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Agents

Date

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Mombasa Water Supply

23 Jan.

Sends Consulting Eng'rs report on proposals for obtaining supply from the water works.

prev. us Paper

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to Brit.

See account in 2541

MS 2/2

MS Report on water supply

MS

WILSON & CO  
1115 A.B.M.

Subsequent Paper

2541

291/9



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ALL COMMUNICATIONS  
TO BE ADDRESSED TO THE  
CROWN AGENTS FOR THE COLONIES,  
THE ABOVE REFERENCE AND THE  
DATE OF THIS LETTER BEING QUOTED.

TELEGRAMS "CROWN, LONDON"  
TELEPHONE 1022 VICTORIA

WHITEHALL GARDENS,  
LONDON, S.W.

23rd January 1911

Mombasa Water Supply  
Shimba Hills Scheme

Sir,

*60  
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In continuation of our letter of the 29th  
December I have the honour to enclose for the  
information of the Secretary of State a copy of  
Messrs Middleton Hunter & Duff's report on the pro-  
posals for supplying Mombasa with water from the  
Shimba Hills, which accompanied your letter of the  
24th of December No 38753/10. As requested in the  
second paragraph of that letter I also return here-  
with the photographs and plan accompanying the  
report of the Director of Public Works.

3rd Jan. 1911

plan  
all of papers

2. Copies of the original plan by Mr Chadwick  
are being made in accordance with your instructions.

I have the honour to be,

Sir,

Your obedient Servant,

for Crown Agents

Under Secretary of State

&c &c &c

Colonial Office

BRITISH EAST AFRICA PROTECTORATE.

MOMBASA WATER SUPPLY.

R E P O R T

-- to the --

CROWN AGENTS FOR THE COLONIES

- by -

MIDDLETON, HUNTER & DUFF, M.M.Inst.C.E.  
Consulting Engineers.

January 23rd., 1911.

17, Victoria Street,  
Westminster, S.W.  
January 23rd., 1911.

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291/9

Gentlemen,

British East Africa Protectorate.

Mombasa Water Supply.

1. In accordance with the request contained in your letter of December 30th., 1910, we have carefully considered the letter from H.E. Sir P. Girouard, the Governor of the British East Africa Protectorate, two Reports by Mr. W. McGregor Ross, Director of Public Works, with two plans submitting a scheme for a water supply for Mombasa, together with an estimate of the cost and other connected papers.

We have, as further requested, seen H.E. The Governor at the Colonial Office and discussed the project with him, and now beg to submit the following observations upon it:-

2. The scheme is clearly described in the Report by the Director of Public Works at Nairobi dated November 12th., 1910, in which it is proposed to obtain the water supply from the M'leri Stream, in the Shimba Hills, at an altitude of about 880 ft. above sea level, the water being conveyed through a 12" steel pipe along the route shown upon the plan and delivered into a service reservoir about 160 ft. above Datum at Railway Point, whence it will be distributed to Mombasa and Kilindini by a pipe over the Makupa Bridge.

3. The consideration of this Report may be conveniently divided under 4 heads:

1. The quality of the Water.
2. The population to be supplied and its requirements for water supply.
3. The quantity of water available.
4. The works proposed to be constructed.

1. Quality of the Water.

Analyses of the water, dated September 13th. and 21st. 1910, are given by the Government Bacteriologist, and H.E. The Governor refers to the matter on Page 3 of his Despatch dated December 15th., 1910, in the following terms:

"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, and the best sample he had analysed in the Protectorate".

We draw the inference from the above quotation and from the analyses that the water is of good quality and may be safely used for water supply, though we do not speak authoritatively upon the question, which belongs to the domain of the Chemist rather than of the Engineer.

2. The Population and its requirements for Water Supply.

4. We gather from Mr. Chadwick's Report, dated March 17th., 1900, that the Island of Mombasa has an area of 3,500 acres, that in form it is an irregular ellipse, the maximum length being about  $3\frac{1}{2}$  miles and the maximum breadth about 2 miles, and that there are no perennial streams in the Island nor evidence of streams or outcrops of water along its coast.

