commissioners

5/11

N^o 1921.

Financial Department
(General)

P.W.D.

27-77

22-77

Referred to the Chief Engineer
for remarks.

(By order)

26-4-77 H. Munnell
Under Secretary

To the Chief Engineer
with 5 plans in
a Envelope

To the Chief Engineer
for remarks
to be sent to the
Chief Engineer

Dated 27-7-77
Recd 21-8-77

N^o 2569

From 20/10/77

Encl: 5 plans
7 estimates

Subject

Comparing plan
and estimate of
the improvement
of the Southern
Supply of Cochin
by the route of the
road to be built
from the district
of Cochin, to plan
the project.

N^o 105 W Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the 8th Jan'y 1878.

Read the following:—

Endorsement of the Financial Department, N^o 921,

do

do

do

do

From the Chief Engineer
for migration

(N^o 105 W-28 Oct 77)
221 W-28 Oct 77

This Council resolves
in Council resolves
to communicate the
remarks of the Chief
Engineer for migration
to the Municipal
Commissioners of
Batacamund for their
careful consideration.
The Engineer in
Council is of opinion
that the raising of the
land

R.F.

Board of the Hawaiian
Reservoir would be of
doubtful utility seeing
that the Board is by
no means unanimous
in its attitude towards
the project and its
success involving heavy
compensation for labor
and even the cost of the
stoppage of the supply
of water from long times
during the progress
of the work.

The Hawaiian Reservoir
project presents a
more hopeful aspect.
It would be an addition
to the existing sources
of supply and at a
high level would command
the whole of the island.

53
most if not all the
houses below. The question
of compensation should
be investigated and
when the cost has
been carefully estimated
an application for
funds can be made
in the usual way.

The extension of the
Doolahet Reservoir
should also receive
special attention.

To the Hon. Secy. of the Interior
D. C. Kilgore
Chief Engineer

Disp'd 21-1-78

But no

31-5-95 (enc) v
13-6-05