GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1896-97.

PREPARED UNDER THE DIRECTION OF

MAJOR-GENERAL C. STRAHAN, R.E.,

SURVEYOR-GENERAL OF INDIA.

CALCUTTA:

OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

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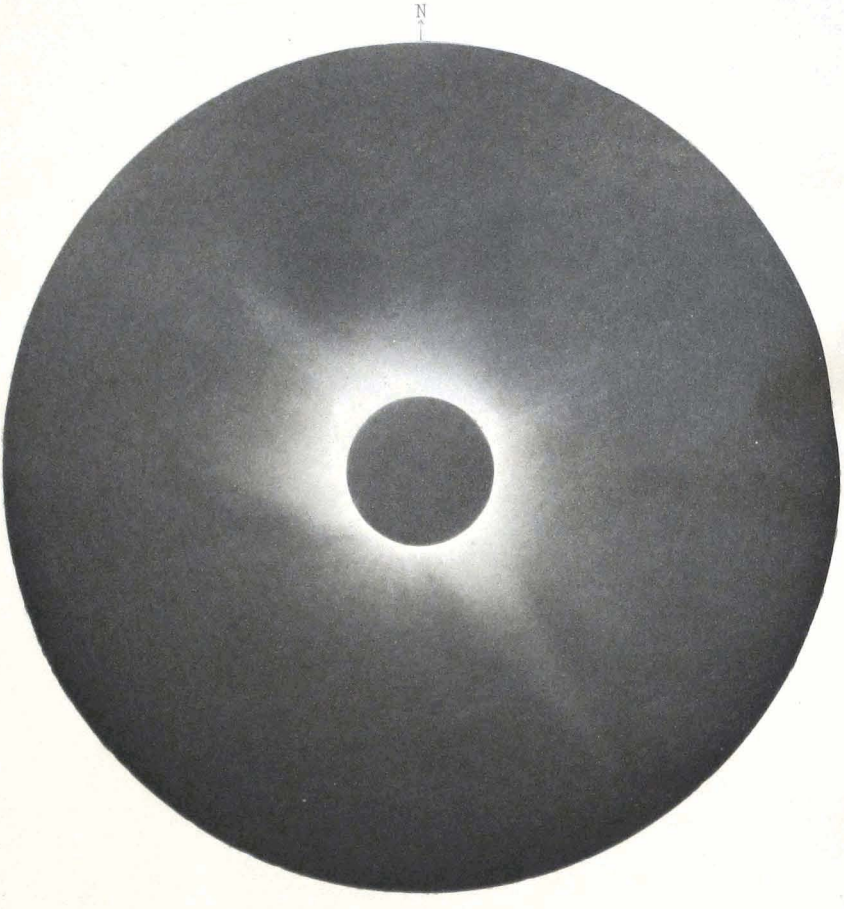

THE TOTAL SOLAR ECLIPSE OF JANUARY 22nd 1898, AT DUMRAON, BIHAR.

Enlarged from a negative by Mr T.A. Pope, Asst Surveyor General of India.

Photo-etching.

Survey of India Offices, Calcutta, March 1898.

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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1896-97.

PART I.

SUMMARY.

ADMINISTRATION.

1. The operations that are now reported on are for the survey year ending 30th September 1897.

2. The general administration of the Department and the superintendence of the Topographical Branch remained in the hands of Major-General C. Strahan, R. E, Surveyor-General of India, throughout the year. The Revenue Branch was under the superintendence of Colonel J. E. Sandeman, I. S. C., up to 18th April 1897, when he proceeded on furlough. During his absence Colonel R. G. Woodthorpe, C.B., R.E., was appointed to officiate as Deputy Surveyor-General in charge Revenue Branch, but as he was himself on furlough at the time and suffering from the effects of malaria, Lieutenant-Colonel J. R. Hobday, I.S.C., acted for him until the close of the year. Lieutenant-Colonel St. G. C. Gore, R.E., continued to be Superintendent of the Trigonometrical Surveys throughout the year, except for a short period of one month, when Captain G. P. Lenox-Conyngham, R.E., conducted his duties

3. The Bengal Government having decided that the Bihár Survey parties should be reduced from four to two cadastral sections, it was proposed that Captain Crichton should, in addition to his administrative duties as Superintendent of Settlement Surveys, take over the executive charge of the Bihár Surveys; this change was sanctioned by the Government of India in their letter No. $\frac{1368}{40\cdot6}$ dated 3rd June 1896.

Inspection Tours of the Administrative Officers.

4. On the 19th April 1897, the Surveyor-General proceeded to Dehra Dún, where he inspected the Great Trigonometrical Office and the training school which has lately been started there and which will in time be of very great service to the department generally. The work being done by it will be found in paragraph 49 on page 12. Major-General C. Strahan then visited Mussooree, meeting the several survey officers from the North-Western Provinces, Bengal and elsewhere, who had just returned from the field. On the 2nd May he arrived at Simla where he remained until the 17th July, inspecting the offices of No. 18 (Himálaya) Party and the Simla Drawing Office during his stay there. On his return to Calcutta he again visited Dehra and consulted with the Superintendent Trigonometrical Surveys, on various subjects.

On the 31st August, Major-General C. Strahan again left Calcutta for Bangalore and Poona, inspecting the offices of the following parties which were recessing at those two stations, *viz.*: Nos. 9, 10, 11, 19, 20 and 21 at Bangalore, and Nos. 17 and 25 at Poona. He returned to Calcutta, *vid* Mussooree, where he met Lieutenant-Colonel Hobday, Mr. G. B. Scott and

Captain Crichton, and consulted with those officers on sundry matters connected with the future progress and conduct of the surveys in the North-Western Provinces and Bengal. He also inspected the office of No. 12 Party, which had been allowed to recess at Mussooree instead of Kurrachee on account of the plague at the latter place. He returned to Calcutta on the 14th October.

5. Colonel Sandeman, Deputy Surveyor-General, Revenue Branch, left Calcutta on 14th December 1896, and proceeded to Madras to inspect the Forest Survey Parties in the field, No. 19 Party at Rénigunta in North Arcot district, and No. 9 Party at Trichinopoly, and returned to Madras on 4th January 1897. He then sailed for Rangoon to inspect the Cadastral and Forest Survey Parties in Burma. At Rangoon he interviewed the Lieutenant-Governor and Financial Commissioner; also attended a meeting at the Municipal Office, Mr. Hall the President being present, when a decision was arrived at to continue the Rangoon Town survey and to apply for an additional grant for its completion by the end of November 1897. He then inspected the maps and records of No. 7 (Lower Burma) Cadastral Party, and on the 17th January proceeded to Pyuntaza in Pegu district, where one of the field camps of the party was at work. On 19th January he arrived at Mandalay, and commenced inspecting No. 3 (Upper Burma) Cadastral Party on 21st idem, proceeding on 25th to Pagan to one of the cadastral field camps, and returned on 29th to Mandalay, where he interviewed the Inspector-General of Forests. He left Mandalay on 31st for Kanyutkwin to inspect No. 20 (Forest Survey) Party, marched into the forests, and examined the field work, returning to Rangoon on 6th February. Here he interviewed the Chief Secretary, the Revenue Secretary, the Director of Land Records and the President of the Municipality; the last mentioned informed him that the estimate for the increased expenditure for the completion of the Rangoon Town survey had been passed by the Municipality. He then inspected some of the topographical sheets done by No. 7 Party in Thatôn district, and personally examined and checked in the field several sheets of the Rangoon Town survey, and eventually returned to Calcutta on the 18th February 1897.

6. Colonel Sandeman obtained furlough for 1 year and 125 days from 1st May 1897, and availed himself of preparatory leave on 19th April, when he handed over his duties to Lieutenant-Colonel Hobday, who left Calcutta on 20th May for Shillong, where he arrived on 25th and inspected No. 6 (Assam) Party. During his stay, he interviewed the Chief-Commissioner, Chief Secretary, and Director of Land Records, and made certain proposals regarding the desirability of retaining the survey party in Assam, which were favourably received by the Chief-Commissioner. He left Shillong on 9th June (3 days before the great earthquake), and arrived in Calcutta on 13th June. On 5th July he sailed for Rangoon to inspect No. 7 (Lower Burma) Cadastral Party. Here he also met the officer in charge, No. 3 (Upper Burma) Cadastral Party, and discussed several matters connected with cadastral surveys in Upper Burma. He also interviewed the Lieutenant-Governor, Chief Secretary, and Revenue Secretary. On 16th July he sailed for Madras, arriving on 20th, and proceeded to Bangalore to inspect Nos. 9 and 19 (Madras Forest) Parties, and No. 20 (Burma Forest) Party at their recess quarters. An arrangement was made for the amalgamation of Nos. 9 and 19 into one combined party. He left Bangalore on 31st July and returned to Calcutta on 4th August. On 6th September he then started for Náini Tál, to inspect No. 8 (North-Western Provinces) Traverse Party, interviewed the Senior Member of the Board of Revenue, and Chief Secretary, and attended a meeting of the Board, when it was decided to amalgamate Nos. 2 and 8 Traverse Parties; also to establish a drawing office for the mapping of the standard sheets of the North-Western Provinces and Oudh. Lieutenant-Colonel Hobday then left Náini Tál on 20th September for Mussooree, arriving on the following day. Here he inspected No. 2 (North-Western Provinces) Traverse Party and No. 4 (Bihár) Cadastral Party, and returned to Calcutta on 14th October.

7. Lieutenant-Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys, on his return from furlough inspected No. 25 Party (Tidal and Levelling) in October, the recess offices of Nos. 14 and 24 Parties at Mussooree in May, and the Office of No. 18 Party at Simla in June. In January the Superintendent visited Calcutta to hold a conference with the Surveyor-General.

FIELD PARTIES.

8. The field operations of the year under report were carried on by 21 parties and one detachment. Of these, one party was employed on trigonometrical surveys; six parties on topographical surveys; five parties on forest surveys; three parties and one detachment on cadastral surveys; one party on topographical and traverse work; two parties on traverse surveys; and three parties on scientific operations. The operations of the Forest Survey Branch were also continued during the year. The Land Records surveys carried on by local agency in the North-Western Provinces and Oudh, which are under the superintendence of the Deputy Surveyor-General, Revenue Branch, have also been included in this report under the head of Cadastral Surveys.

9. The following tabular statement shows the whole of these operations grouped according to the scope and nature of the work on which the parties were severally employed :—

Statment of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Balúchistán . . .	15	Captain J. M. Burn, R.E. .	.....	Supdt , Trig.
	Topographical Surveys.				
10	Upper Burma . .	16	Mr. A. J. Gibson . . Major F. B. Longe, R.E. . Captain A. J. Pilcher, R.E.	1″=1 mile for reproduction	D. S. G , Topo.
11	Ditto . . .	18	Captain T. F. B. Renny-Tailyour, R.E.	1″=1 mile for reproduction .	Ditto.
12	Sind	20	Captain G. B. Hodgson, I.S.C.	2″=1 mile for reduction .	Ditto.
15	Balúchistán . . .	24	Colonel Sir T. H. Holdich, R.E. Captain H. A. D. Fraser, R.E. Mr. T. E. M. Claudius .	Various scales . . .	Ditto.
18	Himálayas . . .	25	Captain C. L. Robertson, R.E. Mr. L. J. Pocock . . Mr. C. D. Potter . .	4″=1 mile for reproduction and reduction to half scale, and 2″=1 mile for reproduction.	Supdt , Trig.
21	Upper Burma . .	19	Major F. B. Longe, R.E. . Captain A. J. Pilcher, R.E. .	1″=1 mile for reproduction	D. S. G., Topo.
6	Assam	65	Mr. E. C. Barrett . . Mr. W. H. Penrose . .	1″=1 mile for reproduction	D. S. G., Rev.
	Forest Surveys.				
9	Madras . . .	33	Mr E. J. Jackson . . Captain H. A. D. Fraser, R.E.	4″=1 mile for reproduction	Ditto.
14	Central Provinces .	28	Mr. C. F. Erskine . .	4″=1 mile for reproduction	Supdt., Trig.
17	Bombay . . .	30	Major W. J. Bythell, R.E. . Mr. C. E. Tapsell . .	16″=1 mile, 8″=1 mile and 4″=1 mile for reproduction	D. S. G., Topo.
19	Madras . . .	35	Captain H. A. D. Fraser, R.E. Captain C. H. D. Ryder, R.E. Lieutenant A. H. B. Hume, R.E.	4″=1 mile for reproduction	D. S. G., Rev.
20	Burma . . .	36	Captain P. J. Gordon, I.S.C. Lieutenant H. J. Hare, R.E.	4″=1 mile and 2″=1 mile for reproduction.	Ditto.
	Forest Survey Branch.				
	Central Provinces . Punjab . . . Burma . . .	38 39 40	Mr. W. H. Reynolds . . Ditto . . Ditto . .	4″=1 mile for reproduction	I. G. Forests.
	Cadastral Surveys.				
3	Upper Burma . .	41	Mr. G. H. Cooke . . Mr. E. G. Little . .	16″=1 mile and 8″=1 mile	D. S. G., Rev.

Statement of Survey Operations and Parties—concld.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Cadastral Surveys—contd.				
4	Bihár	46	Captain R. T. Crichton, I.S.C. Captain C. W. H. Symonds, I.S.C.	16″=1 mile . . .	S. S. S., Bengal.
7	Lower Burma . .	52	Mr. R. G. Gilbert-Cooper . Mr. W. C. Price .	16″=1 mile . . .	D. S. G., Rev.
Land Records Surveys.	North-Western Provinces and Oudh.	56	Mr. G. B. Scott . . .	16″=1 mile . . .	Ditto.
	Traverse Surveys.				
2	North-Western Provinces and Oudh.	59	Captain J. M. Fleming, I.S.C. Mr. W. S. Buttress . .	16″=1 mile (skeleton plots)	Ditto.
6	Assam	65	Mr. E. C. Barrett . . Mr. W. H. Penrose . .	.....	Ditto.
8	North-Western Provinces and Oudh.	62	Mr. J. S. Pemberton . .	16″=1 mile (skeleton plots) .	Ditto.
	Geodetic.				
22 23	India	67	Captain S. G. Burrard, R.E. Mr. J. Eccles, M.A. . . Captain G. P. Lenox-Conyngham, R.E.	.....	Supdt., Trig.
	Tidal and Levelling operations.				
25	India	68	Captain S. G. Burrard, R.E. Captain C. C. D. Morice, R.E. Mr. G. Belcham . .	.....	Supdt., Trig.

OUTTURN.

10. During the year under report the aggregate area surveyed on all scales amounts to 104,987 square miles, of which 78,718 square miles were reconnaissance only. The report of last year shows an area of 63,653 square miles; the increase this year is due to the large amount of reconnaissance completed in Upper Burma, and elsewhere. The aggregate area of rigorous survey on all scales amounting to 26,269 as against 33,374 square miles last year. These areas are exclusive of those embraced by the traverse operations in the North-Western Provinces and Oudh and Assam, carried on for the purpose of furnishing a correct skeleton on which to base the field surveys under the Settlement Department; the area thus traversed during this year amounts to 6,135 square miles, whilst that of last year was 8,719 square miles.

The operations of the various field parties will be found summarized in the following paragraphs. A more detailed report on the operations of each party for the year under review is given in Part II.

TRIGONOMETRICAL SURVEYS.

11. The Principal triangulation of the Makrán Longitudinal Series was continued from the most western stations of last season's work, *viz.*:—Kuliri and Piaro in Longitude 66°30′, and was extended westwards over a direct distance of about 75 miles, comprising 3 figures and embracing an area of 1,380 square miles. Horizontal and vertical angles were taken at 9 principal and 2 secondary stations and astronomical observations were taken at one of the former.

TOPOGRAPHICAL SURVEYS.

12. On topographical operations six parties have been employed, *viz.*, Nos. 10, 11 and 21 in Upper Burma, No. 12 in Sind, No. 15 in Balúchistán, and No. 18 in the Himálayas.

13. No. 10 Party having completed its work in the Southern Mahrátta country last season, was transferred to Upper Burma. The area surveyed in detail by the three parties amounted to 5,747 square miles, including 967 square miles of overlap, whilst 8,690 square miles were triangulated in advance. As the surveyors of No. 10 Party were not only entirely new to the style of country to be surveyed, but were also many of them Mahrátta Bráhmins who strongly object to serving away from their own country, more especially in such a wild jungly country as that of Upper Burma, the progress made by that party was not as much as it should have been. This will be remedied during the coming season, and it is confidently expected that, what with that and an increase to the native establishments of Nos. 11 and 21 Parties, the area turned out next year in the Shan States will be considerably increased.

No. 12 Party continued the survey of Sind on the 2-inch scale. The area completed amounted to 2,244 square miles No work was done by this party on the 1-inch scale, but an area of 1,825 square miles in the hilly portion adjoining Balúchistán was surveyed by a detachment of No. 15 Party. A survey of the Layari quarter of Kurrachee on the scale of 80 feet=1 inch was also completed. The cost rate of the 2-inch survey, exclusive of triangulation and traversing, is R14·2 per square mile, which, as was expected, is much less than the cost rate of last year. The area traversed amounted to 3,635 square miles at a cost rate of R9·1 per square mile; the traversing includes a survey of the village boundaries which are fixed by offsets.

No. 15 Party was employed on geographical reconnaissance and in topographical work in Sind, besides this were several minor surveys. One Sub-Assistant Superintendent, Khan Bahadur Imam Sharif, was also deputed to Zanzibar to undertake a survey of that island.

No. 18, the Himálaya Party, completed a total area of 810 square miles, of which 446 square miles were surveyed on the 4-inch scale, and 364 on the 2-inch scale. The 2-inch work consists of topography in Mandi, Suket and Simla Hill States, and in Sirmur, and the 4-inch in Kángra, Kullu, Sirmur, Patiála and Kalsia (revision survey).

Classification of forests and soils was carried out in 191 square miles of country topographically surveyed in British territory. The large scale (48 inches=1 mile) survey of the town of Náhan was begun.

Small areas were also topographically surveyed on various scales in Assam, Burma, Bengal and Punjab by No. 6 Party, by No. 7 Cadastral Party, by No. 4 Party and by the Forest Survey Branch.

14. The areas topographically surveyed on various scales during the year amount to 14,460 square miles against 19,798 square miles executed last year.

The decrease in the area completed is due to the fact that the ½ inch work of No. 15 Party was almost finished last year, and only 700 square miles were executed instead of 11,307 square miles, as noted in last year's report. The outturn of work on other scales has increased.

The total is made up as follows :—

700	Square miles surveyed on the		½	inch scale.
8,374	,,	,,	1	,,
4,841	,,	,,	2	,,
255	,,	,,	4	,,
21	,,	,,	6	,,
2	,,	,,	8	,,
56	,,	,,	12	,,
211	,,	,,	16	,,

FOREST SURVEYS.

15. In addition to the four survey parties which continued the operations in the Central Provinces, the Bombay and Madras Presidencies and in Lower Burma, the traverse party from the Central Provinces was transferred to the Madras Presidency to expedite the survey of the forest reserves, maps of which are required as soon as possible. The Forest Survey Branch continued its operations in Central Provinces, Punjab, Upper and Lower Burma. Small areas were also surveyed by the party working in the Himálayas.

16. In the Central Provinces, the detail survey of the forests in the Damoh District, as allotted to No. 14 Party was brought to a close. Operations were begun in district Biláspur and triangulation and traversing in advance of topography were carried on simultaneously in districts Damoh, Biláspur and Sambalpur. The total outturn of topography, on the 4-inch scale, during the season was 696·6 square miles, of which 622·7 square miles were in Damoh and 73·9 square miles in Biláspur. The area triangulated in advance was 666 square miles in Biláspur and 1,104 square miles in Sambalpur. But owing to the forest blocks being scattered over large extents of country, of the above areas only 240 and 390 square miles, respectively, will be brought under actual survey.

The usual classification of forest growth and soils was carried out over the area surveyed in detail.

The traversing in advance of topography consists of 356 linear miles. The cost rate per square mile of the detail survey is ₹70·5. Under the orders of Government the remaining portion of the work in districts Biláspur and Sambalpur was transferred to the Forest Survey Branch for completion.

17. The operations in the Bombay Presidency comprised the detail survey on the 8-inch scale of teak reserves in the Thána district, the completion of 4-inch detail survey in the Poona district, the 8-inch survey of teak reserves, the 4-inch survey of ordinary forest reserves, and the 16-inch survey of *bábul* reserves in the Ahmednagar district; the detail survey on the 4-inch scale in North Kánara. The areas completed amounted to 522 square miles on the 4-inch, 168 square miles on the 8-inch, and 33 square miles on the 16-inch scales. In addition to this 1,376 square miles were triangulated. The cost rates are slightly higher than those of last year, which were exceptionally low, but compare favourably with other years.

18. Two full parties were employed in the Madras Presidency, one party having been transferred from the Central Provinces, as already mentioned; this latter party had, however, been employed for years on traverse operations, and the native surveyors were consequently more or less unacquainted with the topographical operations they were called upon to undertake in Madras, and hence the outturn has not been as much increased as it would have been had the men been trained topographers; during the first year in new country the outturn of detail survey can never be very large, owing to the want of triangulation or traverse work in advance. The two parties together completed 1,148 square miles of detail survey on the 4-inch scale, 2,450 square miles of advance triangulation, and 1,252 linear miles of traversing. There should be a considerable increase of detail survey during the next field season.

19. In Lower Burma an area of 395 square miles on the 4-inch and 106 square miles on the 2-inch scales were completed in the Shwegyin and Pegu forest divisions in the Toungoo district. The outturn of 4-inch survey shows a satisfactory increase on former years. The cost rate shows a small increase on that of last year.

20. The party working in the Himálayas surveyed an area of 191 square miles on the 4-inch scale in Sirmur, Patiála, Kullu and Kángra.

21. With the exception of the surveys in Oudh, which were brought to a close last year, the operations of the Forest Survey Branch were in continuation of those of last year, but in addition a new survey in the Ruby Mines district was commenced. In the Central Provinces, surveys were carried on in the forest divisions of Ráipur, Bálághát, Nágpur-Wardha, Seoni, Chhindwára and Saugor; in Chamba in the Punjab; in Salween-Ataran, Pyinmana, and the Ruby Mines in Burma. The total area surveyed amounts to 2,365 square miles, of which 802 square miles were done on the 1-inch scale for topographical purposes only.

22. The total outturn of forest surveys executed on various scales during the year amounts to 4,823 square miles, of which 1,563 were surveyed by the Forest Survey Branch. The area surveyed by the Imperial Survey parties, *viz.*, 3,260 square miles, is 58 square miles in excess of that surveyed last year.

The areas on the different scales are as follows:—

106	square	miles	surveyed	on the	2-inch scale.
4,310	"	"	"	"	4-inch "
168	"	"	"	"	8-inch "
239	"	"	"	"	16-inch "

CADASTRAL SURVEYS.

23. The number of parties engaged on cadastral operations during the year has been as follows:— One party and one detachment in Bengal, one in Upper Burma, and one in Lower Burma. In addition to the operations of the Imperial parties, cadastral surveys have been carried on by local agency in the North-Western Provinces and Oudh, under the immediate superintendence of Mr. G. B. Scott, Superintendent of Settlement Surveys, and the general professional control of the Deputy Surveyor-General, Revenue Branch.

24. Owing to the famine in North Bihár, the programme of the Bengal party had to be somewhat modified; areas, which were least likely to suffer, had to be selected for survey. The programme consisted mainly of the cadastral survey and preparation of the record of rights of certain private estates in districts Sáran and Darbhanga and of certain temporarily settled and Government estates of smaller area in the Noákháli district, Chittagong, and in the Midnapur district of the Bhágalpur division. A reduction in the strength of the cadastral survey party in Bihár having been decided on, Captain Crichton, Superintendent of Settlement Surveys in Bengal, took over executive control of the Bihár surveys in addition to his other duties. As in previous years the survey establishments have been utilised as part of the Settlement Department, one *amin* surveying the village and writing the records during the field season, whilst during the recess season the same man extracted the areas and completed the village records and statistics.

25. The following is a summary of the progress of work in each district:—

In Sarán an area of 210 square miles was cadastrally surveyed at a cost rate of R142·c3 for survey, and R128·62 for records. These abnormally high cost rates are due to the alteration and contraction of the original survey programme in this district, on account of the famine in Bihár. An area of 25 square miles of *diara* lands (lands subject to inundation from rivers) on the 16-inch scale at a cost of R56 per square mile was also completed topographically.

In Darbhanga an area of 545 square miles was cadastrally surveyed at a cost of R78·31 per square mile for survey and R87·47 for records. Also an area of 40 square miles of *diara* lands was topographically surveyed on the 16-inch scale at a cost of R27 per square mile.

In Noákháli an area of 84 square miles of certain Government estates in the islands of Sandip and Hatiya was cadastrally surveyed together with the record of rights at a cost of R89 per square mile for detail survey and R58·5 for records. In addition to this certain other Government estates comprising an area of 146 square miles were topographically surveyed on the 16-inch scale at a cost of R12 per square mile, including traversing: and 199 square miles of *diara* lands on the 2-inch scale at a cost of R6 per square mile.

Small estates in districts Muzaffarpur and Monghyr comprising an area of 2 and 1 square miles respectively were cadastrally surveyed, whilst a special test survey on a scale of 32 inches = 1 mile of an area comprising 3 square miles of the Majnamutha estate was undertaken for the purpose of testing an old survey.

26. The Upper Burma party continued the cadastral surveys in the following districts:—

District.	Area in square miles.	Cost rates per square mile.
		R
Myingyan	781	124·3
Minbu	57	74·9
Upper Chindwin	129	130·4
Katha	229	104·2
Shwebo	46	161·4
Yamèthin	56	74 9
Mandalay	2	75·0

Also an area of 2 square miles was surveyed on the 8-inch scale of the gold tracts in district Katha. The traverse survey of Myingyan is now complete, and only about 1,000 square miles of cadastral survey remain to be done. The survey of Minbu is also nearly completed.

In the Upper Chindwin and Katha districts the areas for cadastral survey were small and much scattered, which caused loss of time and extra expense,

whilst the excessive unhealthiness of the climate especially in Katha added much to the difficulties of the surveyors.

27. The Lower Burma party cadastrally surveyed an area of 509 square miles, *viz.*, 450 square miles in Pegu district, and 59 square miles in Toungoo district, at a cost of R151 per square mile. Progress was much retarded in these two districts by the unhealthiness of the climate, an average of nearly one-fifth of the menial establishment being incapacitated for work throughout the season from dysentery and fever. In Thatôn district 58 villages embracing an area of 41 square miles on the 2-inch scale was re-surveyed on account of changes in the bed of the Sittang river, and extensions of cultivation, at a cost of R35 per square mile. An area of 452 square miles was also topographically surveyed by this party in Thatôn district, on the 2-inch scale at a cost of R58·5 per square mile. The survey of the town of Rangoon, partly on the scale of 50 feet and partly on that of 100 feet to the inch, which was commenced last year, was completed.

28. In the North-Western Provinces and Oudh settlement surveys were continued by *patwári* agency in districts Meerut, Lálitpur, Bahraich, Sítápur, Sháhjahánpur, Kheri and Bareilly under the executive control of Mr. G. B Scott, Superintendent of Settlement Surveys, subject to the supervision of the Deputy Surveyor-General, the work in each district being superintended by an officer of the Provincial service of the Imperial Survey. The total area surveyed in the North-Western Provinces and Oudh amounts to 4,325 square miles, at an average cost of R45 per square mile These surveys are based on traverses run by Nos. 2 and 8 parties. In Lálitpur owing to the famine the *patwáris* were withdrawn from survey work during a considerable portion of the field season, and *amins* had to be employed in their stead. In Bareilly also the work was hampered by the famine. The survey and record writing of the Meerut district and of the Lálitpur sub-division have been completed, and it is anticipated that the surveys of Bahraich and Sháhjahánpur will be finished next year.

29. The total areas cadastrally surveyed during the year in the different provinces, including 211 square miles in which the details of fields have not been shown, are as follows:—

	Square mile.
Bengal	1,056
Burma	1,809
North-Western Provinces and Oudh	4,325
	7,190

The reduction in the total area completed as compared with last year's return is due to the curtailment of the programme in Bengal on account of famine and in Burma, because the survey operations had outstripped the settlement work.

TRAVERSE SURVEYS.

30. Two parties were employed during the year, in the North-Western Provinces and Oudn, on these operations, to furnish a skeleton basis for the Settlement Surveys now being carried on by local agency, whilst a third party was employed on similar operations in Assam, in order to locate geographically certain areas cadastrally surveyed by local agency in the Brahmaputra Valley, and of certain *ilam* lands and tea grants in the Surma Valley.

31. In the North-Western Provinces and Oudh, two parties Nos. 2 and 8, were employed on traverse operations. The former completed an area of 3,005 square miles, of which 237 were in the Sháhjahánpur, 1,600 in the Kheri, and 1,168 in the Pilibhít districts at an average cost rate of R27 per square mile No. 8 Party was employed in districts Meerut, Bareilly, Bijnor and Gonda, in which the areas traversed were 175, 744, 403 and 1,004 square miles respectively, or a total of 2,326 square miles at a cost rate of R29 per square mile.

These traverse surveys are to furnish correct plots on which to base the cadastral maps which are made by *patwari* agency under Mr. Scott, Superintendent of Settlement Surveys.

32. In Assam, No. 6 Party completed the traversing of an area of 596 square miles in the Brahmaputra Valley, *viz.*, 287 square miles in the Goálpára, and 309 square miles in the Kámrúp districts at a cost of R30 per square mile.

In the Surma Valley 208 square miles were traversed in Sylhet district at a cost of ₹26 per square mile. In addition to this, an area of 629 square miles was topographically surveyed in the Assam Valley on the 2-inch scale by this party at a cost of ₹43·7 per square mile.

33. The areas traversed during the year, exclusive of the preliminary traversing connected with the cadastral surveys made by this Department, are as follows :—

	Square miles.
North-Western Provinces and Oudh	5,331
Assam	804
Total	6,135

SPECIAL OPERATIONS.

34. Observations for redetermining the value of the latitude of Madras were taken by Captain S. G. Burrard, R.E., with the Zenith Sector, and the result, combined with a value obtained by Mr. Michie Smith and two previous values, gives a mean value for Madras of 13°·4′·8″ 02 north latitude.

35. The Tidal observations have been continued as usual. Observations with the self-registering tide-gauges have been made at 12 stations in India, Burma, the Persian Gulf, the Andaman Islands and the Red Sea. During the coming year it is intended to dismantle the observatory at Muscat and possibly also that at Bushire, and to open new observatories at Perim, Porbandar, and perhaps Port Albert Victor.

36. In connection with the tidal operations, spirit-levelling was carried on from Potanghi to Vizianagram, and from Biláspur to Katni within 150 miles of the terminus at Allahabad. The total out-turn amounts to 291½ miles of double levelling, fixing 23 embedded bench-marks, 298 ordinary bench-marks, 8 verificatory points, and 5 stations of the Great Trigonometrical Survey.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

37. In Upper Burma an area of 11,718 square miles of new country was geographically surveyed on the ¼ inch scale by Nos. 11 and 21 Parties; 2,000 square miles of triangulation were also completed.

38. The aggregate areas geographically surveyed during the year on the eastern and western frontiers amount to 78,718 square miles.

HEAD-QUARTERS OFFICES.

39 The details of the work done at the various offices at the head-quarters are given in Part III of this Report.

40. The offices located in Calcutta were, as usual, in charge of three Assistant Surveyor-Generals. The Drawing, Engraving and Map Record and Issue Offices, as well as the Bengal Provincial Drawing Office, remained in the hands of Mr. A. E. Spring The Photographic and Lithographic Office remained under the supervision of Colonel J. Waterhouse, I.S.C., until the 8th May 1897, when he was succeeded by Mr. T. A Pope. The Correspondence and Mathematical Instrument Offices were in the hands of Colonel M. W. Rogers, R.E., until 4th February 1897, of Lieutenant-Colonel J. R. Hobday, I.S.C., up to 29th April 1897 and of Major F. B. Longe, R.E., for the remainder of the year.

41. The more important work of the Geographical Section of the Drawing Office has been the completion of the maps of the North-Eastern and South-Eastern Frontiers. Sheet No. 15 N. W. of the North-Eastern Frontier and sheets Nos. 4 S. W. and 6 N. E. of the South-Eastern Frontier series on the 4 mile scale have been published, and the latter sheet has also been published on the 8-mile scale, Sheets Nos. 14 S E. and 23 N. E. and N. W. (in one sheet) of the North-Eastern Frontier on the 4-mile scale, and sheets Nos. 3 S. E. and 3 A N. E. of the South-Eastern Frontier on the same scale have been brought up to date as regards railways, etc. Sheet No. 306 of Upper Burma on the 1-mile scale was also published as a preliminary edition.

The general maps of India on various scales have received additions and corrections, and the second edition of the Map of India on the 32-mile scale was brought up to date as far as possible; a new canal map on the same scale was also commenced and will be published very shortly as also the Railway Map on the 48-mile scale. The third edition still awaits orders for publication. The 128-mile Map of India had the hills completed for engraving. The engraved provincial maps on the 16-mile scale of Assam, Bengal including Bihár, Orissa and Chota Nágpur and Punjab were all revised and brought up to date, and those of the Bombay Presidency, Central Provinces and Rájputána Agency were similarly revised for lithography: the Map of Bengal, Bihár, Orissa and Chota Nágpur had the hill shading also completed for engraving. Several standard sheets on the 1-mile scale of the Rájputána Agency, the Central India Agency, and Central Provinces have been completed to margin, twenty-seven having been completed and sixty-eight are still in hand. The sheets of the Atlas of India have as usual formed a large and important part of the work of this section; fifty-eight sheets have been corrected up to date as regards railways, roads and boundaries.

The maps received from field parties were completed and rendered suitable for publication, and a large number of proofs and other data was supplied to district officials.

42. The work of the Revenue Section has been mainly of the usual routine nature. A second edition of the Map of Calcutta and surrounding country on the scale of 1 inch=1 mile with additions has been passed through press. Thirty-seven sheets of the large scale map of the town of Moulmein have been redrawn in a style suitable for reproduction by photography. Fourteen standard sheets on the 2-inch scale of district Tavoy; 19 standard sheets of the Indus Riverain Survey on the 1-inch scale and 10 standard sheets (in 4 sections each) of Bombay and Burma were received from survey parties, finally examined, corrected, and rendered suitable for photography. Of the old maps, 20 standard sheets of the Indus Riverain Survey, 29 standard sheets of North-Western Provinces and Oudh on the 2-inch scale, 30 sheets of district Náini Tál on the 4-inch scale, and 37 *pargana* or main circuit maps of Bengal on the 1-inch scale were touched up, corrected and brought up to date for republication. Besides these, 51 standard sheets on the 1-inch scale of the North-Western Provinces and 57 maps of Bengal on 1-inch scale were corrected and brought up to date for new editions.

