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15 Dec
Previous Paper
26965

Water Supply - Mombasa

Submit scheme for obtaining water supply from Mombasa Hills. Includes report by Dir. of Public Works with estimate £85000

Copy (Carlyle - my) / T. 20.10.1910 / 26965
Subsequent Paper
26950

Mr. Peacock, F.R.S.

As I promised is to be congratulated on this discovery. The first thing to be done is to obtain the views of the C.E. on these estimates. I submit them to the C.E. accordingly. I have obtained a copy of Mr. Peacock's report to which I forward after I have put it up with the other papers. [This is one of the projects for which Mr. Peacock wants a loan]

13th Dec 1910
H. R.
23/24

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COLONIAL OFFICE,
L O N D O N.

15th December 1910.

Sir,

With reference to my telegram No. 151 of August 2nd 1910, informing you of my visit to the Shimba Hills and the discovery of a water supply which might be made available for Mombasa, I would now beg to lay before you the details of the discovery and the subsequent action taken upon it.

1. As far back as April 1900, a detailed report on the water supply of Mombasa was made by Colonel J. du T. Bogle, R.E., details of which were forwarded to the Foreign Office from the Crown Agents for the Colonies under cover of a letter dated April 11th 1900. The supply in question was drawn from what was called the river "Pamba" or "Manola". Upon chemical analysis the water was not considered a suitable one for domestic purposes.

2. In considering this most important matter, I was impressed by a report furnished by Mr. Hay of the Uganda Railway staff in February 1908. That officer discovered that the source adopted for a supply by Col. Bogle was formed by a subterranean stream which emerged from the hills many miles beyond the point which Colonel Bogle had fixed upon.

He

The Rt. Hon. LEWIS HARCOURT, P.C.,
COLONIAL OFFICE.

L O N D O N.

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He stated that he had never seen purer looking water in Africa, and that this point somewhere up in the hills would form an excellent place for an intake - the flow after a prolonged drought being no less than 750,000 gallons a day. No sample appears to have been taken of this water at the time. From the date of this report, February 1908 until my arrival in 1909, no further attempts were made to follow up the river or to further investigate Mr. Hay's discovery, though everything went to indicate that a pure supply would be obtained in this direction.

3. In the meantime a project was put forward to obtain water from the Vol River or from Tsavo, but the financial charges involved precluded any serious consideration of this proposal.

4. In consequence of the excellent report of Mr. Hay, I directed the Public Works Department in November 1909 to send an Engineer to further investigate this supply and to if possible obtain samples. The samples as obtained were not satisfactory - the water being considered to be merely on the border line of safety as a drinking water. From the description furnished by the officer entrusted with the duty, it appeared to me that he had not visited the site reported upon by Mr. Hay.

5. In July 1910, accompanied by the Commissioner of Public Works, I myself proceeded to the

- Shimba

- 3 -

Shimba Hills, visited the sources proposed for utilization by Colonel Bogle, and ascertained the fact that the river concerned disappeared underground and was said by the natives to re-appear in the hills at a very much higher elevation. Proceeding on the following two days, two springs were discovered which answered in description to those of Mr. Hay. It was estimated that they were some 20 to 25 miles from Kombasa and at least one thousand feet above it.

The water appeared as two springs emerging from the ^{side} of the hill, was quite palatable and had an extraordinarily pure appearance as compared with any water in East Africa. Samples were duly taken and reported upon by the Government Bacteriologist, who stated that the water could be regarded as chemically excellent water and the best sample he had analysed in the Protectorate. There was a slight milkiness in the samples, but the Bacteriologist was of opinion that, should the water retain its chemical characteristics under the varying conditions of rainfall, it would afford a perfect water supply. The analysis of this water was continued monthly, and to the date of my departure, and has given uniform results.

The following is a comparison of the analyses:-

Col. Eagle,
1899.

Sikes.
Decr. 09.

July 1910.

	Grains p.gallon.	Grains p.gall.	Grains p. gal
solids.	14.98	8.0	8.0
chlorine	3.99	4.0	1.6
	Parts p.100,000	Parts p.100,000	Pts.p.100,000
Ammonia.	.006	.006	.001
Ammonid Ammonia.	.003	.012	.005
Oxygen Absorbed after 4 hrs	.06	-	.06
Nitrogen as Nitrites	-	.03	Nil.
Nitrogen as Nitrates.	-	Trace.	Nil.
Minerals.	3.0	Not given	0

8. The Medical Officer of Health at Mombasa was deputed to make a further report on this proposed water supply, which appeared to promise a most desirable source of supply. He stated that the hills were of sandstone formation, covered for the most part with small sandy soil. The uplands showed no sign of recent native population; no cattle were seen and little game - the catchment area of the proposed supply being practically free from population, and the streams apparently deriving their supply from underground reservoirs. He expressed the conclusion that should the analysis not condemn this source of supply, it would be a huge improvement on the existing wells, and provide a sufficiency of water for the needs of Mombasa.

The

- 5 -

The Health Officer was not then aware of the excellent reports furnished by the Government Bacteriologist, ^{7 Director of P.W. ~~and other officials~~} and everything therefore up to this date pointed to the final discovery of a thoroughly workable water supply within reasonable distance of Bombay. In consequence, the Director of Public Works was instructed to proceed at once with a preliminary survey based upon the detailed surveys of Colonel Bogle, which could be utilised for the major part of the distance over which the supply would run, and these are now attached to this Despatch.

