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TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

P.W. DEPARTMENT

G.O. No. B.P. No.	692 W	Press. Mis.
Dated	18.3.1880	~~197~~

Not to be folded or roughly handled

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

18th March 1880, No. 692 W.

General.
Establishment.

Read the following papers :—

No. 83. Read again Proceedings of the Madras Government in the Public Works Department, dated 4th February 1880, No. 271 W.

Endorsement of the Superintending Engineer, Fourth Circle, dated Coimbatore, 13th January 1880, No. 19.

From Major J. L. L. MORANT, R.E., Executive Engineer, West Coast Division, to the Superintending Engineer, Fourth Circle, dated Ootacamund, 5th January 1880, No. 9.

During the past few years I have had occasion to ascertain altitudes by Barometers on these Hills. I was at first puzzled to know what formula to use in calculating the heights ; and it took me a long time to discover where the most reliable information was to be found, and the best tables to use for the purpose.

2. Having at length after considerable research collected reliable information on this subject, I have thought it might be of use if such information was made generally available to departmental offices.

3. Therefore, at my own expense, I have had printed 80 copies* of the accompanying pamphlet, and beg to be allowed to send them to you with this letter for submission to the Chief Engineer for the favor of his acceptance.

4. Since this brochure was printed I have received the newest edition of "Hints to Travellers," published by the Royal Geographical Society, and drawn up by a distinguished Committee of Officers presided over by Captain Douglas Galton. I am gratified to find that the tables therein given for ascertaining altitudes by Barometers are in all essential respects identical with those I have collected.

5. I need hardly say that much more information might have been given in the pamphlet I have prepared, but the time at my disposal did not admit of this ; such further information can however be sought in the books of reference of which I have given a list. As far as I have gone I believe my information to be perfectly reliable—at least I have taken every pains to try and make it so.

6. I also append two books of forms for calculation. In book No. 2 the tables have by an oversight been omitted.

Copy of Hypsometrical Tables.

True copy. Submitted, with enclosure, to the Chief Engineer, Public Works Department, as desired.

(Signed) A. S. RUSSELL,
for Suptg. Engr., Fourth Circle

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* Forwarded by rail.

THE Superintending Engineer will convey the thanks of Government to Major Morant for his useful pamphlet, which will be distributed among the officers of the department.

2. The Government will be glad to reimburse to Major Morant the cost of printing the pamphlet if he will report the amount.

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Government.

To the Superintending Engineer, Fourth Circle.

No. 83-A. From Major P. MONTGOMERIE, R.E., Superintending Engineer, Fourth Circle, to the Chief Engineer, Public Works Department, dated Coimbatore, 12th March 1880, No. 135.

One Bill.

WITH reference to paragraph 2 of G.O., No. 271 W., of 4th February 1880, Major Morant has forwarded the accompanying bill for Rs. (89-5-6) eighty-nine, annas five and pies six, being the cost of printing the pamphlet in question, and I have the honor to request that you will be so good as to obtain the sanction of Government for payment of the bill.

No. 84. ORDER THEREON, 18th March 1880, No. 692 W.

THE bill, amounting to Rs. 89-5-6, on account of expenses incurred by Major Morant, R.E., in printing his "Hypsometrical Tables," is sanctioned.

(True Extract.)

Major, R.E.,
Ag. Under Secy. to Govt., P.W.D.

To Superintending Engineers.
,, the Examiner of Public Works Accounts.

Exd. S. T. Austin.
Spare Copies

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Govt. of [1880] Madras.

PUBLIC WORKS.

To

SUPERINTENDING ENGINEERS,

&c., &c., &c.

Dated March, 18

Issued

Recd. E.

G. O., 18th *March* 1880, *No.* [illegible] W.

MARCH.

Nos. 83-84.

Hypsometrical Tables [illegible]

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HYPSOMETRICAL TABLES

FOR

ASCERTAINING ALTITUDES

BY

BAROMETERS,

AND INFORMATION CONNECTED THEREWITH,

BY

J. L. L. M.

MADRAS:
PRINTED AT THE LAWRENCE ASYLUM PRESS, MOUNT ROAD,
BY W. H. MOORE.

1879.

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Tables for ascertaining Altitudes by the Barometer (Mercurial or Aneroid) and by the Thermo-Barometer or boiling point apparatus.

The following tables are calculated from La Place's formula, modified to accord with the results of more recent investigations. The readings of the mercurial barometers at the upper and lower stations must be reduced to the same temperature: this can be done either by reducing the reading of the upper barometer to the temperature of the lower, or by reducing both the upper and lower readings to freezing point (32° Fahr.). In the former case a Table [I_b] is supplied to be worked in with the calculations. But, if preference be given to the latter method, Mr. Blanford's Indian Table is the most accurate and complete; in this latter case the corrections must be made first of all. Mercurial barometers must be corrected for index error; and in some forms for capacity and capillarity. Aneroids, which are seldom properly compensated and graduated, require corrections (i) for temperature, to be ascertained once for all for each instrument by experiment; (ii) for graduation and for (iii) index error, both of which will be found by comparison with a standard mercurial barometer reduced to 32° Fahr., such comparison being made for the former [ii] at different elevations or under an air-pump. These corrections with other data can be copied on the blank pages at the end of this pamphlet. Aneroids must be frequently compared with a standard mercurial barometer. Whenever aneroids are used Table I_b is inapplicable, as their readings are supposed to be always at 32° Fahr. Duplicate instruments for simultaneous observations must of course be first carefully compared at all points, and corresponding corrections made in the readings of all their parts, so that all such readings may be comparable.

La Place's modified formula is this :—

$$\text{Difference of altitude} = A = \overbrace{60158{\cdot}6 \log. \frac{H}{h}}^{\text{Tables I}_a\text{ and I}_b.} \times \overbrace{\left\{ 1 + \frac{t+t'-64^\circ}{900} \right\}}^{\text{Table II.}}$$

$$\times \overbrace{\left\{ 1 + {\cdot}00265 \cos 2\,L \right\}}^{\text{Table III.}}$$

$$\times \overbrace{\left\{ 1 + \frac{A + 52251}{20888629} + \frac{s}{10444315} \right\}}^{\text{Tables IV and V.}}$$

Wherein H = the height of the barometer } at the lower station.
T = the temperature of the barometer } at the lower station.
t = the temperature of the air } at the lower station.
h' = the height of the barometer } at the upper station.
T' = the temperature of the barometer } at the upper station.
t' = the temperature of the air } at the upper station.
s = the height of the lower station above the sea (approximately).
L = the mean latitude of the two places.
h = the observed height h' reduced to temperature T; or to 32° Fahr. if H is reduced to the same.