43. In the Cadastral Section 5,493 cadastral sheets were prepared for publication, of which 2,905 belonged to the North-Western Provinces, 2,206 to Burma, 261 to Bengal and Orissa, and 120 to Assam.

44. The Bengal Provincial Drawing Office continued to be employed on the compilation, from maps supplied by cadastral survey parties in Orissa and Bihár, of standard sheets on the scale of 2 inches to a mile for reduction to half. Eleven standard sheets in 44 sections on the 2-inch scale of Orissa were sent to the Photographic Office for reduction to the 1-inch scale. The final press order for 12 sheets (1-inch scale) was passed. Forty-one unpublished proofs (blue prints) were forwarded to District, Railway and Settlement authorities for scrutiny, prior to final publication. By this means the alignment of the East Coast and Bengal-Nágpur Railways which were laid down subsequent to cadastral surveys was obtained. The standard sheets of Orissa are nearly completed and those of Bihár will be put in hand.

The special publication of some of the standard sheets of Orissa on the 2-inch scale for the Department of Public Works (Irrigation Branch), Bengal, was completed.

45. In the Engraving Office, the preparation of the quarter-sheets of the Atlas of India was continued, six new plates having been completed during the year; 50 unpublished plates were in various stages of progress and 93 quarter and 19 full published plates were added to and corrected, whilst 35 new ones were projected. Fourteen district maps for administration reports were completed and 23 others were in hand. The index to the standard sheets of the Bombay Presidency, a new weather chart and two scale plates were completed. Two brass plates, one with an inscription of the standard bench marks of Calcutta and the other for the Great Trigonometrical Office have also been completed. Of the provincial maps on the 16-mile scale that of Mysore and Coorg with hills was

completed, those of Assam, Central India Agency and Mysore (without hills) were in hand for additions and corrections; Bengal, Bombay, Madras and Rájputána are in various stages of progress. The Punjab and Kashmír Map in four sheets has been constantly in hand for corrections and additions; sheet No. 1 has been completed with hills

46. In the Photographic and Lithographic Office the outturn of work is again satisfactory. The departmental work performed shows a considerable increase under almost every head, though there was a slight falling off in the amount of work done for other departments. The number of original subjects of all kinds received and reproduced during the year was 7,880 or 860 in excess of last year, and considerably more than in any previous year. Of these, 1,049 were maps and plans, etc., done for other departments, and 5,634 were cadastral maps. The total value of the work done was slightly less than that of last year, being R2,13,518 against R2,19,779.

Owing to the decrease in the work received from other departments, the amount of work turned out by the lithographic and zincographic machines and presses, as represented by the number of copies turned out, is a little less than last year. The number of pulls was practically the same, being 853,945 against 862,623, and of copies 853,072 against 948,057. As, however, the number of original subjects dealt with was larger, the actual amount of work done cannot be said to have fallen off in any respect, as explained in paragraph 434. The machines, presses and printing establishment were kept fully engaged during the whole year. The type-printing work fell off somewhat, owing to a large supply of professional forms for departmental use having been prepared in advance last year. Under this head 529,664 copies were printed from 10,054 items against 668,795 copies from 11,915 items last year. In the Heliogravure and Silver-printing Sections satisfactory increases are recorded. No less than 72,246 prints were made from 131 photo-etched copper plates, or nearly 16,000 prints more than last year.

The more important publications of the year are referred to in Part III, and full details of the work done in every section are, as usual, given in the Appendix.

The experimental work of the year was chiefly carried on in the Heliogravure Section, where marked progress was made in the preparation of half-tone and line blocks for machine printing. The process known in England as "Enameline" was worked out in every detail and promises to be most useful in the speedy reproduction of half-tone subjects in large numbers. Full details of the process will be found in the Appendix.

Under the orders of the Surveyor General, a scheme for the re-organisation of the office, abolishing progressive salaries and placing the entire establishment, together with the photo-zinco. and type-printing staff of the Trigonometrical Branch Office, in one list for the purposes of promotion, was prepared during the year and submitted to the Surveyor-General immediately after its close.

47. In the Map Record and Issue Office the number of new maps and editions of departmental subjects received during the year amounted to 8,148, of which 7,833 were cadastral maps. The total number of maps issued was 2,07,350 and their value R1,57,927, which show an increase of 6,914 in number and R51,225 in value over those of the previous year. The cash sales of maps amounted to R24,659 which shows an increase of R1,152 over last year's figures.

48. In the Mathematical Instrument Office the total number of instruments issued was 50,727 and their value R2,68,704 against 96,673 and R3,54,890 last year. The number of instruments received into store was 61,558 and their value R2,59,405 against 89,022 and R2,88,055 last year. There has been a decrease both in the number and value of instruments received and issued owing to the demand from railways and other large works being less this year than in the previous one. The number of instruments taken from the repairable stock and rendered serviceable was 20,857 and their value R82,453, against 11,547 and R77,323 last year. This shows an increase of 9,310 in number, and R5,130 in value.

In 1887 the gradual increase in the stock of repairable instruments rendered it necessary to obtain from the Government of India an extra establishment at a

cost of R150 per mensem; this was made permanent in 1890; and again in 1889 a further increase to the establishment at a cost of R120 per mens m was obtained. In 1895 a still further increase in the establishment, costing R220 per mensem, was obtained for the conversion of levels. Since these grants were sanctioned 336 levels and 53 theodolites have been converted and issued and all indents for such instruments have been discontinued. The value of the indents for instruments manufactured in England has been greatly reduced in consequence, having fallen from over £13,000 in 1893-94 to less than £4,000 in 1897-98.

49. In the Trigonometrical Branch Office, Dehra Dún, the second edition of the Hand-book of Instructions for the Topographical Branch alluded to in last year's report has been published and issued. A considerable amount of computations in connection with Captain Deasy's exploration work in Tibet and other work was done. The usual meteorological and solar photographic observations were continued. A great deal of extra work on account of the demand for maps for the frontier expeditions was thrown on the Photozincographic Section. The Drawing Section was also kept fully employed during the year.

Of the eight pupils entertained in the training school in June 1896, six passed the qualifying test on examination in September 1896, and were posted to the field parties in the following month. It is very satisfactory to note from the accounts received from the Executive Officer of No. 11 Party, that the four men, who worked under his orders, were found to promise well, and "the result is," he says, "a decided success and certainly a great saving of expense to Government." Eight more pupils were entertained in November 1896, these underwent a full course of training, were examined in September 1897, and have since been posted to field parties.

It is intended that, in future, officers appointed to the Provincial Service shall be attached to this school to receive a regular course of training prior to their being posted to field parties.

50. The Forest Survey Branch Office at Dehra Dún was engaged as usual during the year upon the final computations of the various field detachments; on the up-keep of the Forest Department map records; on the compilation and drawing of special maps; and on the training of surveyors in field work. Seventy-eight special maps on various scales were prepared, of which 24 have been published, 17 were in press and 37 were in progress; of 4-inch standard sheets 101 were published, 65 were in press and 214 were in hand. Two 1-inch standard sheets were also published. Besides the above a considerable amount of colouring, tracing, mounting and other miscellaneous work for forest and district officers was performed.

ESTABLISHMENT.

51. During the year under report the Department has lost the services of five officers of the Imperial list.

Colonel J. Waterhouse, I.S.C., Assistant Surveyor-General and Superintendent, 1st grade, retired on the 10th June 1897, after having served in the Department for 31 years. On account of his skill in photography, Colonel Waterhouse was selected in 1866 as a suitable officer to superintend and develope the photozincographic process of reproducing maps for the Survey Department. The process was then in its infancy and the great improvements in it are due to this officer's skill and exertions. He introduced the collotype process with great success, but this has since been superseded by the system of etching on copper which is used for reproducing photographs and fine or half-tone drawings for which the photozincographic process would not be suitable. In 1871-72 he was attached to the Indian Eclipse Expedition, and again in 1874-75 he was selected to take photographs of the transit of Venus, whilst in 1875 he was placed in charge of the Eclipse Expedition in the Nicobar islands. His name is well known in England and on the Continent, and he has received many tributes to his success, amongst others, medals from the Photographic Societies of Great Britain and of Vienna; a gold medal was also awarded to the reproductions exhibited by his office at the Calcutta Exhibition of 1884-85. He has written several most useful works on the application of photography to the reproduction of maps and drawings of all kinds. The immense development and the

great success of the various methods of reproducing maps and half-tone subjects now in use, are entirely due to Colonel Waterhouse, and his retirement is a serious loss to the Department.

Colonel M. W. Rogers, R. E, Assistant Surveyor-General and Superintendent, 1st grade, retired on the 4th February 1897, after having served for 31 years. He joined the Department in July 1866. He was principally employed on trigonometrical operations in Dehra Dún, Madras, Bombay and in the Mergui Archipelago. During the Kábul War he served as Survey Officer with the 1st Division of the Quetta Field Force, for which he was mentioned in despatches and was made Brevet Major. From 1882, except for short intervals during which he held charge of the Computing Office at Dehra Dún and the Tidal and Levelling operations, he held the office of the Assistant Surveyor-General in charge of the Correspondence and Mathematical Instrument Offices of the Head-Quarters, Calcutta, which post he filled most ably. He was a talented and energetic officer and the loss of his services is greatly regretted.

Mr. G. H. Cooke, Superintendent, 2nd grade, retired on superannuation on the 12th December 1896. He joined the Junior Division of this Department in December 1866 and was promoted to the Imperial service in September 1872. He served in the Central Provinces, Hazáribágh, with the Lushai Expeditionary Force up to June 1872, in the North-Western Provinces, Central Provinces and Bombay in the capacity of assistant as well as in charge up to 1892. From 1893 he held charge of the forest and cadastral operations in Burma.

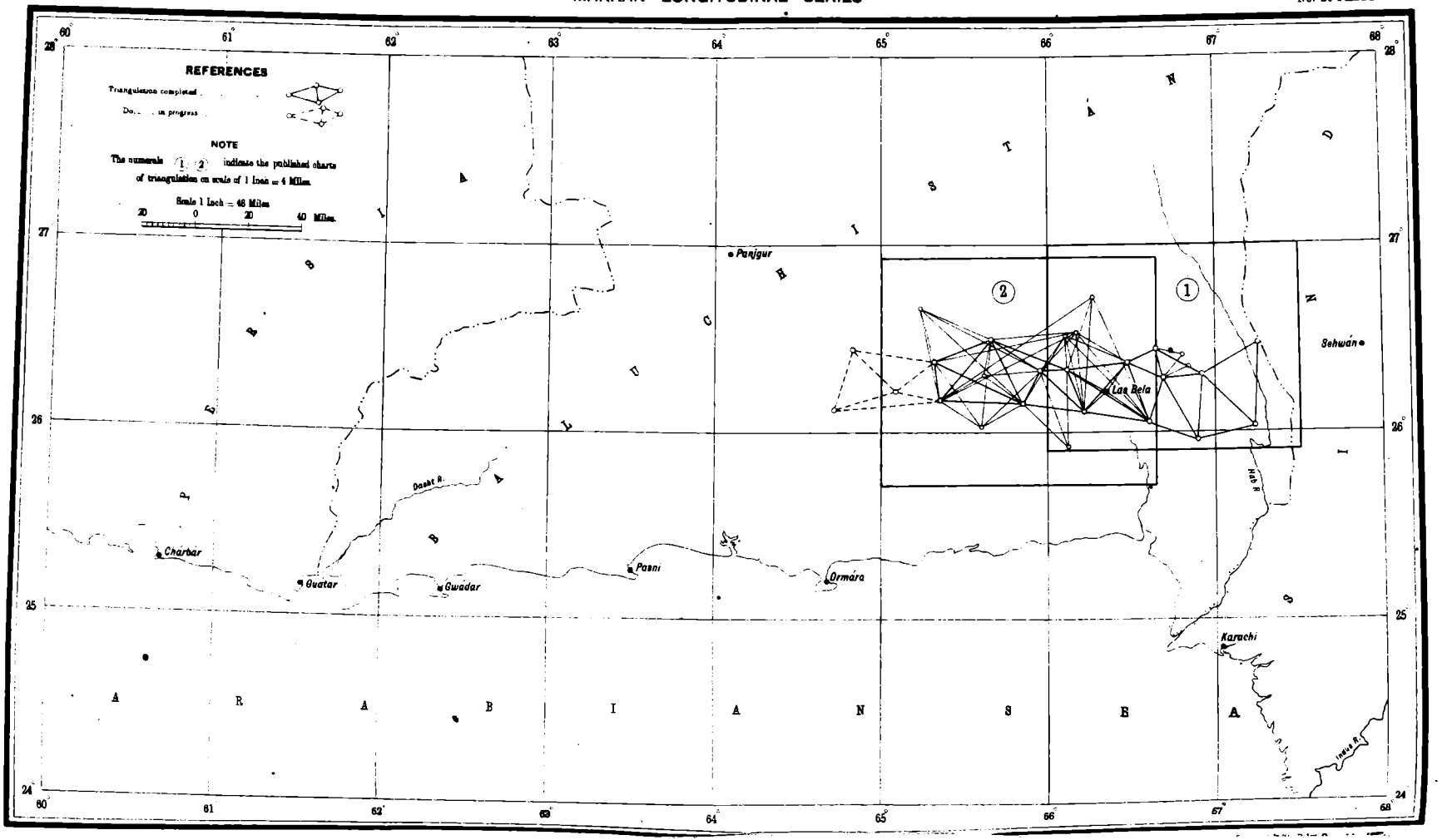
Captain R. J. H. L. Mackenzie, R.E., Deputy Superintendent, 1st grade, reverted to the Imperial Establishment on the 1st January 1897. He joined the Department in March 1888 and was employed throughout on frontier topographical surveys with the Balúchistán Party. He accompanied the Gumal and Zhob Valley Expeditions in 1889-90, served as Survey Officer with the Miranzái and Khajuri Kach Field Force in 1891-92. He was attached to the Domandi Section of the Anglo-Afghán Boundary Commission in 1895, whence he returned ill and was invalided to Europe.

Captain C.C.D. Morice, R.E., Deputy Superintendent, 2nd grade, reverted to the Imperial Establishment on 1st March 1897. He joined the Department in November 1891, and was attached to the Tidal and Levelling Party throughout his service, except for a short period, when he was attached to the Trigonometrical Branch Office. He held charge of the party for about three months in 1893, for six months in 1895, and from December 1895 to December 1896. Captain Morice is a good mathematician and has done excellent work, but his health broke down mainly from over work and he was obliged to give up service in India.

52. In the Provincial list there were four vacancies, *viz.*, two by the retirement of Messrs A. J. Wilson and A. J. Gibson, and two by the deaths of Messrs. W. J. O'Sullivan and P. A. Peters; three appointments were transferred from the Imperial to the Provincial list by which three supernumerary appointments of Extra Assistant Superintendents, 1st grade, were created during the year. Two appointments in the 4th grade of Extra Assistant Superintendents have, however, been kept vacant.

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION OF THE MAKRÁN LONGITUDINAL SERIES

1896-97. NO. 24 PARTY.



PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

PRINCIPAL AND SECONDARY TRIANGULATION.

BALÚCHISTÁN.

No. 24 PARTY.

53. This party under Captain Burn continued the triangulation westwards of the Makrán Longitudinal Series from the most westerly of the completed stations of last season's work.

Personnel.

Captain J. M. Burn, R. E., Officiating Deputy Superintendent, 1st grade, in charge.
Mr. J. Hickie, Extra Assistant Superintendent, 5th grade.
Mr. P. F. Prunty, " " 6th grade.

54. The triangulation was carried across the Las Bela plain, then across the hilly tracts between this plain and the Jháu plain, closing finally on two stations to the west of Jháu, which are at the eastern extremity of the long Kej valley, in all covering a direct line of some 75 miles.

55. The season's outturn is as follows :—

Horizontal and vertical angles have been taken at nine principal stations.

The principal series has been extended over a direct distance of some 75 miles, embracing an area of 1,380 square miles.

Horizontal and vertical angles have been taken at two secondary stations embracing an area of 520 square miles, while in addition an area of some 1,200 square miles has been embraced by secondary triangulation to intersected points. Astronomical observations for azimuth were taken at one station.

56. The principal observations were taken with Troughton and Simm's 12-inch micrometer theodolite No. 1. The method of observing was to measure angles on nine zeros, two faces on each zero, and two swings on each face.

The mean triangular error was 0"44 seconds, ranging from 0"154 seconds to 1"130 seconds.

57. The party left Kurrachee for the field in October, marching with the strong escort of the Political Agent for South-East Balúchistán, who was also on his way to Las Bela. The Political Agent would not allow work to be started for some time after their arrival in Las Bela, owing to the unsettled state of the country, and early in December the whole work of the party was completely stopped by the obstructive tactics of the local inhabitants. Captain Burn after getting a personal interview with considerable difficulty with some of the headmen in the district concerned, managed by tact and persuasion, to arrange that the party should continue to work in peace until the end of the season in April.

58. The health of the party was on the whole good, though the quality of the water at times was very bad and caused a certain amount of dysentery.

59. Statements showing the details of the outturn of the party, and of the differences between the values of the initial elements of certain stations of the old secondary Makrán Series and of the present principal series will be found in the Appendix.

Captain Burn expresses himself perfectly satisfied with the work of all his assistants.

TOPOGRAPHICAL SURVEYS.

UPPER BURMA.

No. 10 Party.

60. Mr. A. J. Gibson, Extra Assistant Superintendent, 1st grade, who had held charge of the party from the 10th July 1896, on which date Captain A. J. Pilcher was granted sick leave, handed over charge to Major F. B. Longe, R.E., on the 15th November 1896, the date on which he had completed the records of the party as far as its previous work in the Bombay Presidency was concerned; he then retired on superannuation pension. Under Major Longe it commenced its new work in Upper Burma. On that officer's being ordered to officiate as Assistant Surveyor-General at the Head-Quarters Office, Calcutta, the direction again devolved on Captain A. J. Pilcher, R.E., who, having rejoined, was attached to the party and assumed charge of it on the 15th April 1897.

Personnel.

Major F. B. Longe, R.E., Superintendent, 2nd grade, in charge from 15th November 1896 to 9th April 1897.
Captain A. J. Pilcher, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 15th April 1897.
Mr. A. J. Gibson, Extra Assistant Superintendent, 1st grade, in charge up to 14th November 1896.
Mr. G. D. Cusson, Extra Assistant Superintendent, 5th grade.
" G. T. Hall, " " " " "
" P. J. Serrao, Sub-Assistant Superintendent, 1st grade.
" J. A. Freeman, " " 2nd "
15 Sub-Surveyors, 4 Apprentices.
1 Writer and 1 Hospital Assistant.

61. The party which had for many years been employed in the Bombay Presidency was this year transferred to Burma with recess quarters at Bangalore. With a view to its services being made the most of, it was temporarily amalgamated, so far as its work was concerned, with No. 21 Party and was occupied in surveying portions of the Northern and Southern Shan States and the Mandalay and Ruby Mines districts. No large defined area was told off to it, but its members were employed on ground considered most suitable to their capacities; but few of the sub-surveyors had ever been employed in such hilly jungly country.

62. The party left recess quarters at Poona about November 9th, arrived in Mandalay on the 20th, and thence the various detachments were sent into the field, work being commenced about the 1st December.

63. The only area specially told off to this party was the unsurveyed portion of sheets Nos. 257, 258, 259 and 260, and for this purpose a detachment of 5 surveyors under Mr. Serrao was formed, to be strengthened later on if necessary. This detachment, notwithstanding the energy displayed by the officer in charge, failed to carry out its programme, and, with the exception of sheet No. 260, the rest of the work had to be abandoned; many of the surveyors fell sick and the work was beyond their capabilities. Some were invalided and the remainder employed on easier ground in the North Shan States.

64. The triangulation of sheets Nos. 257 to 260 was supplemented or completed by Mr. Serrao, while Mr. Hall connected that of No. 21 Party of the previous season with that of No. 11 Party on the southern edge of sheet No. 402. At the same time Captain Pilcher extended and supplemented that in sheet No. 304. The remainder of the party was employed in plane-tabling, Mr. Cusson being in charge of a detachment of surveyors of both Nos. 10 and 21 Parties.

65. The outturn for the season is as follows:—

	Square miles.
Triangulation	2,503
Topography on 1-inch scale (including 236 square miles overlap)	1,961

This, considering the strength of the party, is poor, but allowances must be made for the fact that the men were all quite new to the people and country, and the latter being of a very intricate description and mostly covered with thick forest, more or less staggered the surveyors, who had of late years been accustomed to the undulating and almost treeless tracts of the Bombay Presidency.

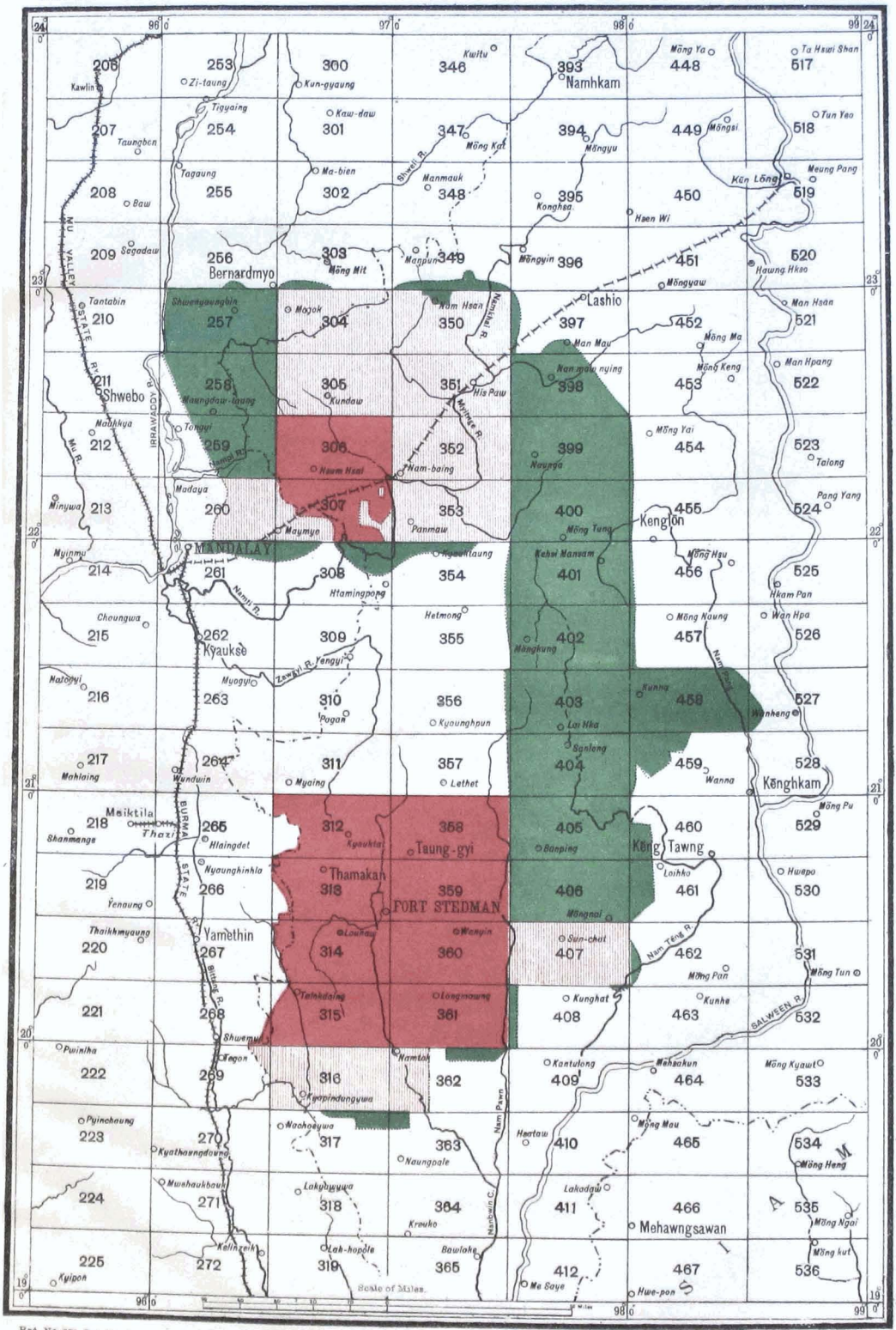
66. The country on the west (sheets Nos. 257 to 260) which was allotted to the surveyors is very hilly, consisting, as it does, of the western slopes of the Ruby Mines hills and of the Shan plateau; this area is all the more difficult on account of the paucity of paths and villages. It is also very feverish in the early part of the cold weather.

The remainder of the country is hilly and mostly forest-clad, but well populated and intersected by paths in all directions.

UPPER BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN UPPER BURMA & SHAN STATES.

1896-97. Nos 10,11 & 21 PARTIES.



Reg. No. 370, S. I. D.—Jan. 98.—650.

Photo. S. I. O., Calcutta.

NOTE.

The numerals 312, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

REFERENCES.

1"=1Mile

Area previously Surveyed.....

.....Surveyed in Season 1896-97.....

.....Triangulated in advance.....

No. 302-S. 98.

The inhabitants are Burmans, Shans and Palaungs, the latter inhabiting almost exclusively the hills north of the Maymyo-Lashio road, the two former remaining for the most part in the valleys and on the Shan plateau, where they cultivate rice, etc., while the Palaungs, especially throughout Tawng Peng, cultivate tea (called Let-hpet) which they export in large quantities, after it has been "pickled": throughout the field season large caravans of oxen were to be seen carrying it to Mandalay to be distributed over the whole of Burma.

67. The health of the party during the field season except in the case of the detachments in sheets Nos. 257 to 259 was good, and much of the sickness in these parts was due to want of care and energy on the part of the surveyors. During recess, however, as has been so frequently noticed by the officer in charge of No. 21 Party, the effects of the climate showed itself, and most members suffered from fever and other complaints.

68. Field operations ceased on the 15th May, and the party left Rangoon for Bangalore on the 21st, the recess office being opened there on June 3rd.

69. During recess the computations have been completed, and the party assisted No. 21 Party in the drawing of sheets Nos. 260, 305, 351, 352 and 353. Sheets Nos. 304 and 350 have also been partially krawn. These sheets have been prepared for reproduction in two colours, which method, it is hoped, will commend itself to tne public, making, as it does, the maps much clearer and easier to read.

70. The total cost of the party for the year was ₹92,317 and the cost rates per square mile are :—

	₹	a.	p.
For triangulation	14	15	0
For topography	31	13	2

71. The programme for next season is as follows : —

The triangulation of the eastern halves of sheets Nos. 261 to 268 and, if possible, of sheets Nos. 255 and 256.

The survey of sheet No. 257 will be completed, and the remainder of the plane-tablers will be employed in sheets Nos. 401 and 402, which are urgently required for the railway authorities; elsewhere they will be combined, as in the season under report, with those of No. 21 Party, there not being at present sufficient triangulation in advance for them all to be employed within the limits of the area specially told off to the party.

72. The recess office was inspected by the Surveyor-General in September who was satisfied with the general state of the party and the progress made, considering that this was its first season in Burma. The Mahrátta Brahmins, of whom there were several in the party, were unable to cope with the difficulties, and they more or less gave in and either shirked their work or took sick leave. Steps are being taken to discharge or transfer these unsuitable men, and replace them by natives of Upper India. This, however, cannot be done in a season, and time must be given to allow of new men being trained at the Dehra school, which is doing good work, but should be largely increased. To do this without some addition to the Great Trigonometrical office building is impossible, but in the present state of the finances, this appears to be out of the question, and efforts will be made to do the best possible without such additional expenditure.*

* Of the European assistants, Messrs. Hall and Serrao are worthy of special mention. The Native assistants did not do well, but it is hoped that during this next field season a marked improvement will be seen.

UPPER BURMA.

No. 11 Party.

73. Again this year Captain Renny-Tailyour, R.E., held charge of this party, the bulk of which continued the 1-inch survey of the Southern Shan States, whilst two detachments were sent, the one under Lieutenant Coldstream, R.E., to survey part of the Chin hills and the other under Surveyor Mahmud Husain to survey the boundaries in Karenni. Lieutenant Coldstream's report will be found in the Appendix.

Personnel.

Captain T. F. B. Renny-Tailyour, R.E., Deputy Superintendent, 1st grade, in charge.
Lieutenant W. M. Coldstream, R.E., Officiating Deputy Superintendent, 2nd grade.
Mr. P. J. W. Doran, Extra Assistant Superintendent, 4th grade.
" W. M. Kelly, " " 5th grade.
" P. White, " " 6th grade.
" H. G. Shaw, Sub-Assistant Superintendent, 1st grade.
" H. H. B. Hanby, " " 2nd grade.

Surveyors and Sub-Surveyors.

Mahmud Husain, J. Sebastian, Ramsabad, Abdul Rahim, Kudratullah, Mowni Ram, Ram Pershad, Ali Husain, and 11 Probationary and Apprentice Sub-Surveyors.

74. The general plan of detail operations on the 1-inch scale was to survey sheets Nos. 316 and 407 and portions of sheets Nos. 362 and 406; owing however to the difficulty of the country in sheet No. 407, it was found impracticable to commence sheet No. 406. Triangulation in advance for next season's plane-tabling was carried on over sheets Nos. 403, 404 and 405.

75. The majority of the party left Bangalore on the 28th October and embarked at Madras for Rangoon on the 29th idem; at Rangoon the men to whom departmental leave had been granted, and the *khalásis* joined the party, and the whole proceeded by rail to Thazi and by road to Fort Stedman, where the field head-quarters was formed. Most of the surveyors started thence to their work on the 25th November.

76. The outturn of work is as follows:—

				Square miles.
Triangulation for the	1-inch	survey	. . . . .	3,220
" "	¼ "	"	. . . . .	2,000
Topography on the	1 "	scale	(including 454 square miles of overlap and riverain survey)	1,649
Geographical survey	¼ "	"	. . . . .	8,170

The area surveyed on the 1-inch scale would have been considerably increased had it not been that four of the best surveyors were otherwise employed, and none of the new hands were able at the commencement of the season to do independent work in such difficult country; at the same time the preliminary training given to those apprentice sub-surveyors, who had gone through a course at the school at Dehra Dún, was found to be a most valuable assistance. This is the first season these trained apprentices have been tried and the experiment so far has proved successful. The results of the expedition into the Chin hills by Lieutenant Coldstream and his three surveyors were an area of 8,170 square miles on the ¼-inch scale, a good outturn considering the difficulties they had to contend with. Lieutenant Coldstream deserves much credit for the success of his work in the Chin hills.

77. The country surveyed in the Shan States is hilly, the ranges and valleys running more or less north and south. The hills as a rule are covered with tree jungle and the valleys, though open in places, are mostly covered with small tree or scrub jungle. A great peculiarity of the country is the number of hollows or devil's cauldrons into which a great deal of the drainage flows and disappears, making its way presumably into the larger rivers flowing at a lower level, though of this there is no outward sign.

78. The health of the party was on the whole excellent. As usual there were cases of fever on the road both going and coming, but the exceptionally dry season was in their favour.

79. The party returned to Fort Stedman during the last week in April 1897, and proceeded to recess quarters at Bangalore where the office was opened on the 25th May. During the recess all the triangulation was computed and the 1-inch mapping brought up to date, with the exception of the hill shading of sheet No. 316 which will be finished in the Calcutta Drawing Office, and of sheet No. 407, a small area in which will have to be resurveyed. The ¼-inch

survey in the Chin hills was incorporated in sheets Nos. 2 N.E., N.W., S.E., S.W., and a special boundary map of part of Karenni was drawn.

The programme for the ensuing season comprises the detail survey of sheets Nos. 403 to 406 and triangulation in advance will be carried on in sheets Nos. 310, 311, 356 and 357.

In addition to the above it is probable that Captain Renny-Tailyour and three surveyors will be detached to accompany the China Boundary Commission.*

UPPER BURMA.

No. 21 PARTY.

80. Major Longe continued to hold charge of this party until the 9th April 1897, when he left the field to take up the duties of Assistant Surveyor-General at the Head-Quarters Office in Calcutta; the direction then devolved on Captain A. J. Pilcher who took over charge from the 15th idem and held it till the end of the year.

Personnel.

Major F. B. Longe, R.E., Superintendent, 2nd grade, in charge up to 9th April.
Captain A. J. Pilcher, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 15th April to close of the year.
Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade, up to 17th June 1897.
„ A. J. James, „ „ „ 3rd „
„ J. M. Kennedy, „ „ „ 6th „ on deputation in Siam up to 28th June 1897.
„ W. F. E. Adams, Sub-Assistant Superintendent, 1st grade.
„ P. R. Anderson, Probationary Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Ikbaludin, Lachman D. Jadow, Ganu Mall, Mahomed Latif, Natha Singh, Budhi Bulram, Jamna Pershad, and ten probationary and apprentice sub-surveyors.

81. The party left recess quarters at Bangalore during the first week of November and proceeded to Nammaw in Hsi Paw State where field head-quarters were established.

82. The operations of the season comprised:—

(1) The continuation of the 1-inch topographical survey of the Shan States.
(2) The 1-inch survey of a small area round Nanyatseik in the neighbourhood of the Jade mines.
(3) The filling in and revision of certain areas in the same district on the $\frac{1}{4}$-inch scale.
(4) One sub-surveyor was told off to accompany the Superintendent, Northern Shan States, on tour along the China frontier.

83. Owing to the fact that No. 10 Party was employed in the same district, the three European assistants of this party had to be employed supplementing and extending the triangulation, working out their computations in the field. Mr. Anderson, who only joined the department in November, was first instructed in and then took up detail survey.

Lachman Jadow and an apprentice were detached to carry out the second and third portions of the programme, while Natha Singh accompanied the Superintendent, Northern Shan States, after having surveyed a small area on the 1-inch scale in Hsi Paw.

84. The areas completed are as follows:—

	Square miles.
Triangulation	2,967
Topography on 1-inch scale (including 277 square miles of overlap)	2,137
„ on $\frac{1}{4}$-inch „	3,548

85. The country surveyed, which included parts of Hsi Paw, Tawng Peng and Lawk Sawk States and of the Mandalay district, was as in previous years intricate and difficult, being very hilly and generally covered with thick jungle and almost impenetrable grass. Hsi Paw town fell within the area, but beyond this, which is of importance as being the residence of the Hsabwa, no town of any note was met with.

*The officer in charge reports that as usual Mr. Doran did his work in a very satisfactory manner, that Messrs. Kelly, White and Shaw have also done well, and that Mr. Hanby promises to turn out a useful assistant. In the subordinate staff the majority have done well, Surveyors Mahmud Husain and J. Sebastian being specially mentioned.

The country surveyed round Nanyatseik was particularly intricate, and the survey was specially undertaken on account of the value of the land as being productive of rubies, and the many disputes consequently arising. The undergrowth in this area was very dense.

86. The total cost of the party for the year was R89,383, and the cost rates per square mile are as follows:—

	R	*a.*	*p.*
Triangulation	10	8	3
Detail survey on the 1-inch scale	21	5	4
„ „ ½-inch „	3	8	9

These rates are lower than in previous years, which is satisfactory.