7. Whereas Colonel Bogle, after detailed consideration, furnished estimates in 1902 amounting to 295,347, the Director of Public Works today is of opinion that on figures at market prices available in British East Africa a sum of 285,903 would suffice for a daily supply which would meet the requirements of the town and port for many years to come - the supply contemplated being almost three times as much as that proposed in 1899.

It will be noted that the Director of Public Works is of opinion that if his figures are scrutinised it may be quite possible to materially reduce his estimates, more particularly in regard to material. I would suggest that as this scheme forms an integral portion of my proposals with regard to loan works, that it should be submitted to the consulting Engineers to the Crown Agents for their opinion.

It


It is the intention of the Legislature that this long-deferred object should be accomplished at any rate as the existence of pure water is concerned - fully established.

Much credit is due to the Director of Public Works for having produced such a well worked out preliminary estimate which, based as it is upon the detailed investigations of Colonel Bogle in 1899 and their extension by the Director of Public Works in 1900, may be looked upon as fairly reliable. The whole cost of the present investigations has been borne by the ordinary Recurrent expenditure of the Public Works Department.

I have the honour to be,

Your most humble

obedient servant,


GOVERNOR.

X *Journal* X
340

Public Works Department,
Nairobi,
East Africa Protectorate.

November 18th, 1910.

Your Excellency,

I have the honour to submit a preliminary estimate of the cost of supplying Mombasa and Kilindini with a copious supply of water from streams in the Shimba Hills. It amounts to £85,923.

In endeavouring to frame estimates in this country for operations of this magnitude, one is much hampered by the impossibility of obtaining recent market prices for materials. So when there has been doubt as to English prices, a perfectly safe figure has I think in all cases been put forward. The result is a total which would certainly not be exceeded in installing the system which is now suggested. It will be seen that the total is some £10,000 less than the estimate of 1899 for the supply of water on lines suggested by Colonel Peile, and this in spite of the facts that -

- (a) the supply contemplated is three times as large as that proposed in 1899,
- (b) the source of supply is at a distance of 28 miles, instead of 20 as in the former project,
- (c) the supply is from a valley where some costly work would be necessary, instead

of from

Sir Excellency

Sir E. E. C. Girouard, K.C.M.G., D.S.O., P.E.
Governor.

of from a steep rocky stream-bed where head-works would be of a trivial nature.

It is the case however that the distribution system in the island is not as full and complete as that proposed by Colonel Hoyle. It is moreover quite likely that if this estimate be placed in the hands of any Engineer conversant with recent market prices, an immediate reduction of several thousand pounds could be made even on a first perusal.

I understand that the present execution of this project will not be feasible unless it should receive sanction as an item of loan expenditure. Should this latter be the case however, I presume that it will be considered desirable to arrange a supply now which will probably suffice for a number of years to come, so that Government, or local authorities, as the case may be, will not be faced after four or five years with the necessity of raising funds and of going to the considerable trouble and expense in organization and execution which the duplication of a small pipe-line would involve. Arrangements are therefore proposed for bringing one and a half million gallons a day to Mombasa Island, and of there distributing such (comparatively) small quantity as is required for immediate daily consumption. If sufficient funds could be obtained, it would be preferable, inasmuch as it would lead to economy in the long run, and would avoid recurring obstruction of business and interference with private property, to lay down now the principal circuits of

the

the distribution system which will be necessary when the entire available supply is being usefully consumed. An alternative estimate is supplied for this step. It brings the total estimate for the project to £90,977.

4. By adopting "the yellow route" shown on the reconnaissance plan already submitted, a length of 1 1/2 miles of main, involving an estimated expenditure (at £1913 per mile) of £2860, would be saved. The crossing of Luache creek, 800 feet wide, by a light type of suspension bridge carrying a distributed dead load of thirty tons (pipe and water) and a live load consisting only of foot passengers, would certainly cost much less than this figure. Subject only then to an examination of the site not disclosing ground of a hopeless nature for the foundations of bridge-piers, the selection of the yellow route may be recommended. Before this letter reaches London, I shall have taken an opportunity of examining this crossing, and the alternative "blue route", and can then report further, if Your Excellency should require definite information on the point before returning to the Protectorate. It might be still cheaper to lay a pipe below water across this creek, but as I am at present ignorant of the depth of water, nature of bottom, and other conditions, I am unable to give an opinion now.

I have, etc.

(Signed) W. McCREDDEN R.C.S.E.

Director of Public Works.

PRELIMINARY ESTIMATE.INCREASE WATER SUPPLY.SUMMARY.MAIN FIRE LINE.

1. Survey	350
2. Land	260
3. Pipe-line material, landed,	38,037
4. Transport of material to tranch:	7,458
5. Head works,	4,620
6. Laying,	9,713
7. Telephone,	360
8. Supervision charges,	5,198
	<hr/>
	£65,996

SERVICE RESERVOIR.

Installation to meet present
requirements. £1,687

DISTRIBUTION SYSTEM.

Installation to meet present
requirements. £14,220

Total £85,903

(Signed) W. MCGREGOR BOSS,

I.P.W.

Nov. 19, 1910.

RAIN PIPE-LINE.

SURVEY.

Includes nine miles of clearing through dense scrub jungle and forest. Thereafter 20 miles of more open country with occasional traverses of cultivation.

Assistant Engineer (charged to staff) and 60 porters for four months.

Rate of pay Rs.12/- with rations at Rs.4/- per man per month delivered on the spot.

Rs. 60 x 16 x 4

- Rs.3840 - £256.