Now, since h represents the height h' reduced from temperature T' to T, the expansion of mercury for 1° Fahr. being 0·0001; that of brass, which forms the scale of the barometer, being 0·0000104; the difference is 0·0000896; hence

$$h = h' \left\{ 1 + 0{\cdot}0000896\,(T - T') \right\}$$

$$\text{and } 60158{\cdot}6 \text{ feet log. } \frac{H}{h} = 60158{\cdot}6 \log. \frac{H}{h'} - 2{\cdot}3409\,(T - T').$$

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Table I_a furnishes in English feet the value of the expression 60158·6 log. H, for heights of the barometer from 11 to 31 inches; only all these values have been diminished by the constant 27541·5, which does not change the difference, 60158·6 log. H — 60158·6 log. h.

Table I_b furnishes the correction $-2{\cdot}3409\ (T - T')$, depending upon the difference $T - T'$ of the temperatures of the barometers at the two stations: this correction is generally negative; it would be positive if $T - T'$ were negative, that is, if the temperature T' of the barometer at the upper station exceeded the temperature T at the lower station.

Table II. furnishes the correction $\dfrac{t + t' - 64^\circ}{900}$, by adding together the temperature of the air at the two stations, and by multiplying the approximate height *(a)* by the factor given opposite $t + t'$, adding or subtracting the result to or from the approximate height *(a)* according to the sign given in the table. We thus obtain a second approximate altitude A.

With A and the latitude of the place (L), we seek in Table III the correction $A \times {\cdot}00265 \cos 2L$, arising from the variation of gravity with the latitude. This correction is positive from the Equator to 45° N. or S. and negative from 45° to the Poles.

For the approximate height A Table IV gives the correction $A \times \dfrac{A + 52251}{20888629}$ arising from the diminution of gravity on the vertical. This correction is always additive.

Finally when the height, s, of the lower station is considerable the small correction $A \times \dfrac{s}{10444315}$ will be found in Table V; this correction is always additive: but in place of s there has been substituted as the argument of the Table, the height H of the barometer at this station.

The examples given on pages 6 to 8 clearly explain how the Tables are to be used, and also exhibit the accuracy of their results. Calculations of barometrical heights are made very much more correctly and rapidly if entered on printed blank forms similar to those on pages 16 and 17. A form [*X*] for calculating from Tables I to V and one [*Y*] for calculating from the logarithmic Tables *A* to *C* are appended.

Table VI has been added, to shew the height of the barometer corresponding to temperatures of boiling water from 185° to 214° Fahrenheit. It will be useful when a barometer (Mercurial or Aneroid) has been observed at one of the stations and a boiling point thermometer at the other, or for direct comparisons between the barometer and boiling point. The temperature at which water boils in the open air depends on the weight of the atmospheric column above it, and hence, under a diminished barometric pressure, the water will boil at a lower temperature. Since the weight of the atmosphere decreases with the elevation, it is evident that, in ascending a mountain, the higher the station the lower will be the temperature at which water boils. Table VI is derived from a table by Regnault, published in the *Annales de Physique et de Chimie*, t. xiv., p. 206. In Regnault's Tables the temperature is expressed in centigrade degrees, and the height of the barometer in millimetres. From this a new table (No. VI) has been deduced, in which the temperature is expressed in degrees Fahrenheit, and the height of the barometer in English inches, at four different latitudes with a column of differences for each degree. Having observed the height in degrees at which water boils look out in Table VI the corresponding height of the barometer, allowing for the latitude of the place: then calculate the required height of the station by Tables I to V as before.

Simultaneous observations for the determining of heights by observations at places at a distance from each other

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must be taken according to *mean local* time (not railway time). The Washington time of 7h. 35m. A. M. is synchronous with the Greenwich meantime of 12h. 43m. P. M. The following hours of mean local time at some of the chief stations in Southern India synchronise with the above Washington and Greenwich times.

Feet above mean Sea-level.	Station.	Mean Local Time.
	Mangalore	17h. 42m. P.M.
—	Cannanore	17h. 44m. ,,
—	Beypoor	17h. 46m. ,,
12	Calicut	17h. 46m. ,,
—	Alleppey	17h. 48m. ,,
—	Cochin	17h. 48m. ,,
—	French Rocks	17h. 50m. ,,
2,620	Ootacamund	17h. 50m. ,,
7,300	Bellary	17h. 51m. ,,
1,538	Trivandrum Observy.	17h. 51m. ,,
195	Coimbatore	17h. 51m. ,,
1,483	Bangalore	17h. 53m. ,,
2,989	Tinnevelly	17h. 54m. ,,
120	Gooty	17h. 54m. ,,
1,115	Kurnool	17h. 55m. ,,
900	Madura	17h. 55m. ,,
600	Salem	17h. 56m. ,,
907	Cuddapah	17h. 58m. ,,
864	Trichinopoly	17h. 58m. ,,
443	Arcot	18h. ...
599	Tanjore	18h. ...
—	Cuddalore	18h. 2m. ,,
—	Pondicherry	18h. 2m. ,,
—	Negapatam	18h. 3m. ,,
—	Nellore	18h. 3m. ,,
81	**Madras Observatory**	18h. 4m. ,,
22	Guntoor	18h. 5m. ,,
—	Masulipatam	18h. 8m. ,,
—	Rajahmundry	18h. 10m. ,,
81	Vizagapatam	18h. 16m. ,,
—	Ganjam	18h. 23m. ,,

If the Madras time be deducted from that of the stations that follow it, the remainder will show how much the clock set to local time at these stations will be in advance of one set to railway time. And if, from Madras time, that of the stations that precede it be deducted, the residue will shew how much a clock set to their local time will be behind one set to railway time.

When simultaneous observations cannot b[illegible]ken, allowance must [illegible] made in India for the diurnal variation, which must be ascertained for each locality.

Example I.—(From Thuillier's Manual of Surveying.)

Deduction of the height of Sonakoda G. T. Station in the Purneah District at a distance of 255 miles from Calcutta, a[illegible] Calcutta Observatory, by using the six simultaneous barometrical observations made at both places on the 6th December, 1847, with 2 barometers at the former place.

	Barometer. Inches.	Attached Therm.	Free Therm.	Mean Latitude.
Lower Station, Calcutta Observatory	30·169	73·2°	72·8°	24° 24
Upper Station, Sonakoda ..	29·957	70·8	70·8	
	$T - T' = 2{\cdot}4$		$143{\cdot}6 = t + t'$	

	Inches.	
Table I₁ gives	for $H = 30{\cdot}169$ ..	27756·4
	for $h = 29{\cdot}957$ ..	27572·2
		184·2
Table I₂ gives for $T - T' = 2{\cdot}4$		— 5·6
	Approximate difference a	178·6
Table II gives (for $t + t' = 143{\cdot}6$)	·0885 × 178·6 ... =	15·8
	Approximate difference A =	194·4
Table III for Lat. 24° 24′ and 194·4 gives...	... ...	·3
Table IV for 194·7 gives ..	... ...	·5
	The required difference	195·2
By Logarithms [Tables A to C]	... ...	194·1
Taking the former we have the difference	... =	195·2 feet.
Upper Barometer Cistern above Station mark	... —	2·0
Cistern of Calcutta Barometer above Sea-level	... ... +	18·2
		211·4
The same deduced geodetically	... ...	213·8
	Discrepancy...	2·4 feet.