87. The surveyors were visited and their work was examined in the field by Major Longe and Mr. James of No. 21 Party and also by Mr. Cusson of No. 10 Party and was found on the whole to be good.

88. Field work ceased about May 10th, and the party returned to recess quarters from Rangoon by the steamer of the 23rd idem, the recess office being opened at Bangalore on June 3rd.

89. During the recess the whole of the computations have been completed, and the following standard sheets have been drawn for reproduction in two colours, the hill shading being in brown, *viz.*, standard sheets 305, 351, 352, 353 and half of sheet 260.

90. The programme for next season is as follows:—

Major Longe with a small detachment will accompany the Burma-China boundary delimitation commission.

The detail survey of sheets 398, 399, 400 will be completed, and endeavours will be made to survey sheet 397, while sheets 395, 396 and 397 will be triangulated.

91. Towards the close of the year, the party lost the services of Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade, who after a long and honourable career in the department was superannuated on the 1st September 1897.

92. The recess office was inspected by the Surveyor-General at Bangalore in September, and he expressed his satisfaction with all he saw.*

SIND.

No. 12 PARTY.

93. The operations during the year under report were in continuation of those of the previous season. Captain Hodgson held charge of the party throughout the season.

Personnel.

Captain G. B. Hodgson, I.S.C., Superintendent, 2nd grade, in charge.
Mr. R. C. D. Ewing, Extra Assistant Superintendent, 4th grade.
„ G. G. Vander-Beek, Extra Assistant Superintendent, 5th grade.
„ R. F. Warwick, Extra Assistant Superintendent, 6th grade.
„ J. Smith, Sub-Assistant Superintendent, 1st grade.
„ F. P. Walsh, „ „ 1st grade.
Babu S. C. Sen, „ „ 2nd grade.
Munshi Rahmatulla, „ „ 2nd grade.
Mr. E. C. J. Bond, „ „ 3rd grade.
42 Permanent and temporary Sub-Surveyors, Computers and Draftsmen.

94. The programme which was completed was as follows:—

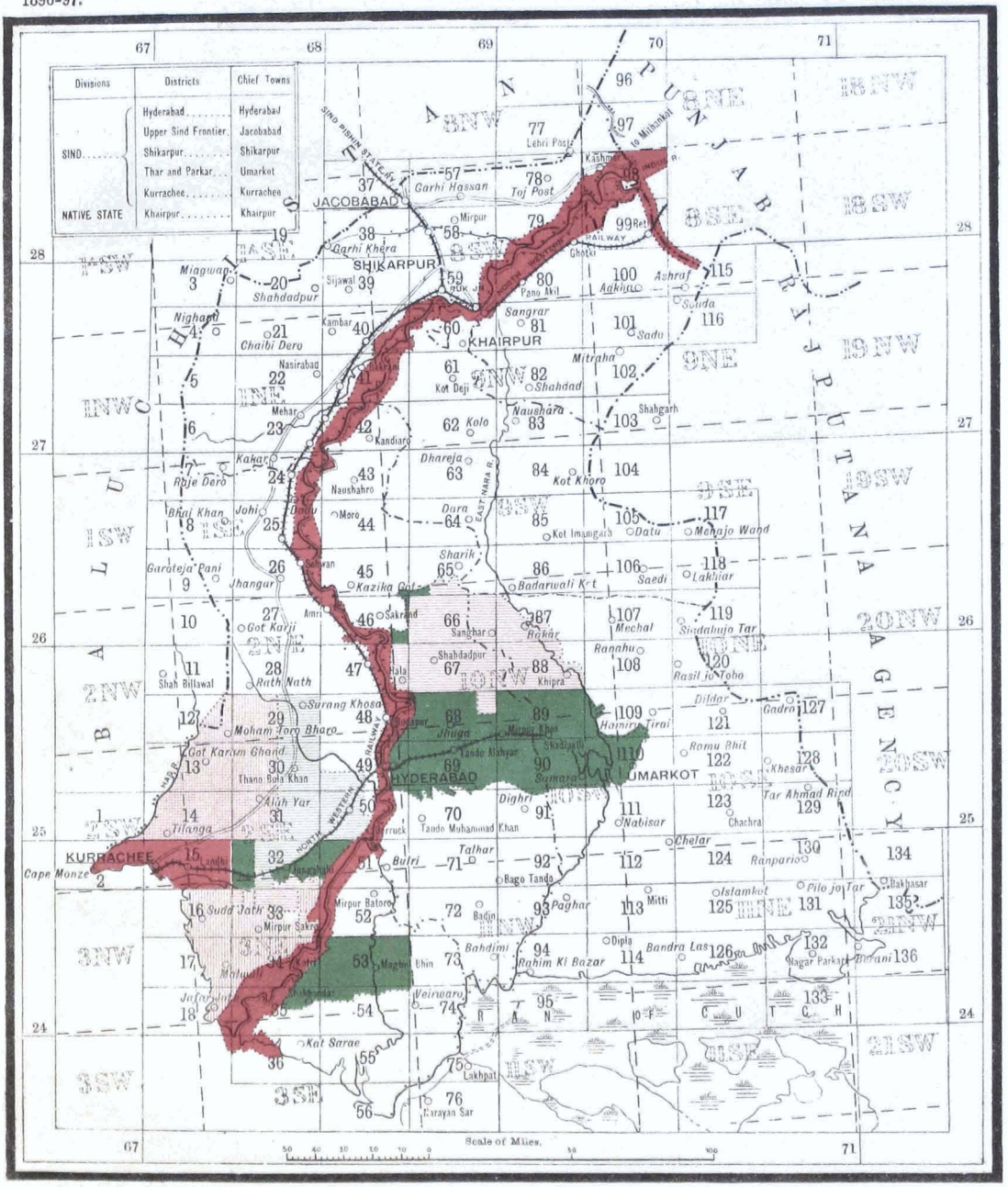
(*a*) Two series of secondary triangulation, each about 90 miles in length as a check on the traversing.

(*b*) The completion of the village boundary traverse survey commenced last season in sheets Nos. 47, 48, 49, 66, 67, 68, 69, 87, 88, 89, 90, 109 and 110 from the Indus river on the west to the desert on the east.

* The officer in charge reports that Mr. James has again proved himself a hard-working and trustworthy assistant, and that Mr. Anderson is a promising assistant. Among the native staff Surveyor Lachman Jadow and Sub-Surveyors Ganu Mall, Natha Sing, Budhi Bulram and Jamna Pershad are deserving of special mention.

SIND SURVEY.

1896-97. No. 12 PARTY.



Reg. No. 300, S. I. D.—Nov. 97.—550.

Photo. S. I. O., Calcutta.

REFERENCES to COLOR.

Surveyed in previous Seasons Scale 1″ = 1 Mile.....

....Do.....do..... 2″ = 1 Mile.....

....Do.....1896-97..... Scale 2″ = 1 Mile.....

Triangulated & Traversed in advance.....

Surveyed on 1″ = 1 Mile by No. 15 Party, 1896-97.....

Triangulated by No. 15 Party.....1896-97.....

No. 454-S. 97.

NOTES.

The numerals **63**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

(*c*) The detail survey on the 2-inch scale of an area between the same limits in sheets Nos. 47, 66, 67, 87 and 88 ; the cultivated portion of sheet No. 32 and the completion of sheet No. 33, of which a little more than half was surveyed the previous season.

95. The recess office at Kurrachee closed on the 20th October 1896, and the party reassembled at Hyderábád on the 25th idem, and each man was on his ground by about the end of the first week of November.

96. As sufficient area was not traversed in advance in the sheets of which the detail survey was to be taken up, a large part of the area surveyed in detail was also traversed this season.

97. The season's triangulation was to serve as a check on the traverse survey and was done by Messrs. Vander-Beek and Smith. The former completed the series he commenced last season, emanating from the side Khánatar H.S.—Thumi S. of the Sehwán secondary series a little to the north-west of Sánghar and closing on the side Rakhrái H.S.—Nága Sha T.S. of the Kurrachee longitudinal series to the south-west of Hyderábád. Throughout its length this series passes across a perfectly flat country with here and there large patches of *tamarisk* jungle and groves of *bábul* trees. In order to extend the view of the surveyor, a trestle 15 feet in height was obtained for this work, but it was never used as the high banks of the numerous canals, formed by the original excavations and the annual clearance of silt, were found to afford sufficiently raised positions for the stations, to observe over short distances. The portion of this series which falls in sheet No. 67 was carried out while the detail survey was in progress; consequently the stations were not utilised by the plane-tablers and do not appear on the maps. They were marked by bricks, one mark on the surface of the ground and another about 2 feet below it. The other series was commenced from Khárora S. and Mánuro S. of the Sehwán secondary series also in the vicinity of Sánghar and closed on Hatodan H.S.—Karúra S. of the Sind meridional series near Umarkot. Very few of the stations were situated on land that will be surveyed at present, as the series was carried along the edge of the desert and the majority of the stations were placed on sand hills. They were marked with bricks also, the lower mark being 3 feet below the surface, but it is doubtful if they will ever be found again owing to the shifting of the sand hills. They have, however, answered their purpose for the present. Lists of the co-ordinates with description of the stations of both these series were sent to the Irrigation Department, so that they might erect marks of a more permanent nature if considered necessary.

98. The traversing consists of a village boundary survey with offsets, and the area traversed is 3,635 square miles, of which 890 square miles have been surveyed in detail, leaving 2,745 traversed in advance. There were $6\frac{3}{4}$ main circuits measured, 29 sub-circuits and 660 villages. The angular work was checked by observations for azimuth at 110 stations on main and sub-circuits, and the average angular error is 3·1 seconds. The linear measurements amounted to 3,477 miles, and were checked by 13 connections with stations of the secondary triangulation executed during the season. The average correction per 1,000 links is 0·9 links. No permanent marks were put down at traverse stations, but the stones used by the Sind Revenue Survey to demarcate the field boundaries were utilised wherever possible, and the positions of all marks on the village boundaries have been fixed by offsets.

99. The cost of the traverse survey is Rs. 33,040, giving a cost rate of Rs. 9·1 per square mile. This is nearly half the cost of the same work done during the previous season, which is mainly due to the fact that last season was the first of the survey, and all the expenses of the transfer from Upper Burma fell into it. The average size of the villages is 5·5 square miles.

100. In addition to the boundary survey, 128 bench-marks of the Irrigation Department—chiefly on embankments and canal banks—and 15 of the Kotri-Rohri branch of the North-Western Railway were connected with the traversing, involving additional observations at 864 stations, and 204·5 linear miles of chain measurements. The cost is included in the figures given above.

101. The area surveyed in detail on the 2-inch scale amounts to 2,244 square miles and was mapped on 52 plane-table sections. It comprises portions of sheets Nos. 32, 33, 47, 65, 68, 87 and 88 and the whole of Nos. 66 and

67. In sheets Nos. 87 and 88, the survey has been carried to the edge of the desert. Sheet No. 47 has been surveyed up to the work of the Indus Riverain survey of a few years back. The remainder of the sheet will be surveyed on the 1-inch scale by No. 15 Party. In sheet No. 32 the cultivated portion only has been surveyed, and the remainder of this sheet also will be surveyed by No. 15 Party on the 1-inch scale. Only a small portion of sheet No. 65 was surveyed to include the head works of the Jamrao Canal at present under construction. The rest of the sheet will not be surveyed for 3 or 4 years to come. Sheet No. 33 was partially surveyed by this party last season and partially by the Indus Riverain survey previously. It has now been completed. The detail survey was carried out almost entirely by interpolation and was based mainly on the traversing. It was tested from 1,072 *in situ* fixings in addition to 33·7 linear miles of check lines, and was done under the direct supervision of the officer in charge and 3 assistants, of whom two were employed on plane-tabling as well.

102. The cost of the 2-inch detail survey is Rs. 14·2 per square mile. This is considerably less than the same work cost last season as was anticipated, *vide* paragraph 95 of last year's report.

103. The character of the country topographically surveyed varied considerably and a good deal of it was somewhat intricate, though, with the exception of a few sand hills here and there, the whole of it was absolutely flat. To the east along the banks of the Nára river it was largely covered with scrub jungle and sparsely populated. To the west of this, in the tract watered by the Mithrao canal the land was well populated, highly cultivated, and contained a great deal of timber, while further west again, it was mostly of a dry sandy nature and very bare and open, though fairly well populated. This was the character of the greater part of sheets Nos. 66 and 67, though in some places the canals were thickly lined with *bábul* trees. In sheet No. 47 the country was more thickly populated and contained many large villages, with huge clumps of *bábul* trees which also lined the canal banks as a rule. The weather was very favourable for survey operations throughout the field season. There was a remarkable absence of wind and dust which were such prominent features in the weather of the previous season. There was little or no sickness at all.

104. Field work closed about the middle of April and, on account of the plague which was then raging at Kurrachee, the party proceeded to Mussooree for the recess. During recess the fair mapping was completed of almost the entire area surveyed in detail. The portion not fair drawn lay in sheets Nos. 65 and 68, in both of which only a small area was surveyed. It is not proposed to draw sheet No. 65 until the survey of the sheet is completed. If required by the Irrigation Department, a trace of the field sheets will be furnished. Sheet No. 68 will be drawn next season when the survey will be completed. The mapping was comprised in 28 quarter sheets, of which 5 were blank. They were drawn on the 2-inch scale for reduction by photography to one-half and have all been despatched to the Trigonometrical Branch Office at Dehra Dún for publication. Sheet No. 32 has been drawn as far as surveyed. The remainder of the sheet will be mapped by No. 15 Party. Sheet No. 33 contains a small area that was surveyed on the 1-inch scale in the course of the Indus Riverain survey, and this will be incorporated with the work of the present survey in the Dehra Office. Sheets Nos. 66 and 67 were mapped in full, but in sheet No. 47 again, some 1-inch work of the Indus Riverain survey has to be incorporated and the western half will be mapped by No. 15 Party. Sheets Nos. 87 and 88 have been mapped as far as they are to be surveyed at present and will be published.

105. The fair maps of the previous season, which had been detained, pending instructions from the local authorities regarding doubtful *gote* names, were completed this season and despatched to the Great Trigonometrical office at Dehra. The names of *gotes* or hamlets which differed from those given in the settlement maps, or did not appear in them at all, were again submitted to the District Officers, who notified the correct names and whether they were temporary or permanent. All those said to be temporary were omitted from the fair maps.

106. The village boundaries were also roughly compared with the settlement maps and in the cultivated parts they generally agreed sufficiently well to make it clear that the correct boundary had been followed by the traverse surveyor, but in jungle lands away from habitations, the marks were often not

to be found and no one could point out the boundary correctly. In such cases the boundary on the fair maps has been taken from the settlement map.

107. The triangulation and traverse charts of sheets Nos. 47, 48, 66, 67, 68, 87, 88, 89, 108 and 109 have been drawn, and a general report in two volumes has been compiled for each of the two series of triangulation. The charts of sheets Nos. 15, 16, 17, 32, 33 and 35 comprising the whole of last season's triangulation and traversing have also been completed, and one general report in two volumes has been compiled for all these sheets. All the charts with lists of co-ordinates and village or *deh* names have been despatched to Dehra, but none of the general reports have yet been submitted as the binding was not quite completed. The charts of sheets Nos. 65, 69, 90, 109 and 110 have not yet been prepared. In sheet No. 65 only a small area was triangulated and in the other sheets small areas still remain to be traversed.

108. The survey of the Layári quarter of Kurrachee on the scale of 80 feet to the inch which was commenced last recess season was completed this season shortly after the party took the field. The area is 899 acres and the survey is based on a theodolite traverse survey by which the area was divided into 40 blocks. The traversing is connected with two G. T. stations of the Great Indus series. The chaining amounted to 18·7 linear miles and the theodolite was set up at 331 stations. The detail survey was carried out by blocks on 30 plane-table sections and not in rectangular sheets, and was tested by 51,088 feet of check lines run by Captain Hodgson and Mr. Smith. The boundaries of holdings were defined and a record made of the tenants or occupiers. The fair maps have been drawn in 18 rectangular sheets and have been despatched to Dehra for reproduction by photozincography. Printed copies will be supplied to the Municipality. The boundaries of the holdings have not been marked off on the fair maps; they will be defined by a ribbon of colour on the printed copies. The fair copy of the record is almost completed. The cost of this survey, to which no share of general charges has been added, amounts to Rs. 3,951, which is divided into the following items:—

	Rs.
(*a*) Traverse and detail survey, including the record . .	1,456
(*b*) Mapping and fair copy of the record	2,495
TOTAL .	3,951

The cost rate of the whole survey, including fair mapping and a fair copy of the record, is Rs. 4·4 per acre and of the field work alone is Rs. 1·6 per acre. There will be a further small expenditure in colouring up, on the printed maps, the boundaries of the holdings or numbers and in completing the record.

The original estimate amounted to Rs. 1,069 but did not include the record nor any charges for supervision, and no charges for the latter item have been added for the field work, which was supervised by Mr. Smith in addition to his other duties, but as the whole of his time was taken up in looking after the fair mapping during the recess, the charge has been added for that period.

109. Next season no triangulation will be done, as the area to be traversed is crossed by the Kurrachee Longitudinal Series of the Great Trigonometrical survey, which will provide a sufficient check on the traversing. The sheets that will be traversed are Nos. 50 and 51 (to the east of the Indus and in continuation of the work of the Indus Riverain survey); the whole of Nos. 70, 71, and 91 and portions of Nos. 92 and 111 up to the edge of the desert—the whole amounting to 2,700 square miles approximately. About 2,800 square miles will be surveyed in detail on the 2-inch scale, covering slightly more than the area already traversed in advance in sheets Nos. 48, 49, 68, 69, 89, 90, 109 and 110.

In addition to the ordinary programme, an area of about 1,500 square miles of the lands watered by the Desert canal in Kalát territory adjoining the Shikárpur district will be prepared for detail survey and about 600 square miles surveyed on the 2-inch scale in connection with a contour survey to be carried out by the Irrigation Department.*

* Of his assistants Captain Hodgson reports that Mr. Ewing is an excellent Head Assistant, and that all the others have worked well this season. Of the Subordinate Establishment he particularly mentions Sub-Surveyors Mukund Dinkar, Irfán Ali, Maksúd Ali, Muhammad Akbar, Muhammad Azam, Khair Uddin, Ishar Singh, Abdul Aziz, Il, Lál Bihári Lál, and Ghulám Husen; Computers Narsu Dinkar and Laxman Daji, and Draftsman Makbúl Husen. Sub-Surveyor Maula Bakhsh was on deputation to the settlement office at Dera Gházi Khán throughout the field season and did good service during the recess.

BALUCHISTAN.

No. 15 Party.

110. The following changes occurred in the superintendence of this party during the year. From the 1st October to the 1st November 1896 Mr. Claudius continued in charge. From the 2nd November to the 2nd of April Captain H. A. D. Fraser, R.E., held charge. Finally, from the 3rd April Colonel Sir T. H. Holdich resumed charge.

Personnel.

Colonel Sir T. H. Holdich, K.C.I.E., C. B., R.E., Superintendent, 1st grade.
Captain H. A. D. Fraser, R.E., Deputy Superintendent, 2nd grade.
Lieut. F. W. Pirrie, I.S.C., Officiating Deputy Superintendent, 2nd grade.
Mr. T. E. M. Claudius, Extra Assistant Superintendent, 1st grade.
Mr. E. A. Wainright, " " 4th grade.
Mr. G. A. Knight, " " 6th grade.
Mr. G. P. Tate, " " 6th grade.
Yusuf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 1st grade.
Hira Singh, Rai Bahadur, " "
1st grade.
Imam Sharif, Khan Bahadur, " "
2nd grade.
Mr. H. C. H. Cooper, " "
3rd grade.
Ahmed Ali Khan Bahadur, " "
3rd grade.

Surveyors and Sub-Surveyors.

Hussain Bux, Khan Sahib.
Sheik Mohiudin, Khan Bahadur.
Asgar Ali Beg, Khan Bahadur.
Jafar Ali.
Gopal Singh, Rai Bahadur, and 20 others.

111. During the field season the head-quarters of the party under Captain Fraser were located at Mooltan. The traverse work for the 2-inch survey was started early in November and this, with all the plane-tabling comprising 932 square miles, was completed by the end of March of the following year.

Lieutenant Pirrie undertook the triangulation for 1-inch survey in Sind and also superintended and checked the topography of his squad; Lieutenant Pirrie with a squad of 5 native surveyors was ordered to join the Tochi Field Force in June.

Mr. Tate with the assistance of surveyor Khan Bahadur Asgar Ali Beg was left at Quetta during the winter months to complete the fair drawing of all the work done during the demarcation of the Balúch-Afghán Boundary Commission.

The services of Khan Bahadur Imam Sharif were asked for by the Government of Zanzibar for the survey of that island. He accordingly left India for this duty on the 5th March 1897.

112. The total outturn of the party is as follows:—

	Square miles.
Triangulation for 1 inch survey	1,620
Ditto 6-inch do.	260
Ditto 12-inch do.	60
TOTAL	1,940

	Linear miles.
Traversing for 16-inch survey	802
Ditto 2-inch do.	735
TOTAL	1,537

	Square miles.
Topographical survey 1-inch	1,825
Ditto do. 2-inch	912
Ditto do. 6-inch	21
Ditto do. 12-inch	56
TOTAL	2,814

PUNJAB SURVEY

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS

75° 76° 77° 78° 79°

33° 32° 31° 30°

64NW. 64SW. 65 66NW. 66SW.

Akhnur · JUMMOO · Chinani Tavi R. · Bhadrawar · Chenab or Chandra Bhaga R. · Bauch · Kyonon · Yoghma · Haule · Haule R. · INDUS R.

JUMMOO · Padua · 245 · 29 · Basauli · DALHOUSIE · CHAMBA · Miyar · 282 · Triloknáth · 283 · Barmaur · 284 · Ravi R. · Bhaga R. · Bára Lácha Pass · 304 · 305 · 326 · 327 · 341 · Two Moreri Lake · 342 · Tíkling La · Párang La · 343 · Kanzam Pass · 328 · 306 · Khoksar · Hámta Pass · 329 · 344 · Dankar · 349 · Karak · 350 · Kuri · Spiti R. · Parechu R. · Chandra R. · Taee · 307 · 330 · Pin Párbati Pass · 345 · Mánrang Pass · 351 · Shipki · Dabling · Sutlej R. · Morang · 352 · Sarhán · Chini · 331 · 346 · Rámpur · 332 · 347 · Sangla · Alingdar · 353 · Baspa R. · KOTGARH · Pabar R. · Rupin R. · Raiengarh · 333 · 348 · 354 · Nilang · Tons R. · Kidarkanta · Pinali · Chipal · 334 · Jumna R. · Chakráta · Bhagirathi R. · Bhelong R.

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REFERENCES.

	8″=1 Mile	4″=1 Mile	1″=1 Mile
Surveyed during previous Seasons			
Do. 1896-97			
Area Triangulated in advance			
Do. 1896-97			
Simla-Kalka Road Survey, published on Scale 6 Inches = 1 Mile			
Approximate limit of Hill tracts			

NOTES.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

The numerals 246, &c., indicate the Standard sheets.

Scale of Miles

10 5 0 10 20 30 40 Miles

Engr. No. D. 198, S. T. D.—Aug. 97—550

Photozincographed at the Office of the Trigonometrical Branch, Survey of I

No. 13

113. During the recess all the computations in connection with the season's triangulation and traverse work have been revised and completed. Four General Reports with their respective fair charts were near completion, but had to be left unfinished on account of a number of assistants being called away for the Tochi and other frontier expeditions.

The head-quarters will be located at Quetta during winter and a drawing section kept up.*

HIMALAYAS, PUNJAB.

No. 18 Party.

114. Mr. C. D. Potter was in charge of this Party at the commencement of the year under report, but was relieved by Captain C. L. Robertson, R.E., on the 12th November 1896, who remained in charge till 5th August 1897, when he was ordered to join the Malakand Field Force. Mr. C. D Potter again held charge until the 20th August, when he was relieved by Mr. L. J. Pocock, who held it till the end of the year.

Personnel.

Captain C. L. Robertson, R. E., Officiating Deputy Superintendent, 2nd grade, in charge from 12th November 1895 up to 5th August 1897.
Mr. L. J. Pocock, Extra Assistant Superintendent, 1st grade, in charge from 20th August 1897.
„ C. D. Potter, Extra Assistant Superintendent, 4th grade, in charge from 1st October to 11th November 1896, and from 6th up to 19th August 1897.
„ W. Robe t, Extra Assistant Superintendent, 5th grade.
„ W. A. Fielding, „ „ „ 6th „
„ W. M. Gorman, Sub-Assistant Superintendent, 2nd grade.
„ E. J. Biggie, „ „ 3rd „
„ C. E. C. French, „ „ 3rd „

Surveyors and Sub-Surveyors.

Shah Nasiruddin, Ram Saran, Asmatullah Khan, Dalbir Rai, Amir Singh and 27 others.

115. The work of the party, as in former years, comprised the topography of British tracts on the 4-inch scale; of the Native States on the 2-inch scale; and of all demarcated forests, wherever situated, on the 4-inch scale.

116. The localities that were under survey were :—

(i) The Kángra district and Kúlu sub-division of that district, on the 4-inch scale.
(ii) The Native States of Mandi, Suket, Sirmúr and Simla Hill States, on the 2-inch scale.
(iii) Special surveys of the forests of the Patiála and Sirmúr Native States and revision of a portion in Kalsia State, on the 4-inch scale.
(iv) Triangulation in advance of topography in the Kángra district, and in Bilaspur of the Simla Hill States.
(v) The classification of forest growth and soils *pari passu* with the topography in British tracts, and special forest surveys.
(vi) The large scale survey, 48-inches = 1 mile, of the town of Náhan in Sirmúr, carried out at the special request and cost of the Sirmúr State.

117. All, except the last, of the above operations were in continuation of the previous season's work. The system of classification of forest growth and soils was continued in Kúlu, Patiála, Sirmúr and in Kángra, and local officers, as before, are supplied with ferrotyped reproductions of the field work, in advance of the publication of the 4-inch sheets. Arrangements have now been made by Captain Robertson, in consultation with the Superintendent, Trigonometrical Surveys, for the preparation of these traces of classification once for all in the field, for reproduction, with a view to avoiding in future the necessity of redrawing them on return to recess. This will save a deal of labour and enable copies to be issued much earlier than formerly. This is of considerable importance to Forest Officers who use these traces to help them in their "working plans."

118. The party was divided into four sections or detachments, the head-quarters being in charge of the Executive Officer, and the other three in charge

* The Officer in charge reports that all the members of the party, both European and native, have worked with energy and good-will both in the field and recess.

of Messrs. C. D. Potter, W. Robert, and W. A. Fielding, who supervised squads of 6, 8 and 6 sub-surveyors respectively. These detachments left recess quarters at various dates between the end of August and about the beginning of November, returning to recess quarters during the period between the end of March and the beginning of May.

119. The outturn of the field season's work was as follows :—

(*a*) Triangulation in Kángra 202 square miles.

(*b*) Detailed survey on the 4-inch scale :—

	Square miles.
Kángra	181·0
Kúlu	152·0
Sirmúr	111·9
Patiála	0·3
Kalsia (revision)	1·0
	446·2

(*c*) Detailed survey on the 2-inch scale : —

Mandi, Suket and Simla Hill States	306·7
Sirmúr State	57·0
	363·7

The surveys of the following forest blocks are included in the areas on the 4-inch scale shown above :—

Localities.	No. of blocks.	Area in square miles.
In Sirmúr, Patiála and Kalsia	39	112·0
„ Kúlu	28	55·3
„ Kángra	13	23·6
TOTAL	80	190·9

120. The detail survey was tested by the Executive Officer and assistants who constantly visited some one or other of the squads. This embraced the examination of 55 plane-table sections on 134 different occasions. No serious errors were detected, and the work as a rule showed a steady improvement.

121. The triangulation of the season was based on sides of the North-West Himálaya series, Great Trigonometrical Survey, and was carried on in district Kángra and in the Native State of Bilaspur. Some additional work was carried on over an area previously reported as triangulated, in which supplementary points were necessary for the 4-inch detail survey. The numerical results prove that the observations have been skilfully carried out, and that care has been bestowed on the work.

122. The cost rates per square mile of the various operations are as follows :—

	₹
Triangulation	29·7
Average of all detail survey, 4-inch	93·3
„ „ „ 2-inch	48·7

The cost of triangulation is in excess of that of the previous season, as it includes the computation of areas and preparation of triangulation charts; also because the ground was prepared for survey on the 4-inch and 2-inch scales, which require more points than for a 1-inch survey, for which scale no triangulation was prepared during the season under report.

The cost of the 4-inch detail work, which is also to be reckoned as the cost of the 4-inch forest surveys, is ₹93·3 per square mile; this is somewhat higher this year; the cost of the 2-inch work is ₹48·7 per square mile, which is somewhat less than last year. These items have a tendency to fluctuate year by year, the cost being based on calculations which include several factors, which keep varying from time to time; such as cost of instruments, style of ground,

pay of superintendence and surveyors, all of which being taken into consideration, account for the changes.

123. The completion of instruction of Native Soldier Surveyor students from the Thomason Civil Engineering College for a further two years course in surveying forms one of the duties of this party. One man completed his course in September and has gone with Major W. J. Bythell, R. E., on frontier survey duty. The second man who has been only one year under instruction will remain a year longer. In lieu of the man gone to the frontier a Naik of the 44th Gurkhas has joined the party for further instruction. These men are reported to have shown aptitude for the work and have learnt to use the plane-table and clinometer.

124. With reference to paragraph 125 of last year's report, wherein it is stated that this party rendered professional aid to the Simla Municipality during the recess months in revision surveys, for the bringing up of maps to date, the President has conveyed his best thanks for the excellent manner in which the revised map of Simla has been prepared.

125. The country surveyed in Sirmúr on the 4-inch scale is mostly ground rising to a height of 5,000 feet with bold features, covered with forest except where there are habitations and cultivation. All this admitted of survey by interpolation and so progress was quick. Besides this there were about 30 miles of ground surveyed which fell in low Siwálik hills, covered with miscellaneous forests. The whole of the ground was divided into forest compartments, the surveying of which took up considerable time.

The 2-inch work done in this state is mostly on the watershed of the Giri and Tons rivers, between 2,000 and 7,000 feet above sea level, most of which is under cultivation.

126. The large scale survey of the town of Náhan was also commenced, the necessary theodolite traverses have all been completed and set up, and some of the detail work on the scale of 48 inches to the mile done.

127. In Kúlu proper, the work lay in the Upper Beas valley right up the head waters of that river and included peaks up to 20,000 feet high. In this valley the scenery is exceedingly grand. In one part the river pierces a line of cliffs 400 feet high and only a few feet apart, races down with a deafening roar for three-quarters of a mile, emerging into a gentle fordable stream before uniting with the tumultuous waters of the Beas Kand. The natural limit of forest growth in this country is 12,000 feet high. In this season's work there are 29 glaciers; the largest is two miles in breadth at an altitude of 17,000 feet.

128. The 2-inch work in the Native States of Mandi, Suket, also of Bágha1 and Kahlúr of the Simla Hill States, was commenced about the end of November. This country lies between the Sutlej river and hills rising up to 11,000 feet. The hills are well-wooded and the valleys cultivated and inhabited throughout. The features in this ground are, as a rule, intricate.

129. In Kángra some of the work in the lower hills at the foot of the Himálayas, including the Beas valley, gave a good deal of trouble owing to the difficulty of getting plane-table fixings by interpolation, the chain having to be freely used, which considerably retarded progress of work. The ground as a rule consisted of low, flat hills covered with forest, with cultivation here and there in the valleys, the streams through which flow between precipitous ravines that necessitate long journeys when getting from one place to another. The intricate nature of the ground combined with much undergrowth added considerably to the labour of the surveyor.

130. The proposed programme for this party for season 1897-98 consists of the continuation of 4-inch topography in Kúlu and Kángra; a small detachment will be employed on 1-inch work in the high ground in Kúlu in anticipation of the survey of Láhul. Topography on the 2-inch scale will also be carried on in Suket, the Simla Hill States and in Sirmúr; the State forests in the latter State will be surveyed on the 4-inch scale as heretofore. The Punjab Government have asked for a special survey of part of the Ghaggar river; the scale and the area are still under discussion. The survey of the town of Náhan on the 48-inch scale will be continued. The above programme has been submitted to the Punjab Government and may be liable to alteration.

131. It may be added that steady progress has been made with the drawing of the fair maps and forwarding of them for publication. Up to date 11 sheets

of the Sirmúr and Patiála work and 3 sheets of Kángra have been sent during the year, and six others are approaching completion.

132. The season's work shows a good outturn and compares favourably with that of previous season.

133. The Executive Officer cordially acknowledges the help received from His Highness of Sirmúr and all District and Forest Officers during the course of the operation.

134. The recess office of the party was inspected by the Surveyor-General in July and by the Superintendent, Trigonometrical Surveys, during 8th June and the following days. Both these officers expressed their appreciation of the efficient state in which they found the party.*

FOREST SURVEYS.

CENTRAL PROVINCES.

No. 14 Party.

135. The party remained under the charge of Mr. C. F. Erskine throughout the year. It took the field at Sihorá, district Jubbulpore, on 1st December 1896, and survey operations were generally commenced in the second week of December. By the beginning of April 1897 the field work in district Damoh was practically finished, but the sections working in districts Biláspur and Sambalpur remained out till the end of April to complete the work required to be done there.

Personnel.

Mr. C. F. Erskine, Offg. Deputy Superintendent, 1st grade, in charge.
„ J. Keating, Extra Assistant Superintendent, 6th grade.
„ R. Waller—Senior „ „ 6th „
„ B. R. Hughes, Sub-Assistant Superintendent, 1st „
„ J. O. Greiff, „ „ „ 2nd „
„ M. C. Peters, „ „ „ 2nd „

Surveyors and Sub-Surveyors, etc.

Muhammmad Zakaria, Gurdutt Singh, Karimdad Khan, Ram Singh and 44 others.

136. The season's work consisted of the following:—

(*a*) Completion of detail survey on the scale of 4 inches=1 mile in the Government forests of district Damoh and commencement of this work in the Lormi reserve of district Biláspur.

(*b*) Triangulation in advance of topography in districts Biláspur and Sambalpur.

(*c*) Traversing with theodolite of forest boundaries and fire lines in districts Damoh, Biláspur and Sambalpur.

(*d*) Classification of forest growth and soil of all the area surveyed in detail in districts Damoh and Biláspur.