(Add for compensation for injury to growing crops and to coconut-palm stands along Fort Raitz. Lump sum

£20

slashes, crowbars, axes, saw, brushes, paint, porters' water bottles and cooking-pots, and other details.

£25

Three porters' tents, made in the Jail at cost of material only, at 18

£18

£119

Add 10% contingencies

£11

£250

N.B. The result will be a staked-out line and a cleared track of 15-20 ft. width along the entire route, except where passing through cultivation, where it would be narrower.

Further, a full report on the East

alignment

alignment for adoption, with plan and section, and report on **geology** of the country traversed, and a complete list of all pipe specials required from the intake to the service reservoir. This would be accompanied by a revised, and probably reduced, estimate of the cost of the work.

The Asst. Engineer's entire survey equipment - tent, instruments, camp furniture, servants' tents, drawing-office material, stationery etc., would be supplied by the Department, without charge to the Water Supply funds.

Ferrying of survey party, regular supply of rations to head of Fort Pitt, soundings, and conveyance of Assistant Engineer and inspecting officer by water would be done by E.W.D. Boat and crew. No charge.

Medicines and first-aid equipment, supplied by Medical Department. No charge.

CARRY TO SURVEY; 1. SURVEY 2350.

ACQUISITION OF LAND.

The first ten miles of pipe-line from the intake would be through almost untouched country, in which Government could reserve occupation of a 50 foot strip without any expense.

On a rough inspection of the country beyond this portion, it is supposed that as much as a total of five miles might be through cultivated land and cocoanut-palm plantations.

Maintaining a width of 20 feet here also, for the sake of uniformity throughout, (since the cost of land is trivial) a total area of 30.5 Acres would be required.

Allow for land only, 40 acres at £2 an acre £80

Allow in addition for the destruction of as many as 200 cocoanut palms, the usual compensation for which is Rs.15.00 each £200

CARRY TO SUMMARY: 2. LAND £280

MATERIALS FOR PIPE-LINE.

29 miles of 12 inch spigot and socket
 steel pipe at 25 lbs. per foot run,
 plain: 1709 tons.

Allow for 1% additional length in the
 sockets and 1% additional weight due
 to the sockets: 1745 tons.

Add one third mile of spares, say 2 tons

Total 1745 tons at \$15.2 = 26,524

Specials. (Tees, bends, collars, etc.)

say 2,000

50 sluices for washouts, for 6"
 off 12" tees, say 150 150

100 air valves for 12 inch main say 100 600

48 tons lead at 1.16 768

2 1/2 tons yarn at say 120 45

Sea freight 1950 tons gross

or say 20% extra when taken by measure-
 ment, 2535 tons at 30/- = 5,805

Not insured,

landing charges at \$4.3 a ton on
 1950 tons gross 390

Contingencies, 10% on 234,579 5,458

Cost of material, landed. 236,387

CARRY TO SUMMARY:

3. PIPE-LINE MATERIAL, LANDED 236,387.

TRANSPORT OF PIPE-LINE MATERIAL.

Lighterage to head of Port Reitz, averaging Rs.6.00 a ton for the entire quantity of 1950 tons gross (By contract)	£780
Porterage say, 9 miles of pipes carried for 14 miles " " " " " 5 miles " " " " " 2 miles at 60 tons per mile of pipes, including load etc. i.e. 11,640 or say 12,000 ton-miles at Rs.7.50	£6,000
Contingencies at 10%	678
Total	£7,458

This gives us:-

Cost of material at site alongside
trench, £41,455
or £1265 per mile.

GROSS TO SUMMARY:-

4. TRANSPORT OF MATERIAL TO TRENCH £7,458.

HEAD WORKS.

A dam would be required to impound water to a sufficient extent to provide a depth of 15 or 20 feet above the intake pipe. Otherwise air and water weeds might be continually drawn down. This might necessitate a dam of 60 ft. length and an average section of 375 square feet. Volume 22500 cubic feet. Allowing concrete, including carriage of cement to site, to cost Rs.1.50 per cubic foot at the head-waters of the Weri, sand and stone being obtainable on site, this would cost, including boxing

Rs.250

Allow for general work at intake:

Clearing of a considerable portion of the valley in selection of the dam site, removal of much surface rock, catch-water drains to keep surface wash out of reservoir, fencing reservoir area, driving one or two short cuts, leading in water from definite springs in the hillside near at hand, planting of slopes, and general treatment of the intake area,

say, lump sum of 1,000

Quarters for caretaker to be left in charge of reservoir area on completion, cement stores, and airing sheds, say

250

Connections from the MANARAPA and MAKOMBO streams with the pipe line at £250 each

500

Tools and plant at 5%

250

Contingencies at 10%

420

 £4,520

CARRY TO EDVLAFF

5. HEAD WORKS

£4,520.

LAYING.

Allow for clearing, re-survey, and re-alignment of short portions of pipe-line, where divergence from the first survey line is seen to be advisable.

Excavation for nine miles may be in a very rocky ground. As a trench cannot be taken out neatly, to close dimensions, allow for a 5' x 3' trench for nine miles. That is 718,800 cub. ft. in rock at Rs. 60/- per 1000 cubic feet

Explosives, say,

For the remainder, allow of half being in hard or rocky ground, and half in soft earth, i. e. 10 miles, 2 ft. by 2 ft. 6 ins.

i. e. 369,600 at Rs. 30.00 per 1000.

Also 369,600 at Rs. 15.00 per 1000

The pipes, supplied in random lengths of 16 ft. and upwards, will not number more than 350 to the mile. Allow for handling pipe into trench, making and caulking 6000 joints, at one rupee per joint.