5. In the same Report, Par. 23, Mr. Chadwick estimated upon the authority of Col. Bogle, R.E., after consultation with the Acting Commissioner that the quantity of water required in 1910 would probably be about 289,000 gallons daily. At our interview with Sir P. Girouard on January 9th., 1911, he informed us that the present population of Mombasa is about 27,000 and that a Commission which sat in November, 1908, estimated that the following provision should be made, which would allow for an increase of more than 50% upon that number.

	gallons daily.
Population 46,500 @ 10 galls. per head per day.....	465,000
Drainage, Sanitation and Fire Extinction...	20,000
Shipping.....	25,000
Railways.....	30,000
Total....	600,000 daily.

The requirements of the 300 Europeans living in Mombasa may be taken to be included in the 10 gallons per head per day estimated for the total population. The Governor is himself desirous that provision should be made for the supply of 700,000 gallons daily.

### 3. Quantity of Water Available.

6. The quantity of water gauged in the streams from which it is proposed that the supply be taken is given in Pars. 3, 6 & 9 of Mr. Ross' Report dated November 12th., 1910, as follows:-

	galls. per day.
Mweri.....	1,114,000
Makombi.....	206,000
Pemba or Madabara.....	102,000
Total.....	1,422,000

In the absence of any particulars as to the catchment area and its geological formation it is impossible to form an authoritative opinion upon the quantity of the supply which will be available. It is satisfactory, however, to note that the rainfall appears to be considerable in amount as will be seen by the following figures recorded at Mombasa:

	inches
1901.....	58.14
1902.....	46.20
1903.....	33.84
1904.....	59.80
1905.....	57.00
1906.....	73.00
1907.....	46.00
1908.....	83.00

Or an average of 53.3" for the eight years, the records for which are available.

The proposed sources of supply lie about 20 miles S.W. from Mombasa and we are informed that the rainfall to the South of Mombasa is slightly greater than that to the North.

Having regard to this considerable rainfall, and to the fact that the gaugings were taken at a dry time of the year, though not at the driest, and as the quantity gauged was 2½ times the estimated requirements for supply as above given there appears to be a fair probability that the quantity of water available will be sufficient for many years to come.

4. The Works proposed to be constructed.

7. We approve the general proposals for the works but suggest a few modifications.

8. It is proposed under Mr. Ross' scheme that the pipe line shall be made sufficiently large to deliver 1,500,000 gallons a day. He rightly points out that a large part of the cost of laying the main will be irrespective of the size of the pipe adopted. On the other hand, it appears to us that the provision of a pipe capable of taking 1,500,000 gallons in 24 hours for the supply of a town whose requirements some years hence are estimated at 600,000 gallons daily can scarcely be justified as being financially economical.

9. We are, therefore, of opinion that a scheme providing for a supply of 700,000 gallons daily, the quantity desired by the Governor, would be sufficient for many years to come. An alternative estimate for this supply is given at the end of this Report.

10. In regard to the Works, we point out that if the main be taken along the route shown upon the plan, the available fall in the first nine miles will be sufficient to deliver the proposed quantity. We are however informed by H.E. The Governor, who has personally inspected the Country, that there will be no difficulty in shifting the line of the main so as to give it the required inclination and we recommend that this alteration be made as shown upon Drawing No.1 accompanying this Report. With the view of reducing the pressure we think it desirable that a small break pressure reservoir should be constructed at the spot shown on the drawing. The level of this break pressure reservoir would be 583 ft. above Datum. The pipe from the source to the break pressure reservoir would be 9 miles in length and 11.5 inches diameter. From the break pressure reservoir to the service reservoir the pipe would consist of 6.25 miles of 12 inch and 15.25 miles of 13 inch main, the pipes being made in these different sizes for the purpose of saving freight by nesting.

11. In considering the alternative routes proposed we have come to the conclusion that it is desirable to avoid the 800 ft. stream crossing marked A on plan, at any rate until further particulars are obtained as to the depth of the water in the channel, and the height above the water line which it would be necessary to leave for navigation purposes. We prepared a sketch design showing a wire rope suspension bridge which would carry the pipes over the channel at a height of 40 ft. above the water, but we cannot recommend its adoption as in our opinion it would be costly both in construction and maintenance and in addition the construction and expansion of such a structure might cause difficulties in regard to the pipe joints.

12. We recommend that the main should be laid along the line shown in red on plan No.1 submitted with this report.



though it will probably have to be modified in places to suit the configuration of the ground. We point out that there are two hillocks between mile 14 and mile 16 round which it is desirable that the main should pass instead of being taken over their summits. By keeping the main on the left bank of the stream two short crossings D. & E. will be avoided.