137. The total area of ground topographically surveyed during the season is 622·7 square miles in district Damoh and 73·9 square miles in district Biláspur, making a total of 696·6 square miles. All the forest survey work in district Damoh has now been completed; but in district Biláspur the detail survey was only commenced this year, and much remains to be done, which, however, has been handed over to the Forest Survey Branch for completion. The work was rigorously tested by the European assistants by 412 linear miles of check lines and by *in situ* fixings, and was generally found to have been carefully and accurately surveyed. The Executive Officer also inspected and tested the work of nearly all the plane-tablers in district Damoh. The outturn of this year's topography exceeds that for last year by 46 square miles. The reason of this excess is that the ground in district Damoh was very easy for survey operations, and bore no resemblance to the difficult and

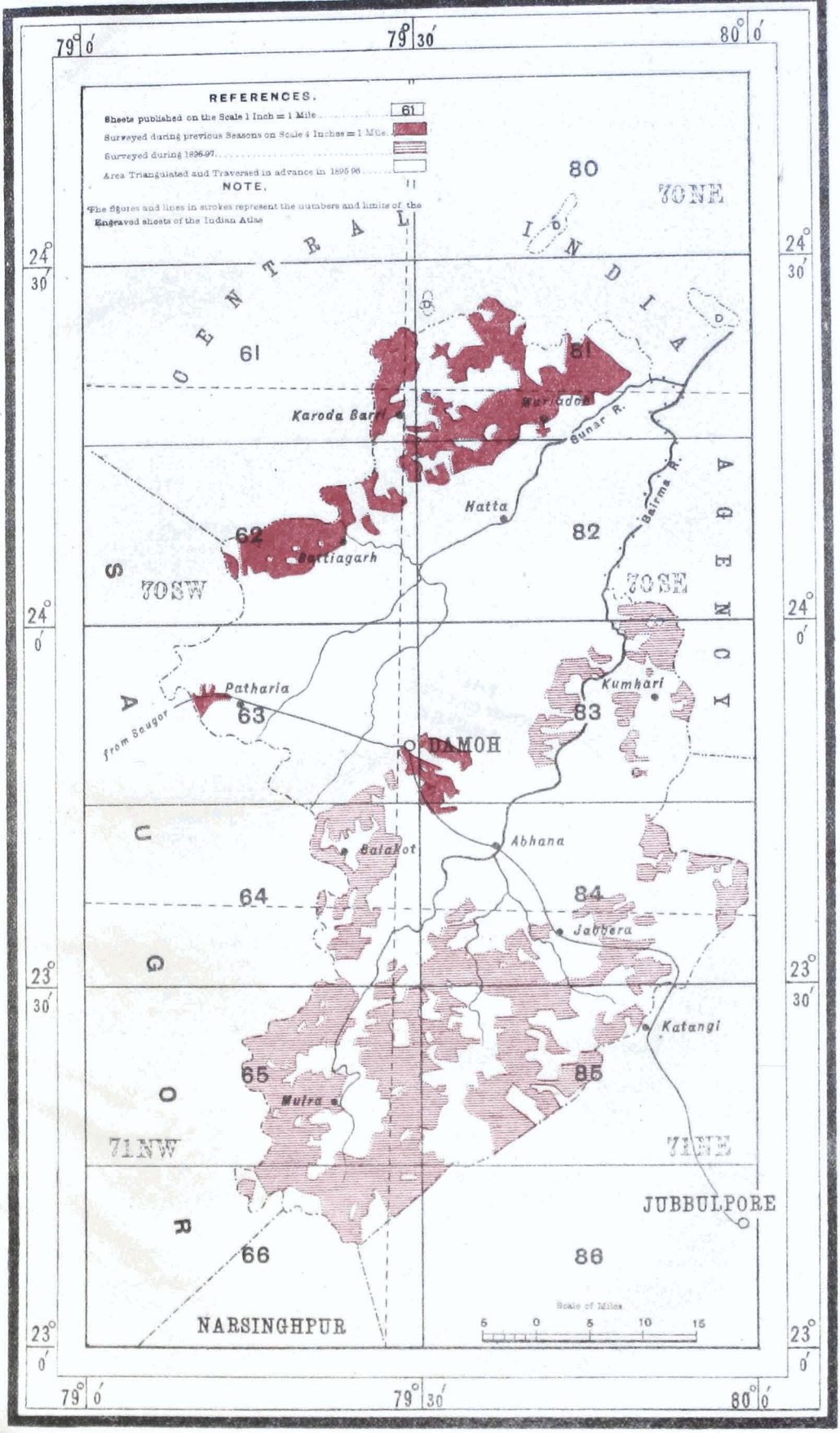
* Mr. L. J. Pocock, who was in charge of the party at the close of the year under report, speaks highly of the services of Messrs. Potter, Robert, and Fielding, who, as heads of their detachments, supervised their establishments most efficiently. Mr. Potter's duties being at times arduous, as besides supervising his detachment, he held executive charge of the party for two short periods. Messrs. Gorman, Biggie, and French have also done well.

Of the subordinate establishment the following are specially mentioned:—

Shah Nasiruddin, Asmatullah Khan, Ram Saran, Garjman Rai, Dalbir Rai, Ram Singh, Nara'e Dutt, and Amir Singh.

CENTRAL PROVINCES SURVEY.

1896-97. **INDEX TO THE FOREST SURVEY IN DIST. DAMOH.** No. 14 PARTY.



Rev. N. D. 199, S. I. D. - Oct. 97 - 550

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, October 1897.

No. 162 — S. 97.

1896-97.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEYS IN DISTRICT BILASPUR.

No. 14 PARTY

REFERENCES.

Sheets published on 1" Scale shown thus 178

Surveyed during 1896-97 .....

Area remaining to be surveyed .....

Area Triangulated and Traversed in advance in 1895-96-97 .....

SYMBOLS.

Province or State Boundary .....

District do. .....

Railway Line .....

NOTES.

The numerals 136 &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Atlas of India.

81° 0′ 81° 30′ 82° 0′ 82° 30′ 83° 0′

23° 0′ 22° 30′ 22° 0′ 21° 30′

C. I. AGENCY

CHOTA NAGPORE

MANDLA

BHATGARH

BALAGHAT

RAIPUR

BILASPUR

177 198 90 NE. Lohari

178 199 Amlibahara 217

Bengal Nagpur Railway

Pendra

Mahatin

157 Amarkantak 179 200 Kenda 218 Uprora 233

90 SW. 158 Taregaon Surhi 180 Lurmi Tartuma 201 90 SE. Ratanpur Arpa River Hasdo River Churi 219 Korba Basin 106 SW. 234

Pandaria Bija Sendri Baluda 220 235

136 Boria 159 Setganga 181 Takatpur Mungeli Mania River 202 BILASPUR Bengal Nagpur Railway

Kawarda

Baraduar

Rengakhar 137 160 Agri Navagarh 182 Maro Sargaon 203 Malhar 91 NE. Noagar 221 236

91 NW. BEONATH RIVER 106 NW.

Jondhra Seorinarayan MAHANADI RIVER

from Raipur Dawanbor 183 204 Bilaigarh 222 237

Bengal Nagpur Railway

Sonakan to Sambalpur

205 223

Scale of Miles

10 5 0 10 20 30

Published under the direction of Major-General C. Strahan, R.E., Surveyor General of India.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, July 1897.

Engr. No. D. 188, S. I. D. - July 97 - 580

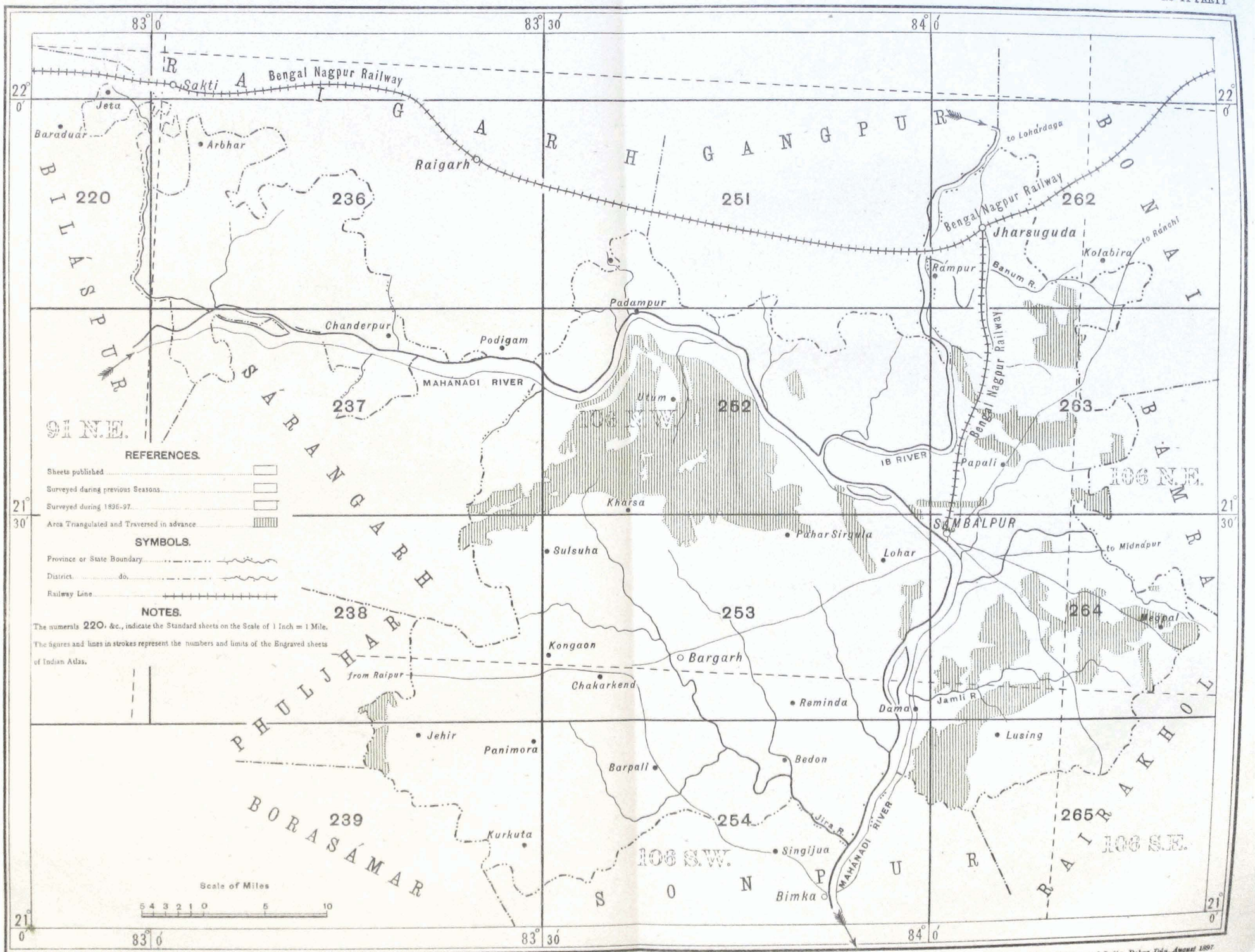
No. 114 – S. 97.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEYS IN DISTRICT SAMBALPUR.

1896-97.

No. 14 PARTY



REFERENCES.

Sheets published

Surveyed during previous Seasons

Surveyed during 1896-97

Area Triangulated and Traversed in advance

SYMBOLS.

Province or State Boundary

District do.

Railway Line

NOTES.

The numerals 220, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of Indian Atlas.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, August 1897

No. 137-S. 97.

Regr. No. D. 900. S. I. D. - Aug. 97 586

hilly ground of district Betúl, where the greater portion of last year's topography was carried out.

138. During the field season the boundaries of all the forest blocks surveyed in district Damoh were compared with the settlement boundary traces received from the Deputy Commissioner, to whom all discrepancies were reported.

139. The triangulation in district Biláspur was carried out in continuation of the same work done last year and covered an area of 666 square miles. But from the scattered nature of the forest blocks this comprises only about 240 square miles of ground for actual topography. The triangulation in district Sambalpur was based on the old triangulation of the East Coast Series. It amounted to 1,104 square miles. The forest blocks in this district are also very much scattered, and hence the above triangulation comprises only about 390 square miles of forest area.

140. The total amount of traversing completed this season is as follows:—

	Linear miles.
District Damoh	10·9
„ Biláspur	226·4
„ Sambalpur	78·2
„ Betúl (revision work)	1·2

The traversing in district Damoh was run over the boundaries of small *malguzari* patches which were found to exist in the heart of the Government forests and which were not traversed in the previous season.

141. Efforts were made this year to utilize the data of traverses done by Nos. 13 and 9 Parties in districts Biláspur and Sambalpur. It was found from the old traverse volumes pertaining to the work that most of the boundaries common to Government forests and *malguzari* land in the above two districts were traversed by the survey parties in former years. The old traverse stations were almost all found standing in their positions, which was a matter of considerable importance, and on which the success of the work entirely depended. This party had only to connect the old traverses to the neighbouring trigonometrical points in order to bring the co-ordinates of the traverses to the present origin of survey. Independent traversing of forest boundaries in these two districts has only been carried out by this party, where the boundaries were not previously traversed.

142 The final results of the computations of all the triangulation and traversing done by this party in districts Biláspur and Sambalpur this year are being handed over to the Forest Survey Branch to be utilized by them when they carry out the detail survey of the ground.

143. The classification of forest growth and soil of all the area surveyed in detail was carried out in the field on separate skeleton traces by the surveyors; the fair maps thereof have been prepared in the recess and supplied in original to the forest officers concerned.

144. The health of the party during the season under report may be said to have remained exceptionally good on the whole. The country in district Damoh, where the bulk of the establishment worked this season, proved to be the most salubrious this party has ever had to survey in the Central Provinces during the past ten years The squads at work in district Biláspur also kept good health generally. But the small detachment working in district Sambalpur suffered greatly from malarious fever, as the climate of that district is notoriously unhealthy.

145. The fair mapping of the season's topography, consisting of 58 standard sized sections of sheets Nos. 63, 64, 65, 66, 83, 84, 85, and 86 in district Damoh and sheet No. 180 in district Biláspur will be completed before the party goes down to the field.

146. Considerable progress has been made during this year in clearing off the arrears of the general reports of the past ten years' work of this party in the Central Provinces In conformity with the latest orders issued last year on the subject 29 triangulation charts pertaining to the work in districts Hoshangábád, Betúl, Nimár and Damoh have been drawn, and list of points shewn on those charts with their co-ordinates and heights have been prepared. It is hoped there will be no arrears under this head by the time the party closes recess office.

147. The co-ordinates of all the forest boundary pillars especially required by the Forest Department for record in their office have been finally completed.

The above data for district Hoshangábád were out of hand last year; and those pertaining to districts Nimár, Betúl and Damoh have been completed this year and despatched to the Forest Officers concerned; and it is satisfactory to note there are no arrears of this work.

148. Three sepoys were sent to this party in December 1896 for survey training. In the beginning of the field season they were put through a course of plane-tabling on the 4-inch scale, and subsequently were employed on independent work. By the end of March they completed the boards given to them. Their work on being tested was found to have been carefully and accurately performed. In April they were given some lessons in the use of the theodolite, and each did a small piece of traverse which was computed out, and they were made to plot their work from the co-ordinates supplied to them. They were also taught the use of the scales and other survey instruments generally employed in a topographical party. They returned to their regiments on 11th April 1897.

149. The cost rates for each description of work for the current survey year are as follows :—

Triangulation	₹ 7·4 per square mile against	₹ 6·8	last year.
Topography	„ 70·5 . . . „	„ 81·3	„
Traversing	„ 17·7 per linear mile	„	„ 13·9	„

150. The increase in the cost rate of traversing this year is due to the fact that a good deal of the men's time was lost in constantly marching from one place to another in order to connect the old traverse work of Nos. 9 and 13 Parties in districts Biláspur and Sambalpur to the trigonometrical points. Besides, corrections had to be applied to all the old computations of the above parties to reduce the co-ordinates to the new survey origin. This necessitated a great deal of office work without any corresponding increase in the field work on which the cost rates have been calculated.

151. Under orders of the Government of India this party has been transferred from the Central Provinces to the Lushai Hills to carry out a topographical survey on the scale of 1 inch=1 mile. In the coming field season triangulation will be undertaken in the North Lushai Hills and almost all the hands will be employed on this work. But it is proposed to compute out the results of part of the triangulation during the field season to enable the detail survey work to be commenced. Efforts will be made to complete as much topography as possible by the end of the field season.*

BOMBAY PRESIDENCY.

No. 17 PARTY.

152. Major W. J. Bythell, R.E., held charge of this party throughout the year, with two intermissions; the first from the 1st October to 2nd November 1896, when he was on privilege leave and the next from the 7th September to the end of the season, when he was deputed on service with the Mohmand Field Force as Survey Officer; during both of these periods Mr. C. E. Tapsell held charge.

Personnel.

Major W. J. Bythell, R.E., Deputy Superintendent, 1st grade, in charge.
Mr. C. E. Tapsell, Extra Assistant Superintendent, 3rd grade.
„ S. F. Norman, „ „ „ 6th „
„ C. A. Norman, „ „ „ 6th „

Surveyors and Sub-Surveyors.

Gopal Vishnu (up to 30th June), G. R. Bhopatkar, R. V. Joshi, Govind Gopal, N. V. Bhopatkar, and 39 others.

153. The party continued the survey of forest areas in the three circles of the Bombay Presidency, the season's operations comprising :—

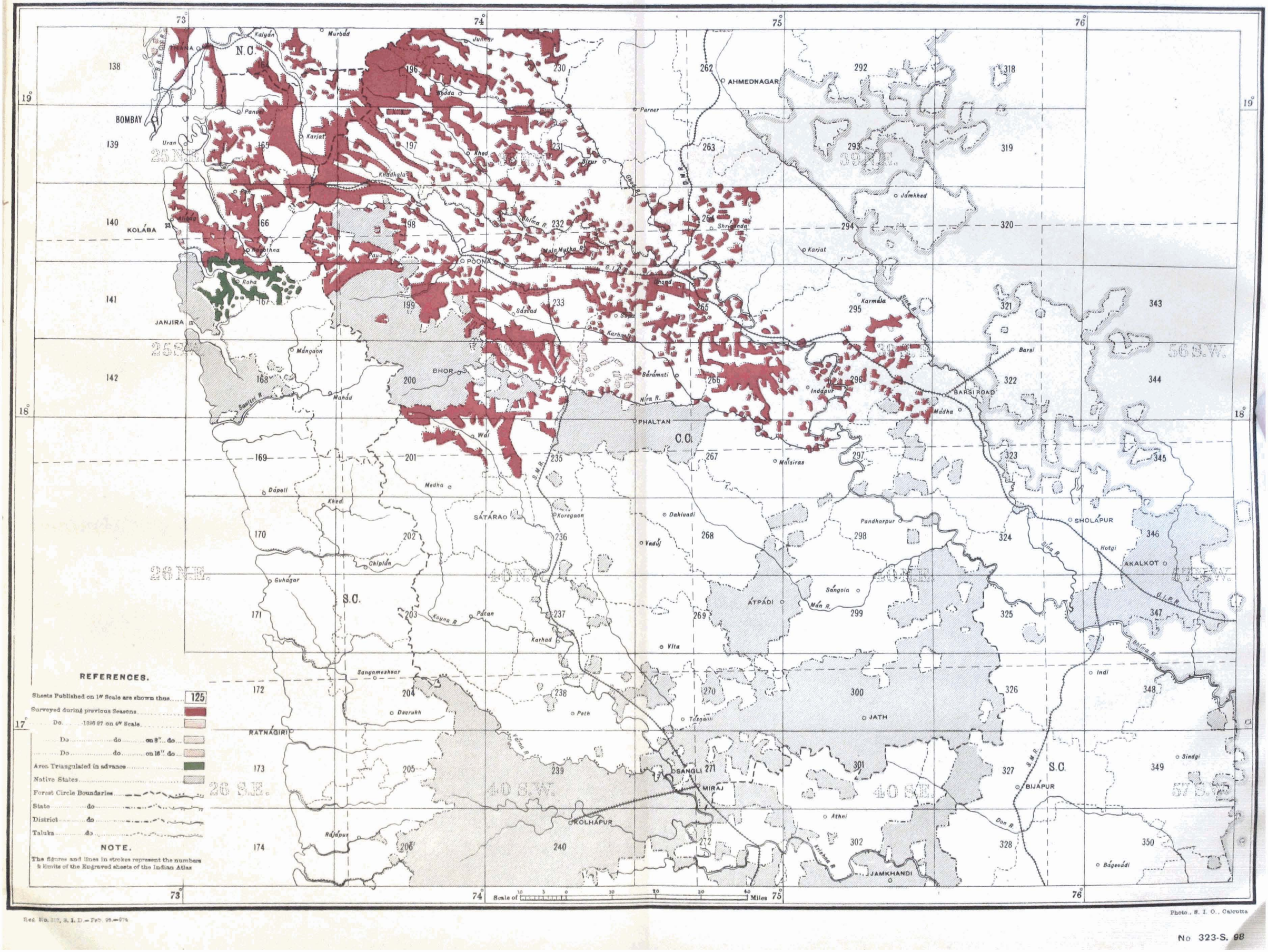
(1) *In the Northern Circle.*—Advance triangulation in the Mándvi *táluka*, Surat district. Detail survey on the 8-inch scale of the teak reserves in the Máhim *táluka*, Thána district.

*Mr. Erskine reports very favourably of all his assistants. The following members of the native establishment are also commended :—

Ram Singh, Mahadeo Daji, Satya Charan Ghosal, Abdul Huq (1), Abbas Ali, Sita Ram, Alay Ahmad (1), Ali Hasan Khar, Baijnath, Anwar Ali, Muhammad Aziz, Alay Ahmad (2), Mahabir, Mohendro Nath Bose, and Syed Razi Hasan. Special mention is made of the services of the head writer, Syed Zille Hasnain.

BOMBAY SURVEY.

1896-97. **INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN, CENTRAL, & SOUTHERN CIRCLES.** No 17 PARTY.



Reg. No. 317, S. I. D.—Feb. 98.—974

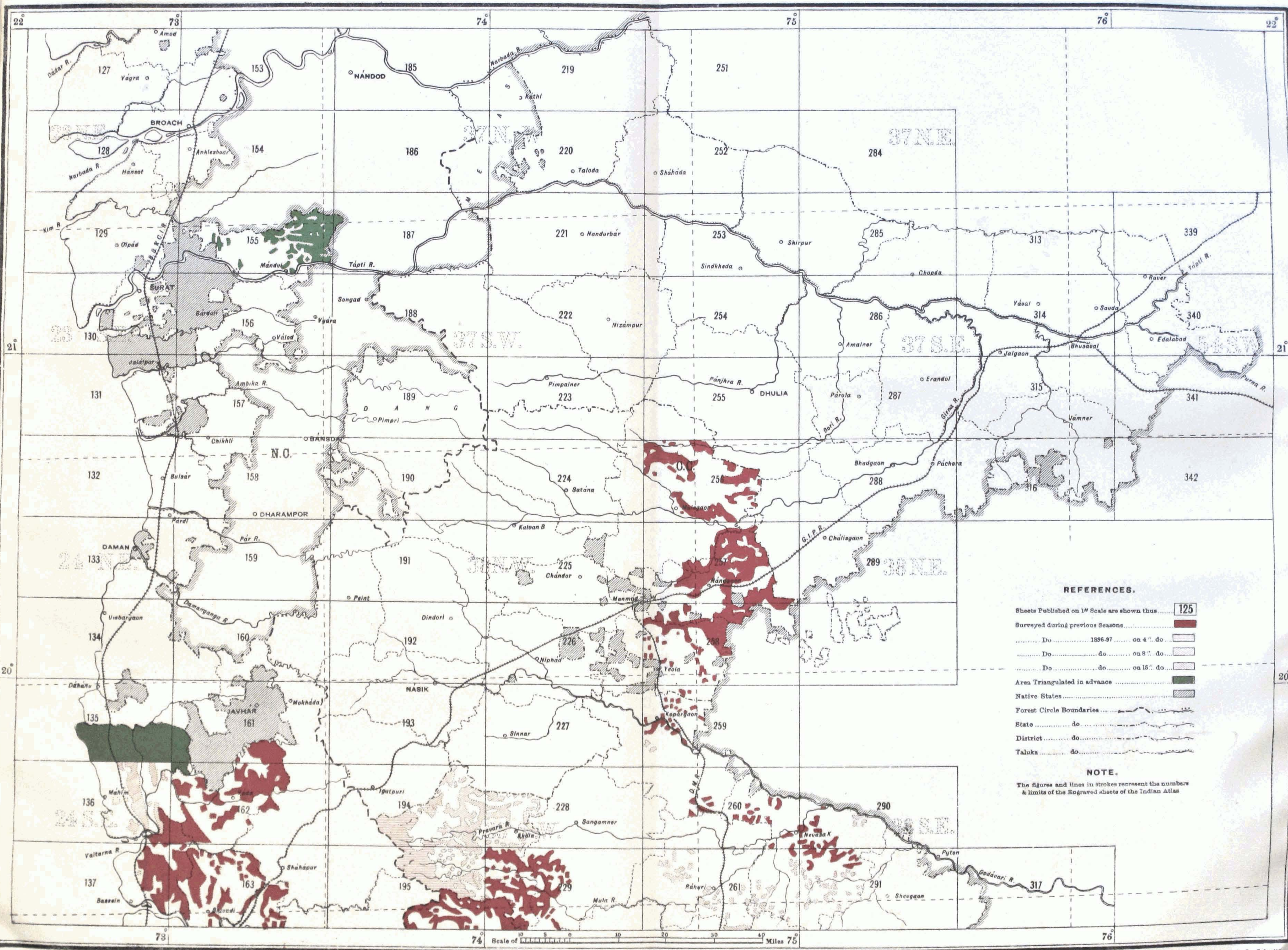
Photo., S. I. O., Calcutta

No 323-S. 98

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN & CENTRAL CIRCLES.

1896-97. No. 17 PARTY.



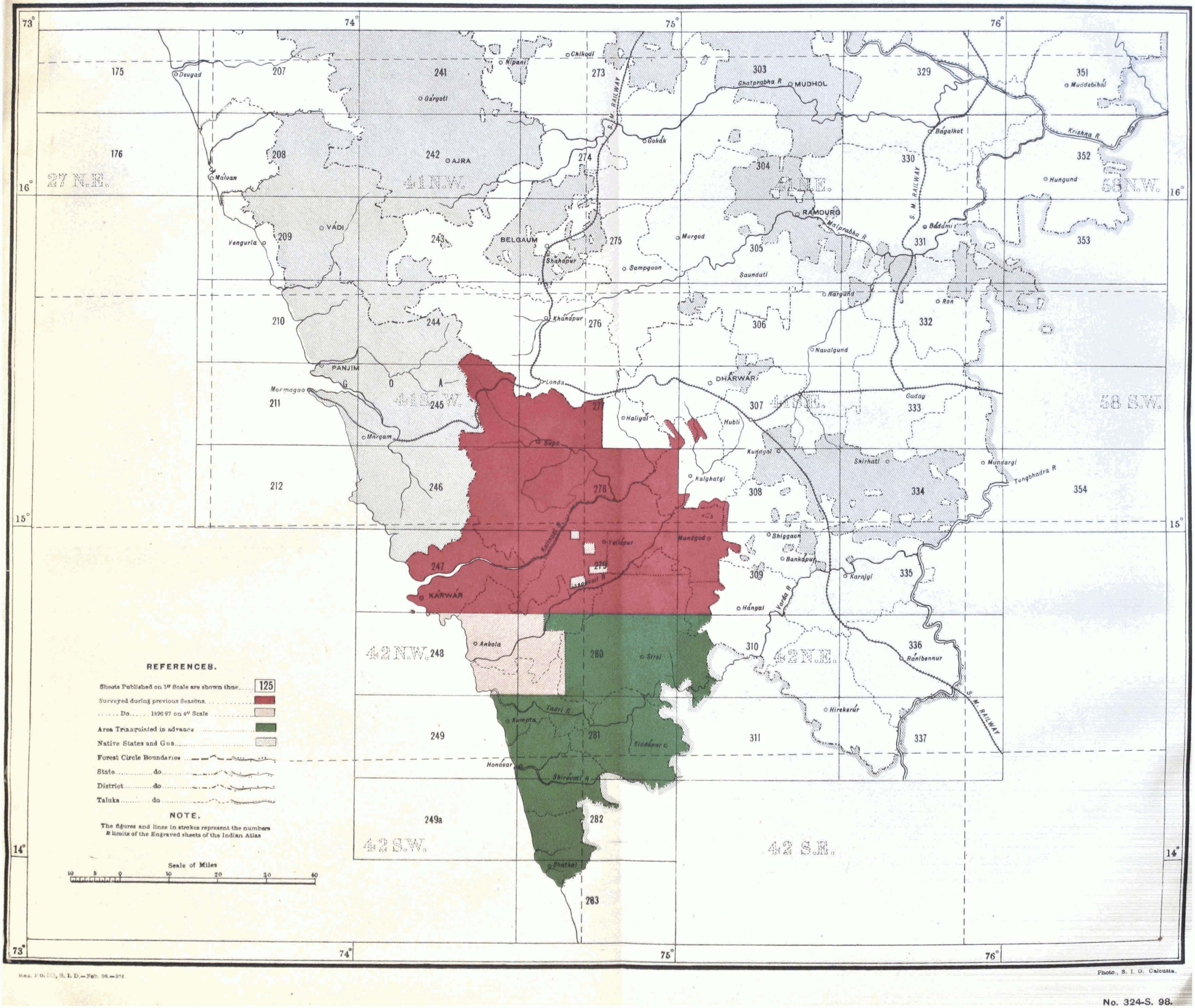
Reg. No. 517, S. I. D.—Feb. 98.—976

Photo., S. I. O., Calcutta.

No. 322-S. 98

BOMBAY SURVEY.

1896-97. **INDEX TO THE FOREST SURVEYS IN PORTION OF THE SOUTHERN CIRCLE** No. 17 PARTY.



REFERENCES.

Sheets Published on 1″ Scale are shown thus..... 125

Surveyed during previous Seasons.....

..... Do..... 1896-97 on 4″ Scale .....

Area Triangulated in advance .....

Native States and Goa.....

Forest Circle Boundaries .....

State.....do.....

District.....do.....

Taluka.....do.....

NOTE.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas

Scale of Miles

10 5 0 10 20 30 40

Reg. No. 111, S. I. D.—Feb. 98.—971

Photo., S. I. O. Calcutta.

No. 324-S. 98.

(2) *In the Central Circle.*—Completion of detail survey of ordinary forest reserves on the 4-inch scale in the Bhimthádi and Purandhar *tálukas*, Poona district; detail survey on the 8-inch scale of teak reserves and on the 4-inch scale of ordinary forest reserves in the Akola *táluka*, Ahmednagar district; detail survey of *bábul* reserves on the 16-inch scale in the Nevása and Ráhuri *tálukas*, Ahmednagar district; supplementary triangulation in the Akola *táluka* of the Ahmednagar district.

(3) *In the Southern Circle.*—Advance triangulation in the Roha *táluka*, Kolába District. Advance triangulation and traversing in the Kumta, Sirsi, Siddápur and Honávar *tálukas*, North Kánara district; detail survey on the 4-inch scale in portions of the Kárwár, Ankola, Kumta and Sirsi *tálukas* and portions of small areas left unsurveyed in the Yellápur *tálukas*, North Kánara district. In addition to which it was found necessary to add certain boundaries, etc., to work previously done, when the surveyors were unprovided with village maps in the Alíbág *táluka* of the Kolába district.

154. The party left its recess quarters in Poona about the 15th November and closed field operations between the end of May and 10th June, when it returned to Poona.

155. The aggregate outturn for each description of survey for the past and preceding field season is shown in the following statement:—

Description of Survey.	1895-96.			1896-97.		
	4-inch.	8-inch.	16-inch.	4-inch.	8-inch.	16-inch.
Triangulation	280	225	...	1,041	335	...
Traversing	344	...	...	234	10	...
Topography	829	108	15	522	168	33

These figures show a considerable increase in the triangulation for both the 4-inch and 8-inch work, of which 880 square miles were in North Kánara. A small area still remains for traversing in that district. Less traversing was done in Kánara during the last season, as only one man was employed against two that were on that work in 1895-96. For a similar reason the outturn of topography on the 4-inch scale is less, as only one camp under Mr. Tapsell worked in Kánara throughout the season, whereas in 1895-96 Mr. C. Norman's detachment of surveyors was sent to help in the detail survey during the months of March, April and May: this latter detachment was to a great extent employed on the 8-inch and 16-inch scale this year, with the result that there is an increase in the outturn on those scales.

156. The details of the outturn of work done during 1896-97 are as follows:—

1.—*In the Northern Circle.*

	Square miles.
Triangulation, Mándvi *táluka*, Surat district . . .	141·0
Traversing, ditto ditto	10·0
Topography, Máhim *táluka*, Thána district	51·7

2.—*In the Central Circle.*

Triangulation, Ahmednagar district	161·0
Topography, ditto ditto . . 4-inch scale .	117·8
Ditto, ditto ditto . . 8-inch „ .	96·1
Ditto, ditto ditto . . 16-inch „ .	32·9
Ditto, Poona district . . . 4-inch „ .	16·7
Ditto, ditto . . . 8-inch „ .	5·6

3.—*In the Southern Circle.*

Triangulation, Kolába district	194·0
Ditto, Kánara ditto	880·0
Traversing, ditto ditto	234·0
Topography, ditto ditto	387·5

157. The detail survey was checked by 146·7 linear miles of check lines, as well as by *in situ* fixings whilst the work was in progress.

158. The cost rates per square mile, as compared with those of 1894-95 and 1895-96, are shown in the following table :—

Description of Work.	Cost-rates per square mile.			
	Scale.	1894-95.	1895-96.	1896-97.
		R	*R*	*R*
Triangulation	4 inch	8·8	7·1	9 5
	8 „	15·0	3·5	5·3
Traversing	4 „	29 5	12·3	11·3
	8 „	4·8	...	4·8
Topography	4 „	81 0	66·8	77 6
	8 „	139·5	122·5	135·7
	16 „	116·5	130·0	156·0

The increase in the cost rates of the triangulation of the 4-inch scale was due to the fact of European agency being employed on it. The Surveyor-General on the occasion of his late inspection of the office has commented on this and given instructions that, whenever possible, native agency is to be employed.

The cost rates of traversing have been considerably reduced owing to greater experience having been acquired by the surveyors in that branch of the work.

The above table shows an increase in the cost rates for topography over 1895-96, but compares favourably with those for 1894-95 and previous years, with the exception of the 16 inch scale; the only apparent reason for this being the employment of very slow and inexperienced hands throughout the season on that class of survey which was unavoidable, as the more experienced surveyors were needed for the 4-inch and 8-inch scales where the hilly nature of the country necessitated their employment. Regarding the 4-inch and 8-inch scales, it is to be noted that the cost rates for 1895-96 had reached a minimum in consequence of the cost for supervision being reduced by a very considerable amount due to the then Superintendent, Lieutenant-Colonel J. R. Hobday, being compelled, through ill health, to go on furlough and Mr. Tapsell acting for him, in addition to his own duties.

159. During the recess the fair mapping and computations of the season's work have been completed, with the exception of some of the computations, the results of which will not be required for immediate use. In the Northern Circle, 18 sections on the 8-inch scale in Máhim *táluka*, Thána district, have been drawn.