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Example II.—(From Negretti and Zambra's Meteorological Instruments.)

As an illustration of the mode in which the *aneroid* should be used in measuring heights, the following example is given:—A gentleman who ascended Helvellyn, August 12th, 1862, recorded the following observations with a pocket aneroid. At 10 A.M. at the first milestone from Ambleside, found by survey to be 188 feet above the sea, the aneroid read 29·89 inches; at 1 P.M. at the summit of Helvellyn, 26·81 inches; and at 5 P.M., at the milestone again, 29·76 inches. The temperature of the lower air was 56½°, of the upper 53½°. Hence the height of the mountain is deduced as follows:—

	Inches		
Lower Reading at 10 A.M ..	29·89		
" " 5 P.M ..	29·76		
Mean ..	29·825	from Table I_a	27456·8
Upper Reading	26·81	" ..	24672·4
			2784·4
Table II (for 56½ + 53½ = 110°) gives ·0511 × 2784·4			142·3
			2926·7
Table III for Lat. 55° N. gives			— 3·1
			2923·6
Table IV for 2923·6 gives			7·7
Difference of Height ..			2931·3
Height of lower Station			188
			3119·3
In Sir J. Herschell's Physical Geography it is given as ..			3115·
Discrepancy ..			4·3 Ft.

Example III.

Required the height of Mount Etna when the altitudes of the barometers and thermometers were as follows :—

	Height of the Barometer.	Attached Thermometer.	Free Thermometer.	Mean Latitude.
Level of the Sea	30·024	77·5	76·5	37° 45'
Top of Mount Etna	20·146	35·5	32·5	

$T-T' =$ 42·0 $t+t' =$ 109·0

	Inches.
Table I_a gives for H = 30·024 ..	27630·6
Table I_a gives for h' = 20·146 ..	17206·3
	10424·3
Table I_b gives for $T-T'$ = 42° ..	− 98·3
	10326·0
Table II gives (for $t+t'$ = 100) ·05 × 10326	516·3
	10842·3
Table III (for Lat. 37° 45' and 10842·3) gives ..	6·9
Table IV for 10849·2 ..	32·8
	10882·0
By Logarithms [Tables A to C] ..	10872·0
	2) 21754·0
The mean...	10877·0 feet.
Keith Johnston gives in his Atlas the height of Mount Etna ..	= 10874·0 feet.
Discrepancy only ..	3 feet.

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TABLES

[From James, Loomis, Thuillier and other sources; some original.]

TABLE Ia.

ARGUMENT, THE OBSERVED HEIGHT OF THE BAROMETER AT UPPER STATION.

Inches	Feet	Diff.	Inches	Feet	Diff.	Inches	Feet	Diff.	Inches	Feet	Diff.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE Ib.

Correction due to T—T', or the difference of the Temperatures of the Barometers at the two Stations.

This Correction is Negative when the temperature at the Upper Station is lowest, and vice versa.

T—T'.	Correction.	T—T'.	Correction.	T—T'.	Correction.	T—T'.	Correction.	T—T'.	Correction.	T—T'.	Correction.
F°	Ft.	F°	Ft.	F°	Ft.	F°	Ft.	F°	Ft.	F°	Ft.
1°	2·3	14°	32·8	27°	63·2	40°	93·6	53°	124·1	66°	154·5
2	4·7	15	35·1	28	65·5	41	96·0	54	126·4	67	156·8
3	7·0	16	37·5	29	67·9	42	98·3	55	128·7	68	159·2
4	9·4	17	39·8	30	70·2	43	100·7	56	131·1	69	161·5
5	11·7	18	42·1	31	72·6	44	103·0	57	133·4	70	163·9
6	14·0	19	44·5	32	74·9	45	105·3	58	135·8	71	166·2
7	16·4	20	46·8	33	77·3	46	107·7	59	138·1	72	168·6
8	18·7	21	49·2	34	79·6	47	110·0	60	140·4	73	170·9
9	21·1	22	51·5	35	81·9	48	112·4	61	142·8	74	173·3
10	23·4	23	53·8	36	84·3	49	114·7	62	145·1	75	175·6
11	25·8	24	56·2	37	86·6	50	117·0	63	147·5	76	177·9
12	28·1	25	58·5	38	89·0	51	119·4	64	149·8	77	180·3
13	30·4	26	60·8	39	91·3	52	121·7	65	152·2	78	182·6

CORRECTION FOR TEMPERATURE

$$\frac{t + t' - 64}{900}$$ TABLE II.

t+t'	−	t+t'	+	t+t'	+	t+t'	+
22	·0467	64	0·	115	·0567	184	·1333
25	·0433	65	·0011	118	·06	187	·1367
28	·04	66	·0022	121	·0633	190	·14
31	·0367	67	·0033	124	·0667	193	·1433
34	·0333	68	·0044	127	·07	196	·1467
37	·03	69	·0056	130	·0733	199	·15
40	·0267	70	·0067	133	·0767	202	·1533
43	·0233	71	·0078	136	·08	205	·1567
46	·02	72	·0089	139	·0833	208	·16
49	·0167	73	·01	142	·0867	211	·1633
52	·0133	76	·0133	145	·09	214	·1667
55	·01	79	·0167	148	·0933	217	·17
56	·0089	82	·02	151	·0967	220	·1733
57	·0078	85	·0233	154	·10	223	·1767
58	·0067	88	·0267	157	·1033	226	·18
59	·0056	91	·03	160	·1067	229	·1833
60	·0044	94	·0333	163	·11	232	·1867
61	·0033	97	·0367	166	·1133	235	·19
62	·0022	100	·04	169	·1167	238	·1933
63	·0011	103	·0433	172	·12	241	·1967
64	0·	106	·0467	175	·1233	244	·20
		109	·05	178	·1267	247	·2033
		112	·0533	181	·13	250	·2067

TABLE III.

Correction due to the change of gravity from the latitude of 45° to the latitude of the place of observation.

Positive from lat. 0° to 45°.

Negative from lat. 45° to 90°.

TABLE IV.

TABLE V.

Correction due to the Height of the Lower Station.

Always Positive.