13. We propose that the main should be taken over the two 300 ft. stream crossings B. & C. either on screw piles braced together as shown upon the accompanying drawing No. 3, or on piles sunk by the assistance of a hydraulic jet, which ever system may be best suited to the quality of the soil forming the bed of the channel.

#### Service Reservoir.

14. We approve the construction of this service reservoir upon Railway Point at a level of 160 ft. above Datum. The proposed capacity of one day's supply is small but it can be increased in the future as found to be necessary, its initial size being dominated by financial considerations.

#### Distribution Works.

15. Mr. Rose's proposals for distribution works appear to us to be sound in principle and they may be curtailed or extended as may be found necessary upon engineering and financial grounds.

#### Estimate of Cost.

16. We have looked carefully into the estimated cost of the works and find that the cost of the pipe line will be materially greater than that estimated. This increased cost is mainly due to two reasons:-

1. That the thickness of the 11 $\frac{1}{2}$ ", 12" and 13" mains ought to be increased from  $\frac{3}{16}$ ths. inch to  $\frac{1}{2}$  inch, and

2. That the cost of freight will be considerably greater than that allowed for in the estimate.

We are further of opinion, based upon West African experience, that competent assistant Engineers and Foremen will not be obtained at the salaries proposed to be paid, and we have therefore increased this item by 50%.

We adopt Mr. Ross' estimates for the Survey Land Head Works and Telephone.

We also adopt Mr. Ross' estimate of £14,220 for Distribution Works for the purposes of this Report as these works can be varied as stated in par. 15.

We think it necessary to provide the sum of £3,000 for Constructional Plant.

17. Our estimate of the cost of the Works is as follows:-

ESTIMATE of Cost of Works with Pipe Line to deliver  
1,500,000 galls. in 24 hours.

	£
Survey.....	350
Land .....	250
Pipe Line 11", 12" and 13" steel pipes with branch pipes.....	65,025
Break Pressure Tank.....	1,000
Two 300 ft. stream crossings.....	1,600
Head Works.....	4,620
Telephone.....	360
Service Reservoir (1 Day's Supply).....	5,600
Plant for Construction.....	<u>3,000</u>
	79,815
Contingencies, &c. 10%.....	<u>7,982</u>
	<u>£87,797</u>
Supervision:	
Mr. Ross' estimate.....	£5,198
Add 50%.....	<u>2,600</u>
	7,798
Distribution, Mr. Ross' estimate.....	14,220
Total.....	<u>£109,815</u>

18. We have also considered a scheme for the supply of 700,000 gallons in 24 hours, which will require a pipe line of 8 $\frac{1}{2}$ " and 9 $\frac{1}{2}$ " steel pipes, the break pressure reservoir being constructed at a level of 630 feet above Datum, and submit the following alternative estimate for the work upon this basis.

In this estimate we have taken the smaller pipes at  $\frac{3}{16}$ " thick but should prefer that they should be made  $\frac{1}{4}$ " thick if the financial resources of the Protectorate will warrant the additional expense.

ALTERNATIVE ESTIMATE of Cost of Works with pipe line  
to deliver 700,000 gallons in 24 hours.

	£
Survey.....	350
Land.....	260
Pipe Line, 8 $\frac{1}{2}$ " and 9 $\frac{1}{2}$ " Steel pipes.....	46,083
Break Pressure Tank.....	1,000
Two 300 ft. stream crossings.....	1,600
Head Works.....	4,620
Telephone.....	360
Service Reservoir (1 day's supply).....	5,600
Plant for construction.....	3,000
	<u>£62,873</u>
Contingencies 10%.....	6,287
	69,160
Supervision.....	7,798
	<u>76,958</u>
Distribution, Mr. Ross' estimate.....	14,220
	<u>£91,178</u>

19. We send herewith drawings Nos. 1, 2 and 3 showing proposed line of pipes, Section along the line of pipe and sketch plan of two 300 ft. stream crossings.

20. We return the original documents and the two plans which you sent us with your letter of instructions dated December 30th., 1910.

21. If there are any other points upon which you require our observations we shall be pleased to consider them upon hearing from you, and we shall also be pleased to co-operate in any way in our power to secure the success of the scheme.

We are, Gentlemen,

Your obedient Servants,

*Wm. Pitt Rivers*

Messrs. THE CROWN AGENTS FOR THE COLONIES,  
Whitehall Gardens,  
S.W.