In the Central Circle, 30 sections on the 8-inch scale in Akola *táluka*, Ahmednagar district, and 27 sections on the 16-inch scale (*bábul* reserves) in the Ahmednagar district have been drawn.

In the Southern Circle 25 sections have been drawn and the arrears brought up in the Kánara district. Twelve sections of the Kolába district, scale 8″ = 1 mile, have also been prepared for publication.

160. The health of the party was good throughout the season in the Northern and Central Circles, but in the Kánara district there was much fever and dysentery, especially during the months of April and May, due chiefly to the want of water, the wells, pools and springs having in a great measure run dry.

161. The programme for the ensuing field season is as follows :—

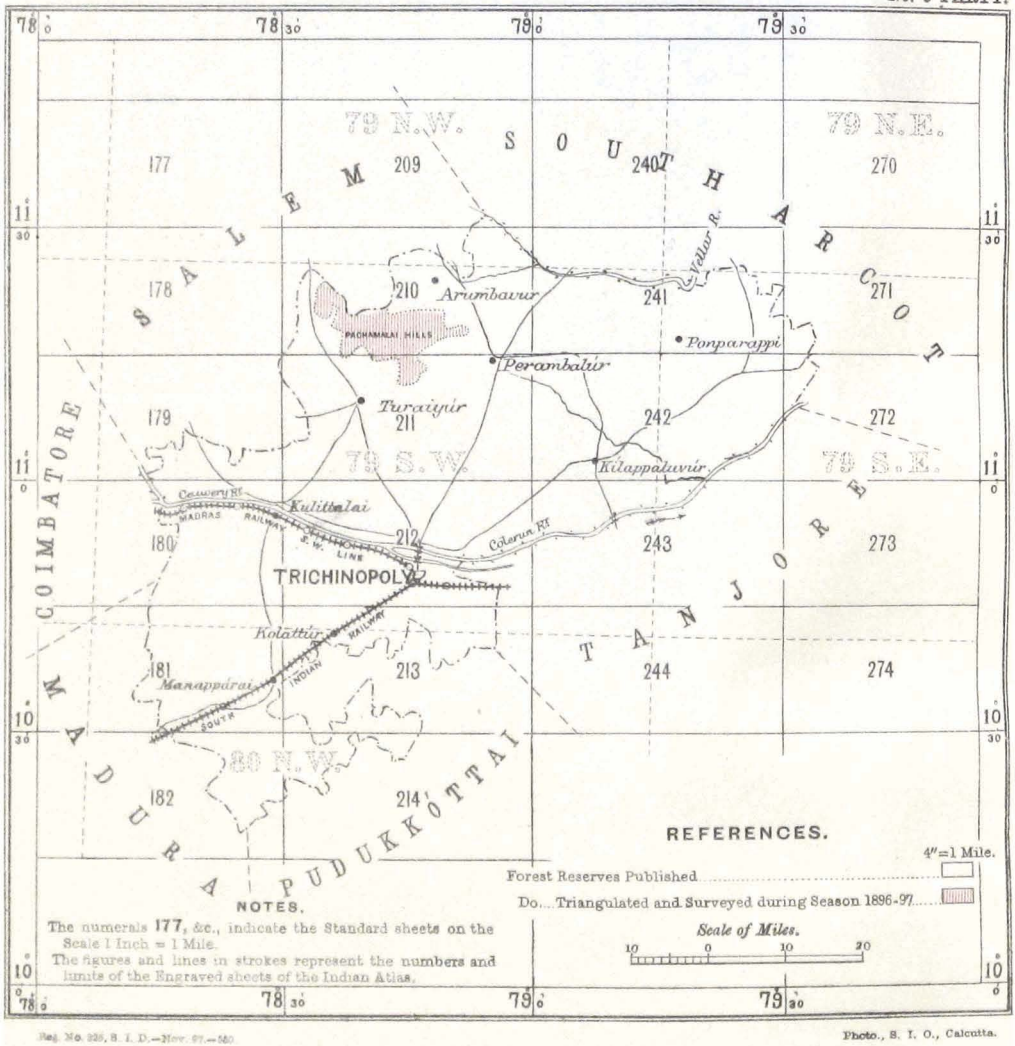
Northern Circle.—Advance triangulation in Dáhánu *táluka*, sheet No. 135. Completion of 8-inch detail in Máhim *táluka* in sheets Nos. 135 and 136.

Central Circle.—Advance triangulation in Igatpuri and detail survey on 8-inch scale in the same *táluka*. Continuation of detail survey on 16-inch scale of *bábul* reserves along the banks of the Godávari.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE TRICHINOPOLY DISTRICT.

1896-97. No. 9 PARTY.



REFERENCES.

4″=1 Mile.

Forest Reserves Published

Do. Triangulated and Surveyed during Season 1896-97

Scale of Miles.

10 0 10 20

NOTES.

The numerals **177**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

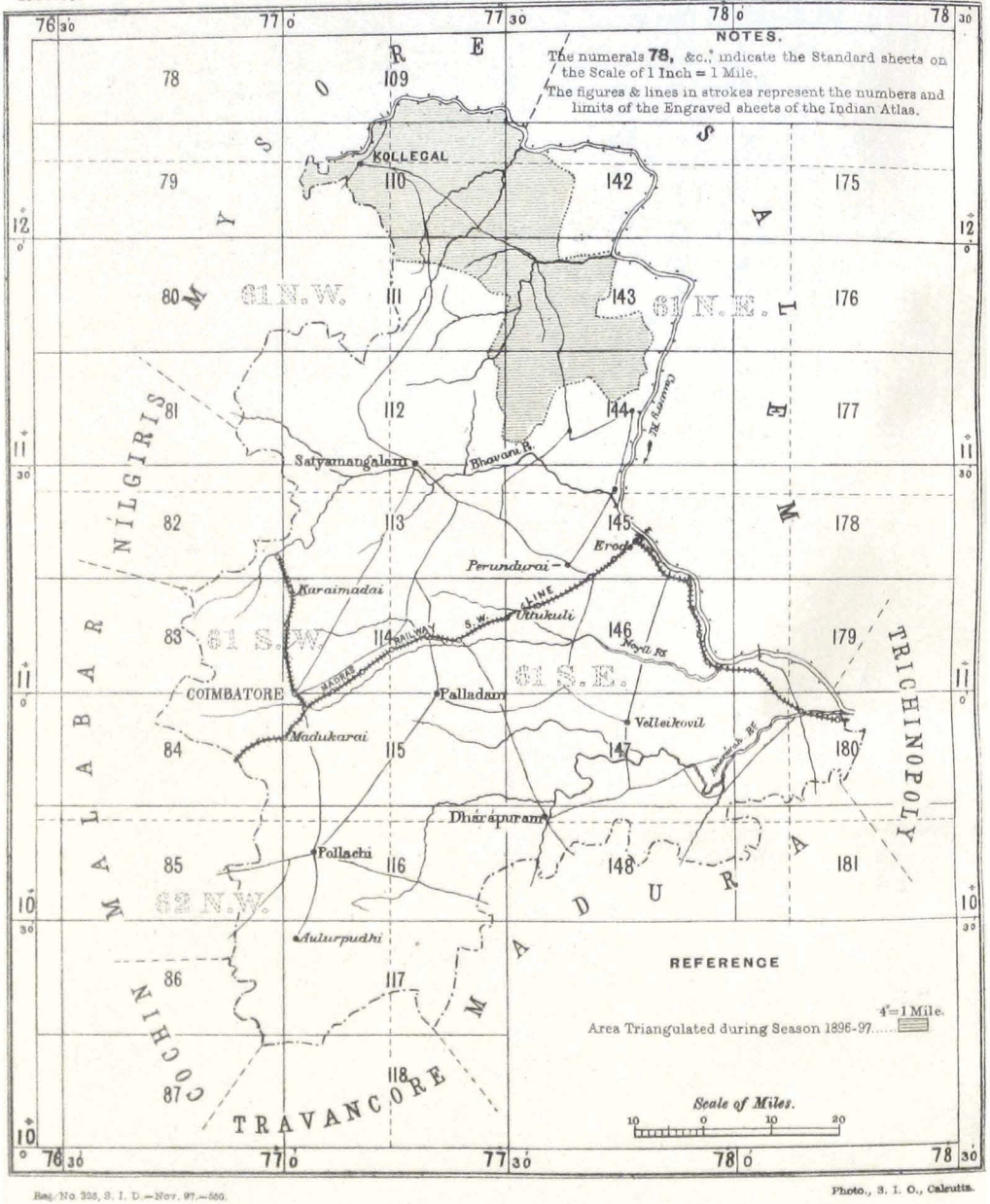
Reg. No. 226, S. I. D.—Nov. 97.—550.

Photo., S. I. O., Calcutta.

No. 452-S. 97.

MADRAS SURVEY.

1896-97. **INDEX TO THE FOREST SURVEYS IN THE COIMBATORE DISTRICT** No. 9 PARTY.



Reg. No. 328, S. I. O.—Nov. 97.—650.

Photo., S. I. O., Calcutta.

No. 453-S. 97.

Southern Circle.—Advance triangulation in the Mángaon and Mahád *tálukas*, Kolába district, in sheets Nos. 168 and 290. Traversing in Sirsi *táluka*, North Kánara district, in sheet No. 280. Commencement of 8-inch detail in Roha *táluka*, Kolába district, in sheet No. 167. Continuation of 4-inch detail in Sirsi *táluka*, North Kánara district, in sheet No. 280.

162. The recess office of the party was inspected by the Surveyor-General at Poona in September, who was thoroughly satisfied with the state of efficiency in which he found the party.*

MADRAS PRESIDENCY.

No. 9 Party.

163. This party was transferred from the Central Provinces to form a second Madras Forest party. It commenced operations on the 4-inch scale on the Pachaimalai range in the Trichinopoly district and remained in charge of Mr. E. J. Jackson up to 21st July 1897 after which Captain Fraser held charge of it.

Personnel.

Mr. E. J Jackson Officiating Superintendent, 1st grade, in charge up to 21st July 1897.
Captain H. A. Denholm Fraser, R.E., Deputy Superintendent, 1st grade, in charge from 22nd July 1897.
Mr. H. Dowman, Extra Assistant Superintendent, 2nd grade, to 30th April 1897.
Mr. A. G. Wyatt, " " 2nd grade, from 8th November 1896.
Mr. W. C. G. Barckley, " " 6th grade
Mr. P. A. Peters, " " 6th grade, died on 20th March 1897.
Mr. C. George, " " 6th grade.
Mr. J. Donaghey, Sub Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Bapu Jadu and 36 others.

The triangulation was entrusted to Mr. Barckley, who left Calcutta early in September. Mr. Dowman was put in charge of the traverse work and left the Central Provinces about the same time. The rest of the party excepting a few men who were employed in the Central Provinces to the end of December, left Kamptee for Trichinopoly about the end of October. Mr. George and afterwards Mr. Wyatt as well were placed in charge of detail sections.

164. The detail work could not be commenced till the values of the triangulated and traversed stations had been computed in the field, and an attempt was made to train the native surveyors in plane-table work during the enforced period of idleness, but with indifferent success, as they had never used a plane table before. Many serious difficulties were encountered at first and very great trouble was experienced in obtaining local *khalásis*. All those first entertained at Trichinopoly absconded when moved off to the scene of operations, and, owing to the evil reputation of the Pachaimalai Range, the men subsequently recruited in the vicinity could not be persuaded to sleep on the hills for fear of fever and returned to their homes at the foot of the hills every evening. Much valuable time was thus lost and progress was also greatly retarded by heavy rain and dense mists up to the middle of December. Practically no detail work was completed before the end of December, and, though after this date matters improved somewhat, the inexperience of the native surveyors in detail work prevented any but the slowest progress being made. Much assistance was given by the temporary transfer of two experienced surveyors from No. 19 Party (Madras Forests) as the effective native staff was very much too small compared with the number of European assistants attached to the party. A large number of the sub surveyors turned out very little, and in some cases absolutely no work at all throughout the season.

165. Plane-tabling was carried on in the Trichinopoly district until the middle of April, whilst preparatory work was commenced in the Coimbatore district in February and was continued till early in August with a view to giving the detail surveyors a fair start next year.

The area triangulated in Trichinopoly district is 250 square miles of which the computations were done in the field. About 1,200 square miles was also partially completed in the North Coimbatore district, which will however require sup-

*Messrs. Tapsell, S. Norman and C. Norman have carried on their duties satisfactorily, while, as regards the Native establishment, the officer in charge reports that, with one or two exceptions, the sub-surveyors worked well throughout the field season. Surveyor Joshi carried out some very good triangulation. The party lost the services of two of the best sub-surveyors, *viz.*, Virapa Piraji and Raghunath Narayan, from death, and of surveyor Gopal Vishnu, who retired on pension after thirty years' approved service.

plementing before it can be considered complete. The traverse work executed in Trichinopoly consisted of 244 linear miles, most of which was computed in the field and 280 linear miles have been traversed in the Coimbatore district.

166. The outturn of topography consists of 120·8 square miles on the 4-inch scale in the Trichinopoly district, where the whole of the work allotted to this party was completed. No other detail work was commenced, and the smallness of the outturn is due to causes previously mentioned.

167. Apart from the difficulties in procuring local labour, the country presented no special difficulties to the surveyor, but the climate proved hot and malarious and appeared to have a very enervating effect on the surveyors, all of whom were natives of Northern India.

168. The work was tested principally by fixings *in situ* supplemented by test lines with the chain where the nature of the country permitted of use being made of this method. The detail was found accurate, but the contouring is very defective owing to the inexperience of the surveyors.

169. The health of the party was not good and much fever prevailed and caused the death of 8 or 9 *khalásis*. Mr. Peters became seriously ill and had to be sent to Bangalore on leave, before the expiration of which he died.

170. During the recess the computations were proceeded with and considerable progress was made, but some of them cannot be finally completed till supplementary observations have been taken next season.

The mapping of the Pachaimalai Forests has been completed and will shortly be sent to Calcutta for publication: as there were no experienced draughtsmen in the party, assistance in this respect was asked for and obtained from No. 19 Party.

171. The cost rate amounts to R349-8-6 per square mile. It must be considered an altogether abnormal rate for the following reasons:—

(1) The native establishment had not been trained in the duties required from them, and much expense was incurred in attempting to train them in the field, an attempt which in many cases failed entirely.

(2) No preparatory work had been executed in advance and a large proportion of the establishment had therefore to remain idle in camp for many days, as work could not be provided for them.

(3) The expense of moving the party by rail from the Central Provinces was very heavy and a large outlay had to be incurred in providing tents for the menial establishment.

(4) A large number of up-country *khalásis* had to be employed and the rail charges on this account are necessarily heavy. All these defects will, it is hoped, be remedied next year. Under any circumstances the first year in new country, even when all hands are experienced, must necessarily show a high cost rate, and in this case the expenditure was immensely increased, as the natives were all untrained to topographical work, almost all of them having been engaged and trained for traverse purposes only in the Central Provinces, where the party has been working for so many years.

172 The party was inspected in the field by the Deputy Surveyor-General at the end of December 1896; and in August 1897, when in recess quarters at Bangalore, it was also inspected by the Surveyor-General in September. It was decided to effect an amalgamation with No 19 Party, and this was carried out from 1st September 1897 and will undoubtedly be the means of effecting great economy. A redistribution of the combined establishments into detail camps for the different districts has been carried out and steps have been taken to train 12 or 15 apprentices with the view of adding another detail section to the combined parties as soon as possible. The details of the revised programme for the combined parties are given in the report of No. 19 Party, which will be found at page 36.*

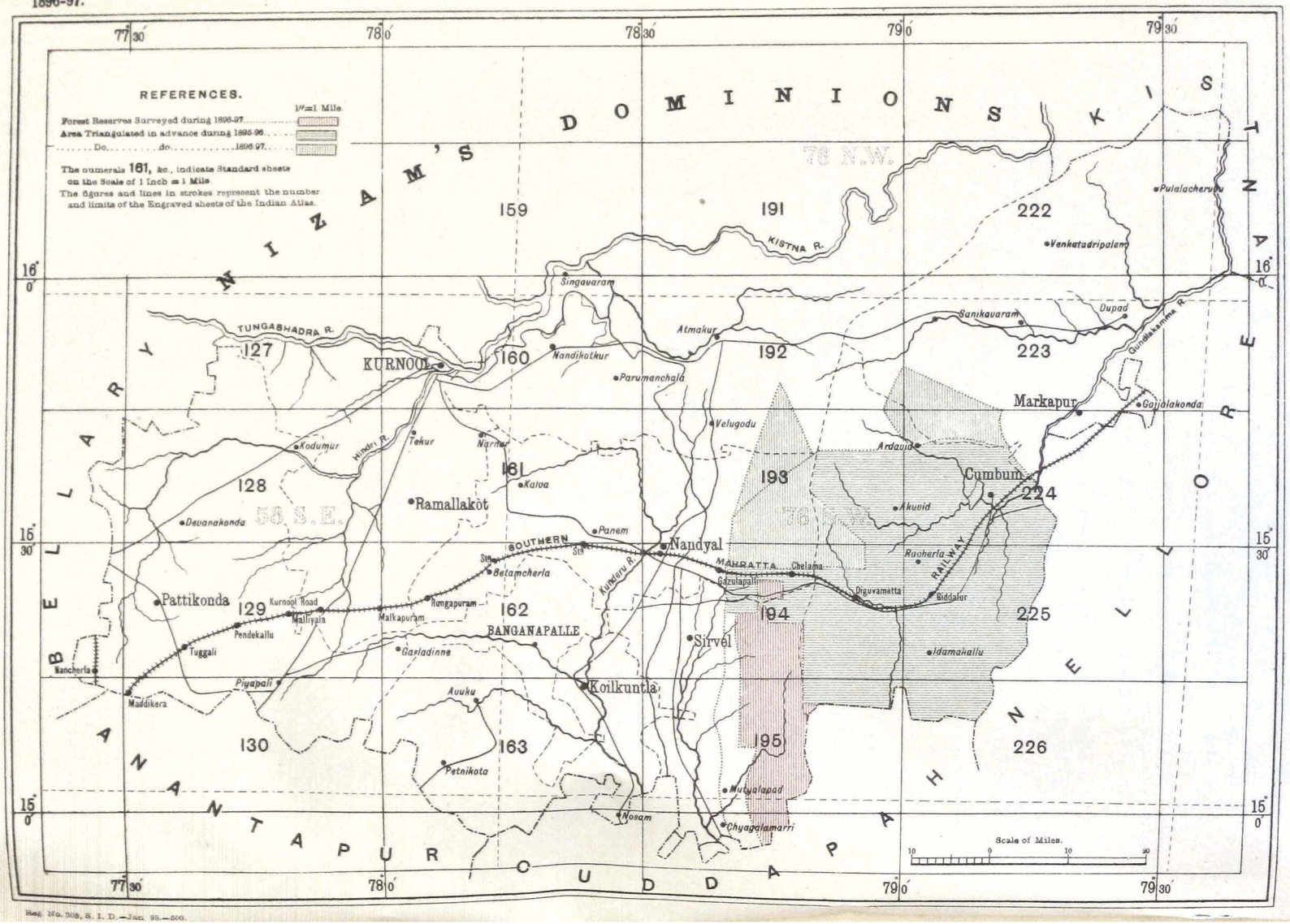
* The officer in charge at the request of Mr. Jackson reports very favourably on the work of Mr. C. George and speaks well of the zeal shown by Mr. Donaghey, who has not been long in the Department. It is necessary to mention that Mr. Barckley failed signally to carry out his orders, and has been a source of frequent trouble to the Executive Officer. Of the native establishment, Sub-Surveyor Hilaluddin is deserving of special mention for exemplary behaviour and consistently good work under trying circumstances. Computer Lall Mohun is a most reliable man with a thorough knowledge of his duties; and mention must also be made of the Writer, Tara Prasanna Roy, who has never failed to do his work satisfactorily.

The majority of the sub-surveyors failed to do good work, as already explained in the report, and many of them have been discharged or transferred to Revenue parties.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE KURNOOL DISTRICT.

1896-97. No. 19 PARTY.



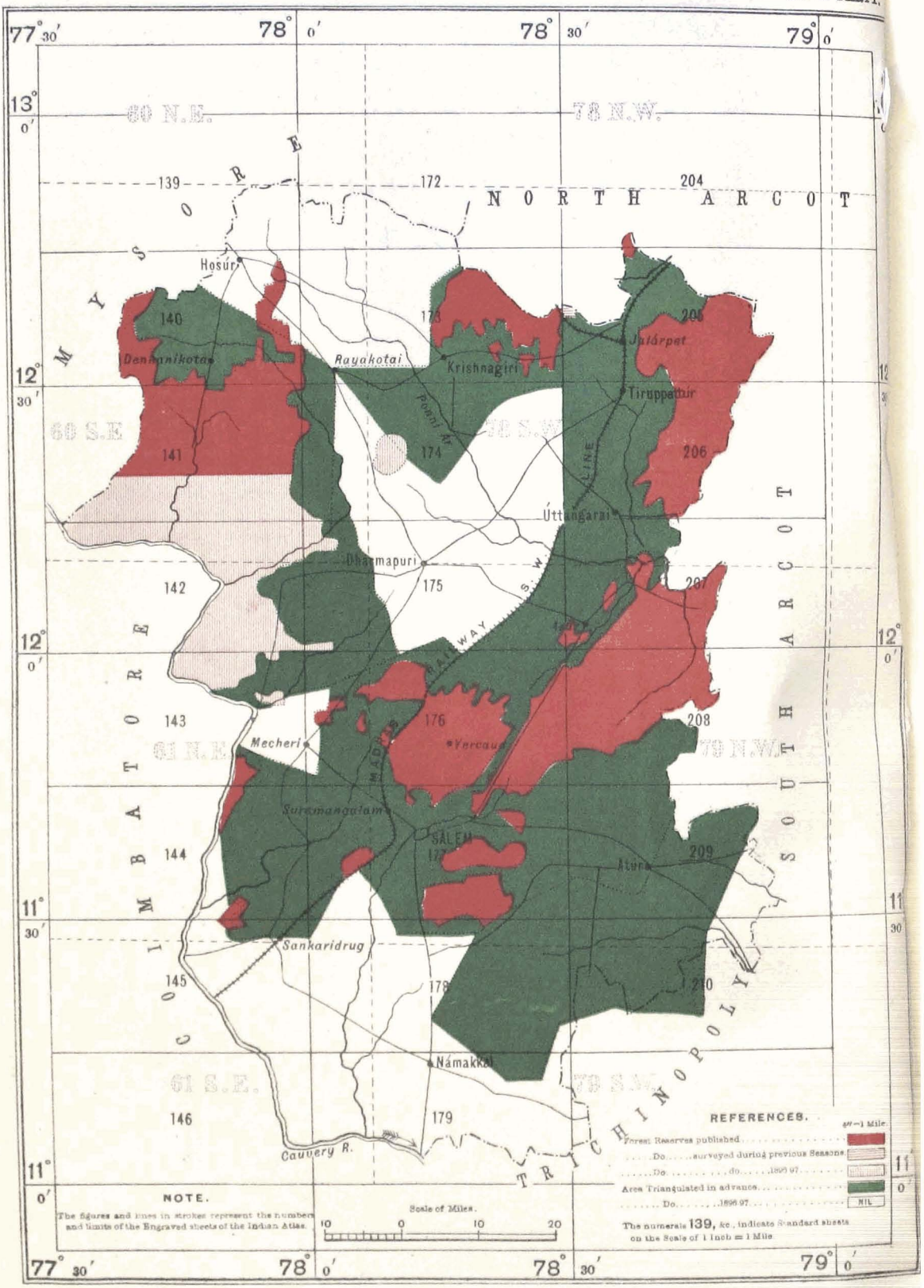
Mad. Ins. 305, S. I. D.—Jan. 98.—800.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SALEM DISTRICT.

1896-97.

No. 19 PARTY.



Reg. No. 305. S. I. D.—Jan. 98—550.

Photo., S. I. O., Calcutta.

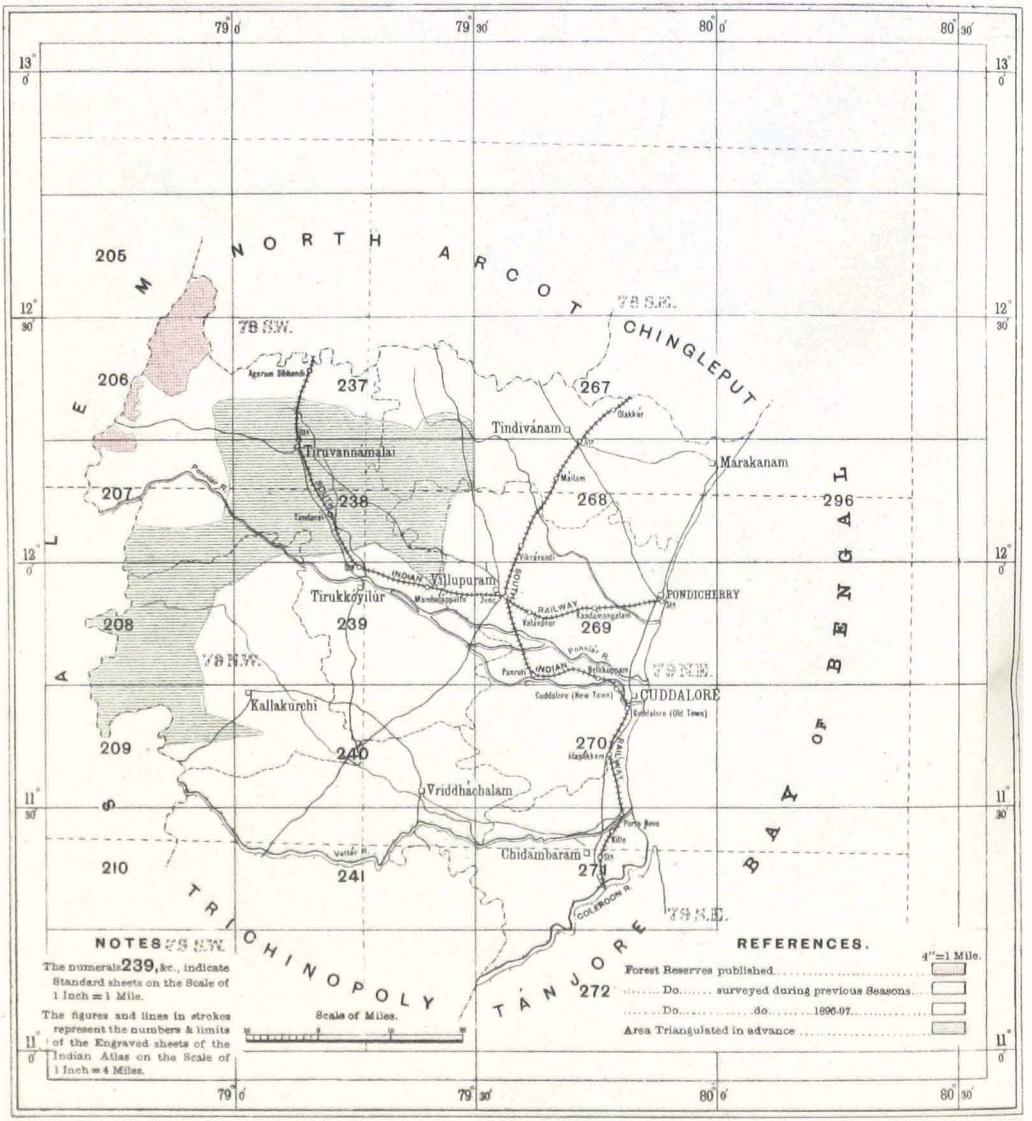
No. 305-S. 98.

MADRAS SURVEY.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SOUTH ARCOT DISTRICT.

1896-97. No. 19 PARTY.



Reg. No. 334, S. I. D.—Sep. 97—350.

Photo., S. I. O., Calcutta.

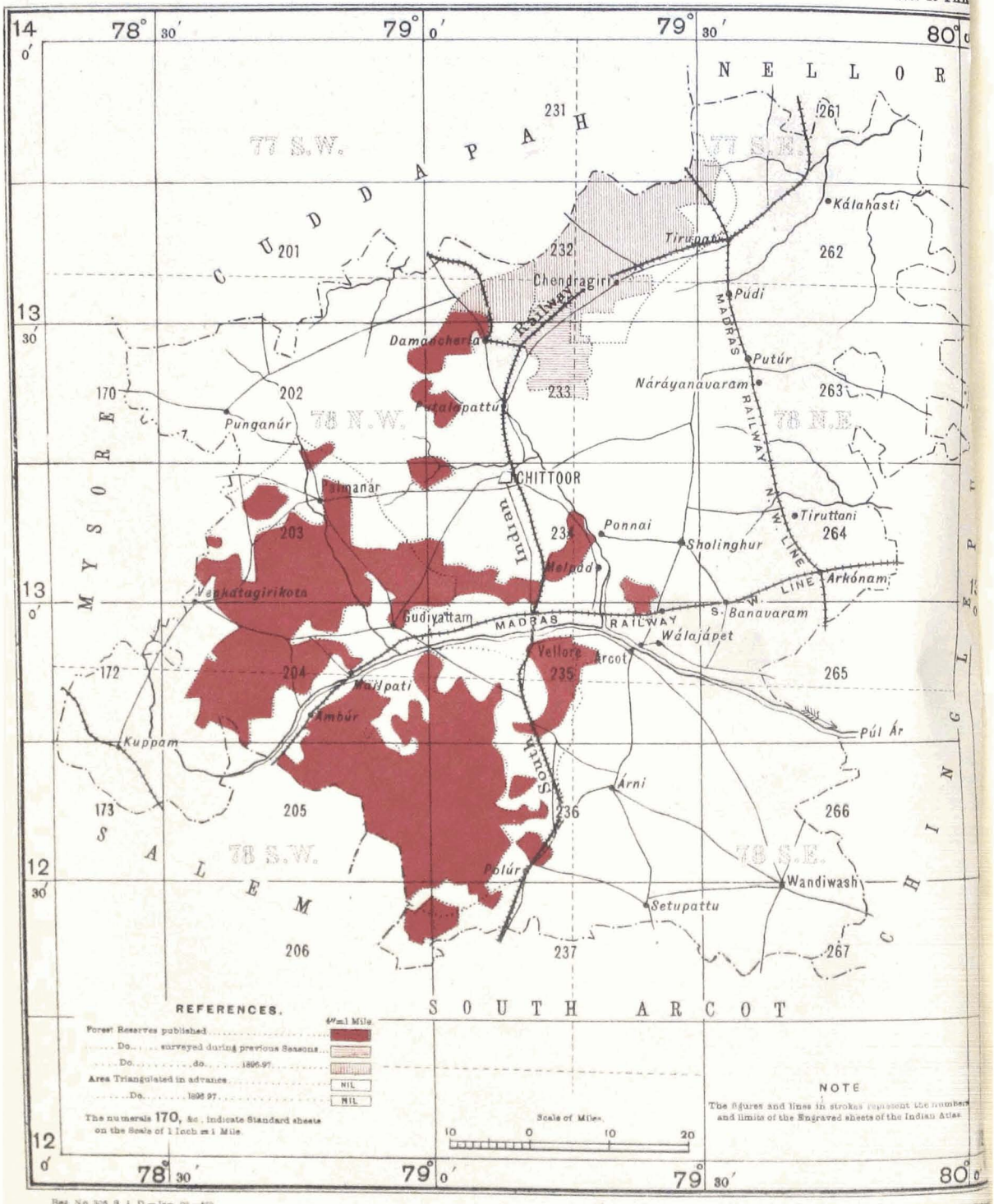
No. 440-S. 97.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE NORTH ARCOT DISTRICT.

1896-97.

No. 19 PAR



Red. No. 305, S. I. D.—Jan. 98.—650

Photo., S. I. O., Calcutta.

No. 310-S. 9

MADRAS PRESIDENCY.

No. 19 Party.

173. The party continued the survey on the 4-inch scale of forest reserves in the Salem, North Arcot and Kurnool districts and remained in charge of Captain Ryder during the whole of the field season. Lieutenant Hume held charge from 18th March to 22nd April and Captain Denholm Fraser from 23rd April for the remainder of the year under report.

Personnel.

Captain H. A. Denholm Fraser, R. F., Deputy Superintendent, 2nd grade, in charge from 23rd April 1897.
Captain C. H. D. Ryder, R. E., Deputy Superintendent, 2nd grade, in charge up to 17th March 1897.
Lieutenant A. H. B. Hume, R. E., Assistant Superintendent, 2nd grade, in charge from 18th March to 22nd April 1897.
Mr. C. F. Hamer, Extra Assistant Superintendent, 3rd grade.
" Hugh Todd, " " " 4th "
" Robert Todd, " " " 4th "
" J. H. S. Wilson, Sub-Assistant " 2nd "
" M. J. Sheehan, " " " 2nd "
" C. J. Veale, " " " 3rd "
Surveyors Sher Shah, Raghava Ayengar, Tiruvenketsami, Balaji Dhondiba, Govind Raju, and 29 Sub-Surveyors, etc.

174. The party was divided into four sections as follows:—No. 1, under Mr. R. Todd, continued the triangulation of the Nallamalai hills, Kurnool district, and completed the triangulation of the South Arcot district; No. 2, under Mr. Hamer, was employed on the detail survey in the Salem district; No. 3, under the personal supervision of Captain Ryder, completed the topography of the reserves in North Arcot; and No. 4, under Mr. Hugh Todd, commenced the detail survey of the Nallamalai reserves, Kurnool district.

175. The field season commenced as usual in the first week of September and closed early in March.

176. The area triangulated amounts to 500 square miles in South Arcot and 500 square miles in the Kurnool district; the smallness of the outturn is due partly to the difficult nature of the country in Kurnool and partly to the partial breakdown of Mr. R. Todd's health. Seven hundred and twenty-eight miles of traversing were executed, of which 602 miles were run along forest boundaries and the remaining 126 miles were along roads, etc., for the purpose of giving additional points for detail surveyors. The area surveyed in detail amounts to 1,027 square miles, being 62 miles more than last year, a result due partly to the increased efficiency of the native establishment and partly to the absence of sickness and the favourable nature of the season.

177. In the Salem district the country surveyed presented no special difficulties; the work was located chiefly in the Hosúr and Dharmapuri *talums*. In North Arcot, also, the country was moderately easy, but considerable difficulty was experienced in locating places named in the Government notifications owing to the scarcity of reliable local guides. The whole of the work lay in the Chendragiri *taluk* and included the site of the famous Tirupati temple.

The locality surveyed in Kurnool consists of the southern portion of the Nallamalai range in the Sirvel *taluk*. The country is very difficult from a surveyor's point of view and has a bad reputation amongst the natives on account of malaria and dangerous wild beasts, which, in spite of the prevalence of great scarcity in the district, made it very difficult to obtain local labour.

178. The work was tested principally by *in situ* fixings and also where the ground permitted of it by test lines run with a chain. The accuracy of the work was very satisfactory on the whole.