App. Alt.	Table III. Latitude 0° / 90°	10° / 80°	20° / 70°	30° / 60°	40° / 50°	45°	Table IV. Correction for Decrease of Gravity on a Vertical, always positive.	Table V. Height of Barometer at Lower Station. 16 In.	18 In.	20 In.	22 In.	24 In.	26 In.	28 In.	App. Alt.
Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Feet.
1000	2·6	2·5	2·0	1·3	0·5	0	2·5	1·6	1·3	1·0	0·8	0·6	0·4	0·2	1000
2000	5·3	5·0	4·1	2·6	0·9	0	5·2	3·1	2·5	2·0	1·5	1·1	0·7	0·3	2000
3000	7·9	7·5	6·1	4·0	1·4	0	7·9	4·7	3·8	3·0	2·3	1·7	1·1	0·5	3000
4000	10·6	10·0	8·1	5·3	1·8	0	10·8	6·3	5·1	4·0	3·1	2·2	1·4	0·7	4000
5000	13·2	12·4	10·1	6·6	2·3	0	13·7	7·8	6·4	5·1	3·9	2·8	1·8	0·9	5000
6000	15·9	14·9	12·2	7·9	2·8	0	16·7	9·4	7·6	6·1	4·6	3·3	2·1	1·0	6000
7000	18·5	17·4	14·2	9·2	3·2	0	19·9	11·0	8·9	7·1	5·4	3·9	2·5	1·2	7000
8000	21·2	19·9	16·2	10·6	3·7	0	23·1	12·5	10·2	8·1	6·2	4·5	2·9	1·4	8000
9000	23·8	22·4	18·3	11·9	4·1	0	26·4	14·1	11·5	9·1	7·0	5·0	3·2	1·5	9000
10000	26·5	24·9	20·3	13·2	4·6	0	29·8	15·7	12·7	10·1	7·7	5·6	3·6	1·7	10000
11000	29·1	27·4	22·3	14·6	5·1	0	33·3	17·2	14·0	11·1	8·5	6·1	3·9	1·9	11000
12000	31·8	29·9	24·4	15·9	5·5	0	36·9	18·8	15·3	12·1	9·3	6·7	4·3	2·1	12000
13000	34·4	32·4	26·4	17·2	6·0	0	40·6	20·4	16·5	13·1	10·0	7·2	4·6	2·2	13000
14000	37·1	34·9	28·4	18·5	6·4	0	44·4	21·9	17·8	14·1	10·8	7·7	4·9	2·4	14000
15000	39·7	37·3	30·4	19·9	6·9	0	48·3	23·5	19·1	15·1	11·6	8·3	5·3	2·6	15000
16000	42·4	39·8	32·5	21·2	7·4	0	52·3	25·1	20·4	16·1	12·4	8·9	5·7	2·7	16000
17000	45·0	42·3	34·5	22·5	7·8	0	56·4	26·6	21·6	17·1	13·1	9·4	6·0	2·9	17000
18000	47·7	44·8	36·5	23·8	8·3	0	60·5	28·2	22·9	18·1	13·9	9·9	6·4	3·0	18000
19000	50·3	47·3	38·6	25·2	8·7	0	64·8	29·8	24·1	19·1	14·6	10·5	6·7	3·2	19000
20000	53·0	49·8	40·6	26·5	9·2	0	69·2	31·3	25·4	20·1	15·4	11·0	7·0	3·4	20000
21000	55·6	52·3	42·6	27·8	9·7	0	73·6	32·9	26·7	21·1	16·2	11·6	7·4	3·5	21000
22000	58·3	54·8	44·7	29·1	10·1	0	78·2	34·5	28·0	22·2	17·0	12·1	7·8	3·7	22000
23000	60·9	57·3	46·7	30·5	10·6	0	82·9	36·0	29·3	23·2	17·7	12·7	8·1	3·9	23000
24000	63·6	59·8	48·7	31·8	11·0	0	87·6	37·6	30·5	24·2	18·5	13·2	8·4	4·0	24000
25000	66·2	62·3	50·7	33·1	11·5	0	92·5	39·2	31·8	25·2	19·3	13·8	8·8	4·2	25000

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TABLE VI.

Giving the height of the Barometer at different latitudes corresponding to temperatures of Boiling Water.

Boiling Point.	Barometer at 32° in Latitude.								Boiling Point.
	0°		30°		45°		60°		
	Barm.	Diff.	Barm.	Diff.	Barm.	Diff.	Barm.	Diff.	
Deg.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Deg.
180°	15·312	0·343	15·292	0·342	15·271	0·343	15·251	0·342	180°
181	15·655	0·350	15·634	0·350	15·614	0·349	15·593	0·348	181
182	16·005	0·356	15·984	0·355	15·963	0·355	15·941	0·355	182
183	16·361	0·363	16·339	0·363	16·318	0·362	16·296	0·362	183
184	16·724	0·370	16·702	0·369	16·680	0·369	16·658	0·368	184
185	17·094	0·376	17·071	0·376	17·049	0·375	17·026	0·375	185
186	17·470	0·384	17·447	0·383	17·424	0·383	17·401	0·382	186
187	17·854	0·391	17·830	0·391	17·807	0·390	17·783	0·390	187
188	18·245	0·398	18·221	0·397	18·197	0·397	18·173	0·396	188
189	18·643	0·405	18·618	0·405	18·594	0·404	18·569	0·403	189
190	19·048	0·413	19·023	0·412	18·998	0·411	18·972	0·412	190
191	19·461	0·419	19·435	0·419	19·409	0·418	19·384	0·417	191
192	19·880	0·427	19·854	0·426	19·827	0·426	19·801	0·425	192
193	20·307	0·435	20·280	0·435	20·253	0·434	20·226	0·434	193
194	20·742	0·443	20·715	0·442	20·687	0·442	20·660	0·441	194
195	21·185	0·450	21·157	0·449	21·129	0·449	21·101	0·448	195
196	21·635	0·459	21·606	0·459	21·578	0·457	21·549	0·457	196
197	22·094	0·467	22·065	0·466	22·035	0·466	22·006	0·465	197
198	22·561	0·474	22·531	0·473	22·501	0·473	22·471	0·473	198
199	23·035	0·483	23·004	0·483	22·974	0·482	22·944	0·481	199
200	23·518	0·492	23·487	0·491	23·456	0·490	23·425	0·490	200
201	24·010	0·500	23·978	0·499	23·946	0·499	23·915	0·498	201
202	24·510	0·508	24·477	0·508	24·445	0·507	24·413	0·506	202
203	25·018	0·519	24·985	0·518	24·952	0·517	24·919	0·517	203
204	25·537	0·526	25·503	0·525	25·469	0·525	25·436	0·524	204
205	26·063	0·534	26·028	0·534	25·994	0·533	25·960	0·531	205
206	26·597	0·545	26·562	0·544	26·527	0·543	26·491	0·543	206
207	27·142	0·553	27·106	0·552	27·070	0·552	27·034	0·551	207
208	27·695	0·562	27·658	0·562	27·622	0·560	27·585	0·560	208
209	28·257	0·571	28·220	0·570	28·182	0·570	28·145	0·569	209
210	28·828	0·588	28·790	0·581	28·752	0·580	28·714	0·579	210
211	29·416	0·591	29·371	0·590	29·332	0·590	29·293	0·589	211
212	30·007	0·602	29·961	0·601	29·922	0·600	29·882	0·600	212
213	30·609		30·562		30·522		30·482		213

LOGARITHMIC TABLES FOR DETERMINING BAROMETRICAL HEIGHTS.