Fill in over pipe, 1,400,000 cub. ft. at Rs. 4/- per 1000 (This may include a lead of some distance in the rocky portions of the country).

Crossing the Kanolo River six times. Special supports to withstand submergence and heavy floods. Six at £100

Two suspension bridges at £1000 each, the home cost of a 300 ft. span being just over £500.

Temporary Staff quarters

Tools and plant at 10%

Contingencies at 10%

Total Rs. 715

CARRY TO SUMMARY:

8. LAYING Rs. 715.

(N.B. Items 2, 3, 4 and 6, give as the cost per mile of pipe, laid complete, 1913)

TELEPHONE.

Telephone connection from Mombasa to the service reservoir at RAS MCHANGAMBE and on to the head-works on the MRERI, say a total length of 30 miles, as the line would follow the path past the Forest Station and would not take the longer route along the pipe

30 miles at £12.

£360.

CABLE TO BUNDARY

7. TELEPHONE

£360.

SUPERVISION CHARGES AGAINST WATER SUPPLY FUNDS.

Supervision would largely be effected by the present staff of the Department.

The work would be under the general direction of the Executive Engineer of the Kavirio Province (Mr W. Blain).

Mr H. L. Elkes would be employed as resident Assistant Engineer on the work. Frequent inspection would be made by the Director of Public Works, and the Deputy Director.

The accounts and Stores work involved in the project would be dealt with in the usual course by the Chief Accountant and the Chief Storekeeper respectively.

Drawing office work would be carried out by the Engineers engaged or in the local drawing office at Nairobi.

There would be required also two junior, and temporary, Assistant Engineers, engaged from home, and two Foremen, who are available locally (see separate memorandum on staff).

It is considered that work would not be completed within two years after survey, but that it would be completed within three. (Labour supply is the ruling factor here.)

2 Assistant Engineers, at £300 for three years,	£1,800
2 1st class return passages for same at £92.	184
2 Foremen at £200 for three years	1,200
Timekeepers, messengers, ambulance staff conveying sick or injured men to Mombasa, headmen, watchmen £200 a year.	600

G.P. £3,784

B.C.

£3,784

Oil launch for the use of inspecting
and executive officers and for
towing up rations and other general
stores during the continuance of the
work. (It might afterwards be
handed over to the Postmaster General) 350

Running and maintenance of same
at £25 a year 75

Camp allowances to staff engaged
from Water Supply funds. 516

Contingencies, at 10% 473

£5,198

CARRY TO SUMMARY:

B. SUPERVISION CLAPNET £5,198.

SERVICE RESERVOIR.

In framing the preliminary estimate for the main pipe-line, provision has been made at every point for a finished project for the delivery of one and a half million gallons of water a day at PAB MCHANGAMWE. Until the requirements of the town rose beyond this figure no further work would be necessary along the main. It would stand as a completed project.

The principal delivery main which is to pass over Makupa bridge should also be capable of delivering this full quantity on to the island. This quantity will not be fully used for domestic, trade and shipping purposes for a considerable number of years. In the meantime, the excess of water above the actual requirements of the town and port could be best used by mains bent in a constant stream down the few main drains in the town delivering into Mombasa harbour near the slaughter-houses and Fish Market.

The same considerations, as to supplying an installation which could not require expansion for many years to come, do not, however, apply to the provision of service reservoirs on PAB MCHANGAMWE. Economy may certainly be introduced here. The site is close to Mombasa Island and small extensions can be conveniently carried out from time to time, as the demand for them arises, by the Executive Engineer stationed at Mombasa.

Service tanks holding 600,000 gallons would be ample for present requirements. Tanks of this capacity, with a depth of 20 feet, partly below ground in concrete lined rock excavation, and partly above in reinforced concrete, the whole roofed with corrugated iron, would cost £2800.

A close

A close estimate for this portion of the work cannot be given until the tanks are designed in detail. And here prices for steel-work obtained for comparison with those for the method of construction outlined above. For purposes of preliminary estimate the following may be taken.

Roofed tank, in compartments to allow of cleaning	£2,600
Inlet pipes, branches to the various compartments of the tank, 12-inch sluices, scour gate for cleaning purposes, discharge channel into Part Haltz.	750
Outlet pipe-connections	200
Skilled labour, erecting	400
Labour of landing material, transport of same to hill-top, fencing, levelling, and general treatment of reservoir site, say	750
Tools and plant at 10%	470
Contingencies at 10%	517
	<u>£5,687</u>

SAFETY TO SUMMARY:

SERVICE RESERVOIR £5,687

DISTRIBUTION SYSTEM.

Similarly the distribution system, with the exception of the main feeders leading into the Island, need only be adapted to the probable needs of the near future, excess water delivered on to the Island being used, as suggested above, for flushing purposes only.

The main supply to the Island should cross Makapa bridge by a pipe which, when the full available supply is being usefully employed in the future, will deliver the full daily supply in, say, twelve hours. If the water were being supplied almost entirely for domestic purposes, by far the greater part the daily consumption would be taken off in four or five hours, but inasmuch as a considerable portion of the consumption will, in the case of Makapa, be for trade and shipping demands, the period of maximum consumption will not be so sharply defined as if domestic uses alone accounted for the draw-off. So it will probably suffice to lay, as the principal feeder into the Island, a pipe which will deliver water at twice the rate at which it is received into the service reservoir.

A pipe to deliver water at the rate of 1,500,000 gallons in twelve hours at a point three miles from the service reservoir and eighty feet below it would have to be of sixteen-inch diameter.