179. The health of the party was wonderfully good, considering the malarious nature of the localities in which operations were conducted. There were no deaths amongst the native establishment.

180. During the recess all the computations were completed with the exception of about 100 miles of traverse work which will be computed during next field season. The fair mapping is comprised in 30 sheets, the whole of which have been completed. Of these 16 have been despatched to Calcutta for publication and the remainder have been held over pending the settlement of certain small corrections and omissions. They will be corrected in the field and despatched to Calcutta before the end of the year. There are therefore no arrears of mapping.

181. The cost rate for the past year is R82-12-8 per square mile as against R65-14-4 last season, showing an increase of R16-14-4 per square mile. This

increase is chiefly due to the following causes:—(1) extra cost of operations in Kurnool district, where the establishment of menials had to be increased more than 30 per cent., compensation for dearness of provisions had to be given, as well as extra travelling allowance; (2) the posting of Lieutenant Hume and Mr. Veale to the party with a view to their being trained; and (3) the increased cost of the triangulation operations in Kurnool.

182. The recess office of the party in Bangalore was opened on the 8th March. The party was inspected by the Deputy Surveyor-General in August, and by the Surveyor-General in September.

183. Under orders from the Surveyor-General, the amalgamation of Nos. 9 and 19 Parties into one double party under a single executive officer took place on the 1st September 1897. The programme for the combined parties as approved by the Board of Revenue, Madras, is as follows:—

Three sections will be employed on triangulation; one to continue work in the Nallamalai hills, Kurnool district; another to commence the triangulation of the north of the Cuddapah district; and the third to complete the triangulation of North Coimbatore.

Traversing will be continued in Kurnool and North Coimbatore and commenced in Cuddapah and a certain amount will also be done in Salem and South Arcot districts.

Three detail camps will be employed: the first will complete the remaining work in Salem and possibly execute a small portion in the South Arcot district adjoining; the second will continue the work in the Kurnool district; and the third will commence operations in the Bhavání *taluk*, North Coimbatore district.

In addition, a training camp for apprentice sub-surveyors will be established in the Salem district.*

LOWER BURMA.

No. 20 PARTY.

184. This party continued under the charge of Captain Gordon until 12th May 1897, when he made over charge to Lieutenant Hare. Its programme consisted of—

Personnel.

Captain P. J. Gordon, I.S.C., Officiating Deputy Superintendent, 1st grade, in charge.
Lieut. H. J. Hare, R. E., Assistant Superintendent, 1st grade.
Mr. W. A. Wilson, Extra Assistant Superintendent, 1st „
„ A. Ewing, Sub „ „ 1st „
„ H. A. Chanier, „ „ „ 2nd „
„ C. A. O'Donel „ „ „ 3rd „
36 Surveyors, Sub-Surveyors, etc., 1 Writer, 2 Hospital Assistants.

(1) Traverse survey in advance of detail survey of forests in the Shwegyin and Pegu forest divisions.

(2) The detail survey on the 4-inch scale of forest reserves in the Shwegyin and Pegu forest divisions, and on the 2-inch scale of unreserved forests in the Toungoo district.

185. The party left recess quarters in Bangalore in the middle of November 1896 and commenced field work during the first week in December. The return to recess quarters was made by the first week in June 1897. Experience shows that December as a rule is too early to commence work in these forests and most of the severe cases of sickness occur in this month; but the field season is already a short one, the heavy rains generally setting in by the middle of May.

186. The outturn for the season is as follows:—

Traversing	512	square miles.	
Topography, 4-inch	395	„	„
„ 2-inch	106	„	„

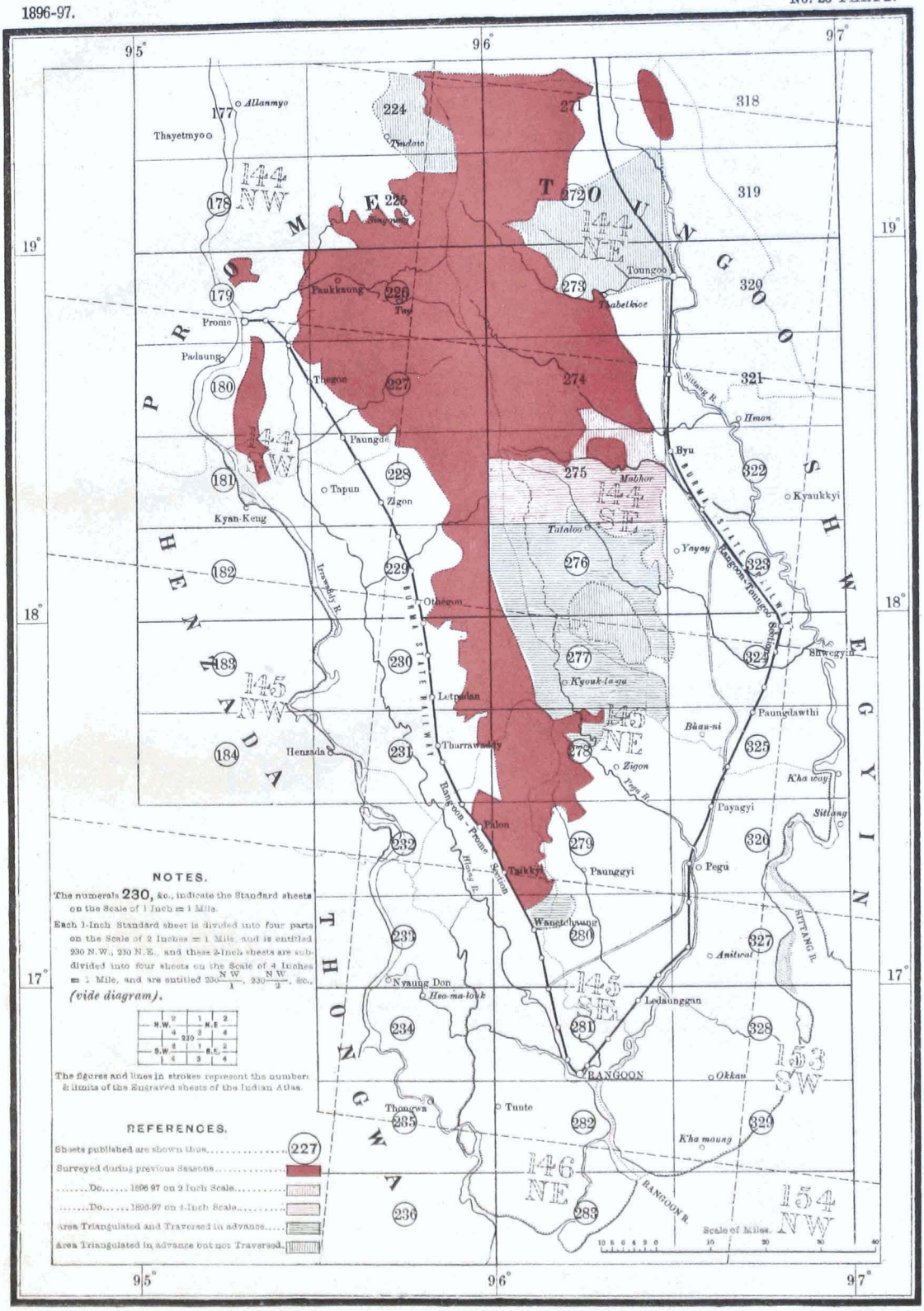
No triangulation was carried out this year, the existing G. T. stations being considered sufficient to check the traverses. The traverse work was conducted by Mr. Wilson and again shows an improvement in quantity and quality considering his reduced staff. The angular measurements were checked by 146 sun azimuths giving good results.

* The officer in charge has much pleasure in reporting favourably on the work of Messrs. Hamer and Hugh Todd who have shown constant zeal and ability in the execution of their duties.
The surveyors and sub-Surveyors have worked well throughout, with the exception of apprentice Sub-Surveyors, Baliram Jadu and Singaravelu Mudaliar.

BURMA SURVEY.

INDEX TO THE FOREST SURVEY IN LOWER BURMA.

1896-97. No. 20 PARTY.



NOTES.

The numerals **230**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2 Inches = 1 Mile, and is entitled 230 N.W., 230 N.E., and these 2-Inch sheets are subdivided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled $230\frac{N.W.}{1}$, $230\frac{N.W.}{2}$, &c., *(vide diagram)*.

N.W. 4	1	N.E. 2	
	230		
S.W. 4	3	S.E. 2	

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus..... 227

Surveyed during previous Seasons.....

.....Do..... 1896-97 on 2 Inch Scale.....

.....Do..... 1896-97 on 4 Inch Scale.....

Area Triangulated and Traversed in advance.....

Area Triangulated in advance but not Traversed.....

Reg. No. 349, S. I. D.—Jan. 98—650.

Photo., S. I. O., Calcutta.

No. 301-S. 98.

187. The principal portion of the detail work in the Shwegyin forest division was under Mr. Ewing. Mr. Charrier and Mr. O'Donel were employed on 4-inch work, the former also testing some plane tables late in the season. The work was systematically tested both by the officer in charge and assistants.

188. The outturn of 4-inch work shows a satisfactory increase on former years, although the country was more broken and the jungle to some extent worse than in previous seasons.

The cost rate calculated as in former years shows a small increase, though in reality the work is again cheaper. This is partly explained by the share of supervision, etc., that formerly was taken by the triangulation falling this year on the detail work; and partly by the extra cost of an Assistant Superintendent and a probationary Sub-Assistant Superintendent attached to the party, more for the purposes of training than because they were actually required. The total cost of the party for the year is practically the same as last year, but the outturn of finished survey shows a considerable increase. The cost of the work should continue to decrease, especially as the most difficult parts of the country have now been completed.

189. The country was much the same as described in former years, except that the work lay wholly in the hills, and the jungle for about 100 square miles was worse than any yet experienced.

190. The health of the party this season was again bad, the deaths being one sub-surveyor, four *khalásis* and one interpreter. Severe sickness generally shows itself in January and few, if any, of the party escaped during the first month of their return to India.

Tigers and elephants were a source of much trouble, the men being badly scared by them at times. Fortunately no deaths occurred from this cause, though a *khalási* was seized and carried out of a hut at night. It is supposed that his escape with nothing worse than a severe bite was due to the tiger stepping back into the camp fire. Twenty guns were obtained from the Local Government and issued to the surveyors working in the worst parts; they were of great assistance in giving the men confidence.

191. No supplies were available in the country where the surveyors were working with the exception of a little rice from Karen villages. The usual arrangements were made by means of depôts for feeding the men, and though the difficulties were great the supplies were successfully kept up.

192. During the recess all the computations and 4-inch fair mapping were brought up to date and thirteen 4-inch sheets were submitted for publication. Considerable progress was also made with the charts and general report of the party's work.

193 The programme for next season comprises :—

(1) The detail survey on 4-inch scale of the remainder of the Aingdon Kun, North Zamayi and Yenwe reserves. Also the Kadat, South Zamayi Nyabwa and Zahakawliya reserves.

(2) The traverse survey in advance of Shwelaung Kodugwe extension and Mayan reserves and unreserved forests in the Pegu district.

194. The party was inspected in the field by Colonel Sandeman, Deputy Surveyor-General, in February 1897, and in recess quarters by Lieutenant Colonel Hobday, I.S.C., Officiating Deputy Surveyor-General, in July 1897.

The Surveyor-General also inspected the recess office of the party in September 1897.*

OPERATIONS OF THE FOREST SURVEY BRANCH.

195 The administration and control of this special branch is in the hands of the Inspector General of Forests, while the direct supervision of the survey operations remained, throughout the year, in the hands of Mr. W. H. Reynolds, Superintendent of Forest Surveys.

* The officer in charge reports that Mr. Wilson deserves credit for the able way in which he has carried out the traverse work.

Mr. Ewing performed his duties most satisfactorily both in field and recess, and showed much energy and self-reliance.

Of the native establishment Amjad Ali, Sharfuddin, Kyaw Nyeing, Zahur Hasan, and A. M. Rodrigues are deserving of special mention.

196. With the exception of the surveys in Oudh, which had already been brought to a close, the operations which were in progress during the preceding season, were all continued during the year under report, *viz.*, those in the forest divisions of Ráipur, Bálághát, Nágpur-Wardhá, Seoni, Chhindwárá and Saugor in the Central Provinces; Chamba in the Punjab; Salween-Ataran in Lower Burma, and Pyinmana in the Eastern Circle of Upper Burma. In addition to the above, the survey of the forests in the Ruby Mines district of Upper Burma was taken in hand.

197. The several provincial field parties were divided into 9 separate detachments, 3 of which worked under the immediate supervision of a Deputy Superintendent (Mr. E. Litchfield) and each of the others worked under European supervision or under reliable and trustworthy native assistants.

198. The total outturn for the year is as follows :—

Triangulation		2,562 square miles.
Traversing		368 linear miles.
Detail Survey	1-inch scale . . . 802	2,365 square miles.
	4 " . . . 1,357	
	16 " . . . 206	
Spirit levelling		934 linear miles.

199. Throughout the 4-inch topographical work, in the Central Provinces and Chamba, instrumental contours were run, as usual, at vertical intervals of 250 feet and in the 1-inch survey of Chamba they were run at 1,000 feet intervals. The topography was further checked by running a considerable number of *partál* or check lines through the work.

Central Provinces.

200. Five detachments of the Forest Survey Branch were employed during the year on field operations in the Central Provinces. The forests operated on were those in the districts of (i) Ráipur, (ii) Bálághát, (iii) Nágpur with Wardhá, (iv) Chhindwárá, and (v) Saugor. Later in the season, after the completion of the survey of Ráipur and Bálághát, the detachments working in these districts moved into the adjacent districts of Seoni and Biláspur and continued field operations there until the close of the season. The several survey detachments took the field towards the end of November and, with the exception of the Ráipur party, returned to recess quarters by the end of June. The Ráipur detachment arrived at headquarters on the 16th July.

Personnel.

Mr. T. S. Marten, Extra Assistant Superintendent, 6th grade.
„ J. Marten „ „ „ 6th grade.
„ C. Litchfield, Sub-Assistant „ 2nd grade.
„ J. H. Nichol „ „ 2nd grade.
Babu Odey Sing, Forest Surveyor.
79 Native Surveyors.

201. The following statement shows the areas surveyed by each detachment and the cost rate per square mile of each branch of the work :—

Forest Division.	Triangulation.		Traversing.		Levelling.		Topography, chiefly on 4 inch scale, including forest growth and soil record.	
	Area in square miles.	Cost rate per square mile.	Linear miles.	Cost rate.	Linear miles.	Cost rate.	Area in square miles.	Cost rate per square mile.
		₹		₹		₹		₹
Nágpur-Wardhá	...	...	...	...	300	4·3	225	37·4
Bálághát	...	...	...	...	...	...	168	37·0
Seoni	...	...	...	...	...	...	179	
Chhindwárá	...	...	...	...	...	...	219	46·9
Ráipur	...	...	35	10·1	476	6·4	165	53·7
Biláspur	...	...	...	...	...	...	20	
Saugor	327	9·4	...	...	158	7·7	230	46·7
Mandlá	...	...	...	...	...	...	2	
TOTAL	327	...	35	...	934	...	1,208	...

202. Of the areas surveyed in detail 1,002 square miles were executed on the 4-inch scale and comprise the interior survey of the reserved forests, and 1,648 linear miles of forest boundary, with a strip of topography 5 chains wide on either side of the boundary, were surveyed on the 16-inch scale in full topographical detail and comprise a superficial area of 206 square miles. The latter surveys have been made for the purpose of securing a large scale and indisputable boundary record of the forest reserves. The outturn of the previous season was 1,025 square miles on the 4-inch scale and 127 square miles on the 16-inch scale.

203. The only district, in which it was found necessary to do any additional triangulation, was Saugor, and this work was done by Mr. T. S. Marten. In the districts of Ráipur, Nágpur and Wardhá, however, in the denser parts of the forests where the trigonometrical stations were few and far apart, as well as in portions of the Saugor district it was found necessary to run lines of spirit levels to afford a sufficient and ample basis for adding instrumental contours to the topographical work. The only traversing that was necessary during the season was that required for connecting the existing traversing with the triangulation of the province, and these connections were only made where the traverse lines passed within easy distance of a trigonometrical point.

204. The topographical work was tested by running 1,399 miles of *partál* or check surveys through it and the instrumental contours, which were run at 250 feet vertical intervals, also afforded a further check on the detail survey.

205. In the way of mapping a large amount of work has been got out of hand. Out of a total of 433 sheets, 254 have been published and the remainder are either passing through the press or are in hand. Of these 202 were completed in previous seasons.

206. The total expenditure was R64,663, of which R61,303 was on account of surveys that are in progress, and R3,360 was expended on drawing and photo-zincographic charges for forest maps of the Jubbulpore, Narsinghpur and Bhandára divisions and of areas previously surveyed. The average cost rate of the detail topographical surveys was R43 3 per square mile, as compared with R41·6 in the previous year and R50 in 1894-95.

207. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was in the Central Provinces from the 27th February to 17th March, and satisfied himself that the field work of the survey detachments was being efficiently conducted.

PUNJAB.

208. The survey of the Chamba State and Government leased forests was in continuation of the previous year's operations. The leased forests are being surveyed on the 4-inch scale and the rest of the State is being mapped on the 1-inch scale for topographical purposes.

Personnel.
Mr W. H. Reynolds, Superintendent, 2nd grade.
„ J. Marten, Extra Assistant Superintendent, 6th grade,
10 Native Surveyors.

209. The field season extended over various limited periods throughout the year which were determined by the nature of the climate in the Himálayas.

210. Nothing in the way of triangulation was done, as this branch of the work was sufficiently in advance for the season's topographical work. A considerable area, however, has been flagged in advance for the coming season's triangulation.

211. Topographical operations on the 1-inch scale extended over the Tisa, Chamba and Barmaur ranges; the 4-inch surveys were also confined to the forests in those ranges. Instrumental contour lines were run throughout the 4-inch surveys at vertical intervals of 250 feet, and similar contours were run through the 1-inch work at vertical distances of 1,000 feet.

212. The following statement exhibits the areas completed during the year, as well as the cost rates per square mile:—

State.	Description.	Area in square miles.	Cost rate per square mile.
			R
Chamba . . .	Topographical survey 4-inch scale.	87	29·8
	Ditto ditto, 1-inch scale.	802	8·5

213. Of the total expenditure in this province, *viz.*, R11,124, the expenditure on account of survey operations in the Chamba State amounted to R9,731,

whilst R1,393 were expended on mapping and the publication of the 4 and 1-inch sheets of the Bashahr State.

214. Mr. W. H Reynolds, Superintendent, Forest Surveys, was in the Chamba State for about two months during the summer and again in September personally directing the survey operations; and Mr. J. Marten was with the Chamba party from the 21st August to the close of the survey year, examining and testing the details of the topographical survey.

BURMA.

215. Three detachments were employed during the year on field operations in Burma and the forests operated on were those in the forest divisions of—

Personnel.
Mr. E. Litchfield, Deputy Superintendent, 2nd grade.
29 Native Surveyors.

Salween-Ataran in Lower Burma.
Pyinmana, Ruby Mines } in Upper Burma.

The above detachments were under the immediate charge of Mr. E. Litchfield, Deputy Superintendent.

216. The surveys in the Salween-Ataran and Pyinmana divisions were in continuation of the previous season's operations, and the operations in the Ruby Mines division were taken in hand during the year under report.

217. The surveyors left Dehra about the middle of November and returned to recess quarters at the end of June.

218. The Salween-Ataran and Pyinmana detachments were employed on traversing and detail survey on the 4 inch scale, while the Ruby Mines detachment was engaged on preliminary work of triangulation and traversing, as a basis for the following season's topographical survey. Some triangulation was also done in the Salween-Ataran division.

219. The triangulation in the Salween-Ataran division was done by Babu Salig Ram, under very trying circumstances, and he succeeded in connecting it satisfactorily, by long rays, with the previous triangulation. In the Ruby Mines district the triangulation in the forest tracts was done by Babu Mittan Lal, and the connecting lines, between the Mandalay series of the Trigonometrical Survey and the Forest Survey triangulation, which necessitated observations at four different stations, was done by Mr. E. Litchfield, Deputy Superintendent. The observations on the connecting triangles are very incomplete and can scarcely be considered satisfactory. The failure to obtain complete observations for the connecting triangles is attributed, by Mr. E Litchfield, to the season being an unusual one in as much as hazy weather set in as early in the season as the 19th December, and it was only at occasional intervals, for a day or so at a time, that the atmosphere partially cleared. When Mr. Litchfield discovered that he had difficulties of this nature to contend against so early in the season, there is no reason why he should not have effected a connection, by shorter rays, with the existing trigonometrical stations farther south, instead of losing valuable time between December and March in making useless attempts to secure observations to unusually distant stations. A second connection with the Mandalay Meridional series with shorter rays will be effected during the early part of the coming field season, as a check on the previous season's triangulation.

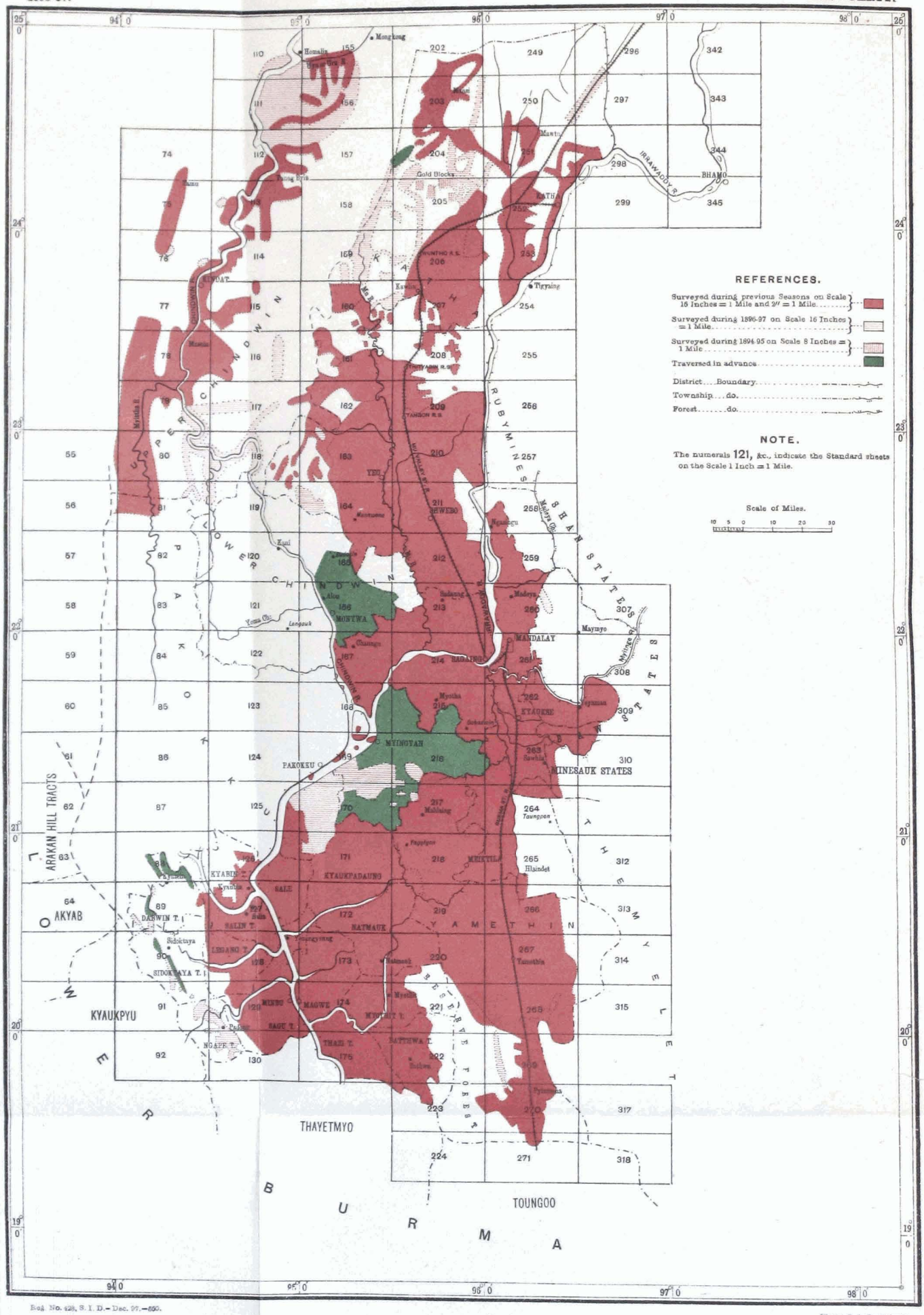
220. The following statement shows the areas completed and the cost rate of each class of survey :—

Forest Division.	Triangulation.		Traversing.		Detail Survey on 4-inch scale.	
	Area in square miles.	Cost rate.	Linear miles.	Cost rate.	Area in square miles.	Cost rate.
		R		*R*		*R*
Salween-Ataran . .	523	7 7	109	29·1	97	99 3
Pyinmana	...	...	83	45·1	171	105 2
Ruby Mines	1,712	7·7	165	33·4	...	...
TOTAL .	2,235	...	357	...	268	...

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN UPPER BURMA.

1896-97. No. 3 PARTY.



Surv. No. 428, S. I. D.—Dec. 97.—600.

Photo. S. I. O., Calcutta.

No. 472-S. 97.

221. The angular measurements on the traversing were checked by 66 azimuth observations and the distances by connections with trigonometrical stations. The detail survey was checked by running 186 miles of *partál* lines through the topographical work.

222. The mapping is well advanced, out of a total of 53 sheets, 40 have been published and the remaining 13 are either in the press or in progress.

223. The total expenditure on the above operations, including the season's mapping and other charges connected with the Burma surveys, amounted to ₹57,253, as against ₹29,792 in the previous year. The increase is due chiefly to an additional Forest division (Ruby Mines) having been brought under survey during the year, as well as, to the fact that it was found necessary to put a Deputy Superintendent, Mr. Litchfield, in charge of the survey operations, thereby increasing the total cost by his pay and allowances.

224. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was in Burma from the 18th January to the 19th February; and visited in turn, each of the survey detachments and inspected the various branches of the field work that were in progress.

225. Further details of the work carried on by the Forest Survey Branch and index maps illustrating the survey operations, will be found in the Progress Report on the operations of the Branch published under the direction of the Superintendent of Forest Surveys.*

CADASTRAL SURVEYS.

MYINGYAN, KATHA, UPPER AND LOWER CHINDWIN DISTRICTS, UPPER BURMA.

No. 3 Party.

226. Up till 11th December 1896, Mr. G. H. Cooke held charge of this party when he retired on a superannuation pension. From the 12th December to the end of the season, Mr. E. G. Little, Extra Assistant Superintendent, 2nd grade, was given charge of it, there being no Imperial officer experienced in cadastral surveys available at the time.

Personnel.

Mr. G. H. Cooke, Superintendent, 2nd grade, in charge up to 11th December 1896.
„ E. G. Little, Extra Assistant Superintendent, 2nd grade, in charge, from 12th December 1896.
„ J. Connor, Extra Assistant Superintendent, 4th grade.
„ G. C. Swiney „ „ 5th „
„ C. W. Wilson, „ „ 5th „
„ A. George, „ „ 6th „
„ W. J. Baker, Sub-Assistant Superintendent, 1st „
„ O. C. Ollenbach, „ „ 2nd „
„ W. Newland „ „ 2nd „
Babu H. K. Roy, „ „ 3rd „
Mr. E. G Hardinge, „ „ 3rd „
98 Sub-Surveyors and others.
10 Inspectors.
100 Field Surveyors (Indians).
20 „ „ (Burmans).

227. As has been the case with this party for the last two or three seasons, the programme was most varied and scattered over no less than eight districts. It consisted of—

(1) The completion of the traverse and continuation of the field survey of the Myingyan district.
(2) The traverse and cadastral survey of some of the valleys in the Minbu district, omitted by No. 12 Party.
(3) The traverse of a portion of the Lower Chindwin district.
(4) The continuation and the completion of the traverse and cadastral survey of the Katha district (including the survey on 8-inch scale of two gold blocks).
(5) The continuation and completion of the traverse and cadastral survey of the Upper Chindwin district and the revision of certain portions.
(6) The cadastral survey of 22 villages in the Shwebo district.

* Mr. Reynolds reports most favourably of all his European Assistants and specially mentions Mr. J. Marten, as being an able surveyor and as having done excellent work both in the Central Provinces and in Chamba.

Of the Native Surveyors, Salig Ram is highly commended for his zeal and ability in triangulation; Odey Sing, Dalip Sing, and Bhoop Sing, are mentioned as being good topographical surveyors, and Badri Dutt, and Bimala Charan Shome as good computers.

In office Kali Kanth Kar has done excellent work and is deserving of special mention, and Lalit Mohon Basak has also done good work.

(7) The cadastral survey of 45 villages in the Pyinmana sub-division of the Yamèthin district.
(8) The cadastral survey of seven outlying villages in the Mandalay district.
(9) The triangulation of a portion of the Myingyan district, and,
(10) Revised tracing and recasting of area statements according to the rearrangements of boundaries by Settlement Officers in districts Sagaing, Meiktila, Katha and Shwebo, etc.

228. The party left Mandalay between the middle and end of November and field operations were started on arrival of the camps at their destinations.

The return to recess was made during the months of May and June as each camp finished its work.

District Myingyan.

229. The work in this district was simply a continuation of what had been done the previous year and consisted of the traverse survey of 881 square miles and the cadastral survey of 781 square miles.

The demarcation had been effected and the boundaries of *kwins* marked by wooden posts, but these were in most cases too far apart to indicate the boundary clearly; so the field surveyor often had to depend on the *thugyis* interpretation of it in the portions that intervened.

230. The traverse survey of this district which is now complete contains 10,014 stations and 2,085 linear miles of chaining; the angular measurements have been checked by 55 observations for azimuth, whilst the linear measurements have been connected with five triangulated points specially fixed from the nearest G. T. bases. Forty-two permanent marks, such as pagodas, were also connected with the traverses.

231. The cadastral survey was mapped on 1,041 sheets on the 16-inch scale and was checked by 2,033 linear miles of *partal*, giving an average of 2·6 miles of check line per one square mile of area. The average area of the field is 2·18 acres. Only about 1,000 square miles remain for detail survey in this district, and it is believed that next season will see it completed.

232. The country was in portions much cut up by ravines and covered with sparse vegetation, such as thorny trees and cactus, but still containing a good deal of upland cultivation, portions of which have been abandoned for the last two or three years, but which a more favourable season would soon see resumed. The want of water has been much felt in this district, and great difficulty was experienced in keeping the men supplied.

233. In the Pagan township the ruins of the town and fort of Pagan (one of the ancient capitals of Burma) are still to be seen and include many large pagodas, some few of which are kept in repair and visited by thousands of Burmans during their festivals. Surrounding the site of the old town for some miles in all directions lie the ruins of pagodas of all sizes and shapes, which can be numbered in hundreds and form a desolate picture but a characteristic feature of this part of the country. Pagan is now famed chiefly as the seat of the important industry of lacquer work manufacture, which appears to be the principal occupation of its present inhabitants.

District Minbu.

234. The work in Minbu consisted of the traverse and cadastral survey of scattered villages along the valleys of Ngapè, Kyabin, Salin and Sidôktaya townships which had been omitted by No. 12 Party and maps of which were now called for by the Land Records Department to complete the district records. These valleys are situated at the foot of the Arakan Yomas, some miles to the west of the work done in this district by No. 12 Party, with which they had to be connected at intervals by traverse lines which had to be carried over very rough ground and through dense jungle, adding greatly to the labour and cost. They are as well known for the fertility of their soil as for the unhealthiness of their climate, and the men suffered a great deal from fever and dysentery while engaged in surveying them; this, added to the absence of definite information as to the extent of work required which demarcation maps could alone have supplied, prevented the district being finished. The demarcation was not started until

after work had actually commenced, and the traverse sub-surveyors were obliged to precede the demarcation officer, doing the best they could under the guidance of the *thugyis*. As it is believed that the lines run by the sub-surveyors fairly represent the limits of each *thugyis* charge, it would be advisable as much as possible to adopt the traverse stations as the boundary marks of the *kwins*. The detail survey comprised 160 villages which were mapped on 175 sheets on the 16-inch scale. The average size of the field is 0·74 of an acre. It was checked by 141 linear miles of chain lines.

235. The area remaining, which cannot be large, will be taken up and completed during the ensuing season.

District Upper Chindwin.

236. This district up to the Uyu river has been completed; all that was left for traverse and cadastral survey, in the portions allotted for work, having been taken up during the season. No demarcation had been attempted in this district, the survey being confined to the areas of cultivation wherever it was found, the limits of each area forming a block; where these blocks were large, they were divided up into *kwins* as pointed out by the *thugyis*.

237. The cadastral area comprised 317 villages which were plotted on 292 16-inch sheets; the average size of the field being 0·33 acre. It was not considered advisable to extend the survey to the north of the river Uyu as, though extensive tracts of cultivated land are reported as existing in the Hukong valley, it was considered too remote to be included in this year's programme.

238. The area surveyed is small, but is so scattered and with such masses of hills and jungle dividing the separate blocks of cultivation which had to be connected to each other by traverse lines that the cost and labour involved and difficulties experienced in surveying them are out of all proportion to the result.

District Katha.

239. The traverse operations in this district embraced nearly the whole of Pinlèbu, and parts of the Banmauk and Mansi townships, and are now completed. As in Upper Chindwin there was no demarcation in Katha and the same procedure that was carried out in this latter district had to be adopted here also. The angular measurements were as usual checked by astronomical azimuths, whilst the chaining was connected with four G. T. stations. In addition to the traverse stations 116 permanent objects, such as pagodas, were fixed by the traverse surveyors.

240. The cadastral survey covered an area of 229 square miles, leaving about 20 square miles in the Ga-nan circle to be completed next year, which will complete the district. This circle was at the request of the Deputy Commissioner included in our programme in the middle of the field season; it was traversed, but owing to the early setting in of the rains the detail survey could not be completed. The season's detail survey comprised 616 villages which were mapped on 654 sheets on the 16-inch scale. Chain lines aggregating 584 linear miles were run to check it. The average size of the field is 0·55 acre.

241. Most of the cultivation was found bordering the streams or lining the valleys, especially along the banks of the Mu river, which flows north and south through the township of Pinlèbu. All the difficulties experienced in Minbu and Upper Chindwin owing to unhealthiness of climate, rugged nature of country, difficulties of transport, and scattered style of work, were intensified in the portions surveyed this season of Katha. Not only was the work dotted over a vast area, but the difficulties were enhanced owing to the greater sparseness in the population of the country, the loftier and more rugged nature of its hills and its more deadly climate, all combining to swell the cost and make the work very expensive.

242. Two square mile blocks in the gold tracts traversed in season 1894-95 were surveyed topographically on the scale of 8″=1 mile, completing the surveys of the grants which have been applied for so far.