Tables for determining Altitudes with the Mountain Barometer, or Aneroid.

Thermometers in Open Air.							
t + t'	A.	t + t'	A.	t + t'	A.	t + t'	A.
40	4·76891	80	4·78830	120	4·80686	160	4·82466
41	4·76940	81	4·78877	121	4·80731	161	4·82509
42	4·76990	82	4·78924	122	4·80777	162	4·82553
43	4·77039	83	4·78972	123	4·80822	163	4·82596
44	4·77089	84	4·79019	124	4·80867	164	4·82640
45	4·77138	85	4·79066	125	4·80912	165	4·82683
46	4·77187	86	4·79113	126	4·80957	166	4·82727
47	4·77236	87	4·79160	127	4·81003	167	4·82770
48	4·77285	88	4·79207	128	4·81048	168	4·82813
49	4·77335	89	4·79254	129	4·81093	169	4·82856
50	4·77384	90	4·79301	130	4·81138	170	4·82900
51	4·77433	91	4·79348	131	4·81183	171	4·82943
52	4·77482	92	4·79395	132	4·81227	172	4·82986
53	4·77530	93	4·79442	133	4·81272	173	4·83029
54	4·77579	94	4·79488	134	4·81317	174	4·83072
55	4·77628	95	4·79535	135	4·81362	175	4·83115
56	4·77677	96	4·79582	136	4·81407	176	4·83158
57	4·77725	97	4·79628	137	4·81451	177	4·83201
58	4·77774	98	4·79675	138	4·81496	178	4·83244
59	4·77823	99	4·79721	139	4·81540	179	4·83286
60	4·77871	100	4·79768	140	4·81585	180	4·83329
61	4·77920	101	4·79814	141	4·81629	181	4·83372
62	4·77968	102	4·79860	142	4·81674	182	4·83415
63	4·78016	103	4·79907	143	4·81718	183	4·83457
64	4·78065	104	4·79953	144	4·81763	184	4·83500
65	4·78113	105	4·79999	145	4·81807	185	4·83542
66	4·78161	106	4·80045	146	4·81851	186	4·83585
67	4·78209	107	4·80091	147	4·81895	187	4·83627
68	4·78257	108	4·80137	148	4·81939	188	4·83670
69	4·78305	109	4·80183	149	4·81983	189	4·83712
70	4·78353	110	4·80229	150	4·82028	190	4·83754
71	4·78401	111	4·80275	151	4·82072	191	4·83797
72	4·78449	112	4·80321	152	4·82116	192	4·83839
73	4·78497	113	4·80367	153	4·82160	193	4·83881
74	4·78544	114	4·80412	154	4·82203	194	4·83923
75	4·78592	115	4·80458	155	4·82247	195	4·83966
76	4·78640	116	4·80504	156	4·82291	196	4·84008
77	4·78687	117	4·80549	157	4·82335	197	4·84050
78	4·78735	118	4·80595	158	4·82378	198	4·84092
79	4·78782	119	4·80640	159	4·82422	199	4·84134
80	4·78830	120	4·80686	160	4·82466	200	4·84176

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Attached Thermometers.				Latitudes of the Place.			
T-T'	B	T-T'	B	L	C	L	C
0	0·00000	20	0·00087	8	0·00112	24	0·00078
1	0·00004	21	0·00091	9	0·00111	25	0·00075
2	0·00009	22	0·00096	10	0·00110	26	0·00072
3	0·00013	23	0·00100	11	0·00108	27	0·00069
4	0·00017	24	0·00104	12	0·00107	28	0·00065
5	0·00022	25	0·00109	13	0·00105	29	0·00062
6	0·00026	26	0·00113	14	0·00103	30	0·00059
7	0·00030	27	0·00117	15	0·00100	31	0·00055
8	0·00035	28	0·00122	16	0·00099	32	0·00051
9	0·00039	29	0·00126	17	0·00097	33	0·00048
10	0·00043	30	0·00130	18	0·00095	34	0·00044
11	0·00048	31	0·00134	19	0·00092	35	0·00040
12	0·00052	32	0·00139	20	0·00090	36	0·00036
13	0·00056	33	0·00143	21	0·00087	37	0·00032
14	0·00061	34	0·00147	22	0·00084	38	0·00028
15	0·00065	35	0·00152	23	0·00081	39	0·00024
16	0·00069	36	0·00156	24	0·00078	40	0·00020
17	0·00074	37	0·00160				
18	0·00078	38	0·00165				
19	0·00083	39	0·00169				
20	0·00087	40	0·00173				

Make D equal to Log. b—(Log. b' + B) then will the Logarithm of the difference of altitudes in English feet be equal to A + C + Log. D.

b, t, T, are the heights of the Barometer, and the Temperature of Air and Mercury at the Lower Station; b', t', T, refer to the Upper Station.

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FORM X. FOR USE WITH TABLES I TO V.

CALCULATION OF THE HEIGHT OF

from Barometrical Observations.

Date
Weather at the Upper Station
Weather at the Lower Station

Observations.

Place	Hour.	Barometer.	Att. Th.	Free Th.

Mean Latitude Table III.

Abstract.

	Barometer	A. T. Fahr.		F. T. Fahr.
Lower Station,			....	
Upper Station,			....	
	Diff.		[T−T′.] Sum	[t+t′]

Table I$_a$ gives { For Barometer at *Lower* Station.
{ For Barometer at *Upper* Station.

Difference...

Table I$_b$ gives for T − T. ....

Approximate Altitude *a*

Table II gives (for t+t.)

×
....

Approximate Altitude A..... ....
Table III for and Lat , gives...
Table IV for gives.........................
Table V for and gives.........

Height deduced in English Feet.

FORM Y. FOR USE WITH THE LOGARITHMIC TABLES A TO C.

CALCULATION OF THE HEIGHT OF

from Barometrical Observations.

Date
Weather at the Upper Station
Weather at the Lower Station

Observations.

Place	Hour.	Barometer.	Att. Th.	Free Th.

Mean Latitude [C.]

Abstract.

	Barometer	A. T. Fahr.		F. T. Fahr.
Lower Station,			....	
Upper Station,			....	
	Diff.		[B.] Sum	[A.]

Bar. at *Upper* Station, Log.
Corr. for Att. Ther. Log. [B]
,
Bar. at *Lower* Station Log. ,

Difference, Log. ,
Coefficient, corrected for Temp...Log. [A] ,
Correction for Latitude,............Log. [C] ,
Height deduced in Eng. Feet,..........Log. ,
Difference of Height.