So for the purposes of this rough estimate, the cost of meeting the present requirements of the Island may be taken as follows:-

3 miles

3 miles of 16 inch main, weighing 235 tons at \$15.20	£3,572
Expansion joints and connections on Makupa Bridge, complete	400
Special connections at the ends of the 16 inch main	150
Lead, 8 tons at £16	128
Yarn, 1 ton at £10	10
Channels for conveying the excess discharge of the 16 inch main to the made drains in the town,	250
Freight on above material at 30/- a ton	450
Landing charges on 303 tons gross,	60
Excavation and laying,	150
Compensation for land and interference with property	50
Distribution system by 4", 3" and 1" galvanized wrought-iron pipes as extensive as that installed in Nairobi (and in its suburb of Parklands). This includes the erection of over 200 hydrants and all charges for material, freight, and laying.	6,000

£14,230

CARRY TO SUMMARY:

DISTRIBUTION SYSTEM

£14,230

ALTERNATIVE ESTIMATE FOR THE DISTRIBUTION SYSTEM.

The principal circuits for the distribution system which would be required to deal with the total supply of one and a half million gallons a day may be considered to consist of

3 miles of 16 inch steel main washing	235 tons.
4 miles of 14 inch " " "	274 tons
3 miles of 9 inch " " "	270 tons

An estimate of the cost of getting in this installation now is as follows:-

Principal circuits, 780 tons.	
Branch lines, steel, 150 tons	
i.e. 830 tons at £15.20	£14,136
Expansion joints and connection on Macclesfield bridge	400
Specials, - junctions, bases, bends, reducing pieces, etc.	1,000
Sluices and air-valves	250
Brought iron piping	300
Stand-pipes and fire-hydrants	750
Load, 35 tons at £16	560
Yard, 1½ tons at £20	30
Freight on 1220 tons by measurement, at 50/-	1,830
Landing charges on 1000 tons gross	500
Load carriage to site, 300	250
Compensation for land and for inter- ference with private property	500
Excavation	950
Laying	1,280
Concrete boxings to junctions and sluice, and bases and drain connec- tions to stand pipes	500
Carried forward	£23,186

Brought forward	£23,186
Special installation at Kilindini for supply to shipping.	250
Tools and plant at 2% only, inasmuch as much of the plant in use on the mainland would be available for work on the Island, which would not be begun until mainland operations were well advanced,	468
Contingencies, at 10%	2,390
Total	<u>£26,294</u>

N.B. Before this complete installation
came into use, the extension of
the service reservoirs on RAS
MCHANGAMWE would be necessary.

copy.

~~For return~~

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Public Works Department,

Nairobi,

November 18th. 1916.

Sir,

I have the honour to submit herewith a report by the Director of Public Works upon the water resources of the Shimba Hills. It is accompanied by a plan, which is forwarded in a separate tin case.

I have, etc.,

(signed) V. MCNEGOR MESS,

Far Commissioner of Public Works.

The Secretary to the Administration,

NAIROBI.

NON-COMMISSIONER OF PUBLIC WORKS.

I have the honour to submit the following report on my investigation of the water resources of the Shimba Hills.

2. I went direct to the spring which you visited in company with His Excellency the Governor. It turned out not to be the actual source of the Mweri stream, but only one of several reappearances after short journeys underground. Its valley extends for 2½ miles above this point and the stream is a flowing one for 4 miles above the same point. Beyond that the valley becomes successively marshy, damp, and finally dry. The valley is entirely uninhabited. The collecting ground is mainly of sandstone, covered with light sandy soil on which rough grass and scattered bushes grow. (See photograph of the Mweri valley).

3. The stream disappeared partially so frequently (in addition to several complete disappearances) that it was a matter of difficulty to know whether the entire yield of the valley was passing above ground in the stream bed at any particular point or not. I selected a point where the stream appeared to be as full as anywhere else and had it gauged there. The figure obtained by Executive Engineer Mr Blain, who came out to me for one day from Mombasa to get acquainted with the region and see where I was working, was 1,114,000 gallons a day. About 2000 feet down stream and 85 feet in altitude below this point, the spring which you visited was

then

then discharging slightly more than 1,400,000 gallons a day. The entire hillside appeared to be thoroughly "wet", and I have no doubt that if the river bed were cleared out, and a few short tunnels driven into the hillside, the yield at any particular point would be considerably increased.

4. From this point, which turned out to be at an altitude of 880 feet, I commenced a traverse of 18 1/2 miles in length, passing and connecting with Shimba primary Trig. station, from which my altitudes are derived, and finally reaching the shores of Port Keita at Jimbo. A plan showing this traverse is submitted.

5. In making this traverse, my aim was to see which, if any, tributary streams en route could be captured and taken on in a pipeline, laid at a very flat grade, to the precipitous northerly termination of the Shimba Hills near the well known "Wombasa Gap", there to be sent, as you suggested, down a drop of some 500 feet and used by means of a Pelton wheel installation for the generation of electrical energy for transmission to Wombasa.

6. By laying the main at a grade as flat as five feet to the mile streams supplying the following quantities (at that time of the year) could be captured:

the MAKOMBO	206,000 gallons a day
the PEMBA or MADABARA	162,000 gallons a day
the KITZANZI	250,800 " "

These, with the original WRERI source of 1,114,000 gallons, would yield 1,672,800 gallons a day, (i.e. 1161 gallons, or 186 cubic feet, a minute)

minute) This, utilized down a five-hundred foot drop should theoretically give 176 horse power. As a matter of actual practice however, a 30 inch diameter Pelton Wheel, running at between 600 and 700 revolutions a minute would, with this quantity of water develop about 120 horse power.