Districts of Shwebo and Yamèthin.

243. The work in these districts comprised the cadastral survey of 22 villages in the former and 34 in the latter traversed the year before, thus com-

pleting these districts. The area was mapped on 98 and 81 16-inch sheets respectively, and was *partalled* by 39 and 26 linear miles of chaining. The average size of the field in Shwebo is 5·7 and in Yamèthin 3·4 acres.

DISTRICT MANDALAY.

244. Seven outlying villages, which were not demarcated at the time of the survey of the district, were surveyed at the request of the local authorities.

DISTRICT LOWER CHINDWIN.

245. The whole of the country on the left bank of the Chindwin river having been demarcated, the traverse survey of the district was started and 482 square miles completed, the cadastral survey of which will, according to orders just received, be undertaken during the ensuing season. The tract brought under survey is chiefly a rice-bearing one and extends along the river bank and about two miles inland as far south as the Sagaing district. The principal road of the district is the bridged and partially metalled one, that connects Myinmu on the Irrawaddy in the Sagaing district, to Mônywa on the Chindwin the chief town of the district,—and is continued on to Ablow, the former capital. The greater part of the Chindwin-Mandalay trade is carried on by this route.

246. The total outturn for the season is shown in the following table :—

DISTRICTS.	TRAVERSE SURVEY.		CADASTRAL SURVEY.		
	Number of villages.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Myingyan	835	881	782	230,161	781
Minbu	281	151	160	49,940	57
Upper Chindwin	64	46	317	244,535	129
Katha	447	186	616	267,235	229
Shwebo	...	...	22	5,053	46
Yamèthin	11	16	34	10,551	56
Mandalay	...	...	7	6,783	2
Lower Chindwin	361	482	...	...	...
Katha (gold fields)	...	2	...	...	2
TOTAL	1,999	1,764	1,938	814,258	1,302

247. In addition to the area traversed, as shown in the above statement, there are the lines which were run to connect the outlying blocks in the Upper Chindwin and Katha districts; the expenditure of time and money on these has been considerable, and there is little or nothing to shew for it. It is a question whether these should be run in future, now that topographical survey parties have been organised for the whole of Burma.

248. The usual precautions, such as the employment of two chains in the measurement of main and sub-circuit lines and the use of the clinometer for observing angles of elevation and depression in hilly ground were taken; the different camps and field parties were inspected frequently during the field season by the officer in charge, and every means adopted to ensure good work.

249. In accordance with the Deputy Surveyor-General's instructions, the *amins* were directed to ink up their sheets, and if capable of doing so, extract the areas of the fields surveyed by them before sending in their work; the system inaugurated, new as far as Burma is concerned, proved quite a success as regards the inking in of the maps, but the area work, whenever attempted by the *amins* leaves much to be desired, as most of the field areas have had to be re-estimated in office.

250. The Local Government having ordered cash to be paid daily for all labour employed, the sub-surveyors and *amins* had to be entrusted with money

to make these payments, but the system has proved a failure, as the men are not to be trusted to pay the coolies employed in full. The officer in charge strongly recommends the reintroduction of the old system, *viz.*, that of all payments being made by the European officers only, on production of vouchers by *thugyis*, signed by the sub-surveyor or *amin*. This system has proved a success in almost every district in which it was adopted, the only exception being, so far as is known, in the Upper Chindwin district, two or three years ago when there were no assistants available to visit the work which was situated far away from the rest of the area under survey and where some bills were left unpaid in consequence. The system here advocated not only ensures payment for all labour employed, but brings the *thugyis* into contact with the European Officers, who are thus enabled to enquire into any little differences that may arise between the *thugyis* and survey staff, and is beneficial in every way both to the work and the people of the country.

The rains having again failed, the season has been a very severe one, and the money paid for coolies, R13,484, must have been of some help in tiding the people over a time of scarcity. Four annas a day was generally paid, but in portions of Upper and Lower Chindwin and in Katha six and eight annas a day per man were demanded, which seemed to be very excessive, considering the rates that prevailed at the famine works, where the men were paid at only $2\frac{1}{2}$ annas per day.

251. Thirty-eight Burman *amins* presented themselves for training in practical surveying. Seventeen of these belonged to Class I. and twenty-one to Class II of the Scheme of 1894. Seven joined the camp at Wuntho, and thirty-one the camp at Pagan. One man died and another went away ill and did not return; but the rest stuck to their posts and have been well trained, the work they turned out being very fair both in quality as well as in quantity.

252. After the first showers in April the men working in Minbu, Upper Chindwin, and especially in Katha, suffered terribly from fever and dysentery, in some cases whole squads including the *amin*, inspector and measurers, going down as one man. Only fourteen died in the field, but some have succumbed since, and many more have had their constitutions thoroughly shattered.

253. One sub-surveyor was deputed to the Marine Transport Department to survey the upper reaches of the Irrawaddy river above Bhamo.

254. The head-quarters and one camp were inspected at Mandalay and Pagan, respectively, during January last by the Deputy Surveyor-General, who expressed himself as well pleased with all he saw.

255. Relations with the district authorities were of the most cordial nature, all assistance asked for being readily afforded; and thanks are especially due to Mr. B. S. Carey, C.I.E., Deputy Commissioner of Myingyan, and Mr. Martin, the Sub-Divisional Officer of Wuntho.

256. Exclusive of the current season's work the following traces of *kwins*, as revised, were made for the Settlement Officers of Meiktila, Sagaing, Shwebo and Katha and for Calcutta, and a large number of volumes of the traverse work of previous seasons were examined, indexed and bound:—

District.	Tracings for Settlement.		Tracings for Calcutta.		Tracings of 4″ & 2″ sheets.
	Kwins.	Fields.	Kwins.	Fields.	
Sagaing	24	22,021	24	22,021	...
Shwebo	631	268,499	615	322,101	...
Do.	104	45,198	...	...	...
Meiktila	...	...	654	2,81,069	...
Katha	76	137,022	..	...	...
Yamèthin	Tracings prepared for Irrigation Department				28 four inch. 11 two inch.
Total	835	472,740	1,293	625,191	39

257. A second set of tracings of 18 two-inch sheets of district Meiktila was prepared for the Deputy Commissioner, and a tracing of 1 two-inch sheet of district Meiktila was prepared for Irrigation Department.*

BIHÁR.

No. 4 PARTY.

258. The programme of this party as originally sanctioned by the Government of Bengal provided for the continuation of the Bihár surveys by one traverse section and two cadastral sections, and the areas to be completed were to have been 50 square miles of traverse and 500 square miles of cadastral survey in Sáran and 317 square miles of traverse and 600 square miles of cadastral work in the northern part of Darbhanga. Owing, however, to the threatened famine in North Bihár, orders were subsequently issued to the effect that the Sáran cadastral section should take up a small area in Thána Basantpur, and that the Darbhanga section should work in the south of that district instead of in the north. These areas were selected as being those least likely to suffer from the threatened famine, and the experience of the year shows that no better tracts could have been chosen. In addition to the above a detachment under Mr. E. F. Berkeley was employed in district Noákháli (*a*) in the traverse and cadastral survey and in the record writing of certain Government estates in the islands of Sandip and Hatiya; (*b*) in the traverse and topographical survey on the 16-inch scale of other Government estates; and (*c*) in the traverse and topographical survey on the 2-inch scale of the remaining portions of the islands of Sandip and Hatiya, as well as of the other islands and new accretions at the mouths of the Fenny and Meghná rivers. A traverse surveyor under the immediate control of Captain Crichton himself was also sent to Midnapore, with a view to surveying and writing the records of 14 villages of the Majnamutha Estate, as a test of the accuracy of the old maps and records of that estate prepared by Mr. J. C. Price in 1875; this was required in order to decide whether the old maps were capable of revision or whether a new survey would be necessary.

Personnel.

Captain R. T. Crichton, I.S.C., Deputy Superintendent, 1st grade, in charge.
„ C. W. H. Symonds, I.S.C., Officiating Deputy Superintendent, 2nd grade.
Mr. H. Dowman, Extra Assistant Superintendent, 2nd grade, from 21st September 1897.
„ A. W. Smart, Extra „ „ 5th „
„ C. S. Kraal „ „ „ 6th „
„ C. S. Gasper Sub „ „ 1st „
Babu Nilmoni Chatterjee „ „ „ 2nd „
Mr. P. K. Vaughan „ „ „ 2nd „
59 Supervisors and Inspectors.
10 Surveyors and Sub-Surveyors.
15 Computers.
249 Amins (local).
287 do. (imported).

Noákháli detachment.

Mr. E. F. Berkeley, Sub-Assistant Superintendent, 1st grade in charge.
5 Inspectors.
6 Surveyors.
32 Amins.

259. It having been decided that the Bihár survey parties should be reduced from four to two cadastral sections, it was proposed by the Government of Bengal and sanctioned by the Government of India, *vide* letter No. $\frac{1368}{40\cdot6}$, dated 3rd June 1896, that Captain Crichton should, in addition to his administrative duties as Superintendent of Settlement Surveys in Bengal, take over the executive control of the Bihár surveys, and that his head-quarters should be transferred from Calcutta to Bihár. Captain Crichton accordingly took over charge of the survey party from Captain Symonds on the 30th October 1896, that officer remaining as his assistant in charge of the traverse section. Captain Symonds also held charge of the party from the 12th February to the 17th March, when Captain Crichton was forced to take privilege leave owing to ill health.

260. As was the case in previous years the survey establishments have been utilised as part of the Settlement Department. The same *amin*, who surveys

* The officer in charge reports that Mr. Connor and all the European assistants have worked well, and that amongst the Native Establishment the names of Babu Bhagobutty Charan Chuckerbutty and Pandit Kedar Nath have been brought to special notice, whilst the following have done excellent work:—Tufail Ahmed, Mohamed Nisar Ali, Harput Rai, Tajammal Aly, Bhikam Chand, Pardrajlu, Rohan Lall, Ram Sarup, Rafaulla, Srikristo Chatterjee, Bachai Khan, Shib Lall, Surfraz Khan, and Abdul Saqur.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT SARAN.

1896-97.

No. 4 PA

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Photo. S. I. O.

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a village, writes the *khánápuri* thereof under the supervision of the Settlement Department, assisted by the inspectors of the Survey Department. During the recess season the same *amin* extracts one set of the field areas of the village surveyed by him and completes, with the aid of his *moharrir*, all the village records and statistics. No areas have been extracted in the field, it having been proved, by an experiment made last year, to lead to inaccuracy and to add considerably to the expense without any corresponding advantage.

261. For the temporary demarcation of village boundaries, notices in duplicate for every village were sent to the Collectors of districts who distributed them. In these notices the inhabitants were directed to mark every salient angle on their boundaries with a bamboo staff and small earthen mound. As a rule, the demarcation has been very fairly done, and it generally followed the limits of the revenue survey *mauza*, but in certain cases it followed the limits of existing *mauzas*, *i.e.*, in cases where the revenue survey *mauza* had been divided into two or more portions, each portion was demarcated as a separate village. All theodolite stations, whether actually on the village boundary or not, have been permanently marked, except in *diára* tracts, or on disputed boundaries. Receipts on printed forms for all permanent marks were taken from the *zamindárs* and other parties concerned, and as a further safeguard all such marks were covered over with small mounds of earth.

262. Except in the Government estates in Noákhálí, all village sites were surveyed in detail on the scale of 64 inches=1 mile.

263. During the year under report the procedure in dealing with lands liable to flooding by river action has been altered. The main difficulty was to arrive at a line which would, with fair accuracy, define villages subject to river action from those not so subject, more especially so as in many cases only a portion of a village is affected. It was eventually decided that all *diára* lands should be traversed, and that a surveyor should pass over the ground and mark on a skeleton map on a small scale the approximate position of the line separating fields which have permanent boundaries from the true *char* lands. On the riverside of the line thus arrived at, all villages entirely or partly belonging to Government were to be cadastrally surveyed in the ordinary course, and villages entirely permanently settled or temporarily settled, but not the property of Government, were to be only topographically surveyed on the 16-inch scale.

264. No labour has been supplied free of charge in any of the districts in Bengal during the past season. Besides his chainman on fixed pay of R4 per mensem, each *amin* is allowed 3 coolies while employed on survey. In districts Sáran and Darbhanga coolies were obtainable everywhere at 1½ annas each per diem, but in Midnapore 2 to 3 annas had to be paid to each cooly. In Noákhálí no coolies could be obtained, and *khalásis*, on fixed pay, had to be provided.

265. During the field season the health of the survey establishments was very good. In the islands of Noákhálí there was an epidemic of cholera, but the establishment did not suffer therefrom, only one *amin* dying of cholera; the *khalásis*, however, suffered a good deal at the end of the season from fever and dysentery.

266. The head-quarters of the Bihár survey and the traverse section recessed at Mussooree. The Sáran and Darbhanga sections recessed at Dígna near Dinapore, whilst the Noákhálí detachment recessed at Dacca.

Survey of the Sáran District.

267. *Traverse Survey.*—The traverse survey in this district was commenced on the 25th October 1896, and closed on the 18th March 1897, when the section moved up to Mussooree to its recess quarters. The whole of the area traversed is *diára* land on the Gandak river and was contained in one river circuit which was sub-divided into 7 sub-circuits, each sub-circuit containing from 14 to 15 villages. The total linear miles of chaining amounted to 189 miles. Two chains of 100 and of 93 links respectively were used on the river and sub-circuits, the results being compared on the spot. Only one chain was used on the village circuits. The angular work was checked by two star azimuths and the bearings and azimuths of the adjoining traverses. No permanent marks were put up, as the entire area is *diára* land; only pegs were used. The cost rate is R89·3 per square mile.

268. *Cadastral survey and writing of records.*—The cadastral operations were confined to the Basantpur Thána and to a strip of *diára* land along the Gandak river and in Thána Gopálganj. Field work was not commenced until the 25th November, owing to the uncertainty as to the programme which would be finally approved of by the Bengal Government. The programme eventually sanctioned was a very small one, but, as field work commenced late and it was necessary to close work early on account of the threatened scarcity, sufficient employment was found for the full strength of the section. It closed field work and moved into recess quarters at Dinápore on the 29th March.

269. The area surveyed which lies in Thánas Basantpur and Gopálganj is mapped on 363 sheets on the 16-inch scale, and in addition there are 218 sheets on the 64-inch scale on which village sites have been mapped. The average size of the field in Thána Basantpur is a little under 0·32 of an acre and in Thána Gopálganj 0·70 of an acre ; the larger size of the field in Gopálganj is due to the villages there being *diára*. To check the survey 656 linear miles were chained by European officers or by independent *partáls*, and 563 linear miles by inspectors. The number of entries checked in the field records by European officers was 3,924 and by inspectors 102,900, which gives an average of 26 per cent of the whole number of fields. The cost rate for detail survey is ₹142·03 per square mile and for record writing ₹128·62. The *raiyats* on the whole showed great interest in the operations and were always anxious to obtain their *parchas*; the attendance during the survey stage was, however, as usual very indifferent.

270. *Topographical survey.*—In accordance with the orders of the Bengal Government the *diára* lands were surveyed on the 16-inch scale; all topographical details of importance were carefully surveyed and extensively checked. Nearly the whole of the *diára* tract, which occupied 24 entire villages and portions of 31 others, was under temporary cultivation. The village sites were surveyed on the 16-inch sheets in blocks only not in detail. The cost rate of this work is ₹55·48 per square mile.

271. The areas of work completed are given in the following table:—

District.	Traverse Survey.		Cadastral survey, 16 inches=1 mile and Record writing.			Topographical survey, 16 inches=1 mile.
	No. of stations.	Area in square miles.	No. of villages.	No. of fields.	Area in square miles.	Area in square miles.
Sáran . .	765	60·1	324	412,843	209·6	25·2

272. The area remaining for traverse survey in Sáran is 168 square miles and for cadastral and topographical survey 1,190 square miles.

Survey of the Darbhanga District.

273. *Traverse Survey*—After a delay of 3 weeks, caused by the doubt as to where the traverse section was to work, sanction was received to commence in the southern portion of the district in Thánas Dalsingh Sarái and Mohamdinagar. The area in the former consisted almost entirely of *diára* lands on the Ganges river, the plots of which were required at once for detail survey. The whole area traversed was comprised in one river and two main circuits, which were again sub-divided into 21 sub-circuits. Each sub-circuit contains on an average 22 villages.

274. The total number of linear miles chained amounted to 1,745. As in Sáran, two chains were used on the main and sub-circuits and only one on the village circuits. Two stations of the Great Trigonometrical survey were connected with to check the chaining. The angular measurements were checked by 42 star azimuths. Of the 8,608 new stations, 705 were trijunction points and were marked by stones and large glazed cylinders 8-inches in diameter. Along village boundaries 6,642 stations were marked by clay cylinders 2-inches in diameter. The remaining 1,261 stations being in the *diára* tract or on

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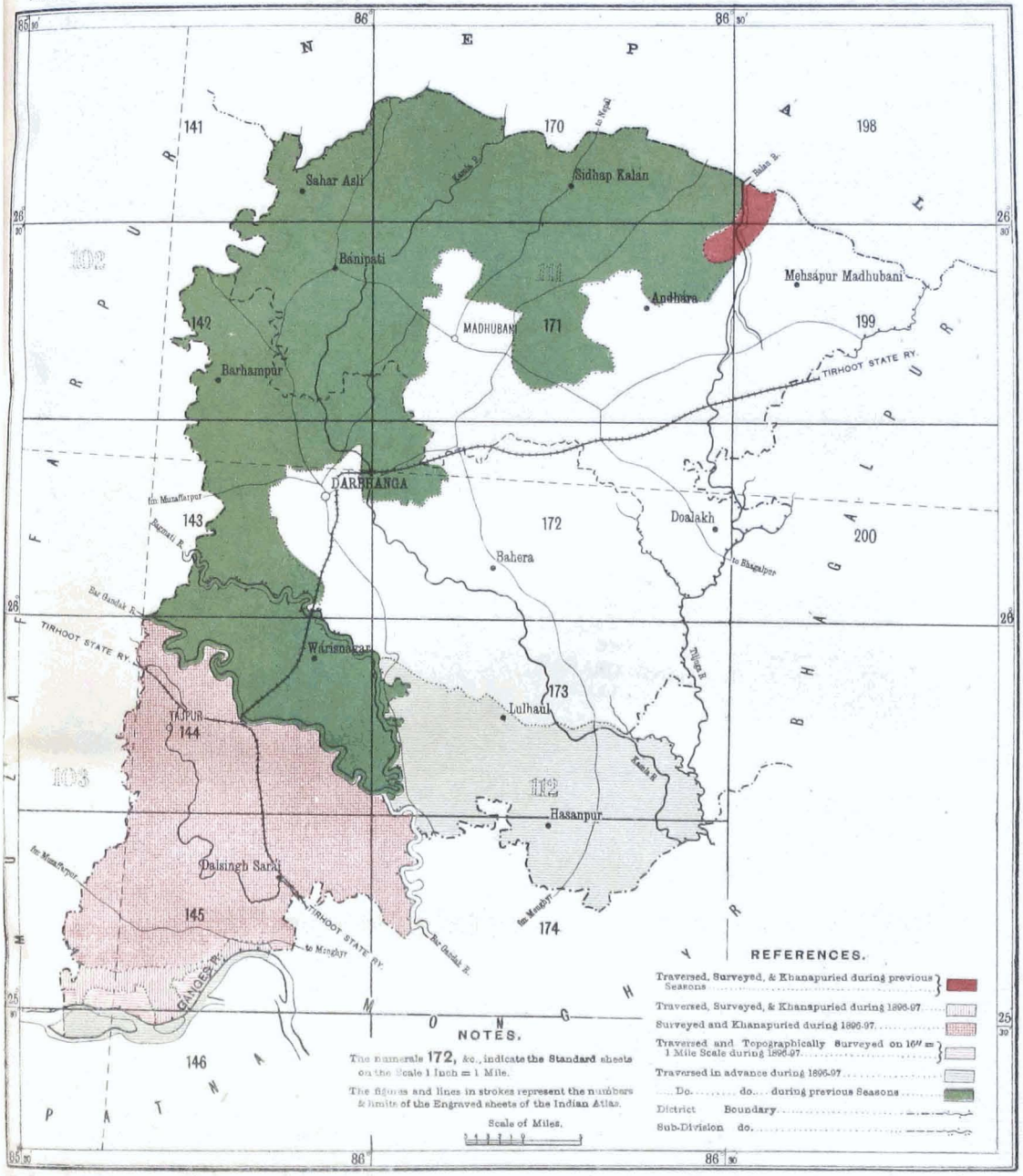
1896-97. No. 4 PARTY.



Reg. No. 490, S. I. D.—Nov. 97.—1,150.

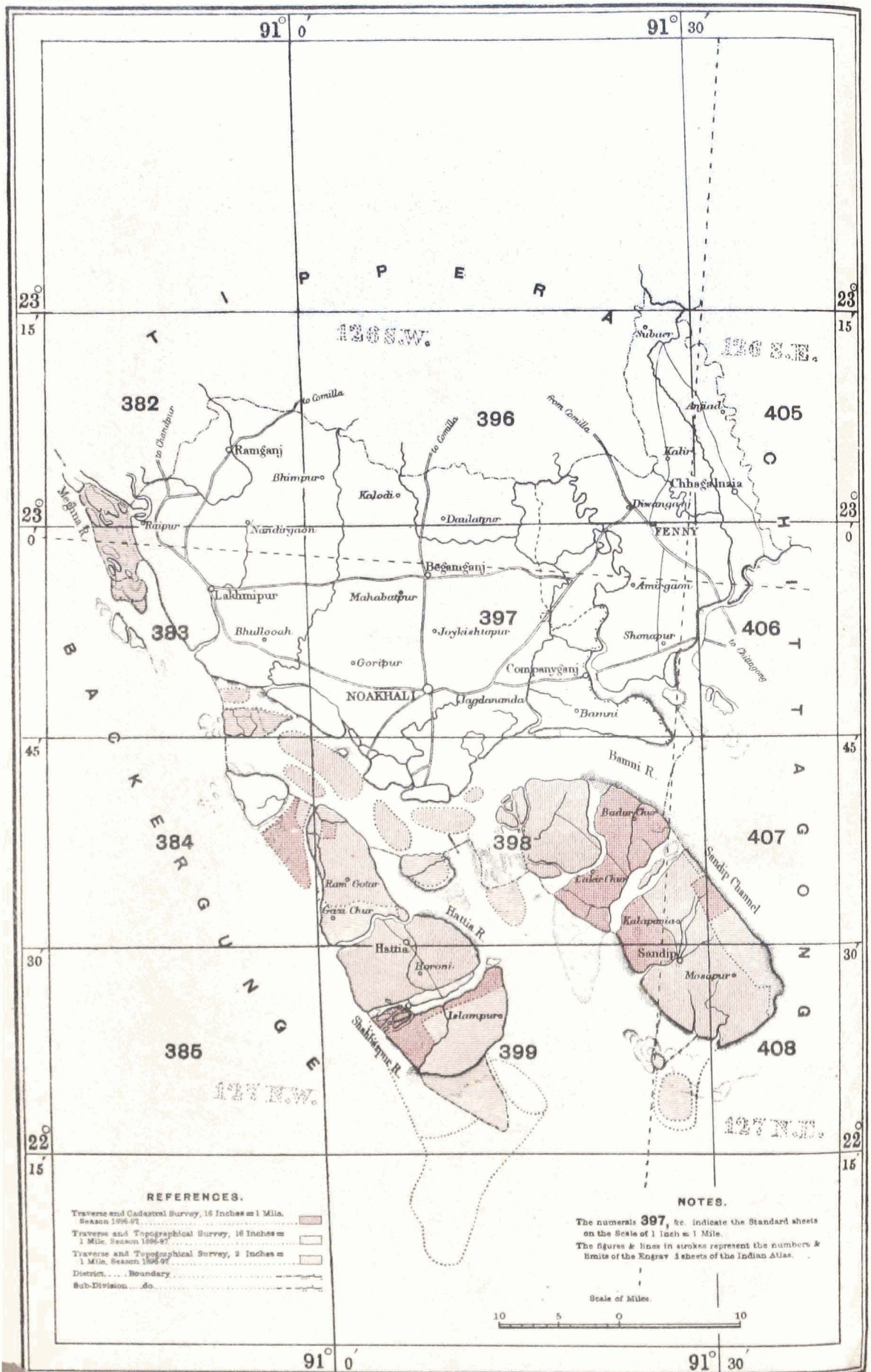
Photo S. I. O., Calcutta

No. 458-S. 97.

BENGAL SURVEY.

INDEX TO THE CADASTRAL & TOPOGRAPHICAL SURVEYS IN DISTRICT NOAKHALI.

1896-97. DETACHMENT.



REFERENCES.

Traverse and Cadastral Survey, 16 Inches = 1 Mile. Season 1896-97.

Traverse and Topographical Survey, 16 Inches = 1 Mile. Season 1896-97.

Traverse and Topographical Survey, 2 Inches = 1 Mile. Season 1896-97.

District.... Boundary

Sub-Division .... do.

NOTES.

The numerals **397**, &c. indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures & lines in strokes represent the numbers & limits of the Engrav d sheets of the Indian Atlas.

Scale of Miles.

10 5 0 10

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Photo., S. I. O., Calcutta.

disputed boundaries have been marked by pegs only. The cost rates are Ro·50 per square mile for marking stations and R54·34 per square mile for traversing.

275. *Cadastral survey and writing of records.*—The tract sanctioned for detail survey was comprised in Thánas Tájpur and Dalsingh Sarái in the south of the district, where the effects of the famine were not appreciably felt during the field season. The area surveyed is mapped on 976 sheets on the 16-inch scale and on 328 sheets on the 64-inch scale showing village sites. The average size of the field calculated on the whole area surveyed is 0·32 of an acre, but in the *diára* villages on the Ganges river it is 0·86 of an acre. The detail survey was checked by 863 linear miles of test survey run by Europeans and by independent *partáls* and by 1,398 by inspectors. The number of entries checked in the field records by European officers was 8,016 and by inspectors 214,939 which gives an average of 20·4 per cent of the whole number of plots. The cost rates are:—For detail survey R78·31 and for record writing R87·47 per square mile. In this district the inhabitants gave considerable trouble at the commencement of operations; no active opposition was offered, but there was much difficulty in inducing the people to attend whilst the survey was being made.

276. *Topographical survey.*—The area topographically surveyed comprised 23 villages and has been mapped on 53 sheets on the 16-inch scale. The villages were surveyed in block only in their proper positions and not on separate sheets in detail. It was checked by 146 linear miles of chaining; the cost rate is R27 per square mile.

The areas completed are given in the following statement:—

District.	Traverse survey.		Cadastral survey, 16 inches=1 mile and Record writing.			Topographical survey, 16 inches = 1 mile.	
	No. of stations.	Area in sq. miles.	No. of villages.	No. of fields.	Area in sq. miles.	No. of villages.	Area in sq. miles.
Darbhanga .	8,608	416·6	638	1,091,765	545·0	23	40·2

277. The area remaining for survey is as follows: For traverse survey 1,119 square miles and for cadastral survey 2,632 square miles. The *diára* tract is completed, and there is therefore no area remaining for topographical survey.

Survey of the Noákhálí District.

278. The work in this district consisted of three kinds, *viz.*, (*a*) the cadastral survey and record writing of certain Government estates in the islands of Sandip and Hátiya; (*b*) the topographical survey on the 16-inch scale of other Government estates; and (*c*) the topographical survey on the 2-inch scale of the remaining portion of Sandip and Hátiya as well as of the other islands and new accretions at the mouths of the Fenny and Meghná rivers. The traverse surveys for all these operations had also to be done, none having been made in advance, and during the recess a map on the 4-mile scale had to be compiled in order to test the additions and corrections made on the district map by the local authorities.

279. Anticipating difficulties with the inhabitants who were described as being of a sensitive and turbulent character, the Director of Land Records requested that the native agency should consist as far as possible of Bengalis; the greater portion of the establishment was therefore recruited locally and from passed students of the Dacca Survey School; a few expert surveyors (not local men) only being employed on the more intricate portions of the work such as the astronomical observations and triangulation. Field work commenced on the 7th December and closed on the 25th May, on which date the detachment went into recess quarters at Dacca.

280. Fortunately the anticipated opposition was not experienced; on the contrary great attention and interest were displayed in the survey operations, still the difficulties in surveying the islands of this district have been very great; the work was very scattered, provisions and especially drinking water were hard to procure; local chainmen were very difficult to get, and when obtained they did not perform a fair day's work, whilst towards the end of the season communication

amongst the southern islands was difficult on account of the roughness of the sea. The health of the establishments was on the whole fairly good; though cholera was very prevalent in Sandip and Hátiya only one *amin* died. During April and May there was a water famine which brought on a good deal of dysentery and fever.

281. *Traverse Survey.*—There were no village boundaries within the Government estates which were to be cadastrally surveyed, and as several of the estates were too large to be retained as the unit for the cadastral survey, it was decided to divide them into blocks averaging from one to two square miles in area. There were 44 such blocks which were sub-divided by 54 cross traverses. The total linear miles of chaining was 264·6. Two chains were used throughout. Of the 1,003 traverse stations, 149 were permanently marked by glazed clay cylinders and 200 by locally made clay cylinders; the remaining stations in lowlying and unimportant positions have been marked by pegs only. The cost-rates are R2·50 per square mile for marking stations and R32·06 per square mile for traversing. The unit of the traverse survey for the 16-inch topographical work was the estate or *char*; interior villages were not traversed separately: these *chars* are all Government estates. The number of linear miles of new chaining amounted to 128·4 and the number of new stations was 360. The cost-rate is R8·28 per square mile. For the 2-inch topographical survey the unit was the island. No village boundaries were travesed, as they were not required for the topographical survey. The area consists of private and permanently settled estates. The linear miles of chaining amounted to 217, including triangulation and lines connecting islands and the stations of the Great Trigonometrical Survey. There were 689 new stations, all of which were marked by pegs. The cost rate is R4·64 per square mile.

282. *Cadastral survey and writing of records.*—The area cadastrally surveyed has been mapped on 109 sheets on the 16-inch scale The homestead lands were also surveyed on the same scale in their true position and no enlargements were necessary to enable the numbering to be entered. The average size of the field or survey number was 1·11 acres. In the area surveyed 153 linear miles of check survey were run by the officer in charge or by independent *partáls* and 239 miles by inspectors. The number of entries in the records checked by the survey inspectors was 9,760 and by the officer in charge and the Settlement officers 2,567, which together represent 25·5 per cent of the total number. The cost per square mile for detail survey is R·9 per square mile and R58·49 per square mile for writing the records.

283. *Topographical survey on the 16-inch scale.*—The area of this class of survey was 145·5 square miles, all Government estates. The boundaries of these estates have been mapped in the same detail as in cadastral surveys, offsets being taken from the traverse lines. All village sites, streams, tanks, roads and other topographical items have been surveyed; the limits of cultivation have been shown on the maps. The mapping is comprised in 149 sheets. The accuracy of the survey was tested by 54 7 linear miles of check survey by inspectors and independently. The cost rate is R12·28 per square mile.

284. *Topographical survey on the 2-inch scale.*—The area completed on this scale was 198·8 square miles and the mapping is comprised in 12 sheets. The boundaries of estates were not required and were not therefore surveyed. All topographical items, including the limits of cultivation, were entered. The cost rate is R5·96 per square mile.

285. The following statement gives the areas surveyed:—

Thána.	Traverse survey.	Cadastral survey, 16-inch scale, and Record writing.			Topographical survey.	
					16-inch	2-inch
	Area in sq. miles.	No. of blocks.	No. of fields.	Area in sq. miles.	Area in sq. miles.	Area in sq. miles.
Sandip . . .	214·1	28	37,254	51·5	47·0	118·9
Hátiya . .	184·0	15	11,088	32·5	85·8	65·7
Noákhálí . .	17 0				2·8	14·2
Ráipur . . .	9·9				9·9	...

The outturn of the season has fallen short of the programme on account of exceptional difficulties already alluded to, and there remains an area of 9·5 square miles for cadastral survey, of 39 square miles for 16-inch topographical survey and 3 square miles for 2-inch topographical survey.

Survey in the Midnapore District.

286. In this district the survey and writing of the records of 14 villages were undertaken with a view of judging of the value of the old maps and records of the Majnamutha and Jalamutha estates which had been prepared by Mr. J. C. Price in 1875. The programme was afterwards reduced and only 8 villages were surveyed. The old maps having been prepared on the 32-inch scale, the new survey was made on the same scale. The following statement shows the results of the new survey as compared with the old :—

Name of village.	Area in acres.		Number of fields.	
	Old survey.	New survey.	Old survey.	New survey.
Mahi Sagot	132	189	1,280	832
Bamunia	516	587	2,136	1,508
Gopál Chak	229	214	2,031	1,050
Hirukala	35	23	152	183
Chaulti	329	326	1,682	1,524
Darmat	659	653	2,412	2,420
Chak Gobindabera	69	72	527	166
Bonomálichatta	37	42	180	177
Total	2,006	2,106	10,400	7,860

287. After a careful comparison of the new with the old maps, which were based on magnetic compass traverses, the Superintendent of Settlement Surveys is of opinion that an entirely new survey and an entirely new record should be made. The Board of Revenue agree with the Superintendent and have recommended to the Government of Bengal that a new survey should be undertaken of the Majnamutha and Jalamutha estates.

288. The following statement shows the amount of survey work remaining to be done in North Bihár :—

District.	Traverse survey.	Cadastral survey and writing of records.	Diára Topographical survey.
	Square miles.	Square miles.	Square miles.
Sáran	180	1,090	100
Darbhanga	1,119	2,632	...
Totals	1,299	3,722	100

Under the orders of the Government of India, letter No. $\frac{1368}{40\cdot6}$, dated 3rd June 1896, the above is to be completed by one traverse camp and two cadastral camps by the end of September 1900. About half will therefore be completed during the coming field season. In addition to the above certain portions of the boundary

between Nepál and the districts of Purnea and Bhágalpur are to be relayed, and the resurveys of the Majnamutha and Jalamutha estates as well as the survey of the Balarámpur estate, all in Midnapore district, are to be completed. The small remaining areas in Noákhálí are also to be completed. No orders for surveys in Bengal other than the above have at present been issued.

289. The Superintendent of Settlement Surveys reports that Captain Symonds, who was in charge of the North Bihár traverse section, and for a time acted for him as Superintendent of Settlement Surveys, Bengal, has given him entire satisfaction in the performance of his duties.*

THATÔN, PEGU AND TOUNGOO DISTRICTS, LOWER BURMA.

No. 7 Party.

290. During the year under report the charge of this party was held by Mr. B. G. Gilbert-Cooper, who was, however, temporarily relieved by Mr. W. C. Price on the 5th September 1897, on his availing himself of privilege leave.

Personnel.