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Mr. A. Buchan, in the ninth edition (now issuing) of the Encyclopœdia Britannica, states that Rühlmann's formula for the calculation of barometrical heights is "the simplest and best, being based on the most recent results which have been arrived at." In his formula, Rühlmann takes into consideration the hygrometric state of the atmosphere, as the humidity of the air materially affects its elasticity. Few observers, in India will have time to observe the hygrometer in addition to the barometer and thermometer; tables with this additional correction have therefore not been prepared. They will be found if required in the tables by Lieut. Colonel R. S. Williamson of the Corps of Engineers of the United States Army: these tables form portion of the professional papers of the Corps of Engineers of the U. S. Army, and can be obtained from Trübner. Moreover when the air is very dry, as it so often is in Southern India, the hygrometrical correction hardly affects the result, as has been shewn in Thuillier's Surveying Manual.

Rühlmann's formula reduced for the first time to English measures may however be noted; it is this:—

$$h = 60368{\cdot}7\left\{1{\cdot}00157 + 0{\cdot}001021\,(t + t' - 64^\circ)\right\}$$

$$\times\left\{1 + 0{\cdot}378\,\frac{\frac{e}{B} + \frac{e'}{b}}{2}\right\} \times (1 + 0{\cdot}00262\cos. 2\phi)$$

$$\times\left\{1 + \frac{2z + h'}{20925860}\right\} \times \log. \frac{B}{b}.$$

wherein

h = difference in English feet of level between the two stations.

h' = h used approximately.

t and t' = the temperature Fahrenheit of the air at the two stations.

B and b = the barometrical heights in inches at the two stations, corrected for instrumental errors and reduced to 32° Fahrenheit.

e and e' = the elastic force of vapour at the two stations.

ϕ = the mean of the latitude at the two stations.

and z = the height of the lower station above the sea.

The following works relate to this subject :—

1. Die Barometrischen Höhenmessungen und ihre Bedeutung für die Physik der Atmosphäre, by Dr. Richard Rühlmann, Professor of Physics in the Politecnic at Carlsuhe, Leipzig 1870
2. Tables for the reduction of Meteorological Observations in India, by H. F. Blanford—Calcutta, Thacker Spink & Co. 1877
3. Notes on the Aneroid Barometer, by Major B. R. Branfill, G. T. Survey, India—Bangalore, Mysore Government Press ... 1871
4. The following very able papers in London "*Engineering*" on The Aneroid : its construction, principles and uses :—

Description of Instrument and of its levers ...	Vol. xx. (1875)	Page 99
Do. do.	„	„ 372
Description of Instrument, pocket Aneroids, marking of dial, thermometer, compass	„	„ 489
Construction of Aneroids detailed	Vol. xxi. (1876)	„ 223
Effects of temperature on Aneroids ; how compensated for temperature	„	„ 490
Dial how graduated ; how effected by temperature ; corrections how applied ; best how made	Vol. xxiii. (1877)	„ 374

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Observations for weather, how obtained	Vol. xxiv.	Page 63
Aneroid how far reliable as a weather-glass ...	„	„ 121
Aneroids for calculating heights : formulæ and a table	„	„ 291
Easy measurements of heights	„	„ 18
Aneroid and Thermo-Barometer : correction for Latitude	„	„ 354

5. Article *Barometer* in Spon's Dictionary of Engineering.
6. Manual of Surveying for India, by Colonels Thuillier and Smyth, 3rd edition.—Calcutta, Thacker Spink and Co. 1875
7. Reduction of Barometric Readings at High Stations to sea-level, by Captain Allan Cunningham, R. E., Vol. III (second series) of Professional Papers on Indian Engineering 1874
8. Cape's Mathematics, Vol. II.
9. Practical Tables in Meteorology and Hypsometry, by Colonel R. S. Williamson, U. S. Engineers.—Trübner 1869
10. Article *Barometer* in eighth edition of the Encyclopœdia Brittannica, by Sir John Leslie 1854

    Article *Barometer* in ninth edition of the Encyclopædia Britannica, by Dr. A. Buchan. 1877
11. A Treatise on Meteorolgical Instruments, by Negretti and Zambra 1864
12. Meteorological Tables for the reduction of Barometrical and Hygrometrical Observations, Determination of Heights by the Barometer and Boiling Point Thermometer, &c., by G. Harvey Simmonds.
13. On the use of the *Barometer* on Surveys and Reconnaissances, by Col. R. S. Williamson, U. S. Engineers, Trübner 1868

List showing the heights above mean sea-level of the G. T. Stations in the Nilgiris given by Colonel G. H. Saxton.

Names of the G. T. Stations.	Heights above the Sea of the G. T. Stations in Feet.	Names of the G. T. Stations.	Heights above the Sea of the G. T. Stations in Feet.
Mailkonda Staff	6,921	St. Thomas' Church	7,271
Kolibetta H. S.	8,182	Lake Station	7,228
Davurmali Peak	8,304	St. Stephen's Church	7,429
Sispara Road Staff	7,868	Club Hill Staff	8,030
Kudiakad H. S	8,492	Snowdon H. Staff	8,299
Do West H. S	8,497	Mutanad Centre H. S	7,620
Kolari Staff	8,622	Dodabetta H. S	8,642
Lake Lawrence Bungalow	6,464	Teyrah H. Staff	6,957
Erremaybetta H. Staff	8,074	Pakasura H. Staff	6,552
Pichulbetta H. Staff	8,348	Coonoor Church	5,954
Makurti H. S	8,380	Koribetta H. S	6,698
Derebetta H. Staff	8,371	Coonoorbetta H. Staff	6,894
Velingeribetta H. Staff	8,247	Wellington	6,160
Paikara H. Staff	7,512	Kundanmugi H. Staff	7,690
Paikara Bungalow Station	6,767	Rallia Peak	7,375
Kengadu H. S	7,467	Kukalbetta H. S	7,161
Kattakadu Staff	7,933	Seegoor Peak Staff	6,778
Kulkudi or C. Staff	8,002	Dimhattibetta H. S	6,903
Ulnad H. S	7,793	Mandileru H. S	6,567
Devishola H. S	7,417	Kirkanarabetta H. Staff	6,949
Kolakambi H. Staff	5,601	Shoondhatti Staff	6,885
Chinna Dodabetta H. Staff	7,849	Sugarloaf H. Staff	6,708
Lawrence Asylum	7,330	Kodanad H. Station	6,740
Cairne H. Staff	7,583	Chinakodanad H. Staff	6,599
Mowbray Station	7,366	German Mission Chapel	6,511
Elk H. Staff	8,090		

H. S. means Hill Station.

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MADRAS RAILWAY LEVELS.

MADRAS RAILWAY SOUTH-WEST LINE.

List showing the Height of Rail Level at the centre of each Station and at the principal Bridges, referred to the Mean Sea Level at Madras as shown by Colonel D'Haviland's Bench-mark near Fort Saint George.