7. The power obtainable by the use of this method is thus seen to be quite trivial, and I have no hesitation in recommending that the project of installing a combined power station and water supply should be abandoned. In order to convey the water at so flat a gradient to the power-station, a main of 17 inches diameter would have to be employed. To take the water after it had passed the power-station on to Mombasa would necessitate the use of a 16 inch main. This would involve the purchase, payment of freight charges, landing, lighterage, land transport and laying, of some 2400 tons of steel pipes as compared with only 1700 tons, if a 12 inch pipe were utilized on the lines indicated below. The small amount of power that would finally be obtained would not be worth the largely increased expense at every step which would attend the utilization of these pipes of large diameter. If it is required to generate electricity in this neighbourhood it could be done more satisfactorily at some of the low falls near the Mombasa Gap where the very considerable volume of the MANGLI River is passing.

8. I recommend that the water from the MRERI, MAKOMBO, and MABABARA streams all of which are reported by the Principal Medical Officer to be

- satisfactory

satisfactory potable waters, be piped down to a service reservoir on RAS MCHANGAMWE ("Railway Point") and that for the present, at any rate, the fourth stream, the KITZANZI, be not utilized. Although a sample from the KITZANZI has been favourably reported on, it alone, among the streams mentioned, comes down from a drainage area which is under considerable native occupation. So since it appears likely that a supply of one and a half million gallons a day will be obtainable from the other three streams, which all drain uninhabited areas, and since this will be ample for domestic, trade, and shipping purposes for many years to come, I recommend that the KITZANZI should not be made use of at present. The cost of removing and compensating the native inhabitants of its valley would thus not have to be faced. The length of the main would be reduced from 50½ to 28 miles, by avoiding the loop shown on the plan between miles 30 and 27, and the pipe-line could be carried further down the western slopes of the Shimba range where the ground would be less rocky and excavation therefore cheaper, and through the Nambasa Gap, on an alignment much nearer the MANOLO river than the blue route shown on the plan.

9. The gaugings of the three streams MBERI, NAKOMBO, and MADABARA, indicated a total yield of 1,422,000 gallons per 24 hours, or 167 cubic feet a minute. These were taken at a dry time of the year, though not at the driest. However while allowing that there will be some diminution of flow in drier

in drier weather, it must also be borne in mind that the yield of these sources could almost certainly be increased by clearing out their stream beds and driving a few short tunnels to capture the water with which the entire hillside appears to be streaming. For purposes of preliminary estimate it therefore appears reasonable to allow for a supply of one and a half million gallons, as suggested above. Gaugings of these streams are being repeated at intervals.

10. With a pipe-line twenty nine miles in length and with a fall of 720 feet, a twelve inch pipe would be required to convey this quantity. The length could be reduced to (24) twenty four miles by adopting the green route shown on the plan, but in view of the increased cost of the 2 1/2 miles of pipe which would be required for the submarine portion of the work, and the much increased cost of laying it, the disastrous effect of a leak if one should by any mischance occur, the difficulty of locating and rectifying it, and the chance of partial obstruction of the pipe at the deepest level it would attain by the gradual deposit of suspended matter from the unfiltered water which would be passing, I recommend that the green route should not be adopted, but that either the blue route or the yellow one should be taken, upon a close comparison of estimated costs showing which was likely to be the cheaper. The blue route would necessitate two suspension bridges of about 300 feet span for crossing creeks. The yellow route would necessitate a creek-crossing of 800 feet in length, either by a suspension

a suspension bridge giving a head-room of forty feet above high water, or by a pipe laid along the bottom. The objections which apply to a $2\frac{1}{2}$ mile length of submarine work would not have the same force here, and if any uneasiness were felt with regard to the submerged work, His Excellency's suggestions for a double pipe at this stream crossing might be adopted, with the practical certainty that both pipes would not give trouble at the same time. The adoption of the yellow route would reduce the length of main by $2\frac{1}{2}$ miles.

11. A preliminary estimate of the cost of this work is in an advanced stage and will be submitted in the course of a few days. The figure will certainly be in excess of £50,000 but will probably be less than £75,000. A recommendation as to the staff to be employed for the survey and execution of the project will also be made.

12. I attach copies of the analyses, supplied by the Principal Medical Officer, of samples which I forwarded to Nairobi from the Shimba Hills. "WRERI No. 1" is the source suggested for utilization. "WRERI No. 2" is from the spot visited by you. "WRERI No. 3" may be disregarded. It is from a point on the WRERI stream some miles down the valley where the MWAMOGO stream joins (see plan) and where the flow is more than three million gallons a day. No. 4 is from the MABABARA stream, and No. 5 from the MAKOMBO. No. 6 may be disregarded. It is from the KITIMANI (or MWACHALE) stream which, as already explained, it would not be advisable to

utilize

utilize unless the native inhabitants of the valleys above it were removed. It is the same stream which, at a subsequent emergence lower down the valley, constitutes the original "Bogle source".

(Signed) W. MCGREGOR ROSS.

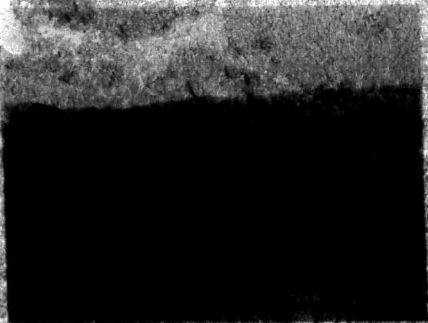
Director of Public
Works.