Distance from Madras.			Name of Station or Bridge.	Height in feet of Rail level above mean Sea level.
Ms.	Chs.	Lks.		
...	...	...	Madras Terminal Station	14·34
1	51	...	Cochrane's Canal	19·11
3	34	...	Perambore Station	22·57
12	78	50	Avady "	80·65
17	68	...	Tinnanore "	115·51
25	64	...	Trivalore "	155·36
29	27	...	Cuddumbatore Station	170·47
32	50	...	Cortilliar River	183·56
36	3	50	Chinnamapet Station	197·11
42	60	34	Arconum Junction	298·39
48	70	...	Cortilliar River (*branch*)	353·41
55	63	...	Sholingur Station	420·96
65	7	...	Arcot "	570·38
71	30	...	Poiney River	635·32
73	...	...	Trivellum Station	630·04
80	40	...	Vellore "	700·88
95	55	...	Gooriathum "	870·30
97	37	...	Gooriathum River	879·76
105	40	...	Mailputty Station	952·75
106	20	...	Palar River	964·36
112	67	50	Amboor Station	1,064·07
122	67	...	Vaniembady "	1,153·18
125	68	...	Godar River	1,182·83
129	2	..	Kullar "	1,259·20
129	61	...	Godar "	1,274·19
132	...	...	Jollarpett Junction	1,321·77
136	72	...	Tripatoor Station	1,272·09
144	50	...	Pauperputty River	1,231·34
146	77	...	Muttoor "	1,204·37
151	27	36	Samulputty Station	1,264·19
161	3	...	Panar River	1,217·46
166	6	50	Moorapoor Station	1,305·31
180	1	36	Mullapoorum "	1,391·02
180	61	...	Toopoor River	1,376·05
192	11	36	Abtoor or Shervaroy Station	1,240·98
199	10	...	Shervaroy River	989·52
206	61	36	Salem Station	922·38
219	65	...	McDonald's Choultry Station	784·85
219	74	...	Pund River	786·23
230	49	65	Sunkerrydroog Station	872·23
239	3	...	Kottypollum River	590·97
241	20	...	Cauvery "	602·19
243	4	...	Erode Station	540·63
252	13	19	Perandooray River	843·94
266	40	61	Watkallee "	976·29

MADRAS RAILWAY, SOUTH-WEST LINE.—(*Continued.*)

Distance from Madras.			Name of Station or Bridge.	Height in feet of Rail level above mean Sea level.
Ms.	Chs.	Lks.		
274	73	...	Avanashy River ...	987·03
290	26	...	Veneatakaray „ ...	1,045·72
285	72	...	Soomanoor Station...	1,114·78
300	80	...	Noyel River...	1,276·66
301	62	...	Coimbatore Station (*Podhanore*) ...	1,303·48
307	76	56	Madookerry „	1,112·07
313	35	99	Walliar „	687·12
323	40	22	Conjecode „	370·81
332	7	13	Palghaut Station	252·82
337	70	40	Purlay	196·06
346	73	41	Lackady Cottah Station	135·83
351	44	21	Wottapollium „	109·93
359	48	...	Shoranoor „	93·60
366	53	14	Putamby „	84·83
373	10	...	Thootha River	45·60
378	13	59	Koottypoorum Station	38·75
387	43	43	Tifoor „	18·97
392	59	...	Tannoor „	20·65
397	38	6	Purpenangady „	35·06
402	50	...	Kuddilahoondy River	7·62
406	23	42	Beypoor Terminus ...	11·77

Chief Engineer's Office,
8th June 1868.

(Signed) JOHN A. PINSON,
for Acting Chief Engineer.

BANGALORE BRANCH LINE.

Distance from Madras.			Name of Station or Bridge.	Height in feet of Rail level above mean Sea level.
Ms.	Chs.	Lks.		
132	...	...	Jollarpett Junction...	1,321·77
136	6	...	Single 12 feet opening	1,444·69
145	36	...	Double 30 feet arches	1,963·59
154	20	...	Coopum Station	2,244·51
157	20	...	Single 30 feet arch...	2,320·83
162	77	...	Three 30 feet arches	2,493·85
175	40	...	Colar Station	2,666·37
175	58	...	Three 20 feet openings	2,667·17
183	16	...	Koneskancaren River	2,796·85
192	20	...	Maloor Station	2,969·92
203	39	...	Pennair River	2,829·14
204	51	...	Cadigoody Station ...	2,850·35
214	71	...	Single 30 feet arch...	2,988·27
216	26	50	Bangalore Station ...	3,033·27

Chief Engineer's Office,
8th June 1868.

(Signed) JOHN A. PINSON,
for Acting Chief Engineer.

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NORTH-WEST LINE.

Distance from Madras.			Name of Station or Bridge.	Height in feet of Rail level above mean Sea level.
Ms.	Chs.	Lks.		
42	50	34	Arconum Junction ...	298·30
50	30	34	Trittany Station ...	285·62
51	23	34	Trittany River ...	285·54
59	57	34	Naggery Station ...	400·18
59	75	34	Naggery River ...	394·69
69	18	39	Pootoor Station ...	406·85
72	62	39	Tadeky River ...	584·39
77	68	39	Poody Station ...	436·99
81	6	39	Soornamookey River	403·74
83	43	39	Tripetty Station ...	371·46
96	71	39	Ballapilly Siding ...	791·01
109	2	39	Coodoor Station ...	647·45
109	59	39	Mooshtyair River ...	636·85
112	75	39	Goondalair River ...	639·19
121	60	39	Reddypully Station	565·25
123	51	39	Poolungair River ...	531·65
129	60	39	Rajampett Station ...	465·75
135	49	99	Cheyair River ...	476·28
136	40	99	Nundaloor Station	482·51
147	33	99	Ontimetta „	429·86
152	30	99	Bankrapett River ...	494·66
161	20	64	Cuddapah Station ...	459·69
174	75	...	Paupugnee Bridge ...	463·41
176	...	...	Camalapoor Station	484·36
185	45	...	Yerragoontla „	547·44
195	40	...	Moodanoor „	617·50
210	20	...	Kondipuram „	720·64
211	60	...	Chittravutty Bridge	702·24
227	40	...	Todputree Station ...	781·85
233	25	...	Pennair Bridge ...	815·85
242	47	...	Royalcherroo Station	940·85
257	20	...	Ghooty „	1,202·39
273	...	...	Goondacul „	1,410·94
281	10	...	Veerapoor „	1,427·16
296	66	...	Huggry Bridge ...	1,350·16
305	5	...	Bellary Station	1,484·16
280	40	...	Nuncherla „	1,552·65
294	45	...	Auspree „	1,496·55
306	74	...	Adoni „	1,364·35
324	25	...	Kosgee „	1,236·35
333	20	...	Toongabudra Bridge	1,080·53
339	26	...	Mutmurri Station ...	1,205·60
350	6	...	Raichore ...	1,311·21

NEILGHERRY BRANCH LINE.