Encls.

1 plan.

3 sheets of analyses

photographs.

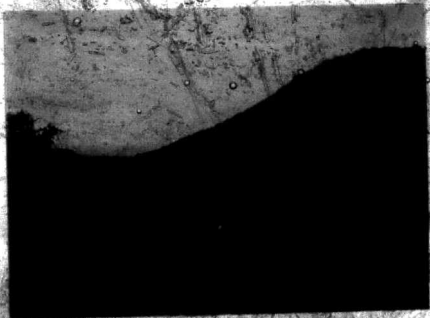


PHOTOGRAPH 221. THE GREEN VALLEY,
LOOKING S. by W.

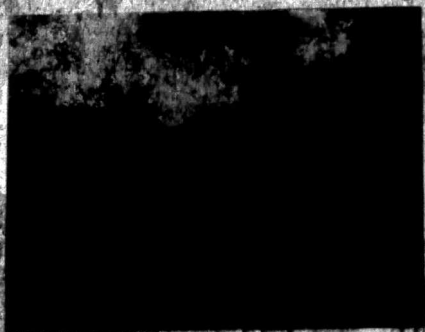


PHOTOGRAPH 222.
THE GAUGE NOTCH ON THE
GREEN STREAM.





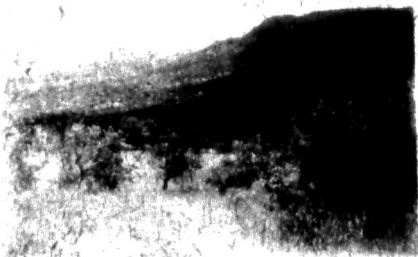
PHOTOGRAPH 2214
THE PROFILE OF THE HILL KIPINGO
LOOKING NORTH FROM TRAVERSE STATION 369



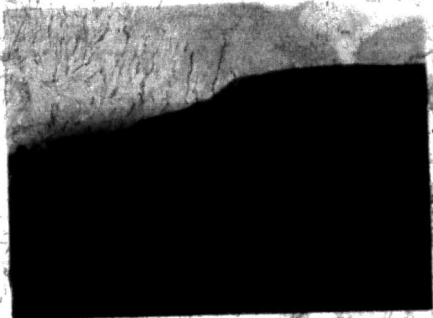
PHOTOGRAPH 2215
THE CUT FOR THE TRAILER LINE ON
THE CLIFFS OF KIPINGO



PHOTOGRAPH 2216
THE WESTERN SLOPE OF THE SANGA HILLS
LOOKING N. BY W. FROM TRAVERSE STATION 365



GODDARD



PHOTOGRAPH 2227.

LOOKING N N W FROM STATION 51

370

STATION

STATION



PHOTOGRAPH 2228.

LOOKING S W FROM STATION 52



FOOTNOTES 222

THE HONORABLE G.M.

LEWIS P. S. N.

THE HONORABLE ALGER OWEN GLOVE



FOOTNOTES 223

THE EDGE OF THE PENDENTOUS

SHEDDING FROM THE SHONA FILL

AT THIS POINT IN TIME

THEY WERE AT THE DISTANCE



W. SWN.

1111

W. S. W.

1111

BY S

PANORAMA OF THE SHIMBA HILLS FROM STATION 115.

Shimba Hills,

September, 1st, 1910.

WATER SAMPLES - SEPTEMBER 1st 1910.WRETI NO. 1

The stream is here flowing in an earth channel 1,114,000 gallons a day. Above this point it frequently goes to earth and re-appears. Higher up the valley one comes to small wet hollows where the flow is badly choked by tall bracken and other growths. Higher up the ground is merely sloppy and spongy. The soil, which is black, smells somewhat of decaying vegetable matter on being turned up, and there is a reddish seam on it here and there which might indicate iron. The hill is apparently a coarse sandstone - generally stained red.

Extensive clearing out of the river bed would probably result in an improvement of quality in this supply. To begin with the water would be passing through a smaller amount of vegetation, and moreover, as the partially choked exits of the water were one by one opened, the bed in its higher and swamplier reaches might go quite dry, as water, at present ponded up in the hill, was drawn off at lower levels. The distance from where this sample was taken up to where the valley becomes merely sloppy and finally only moist is at least a mile.

The whole

The whole of the Mreri valley is entirely uninhabited.

This bottle was rinsed out with corrosive sublimate solution, and filled and emptied six times before being finally charged. The stopper is sealed in with candle wax.

MRERI NO. 2.

A short distance below the above mentioned source, another tributary comes in. The joint stream continues to dodge below and above ground as the former one had been doing. This sample was taken at a point visited by His Excellency and Honorable Commissioner of Public Works. The flow here is 1,411,000 gallons a day. If there are any additional impurities here which are not in the No. 1 sample, they are to be looked for in the small tributary mentioned, of which I shall be able to take a sample if a wire is sent me before September 10th.

(Signed) W. McCREGGH ROSS.

Copy forwarded to the Principal Medical Officer for information.

(Signed) W. H. TANNER.

Asst. Director of Public Works.

Nairobi.

8th. September, 1912.

Samples of water labelled "Mreri No.1" and "Mreri No.2" received on September 5th. 1910. The covering letter was not received until September 12th. but a complete analysis was carried out on No.1 on September 6th. and all determinations except that of Ammonia were made for No.2 on the same day.

The results of the analysis are almost identical for both samples.

Colour slightly milky.

Odour - nil.

Sediment - very slight.

Suspended matter - slight.

Reaction - neutral.

Parts per 100000

	No.1	No.2
Ammonia - free	0.003125	0.005125
Albuminoid	0.0125	0.0125
Hardness	Nil.	Nil.
Chlorine	1.2	1.7
Nitrogen as nitrates.		
and nitrates	?barest trace	?barest trace
Nitrogen as nitrates	Nil	Nil
Oxygen consumed in 3 hrs. at room temperature	0.05357	0.5357
Solids - total	5.0	7.0
Volatile	2.0	3.0
Non volatile	3.0	4.0

Conclusion: - Most of the figures are the same as in previous samples from this stream, but the ammonia figures are not so good. I understand

from

No. Above
(Sd/-) W. M. R.

from the covering letter that both samples came from stream some distance below the eyes from which His Excellency took the first samples. This may account for the increase of the ammonia.

(Signed) P. H. ROSS
Bacteriologist.

Nos. 133 & 134
Sept. 13th. 1910.

Samples of water labelled (3) Mrere river No. 4 (2) Madabura stream and (5) Makomba stream. Received September 14th 1910. No particulars of any sort accompanied the samples. Analysed September 15th and 16th, 1910.

	No. 3	No. 4	No. 5
Colour	Faintly milky	Milky	Milky with brown tinge
Sediment	Very slight	Very slight	Slight
Suspended matter	Slight	Slight	Marked
Reaction	Neutral	Neutral	Neutral
Odour	Nil.	Nil.	Nil.

parts per 100000

Ammonia free	0.002	0.003125	0.003125
Albuminoid	0.006875	0.0125	0.00875
Hardness total	0.3	2.0	0.0
Permanent	0.3	2.0	0.0
Temporary	0.0	0.0	0.0

Chlorine

Chlorine	2.3	4.6	2.2
Nitrogen as nitrates and nitrites	?Barest trace	?Barest trace	?Barest trace
Nitrogen as nitrates	Nil.	Nil.	Nil.
Oxygen consumed in 3 hrs. at room temp.	0.0436	0.00869	0.1087
Solids total	6.0	10.0	5.0
Volatile	4.0	4.0	1.0
Non-Volatile	2.0	6.0	4.0

On ignition Slight blackening Blackening slight Blackening

Conclusion:- There is no sign of dangerous pollution in any of these waters. No.1 is distinctly the best in colour and No.3 distinctly the worst.

(Signed) P.H. ROSS
Bacteriologist.

Nos. 135, 136, 137.

Sample of water labelled "Weachale stream (Shimba Hills) September 14th, 1910.

Received and analysed September 20th, 1910.

Colour very faintly milky.

Suspended matter - slight.

Sediment - slight.

Odour - nil.

Reaction - neutral.

Parts

373

parts per 100000.

Ammonia - free	0.0095
Albuminoid	0.006875
Hardness - total	0.3
Permanent	0.3
Temporary	0.0
Chlorine	8.0
Nitrogen as nitrates and nitrites	? barest trace
Nitrogen as nitrites	Nil
Oxygen consumed in 3 hours at room temperature	0.0578
Solids - total	8.0
Volatile	4.0
Non Volatile	4.0
On Ignition	slight blackening

Conclusion:- No signs of dangerous pollution. The sample is much clearer (less milky) than any other received from this district, but from the covering letter it would appear to be more liable to pollution than any of the others.

(Signed), P.H. ROSS

Bacteriologist.

TREASURY
2752

379

13 FEB 1911

WHITEHALL PAPERS,
LONDON, S.W.

Mr. W. A. Waterbury
St. John's Hill, Chelsea

17th Jan 1911

In continuation of the letter of the 11th inst. I have the honor to acknowledge the receipt of the copy of the Report of the Secretary of State for the Colonies, dated 1st Dec 1910, in relation to the proposed extension of the franchise in the Colonies. I have also the honor to acknowledge the receipt of the copy of the Report of the Secretary of State for the Colonies, dated 1st Dec 1910, in relation to the proposed extension of the franchise in the Colonies. I have also the honor to acknowledge the receipt of the copy of the Report of the Secretary of State for the Colonies, dated 1st Dec 1910, in relation to the proposed extension of the franchise in the Colonies.

Copies of the original letter and the Report of the Secretary of State for the Colonies, dated 1st Dec 1910, in relation to the proposed extension of the franchise in the Colonies, are being sent to the appropriate authorities in the Colonies.

I have, Sir,

(Sd.) H. V. GIBSON

for, Frank Lubbock

SECRETARY OF STATE

COLONIAL OFFICE

9 East
38753
Thyngs

20 Dec 90

Scatterman
I am etc to transmit

copy

to you, for the views

of the C.E. the
accompanying copy of
a letter from Sir P. James

submitting a scheme
for obtaining a water
supply for the town

from the Skipton Wells
and forwarding estimates

of the cost of the
proposed scheme. It
is understood that
a copy of the letter
from the C.E. to the S.O.
of the 1st of April 1900

DRAFT.

C.C.

MINUTE

- Mr. H.B. [unclear]
- Mr. Butler 22
- Mr. Fiddis 23
- Mr. Just
- Mr. Cox
- Sir C. Lucas
- Sir F. Hopwood
- Col. Seely
- Lord Crewe

In a room
 Mr. P. James to the
 (Photographs taken in original)
 (Photographs taken in original)
 Plans by Sir Chadwick
 (in original).

As he desires to discuss
the matter with his
forward which he is
in this country

J

301

(Sign) SAM COX