Distance from Madras.			Name of Station or Bridge.	Height in feet of Rail level above mean Sea level.
Ms.	Chs.	Lks.		
304	5	...	Coimbatore ...	1,346·20
308	35	...	Four 64 feet openings	1,428·00
310	5	...	Tudialoor ...	1,469·40
313	54	...	Four 64 feet openings	1,430·00
321	51	...	Do.	1,215·00
321	45	...	Karamady	1,205·00
326	5	...	Mettapolliam	1,068·60

Chief Engineer's Office,
27th September 1873.

(Signed) T. H. GOING,
Acting Chief Engineer.

Levels from Great Trigonometrical Survey Records.

	Height above Sea.	
Bellary Fort Survey Station	1976	Feet.
Cuddapah Judge's Court	457	,,
Palamcottah Fort Flag Staff (Ground Level Top)	119	,,
Tinnevelly Pagoda Top	213	,,
Bangalore Commissioner's Flag Staff	3055	,,
Height of Roof of Observatory, S. E. of Base Line **Bangalore**	3131	,,
Palmaniar, **North Arcot**—Top of Collector's house in 1865	2247	,,
Karavéri Hill Station, **North Arcot** near Naikeneri Pass	2592	,,
Pattikondah Hill Station, **North Arcot**	2908	,,
Dévarakonda Hill Station (highest point of old fortress called Rájgarh), **North Arcot**	2732	,,
Sátgarhi Hill Station, **North Arcot**	2317	,,
Mugali Hill Station on hill S. of high road below Ghaut, **North Arcot**	2461	,,
Hindupura Station, **Bellary**	2068	,,
Gaddakalgudda, **Bellary**	1918	,,
Pámadi (Paumdy) Hill Station, **Bellary**	1762	,,
Urákonda Hill Station, **Bellary**	2193	,,
Gootydroog, **Bellary**	2171	,,
Mitrapalli Village Temple, **Cuddapah**	1929	,,
Oossoor Hill Station, **Salem**	3120	,,
Devarabetta Hill Station, **Salem**	3368	,,
Anchitti Droog Hill Station, **Salem**	3195	,,
Mariálum Hill Station, **Salem**	3449	,,
Gutiráyan Hill Station, **Salem**	4580	,,
[illegible]onásibetta Hill Station, **Coimbatore**	4970	,,
Randahalli Droog, or, Ekramgiri, **Coimbatore**	4277	,,
Subramanni Station, **Canara**	5583	,,
[illegible]álrayandrug Station, **Canara**	4999	,,

692/19

Executive Engineers Office
Ootacamund, 5th January 1880

No. 9.

692/20

From,
The Executive Engineer
West Coast Division

To,
The Superintending Engineer
4th Circle
Coimbatore

Sir,

During the past few years I have had occassion to ascertain altitudes by Barometers on these Hills. I was at first puzzled to know what formula to use in calculating the heights, and it took me a long time to discover where the most reliable information was to be found, and the best tables to use for the purpose.

2. Having at length after considerable research collected reliable information on the subject, I have thought it might be of use if such information was made

Generally

generally available to Departmental Offices.

3. Therefore at my own expense I have had printed 80+ copies of the accompanying pamphlet, and beg to be allowed to send them to you with this letter for submission to the Chief Engineer for the favor of his acceptance.

+ Forty by.

4. Since this brochure was printed I have received the newest edition of "Hints to Travellers" published by the Royal Geographical Society and drawn up by a distinguished Committee of Officers presided over by Captain Douglas Galton - I am gratified to find that the tables therein given for ascertaining altitudes by Barometers are in all essential respects indentical with those I have collected.

5. I need hardly say that much more information might have been given in the pamphlet I have prepared, but the time at my disposal did not admit of this; such further information can however be sought in the books of Reference of which I have given a list. As far as I have gone I believe my information to be perfectly reliable at least I have taken every pains to try and make it so.

6. I also append two books of forms for Calculation - In book No 2 the tables have by an oversight been omitted.

I have &c.

(Signed) J L L Morant Major R.E.
Executive Engineer.

No 19

Encl 1
Copy of Hypsometrical tables

True Copy submitted with enclosure to the Chief Engineer P.W.D. as desired

A. S. Russell
For Supg Engineer 4th Circle.

Coimbatore
13 January 1880

P.W.D.
14JAN80

From

The Supg Engineer
Fourth Circle.

Dated 13th
Recd: 13th January

No. 19

Enc: 1

Hypsometrical Tables:

Submitting copy of letter No. 9 of 5th Jany. from Major Morant Ex. Engr., requesting accep by the Ch. Engr. of his —

P. W. D.

No. 271 W

892/22

Proceedings of the Madras Government
Under date the 4th Feby 1880
Read the following

From
The Supg. Engr. Fourth Circle } (No. 19 d/ 13th January/80)

The Supg. Engineer will convey the thanks of Government to Major Morant for his useful pamphlet, which will be distributed among the officers of the Department.

2. The Govt. will be glad to reimburse to Major Morant the cost of printing the pamphlet if he will report the amount.

3/2/80

S. E. Fourth Circle

Despd
5-2-80

P. W/1880/Sup

Mis N 271 W of 4 February/80

No. 135

Supg Engrs Office 4th Circle
Coimbatore 12th March 1880

692/53

From The Superintending Engineer
4th Circle

To The Chief Engineer
P. W. Department
Madras

Sir,

Enclosure
1 Bill

With reference to para 2 of G.O. No. 271 W of 4th February 1880, Major Morant has forwarded the accompanying Bill for Rs (89„5„6) Eighty nine Annas five and pies Six being the cost of printing the Pamphlet in question, and I have the honor to request that you will be so good as to obtain the sanction of Government for payment of the bill.

I have the honor to be,
Sir,
Your most Obedt Servant

P. Mc Johnie Major R.E.
Supg Engineer 4th Circle

Pros. No. 271 W. 4-2-80.

P.W.D.
12 MAR 80
No. 1874

From

The Superintg. Engr.
4th Circle.

Dated 12th
Recd. } March 1880

No. 135

Hypsometrical Tables.

Requesting to obtain sanction of Govt. for the payment of the Bill of Rs 89 on account of printing

---

No 692 W

692/24

P. W. Department.

PROCEEDINGS of the MADRAS GOVERNMENT.

Under date the 18 Mar/80

READ the following

From

The Supdg. Engr. Fourth Circle } (H.E. No. 135 d/12th March/80)

The bill amounting to Rs 89-5-6 on account of expenses incurred by Major Morant R.E. in printing his "Hypsometrical Tables" is sanctioned.

15.3

S.E. Fourth Circle ✓

Exr. P.W. Accts. with bill ✓ Despd
1-4-80

Cro 1814

Govt. of (1880) Madras.

PUBLIC WORKS.

To

Dated

Issued

Recd. Encl.

G. O. 18th Mar 1880, No. 692w

Nos. 83-84

Tr

Hypsometrical Tables by Major Trevor R.E.

Sanctions the bill of R 89-5-6 on account of printing —

10/6