Mr. B. G. Gilbert-Cooper, Officiating Deputy Superintendent, 1st grade, in charge up to 4th September 1897.
„ W. C. Price, Extra Assistant Superintendent, 2nd grade, in charge from 5th September 1897.
„ G. W. Jarbo, Extra Assistant Superintendent, 4th grade.
„ J. S. Swiney, „ „ 5th „
„ M. Gastaud, Sub-Assistant „ 1st „
„ T. W. Babonau „ „ 1st „
„ J. H. Murphy „ „ 2nd „
from 1st December 1896 to 16th September 1897.
Babu Amar Singh, Sub-Assistant Superintendent, 2nd „
„ Abinash Chunder Bose, „ „ 3rd „
Mr. C. S. Littlewood, „ „ 3rd „
from 15th November 1896 to 26th June 1897.
22 Sub-Surveyors, etc., and 140 temporary Field Surveyors, Inspectors, etc.

291. The party was divided into 3 sections as follows:—

Section No. 1 (traverse and cadastral combined) under Mr. J. S. Swiney, operated in the Pyuntaza and Zeyawadi townships of districts Pegu and Toungoo respectively, commencing field work on 8th December 1896 and closing on the 30th June; a detachment from this camp under Mr. M. Gastaud, was deputed for the topographical survey on the 2-inch scale of 452 square miles in district Thatôn, to complete standard sheets Nos. 372 and 326, and commenced work on 9th November 1896 and closed on 14th May 1897; Section No. 2 (cadastral), under Mr. W. C. Price, began work on the large scale survey (50 feet and 100 feet=1-inch) of the town of Rangoon, on the 13th November 1896 and closed field work on 5th June 1897; section No. 3 (traverse), under Mr. G. W. Jarbo, started traverse operations in Rangoon on 2nd November 1896 and closed field work on 31st May 1897. On the completion of the traverse work in Rangoon, this section was transferred to take up the advance traverse of district Toungoo on 15th January 1897.

292. The programme of the field season consisted of:—

(*a*) *Traversing.*—Pegu district, 8 square miles, in Ananbaw Circle (1-inch sheets 322 and 323). Toungoo district, 600 square miles in circles Kwindala, Kyaukhmaw and Kyaukkyi. Rangoon town 2·7 square miles, exclusive of water area.

(*b*) *Detail Survey.*—Pegu district, 374 square miles, on 16-inch scale, in Ananbaw and Yèhla Circles, to complete the district. Toungoo district, 150 square miles, on 16-inch scale, in Kwindala and Kyaukhmaw Circles (1-inch standard sheets Nos. 322 and 323). Rangoon town large scale surveys on 50 and 100 feet to the inch as follows:—

2·4 square miles on the scale of 50 feet=1 inch
3·9 „ „ 100 „ „
exclusive of water area.

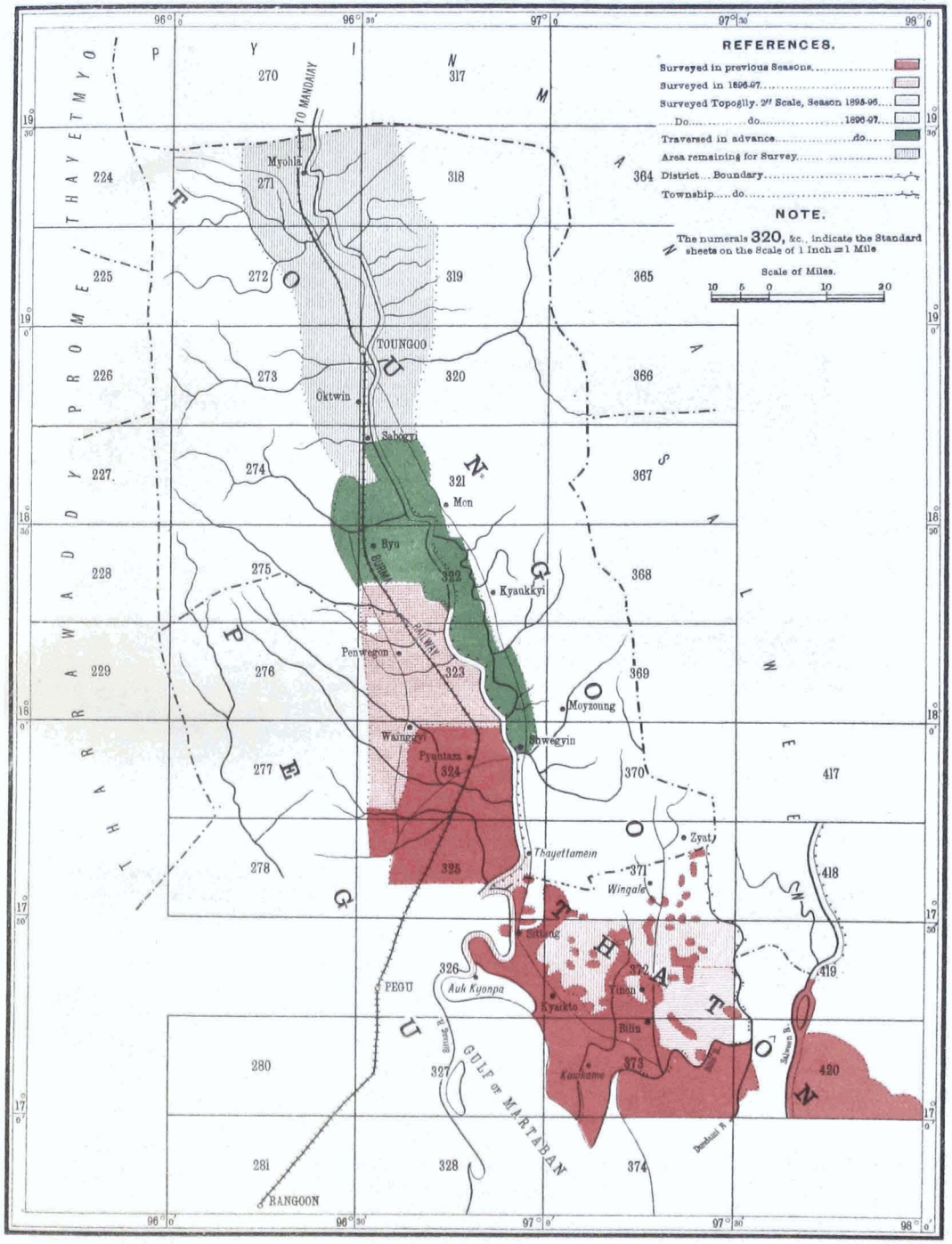
(*c*) *Topographical Survey.*—Thatôn district, 480 square miles, to be triangulated and topographically surveyed on 2-inch scale in

* Messrs. A. W. Smart and C. S. Kraal, in charge of cadastral sections have done excellent work during the year under report. The former has added to his reputation as an exceptionally able revenue surveyor. The junior assistants, Mr. C. S. Gasper and Babu Nilmoni Chatterjee, have afforded very valuable aid to the officers in charge of their sections. Mr. E. F. Berkeley, in charge of the Noákhálí detachment, has done very well in an exceptionally difficult survey.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. THATON, PEGU, & TOUNGOO.

1896-97. No. 7 PARTY.



Reg. No. 480, S. I. D.—Dec. 97.—550.

Photo. S. I. O. Calcutta.

No. 473-S. 97.

standard sheet No. 372. Also 30 square miles on 2-inch scale in sheet No. 325, total 510 square miles.

293. The demarcation was well done, both in Pegu and Toungoo districts. At the commencement of the season it was found that the demarcation was somewhat in arrears, owing to large portions of the area to be demarcated being under water; but this was remedied later in the season by the temporary employment of 3 additional demarcation officers, and the work of survey did not suffer in any way.

294. The following statement shows the season's outturn exclusive of goon Town Survey:—

Localities.	Traverse Survey.		Cadastral Survey, 16-inch=1 mile.		
	No. of *kwins*.	Area in square miles.	No. of *kwins*.	No. of fields.	Area in square miles.
Pegu	295	11	188	209,490	450
Toungoo		679	20	73,680	59
		Topographical Survey 2-inch=1 mile.			
Thatôn		21	...	...	452
		11 (*a*)	...	...	41 (*a*)
Total		722	208	283,170	1,002

(*a*) Resurvey of Sittang river owing to changes.

295. In the Thatôn district, 21 square miles of forest reserve was traversed, and also 11 square miles of river area. In district Pegu 11 square miles were thus surveyed in order to complete the district; and in district Toungoo, 679 square miles of advance traverse was effected. The total area traversed being 722 square miles, embracing 295 *kwins* or villages. The theodolite was set up at 14,888 stations and 2,336 linear miles of double chaining was done. This work was checked by 150 astronomical observations for azimuth. Owing to facilities for carriage, clay cylinders were used throughout for marking the stations.

296. The detail operations on the 16-inch scale in the Pyuntaza township, Pegu district, were checked by 1,244 linear miles of chain measurements, of which 447 were done, partly independently after the sheets had been received in office, and partly by European assistants. The proportion of cultivation to jungle is as 2 to 3 and the average size of the field is 0·56 of an acre, calculated on the cultivated area only. This completes the cadastral survey of the Pegu district.

297. The 16-inch detail operations in the Toungoo district were checked by 328 linear miles of chain measurements, of which 125 were done partly by independent *partáls* and partly by European assistants. The proportion of cultivation to jungle is as 2 to 3, and the average size of the field is 0·44 of an acre, calculated on the cultivated area only.

298. In addition to the above new survey, 58 villages of district Thatôn were revised owing to representations of the Settlement Officer that large extensions of cultivation and alterations in field limits had taken place, particularly in the areas under sugar-cane cultivation.

299. Topographical operations on the 2-inch scale were undertaken in district Thatôn of areas both within and outside the limits taken up cadastrally, in order to fill up standard sheets Nos. 372 and 326. The boundaries of the Onkagyu and Pilkagyu forest reserves, which fell within the area under topographical survey, were taken up and traversed with the theodolite.

300. The total expenditure for the year, inclusive of the Rangoon town survey charges, was R1,98,796, including a charge of 4 per cent for instruments.

The cost rate of the traverse operations in districts Thatôn, Pegu and Toungoo was ₹63-14-2 per square mile, and the cost rate of detail 16-inch survey in districts Pegu and Toungoo was ₹150-13-10 per square mile. The cost rate of revision survey in district Thatôn was ₹35-3-2 per square mile. The cost rate of the topographical work in district Thatôn on the 2-inch scale was ₹45-10-5 per square mile.

301. The country under traverse and cadastral survey this year was very unhealthy, and retarded the work considerably. The area topographically surveyed was more difficult than last year, and was all surveyed on the 2-inch scale, whereas last year more than half the area returned was done on the 1-inch scale.

302. The season's detail 16-inch work is mapped on 588 sheets in district Pegu, and 62 sheets of district Toungoo. The whole of the sheets of the Pegu district will be completed by the end of the recess season, and will be sent to Calcutta for publication as soon as they have been passed by the Settlement Officer. The sheets of the Toungoo district will also be ready for publication by the end of the recess season. The tracings and area statements of the 188 villages of district Pegu are nearing completion, and will be ready for despatch to the Settlement Officer by the commencement of the field season.

303. The 2-inch mapping of sheets Nos. 326 N. E., 373 N. W., and 372 N. W., has been completed; and it is expected that the remaining sheets Nos. 372 and 373 N. E. will be completed by the close of the recess season.

304. Dysentery and fever were very prevalent amongst the *khalâsis* working in the Pegu and Toungoo districts; nearly $\frac{1}{5}$th of the menial establishment being incapacitated for work throughout the field season from these causes, one man died of cholera, and two from fever: a considerable number had to be sent to their homes before the close of field operations. The health of the assistants was good, with the exception of that of Messrs. Babonau and Littlewood, who suffered much from the above mentioned causes.

305. The number of Burmans and Karens employed this year in the detail survey was 56. Of these, 3 inspectors and four field surveyors were already in possession of the five years certificate; one field surveyor had qualified for a certificate under the two years scheme during the previous year; 7 men have served 5 years, and 1 man three years outside Mr. Bridge's scheme; 6 men joined from parties working in Upper Burma; 16 men were apprentices in this party during last season, and were taken on the strength this season; and 15 men, volunteers from the survey schools in Burma, were entertained to undergo a survey training under the two years scheme. The average monthly earnings of the Burman field surveyors is ₹36-6-0, and those of the Hindustani surveyors for the same period ₹49-15-9. The 3 inspectors did their work well: one of these men Moung Po Chôu was deputed, with the sanction of the Local Government to take up one of the temporary posts of demarcation officer, in which capacity he gave entire satisfaction. The older Burman field surveyors worked well; but this cannot be said of the 15 new men, who joined this year from the local survey schools: out of these, 7 only have qualified for a bonus, and of the remainder, 4 failed to earn the bonus, 3 absconded, and one left under the plea of illness.

306. The programme of the party for the coming field season consists of:—

Traversing Toungoo District to complete the district, giving an area, so far as can be ascertained at present, of 800 square miles in circles Kyaungbya, Sethlèdaung, Zeyawadi, Pauktaw, Tetpyauk, Kaungyan, Tantabin, Dinnyawadi, Dwayawadi, Yegyi, Lèhla, Bahnaung, Kanni, Kèlin, Swa, Kunôn, Thagaya, and Myohla, should the area remaining to be completed exceed this estimate, it will be possible to complete 1,000 square miles in the season.

Detail Survey Toungoo District, 800 square miles on 16-inch scale in circles Kyaungbya, Sethlèdaung, Kyaukkyi, Kyaukhmaw, Môn, Bônmadi, Tantabin, Minbôn, Zeyawadi, Tetpyauk and Kaungyan.

307. Thanks are due to the Deputy Commissioner of Pegu, Mr. W. N. Porter, the Deputy Commissioner of Toungoo, Mr. T. C. Mitchell, and to the Deputy Commissioner of Thatôn, Mr. R. C. M. Symns for the cordial assistance rendered by them to the Survey Department during the past year.

Rangoon Town Survey.

308. The traverse operations of the large scale Rangoon Town survey were continued this year on the 2nd November, and brought to a conclusion under the immediate supervision of Mr. Jarbo, on the 15th January. The outturn consisted of 7 sub-circuits, 87 blocks and 476 *purdahs*, covering an area of $5\frac{1}{4}$ square miles, of which half is water area. In effecting this, the theodolite was set up 2,580 times in only 96 linear miles of chaining. The traverse stations in the town proper are marked by small iron pegs driven into the ground, and in the suburban portion, by clay cylinders embedded flush with the ground, and an iron peg driven into the centre. The total cost of the traverse work only was R5,267 inclusive of 4 per cent for instruments, giving a rate of R1,003-3-9 per square mile. Two-thirds of the levelling operations in the town having been completed last year, the remainder was finished by the 15th January, 24 linear miles of chaining being done, staff readings were taken at 538 points, and 78 bench-marks were established at the corners of streets, on walls of culverts, parapets, etc. The records in connection with this work have been completed. The total cost amounted to R2,035, giving the rate of R27-8-0 per linear mile.

309. The detail survey of Rangoon was continued on 13th November and was finished on 5th June. Rather more than half was completed last year, and the remainder 5·96 square miles, was disposed of this year and mapped on 166 sheets, *viz.*, 1·38 square miles on the scale of 50 feet = 1 inch mapped on 68 sheets, and 4·58 square miles on the 100 feet scale mapped on 98 sheets. The total cost of the detail survey was R33,786, giving the rate of R12,334-0-11 per square mile for the 50 feet scale, and R3,660-7-8 per square mile for the 100 feet scale. As the demarcation officer was unable to demarcate the lots in town block C on the 50 feet scale, owing to the original Municipal plan of this block having been surveyed on the 10 feet scale, at the request of the Municipality, this block was surveyed on the 10 feet scale instead of on the former scale. In order to avoid a break in scale for so small an area, a field book record of each measurement was kept, which was subsequently utilized for plotting this block on the 50 feet sheets; thereby avoiding the necessity of pentagraphing it down to the 50 feet scale. The area of this block has therefore been included in that shown above as having been done on the 50 feet scale.

310. Approximate contours five feet apart have been run over the undulating portion covering an area of about five square miles.

311. Every sheet surveyed during the season has been well checked, in effecting which 967 lines = 82·9 linear miles were run by European assistants, 367 lines = 16·5 linear miles by native inspectors, and 122 lines = 5·4 linear miles by independent check *partáls*.

312. Of the 166 sheets comprising this season's work, the whole have been inked in, and working tracings have been made for the Municipality in addition to special field books of each sheet, together with all the area statements which were made over to the Boundary Officer. All the sheets of the wall map on the scale of 300 feet=1 inch, 22 in number, exclusive of blank sheets, have been prepared. A map of Rangoon on the scale of 1,000 feet=1 inch has been asked for, and is being compiled for the Municipality. The cost (R250) will be separately borne by the Municipality.

313. The total expenditure for the year on the Rangoon town survey was R37,635, which, together with the expenditure last year (R64,966), and adding 4 per cent for instruments, bring the total expenditure up to date to R1,06,705. As was anticipated last year the original sanctioned estimate for the town survey (R83,600) was insufficient for the work to be undertaken, chiefly on account of the cost rate for the portion surveyed on the 100 feet scale (covering $\frac{2}{3}$rds of the total area to be surveyed) having been very much underestimated; this was due to the fact that there were no previous surveys on that particular scale on which to form an estimate. The estimate for this scale of work was originally put down at R2,000 per square mile; but actual experience has shown it to amount to about R5,000 per square mile. The estimate for the 50 feet scale survey being based on the cost rate of the Calcutta survey, proved to be very accurate. As it was therefore clear that the total allotment originally

sanctioned for the work (₹83,600,) would be considerably exceeded, a revised estimate was prepared, and an additional grant was obtained from the Municipality of ₹34,990 to enable the work to be completed by the end of November 1897.

314. All the triangulated stations in Rangoon, except those on the roofs of houses, were permanently marked by masonry pillars $1\frac{1}{2}$ feet square, and 4 feet in depth, built at the request of the Municipality, 3 feet being sunk below the surface of the ground and 1 foot above. These (13 in all) were handed over to the Municipality for preservation, and were separately paid for.

315. The conduct of the men employed on the town survey was excellent throughout, and there was not a single complaint made against any subordinate of the survey during the year. Cordial relations were maintained throughout with the officers of the Municipality, who rendered every assistance in their power; in connection with which the name of Mr. Shircore, the Registrar of town lands, should be mentioned. His knowledge of the town and readiness to supply information being of the greatest assistance.

316. The Deputy Surveyor-General inspected the party from 12th January to 16th idem, and again on his return from Upper Burma from 6th February to 14th idem: during these visits the whole of the records and accounts of the office of the Deputy Superintendent, together with those of the 3 camp offices, were thoroughly examined, and the arrangements for carrying on the large scale survey of Rangoon town were fully explained to the Deputy Surveyor-General. Colonel Sandeman also personally checked the field work of the town in several localities selected by himself, and expressed himself as thoroughly satisfied with the minute accuracy of the field work. The Officiating Deputy Surveyor-General, Lieutenant-Colonel Hobday, also inspected the party, in recess, on the 9th and 14th July.*

NORTH-WESTERN PROVINCES AND OUDH.

317. Cadastral survey and record-writing operations were continued in these provinces under the superintendence of Mr. G. B. Scott, Superintendent of Land Records Surveys, in the following districts:—

North-Western Provinces.—Meerut, Sháhjahánpur and Lálitpur Subdivision.

Oudh.—Bahraich, Kheri and Sítápur alluvial *mahals*.

Work was also commenced in Bareilly. In addition to the above, test surveys were made of certain portions of the Náini Tál district.

318. The areas surveyed and the number of villages and fields of which the *khasras* were written up during the year ending 30th September 1897, together with the cost rates per square mile, are given in the following table:—

District.	Cadastral Survey, 16 Inch = 1 mile.		Record writing.			Average size of fields in acres.	Average cost per square mile.			
	No. of villages.	Area in square miles.	No. of villages.	No. of fields.	Area in square miles.		₹	a.	p.	
Meerut	479	593	616	531,861	801	0·9	44	14	11	
Lálitpur Sub-division	224	501	224	129,353	501	2·4	53	14	3	
Bahraich	640	914	638	1,002,471	841	0·7	35	15	4	
Sítápur alluvial mahals	47	62	47	35,090	62	1·1				
Sháhjahánpur	1,184	806	1,184	624,257	806	0·8	40	15	7	
Kheri	654	755	654	500,842	755	0·9	42	8	4	
Bareilly	957	694	724	464,691	515	0·7	52	3	0	
	4,185	4,325	4,087	32,88,565	4,281		45	1	3	mean

* The officer in charge reports that Messrs. W. C. Price, G. W. Jarbo, J. S. Swiney and M. Gastaud have managed their sections in a satisfactory and able manner, and that the other assistants have also given satisfaction. Of the native establishment the following are deserving of special mention, Mr. C. Abrew, Azimulla Khan, Mahomed Umar Nasib Beg, Mahbub Alli, Tha Dun Gyaw and Moung Hpo Kah.

319. A comparison of cost rates, with those of last year, shows that while in Bahraich, Sháhjahánpur and Kheri the expenditure per square mile has been reduced, that in Meerut and Lálitpur has increased, and in Bareilly it is high. In Meerut the total expenditure for the year has been less, but the area surveyed was comparatively small for the supervising staff, and a further expenditure was incurred by the employment of *amins* to survey difficult jungle covered *khadir* lands. In Lálitpur, owing to the famine, the *patwáris* were withdrawn from survey work during a considerable portion of the field season, and as the average size of the *patwáris* circles is nearly 8 square miles, and no *kánungos* were obtainable to aid in the work as in previous years, it became necessary to employ 50 *amins* which was done with the consent of the Board of Revenue. During the recess months also the *patwáris* were kept on famine work in their own circles, and paid *moharrirs* were engaged to prepare the necessary papers in office, otherwise the records of the sub-division could not have been completed this year.

320. In Bareilly the first two months of the field season were taken up entirely in training the *patwáris*, the course being much prolonged by their having to leave the classes several times for famine work, and they were again and again withdrawn, while regular survey was in progress often for a fortnight at a time or even more. In consequence, field work, especially *khasra* writing, had to be carried on till September, to allow of a sufficient area being completed for attestation. This entailed the maintenance of the supervising staff and a larger number of *mirdahas* throughout the recess months instead of up to May only, as is usually the case.

321. Except in Lálitpur, and the *khadir* lands of Meerut, where, with the consent of the Board, some *amins* were employed, the whole of the survey and record-writing was done by the *patwáris*, with, where necessary, the assistance of *kánungos* who had been sent for training; when the *patwáris* were aged and otherwise physically incapable, it was done by their recognized heirs or relatives. The general average outturn of a *patwári* per diem varied in the several districts from 10 to 18 acres of survey, and from 25 to 40 fields of record-writing. Some *patwáris*, during the latter months, surveyed an average of nearly 30 acres a day, while others never got beyond 9 or 10. Several earned rewards for large outturn, one man in Kheri earning R59 over and above his salary during the season. On the other hand, many had to be fined for laziness and absenting themselves without leave. On the whole, the improvement both in attendence and outturn was very marked.

322. Very few *kánungos* could be spared from their other duties, especially those in connection with famine, either for training or supervising. About 120 *umedwárs* received certificates after surveying one or more villages each.

323. In every square mile of survey from 2 to 3 linear miles were checked by chain lines run by inspectors and field-book or "independent" check lines of rather more than half a linear mile. In the *khasras* from 10 to 20 per cent of entries were checked by inspectors. All European officers, with one exception, also tested the records in their respective districts, not as much as is desirable in all cases, but a single officer cannot be expected to do as much checking personally as is the rule in the Survey of India parties. The subordinate district officials had too much other work last year to allow of their assisting, but if in future they and the *kánungos* aid in checking the record-writing, the desired amount of check will be obtained. Several independent *partáls* were examined by the Superintendent himself in each district; as a rule the work was found to be very accurate. Some few sheets had to be entirely rejected and resurveyed, and in several cases sections of work in progress were rejected and resurveyed, but the proportion of rejected work to the entire area surveyed was very small.

324. The number of boundary disputes was much less than in previous years, and those not amicably settled on the ground were reported to district officers for disposal. They are chiefly in alluvial tracts, and those not disposed of before the rains set in necessarily remained over till the coming field season.

325. Alluvial *mahals* were distinguished from permanent lands by a thick line and were separately numbered. Their former limits differ of course from the present high banks. To prevent confusion, the former limits of the *mahals* have been shown in thick lines, the present position of high banks being marked by the usual conventional sign of short hachures, thus the requirements of the settlement officers, and of the topographical draftsmen, are equally met.

326. Fluctuating cultivation is now distinguished from permanent in all districts by being inked in blue. Where possible, that is, in stony upland tracts, most of the minor quadrilateral stations are marked by crosses cut in stones *in situ* or embedded for the purpose, thus giving numerous accurate referring marks for resurveys whenever these became necessary.

327. The survey and record-writing of the Meerut district, and of the Lálitpur sub-division, have been completed, as also the mapping, tracing, area estimating and nearly all the papers required for attestation in Meerut, and for the Settlement Officer in Lálitpur. It is believed that all the records will be made over, complete, before the end of December in Meerut, and earlier in Lálitpur. In Bahraich an area of 440 square miles remains unsurveyed, and in Sháhjahánpur an area of 230 square miles. These should be completed during the coming season. The survey and record work of the Sítápur alluvial *mahals* have been completed. In Bahraich and Bareilly areas of 73 square miles and 181 square miles, respectively, have been surveyed in advance of the record-writing owing to the prolongation of the field season. Endeavours will be made to prevent this in future. In all other districts the records of all surveyed areas have been written up.

328. In office the mapping of surveyed areas is practically completed. Three sets of tracings (one showing soils) have been, or are being prepared. The calculation of field areas has been completed in most districts and is well advanced in others.

329. The old settlement village plans of districts Etah, Etáwah, Mainpuri and Azamgarh were examined and tested by the Superintendent and Mr. Johnson during the past season and reported on. It has been decided that all these districts are to be resurveyed before expiry of present settlement.

330. On a previous report submitted by the Superintendent on the present maps of the cultivated lands in the Náini Tál district, it was ordered that before a resurvey of any village was undertaken, the existing village maps should be carefully checked, and resurveys were only to be made where necessary. The survey of newly cultivated land and potato blocks was to be done. The sanction was only obtained in April 1897, and nearly a month elapsed before the establishment could be collected. It was evident that very little could be done before the rains set in. *Amins* from Garhwál were sent for, and meantime the Superintendent and Mr. Powell personally ran check lines across several villages. These showed such large discrepancies that it was decided to resurvey as many blocks as possible before the rains set in on the same scale as the settlement, *viz.*, 66 inches=1 mile. To prevent needless expenditure, a small establishment of 2 inspectors and 20 *amins* only was engaged. Some were sent under Mr. Johnson to take up the survey of potato blocks in *pargana* Rámgarh, the remainder worked under Mr. Powell in *pargana* Chakhata. Work was closed in July when 76 blocks of ordinary cultivation containing 21,829 fields and 45 potato blocks had been completed. The average size of the fields was 20 to the acre which made the work extremely laborious and even the best surveyors could hardly do more than 2 or 3 acres a day.

331. A comparison with old maps showed these to be unreliable as a rule and on a further report to the Board, a complete resurvey was ordered. This will be commenced immediately and carried on as rapidly as allotted funds will permit. Simultaneously an index map on the 4-inch scale will also be compiled. The scale of ordinary cultivation will be that of 64 inches to the mile, of potato blocks 32 inches.

332. The cost of survey on such large scales on the hill sides will necessarily be great as compared with work on the plains, especially as it must be done by paid *amins*, there being no *patwáris* to do it. The work will be under the immediate charge of Mr. Powell.

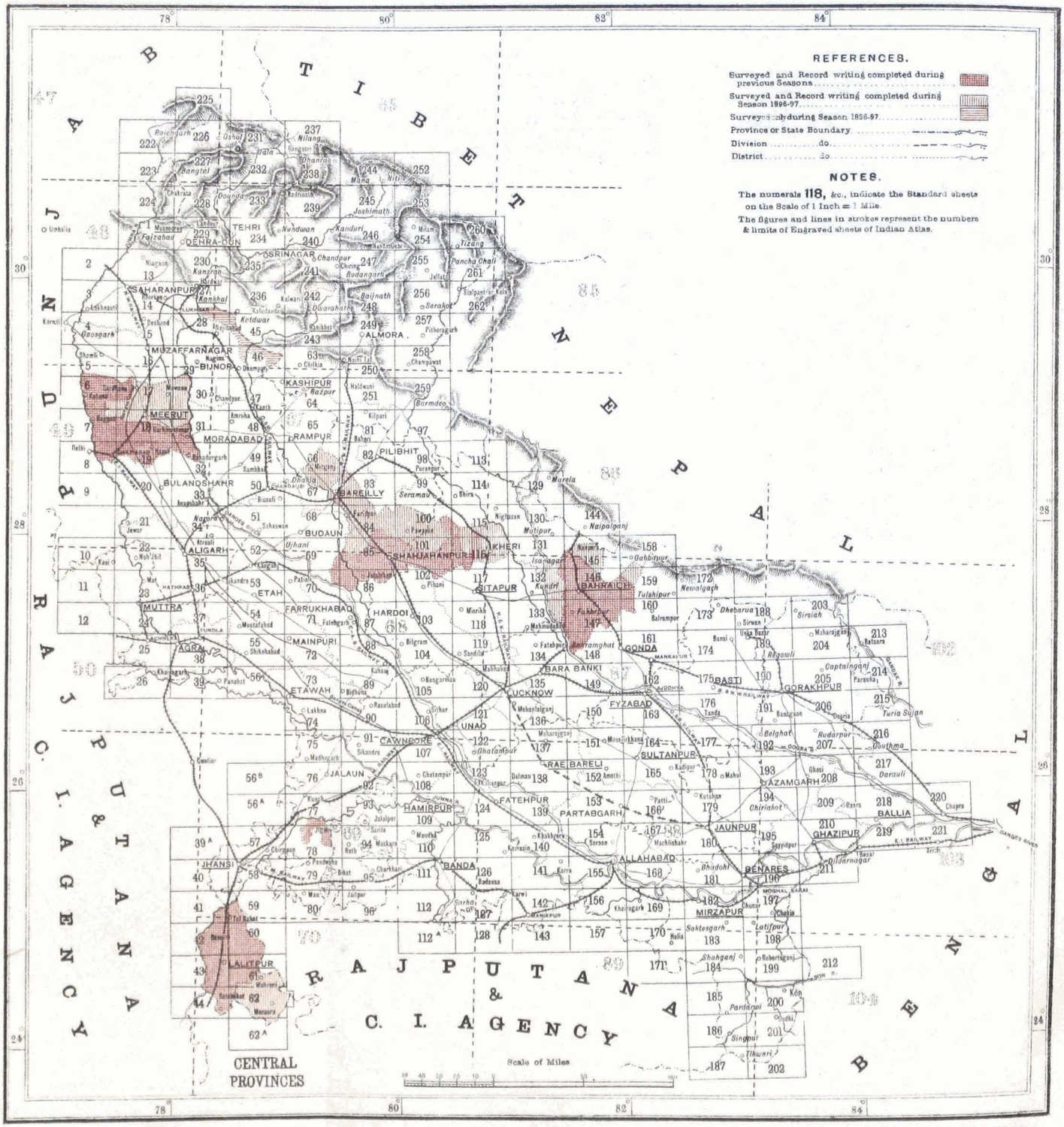
333. For the resurvey of the *halbandi* villages in Basti, mentioned in last year's report, Mr. Johnson started training classes for *patwáris* in Domariaganj, but the men were almost immediately withdrawn for famine work and the resurvey was postponed. It will be resumed during the coming season. Owing also to the famine, the proposed training of the Bánda *patwáris* was not begun.

In conclusion, the Superintendent would again call attention to the zeal, ability and hard work of the several officers in charge of the various operations.

N. W. P. & OUDH SURVEY.

INDEX TO THE LAND RECORDS SURVEY IN N. W. P. & OUDH.

1896-97.



Reg. No. 389, S. I. D.—Jan. 98.—550.

Photo. S. I. O., Calcutta.

No. 461-S. 97.

TRAVERSE SURVEYS.

NORTH-WESTERN PROVINCES AND OUDH.

No. 2 Party.

334. As during the previous year, No. 2 Party has been employed in traversing and supplying plots of the points thus fixed in certain districts of the North-Western Provinces. The party has remained throughout the year under the charge of Captain J. M. Fleming, I.S.C., with the exception of the period from 1st June to 23rd July, when Mr. W. S. Buttress held charge during Captain Fleming's absence on leave. Work was commenced at the beginning of November and terminated at the end of March, when a reduced establishment proceeded to recess quarters at Mussooree.

Personnel.

Captain J. M. Fleming, I.S.C., Officiating Superintendent, 2nd grade.
Mr. W. S. Buttress, Extra Assistant Superintendent, 1st grade.
H. Dowman, Extra Assistant Superintendent, 2nd grade, from 1st May to 20th September 1897.
" H. T. Hanby, Extra Assistant Superintendent, 2nd grade, from 12th October 1896 to 30th April 1897.
" C. G. Lee, Sub-Assistant Superintendent, 1st grade, from 26th October 1896.
" C. H. G. Johnson, Sub-Assistant Superintendent, 1st grade, from 1st to 31st October 1896.
" A. H. Peychers, Sub-Assistant Superintendent, 2nd grade.
Babu Jagadamba Prasad, Probationary Sub-Assistant Superintendent, 3rd grade, from 17th November 1896.
Mr. C. C. Byrne, Probationary Sub-Assistant Superintendent, 3rd grade, from 20th November 1896.
63 Sub-Surveyors, Computers, etc., etc.

335. During the field season two camps were maintained under the charge of Messrs. W. S. Buttress and H. T. Hanby respectively. Mr. Hanby proceeded on furlough from 1st May and was temporarily replaced in charge of a camp by Mr. Lee, who later made way for Mr. Dowman on his joining the party after privilege leave. Two sub-surveyors and five chain squads were retained in the field for a portion of the recess to undertake any required revisions.

336. The object of the season's work has been to furnish the settlement surveys with plots of the different villages traversed, showing the various traverse stations. The *patwáris* by whom the detail survey was carried out were thus supplied with a large number of fixed points on which to base their detail field-to-field survey.

337. The programme of work at first assigned to the party was quite insufficient to fully employ the establishment all through the year, and in addition to this, in order to finish rapidly certain *parganas*, the members of one camp had to be at first distributed in an uneconomical way, the result of which was that several men remained unemployed for a short period during the best working time of the field season. It was early pointed out that the allotted programme would not suffice, but only at the end of January was an enlarged sphere of work assigned to the party. The original area to be traversed comprised the completion of the Sháhjahánpur and Kheri districts, consisting of 237 and 1,679 square miles respectively, while the survey of the Bísalpur *pargana* of the Pilibhít district, an area of 370 square miles, was also ordered. Early in February, on receipt of orders, the traversing was extended further into Pilibhít, and the whole district, with the exception of the Jahánabad *pargana*, was easily completed by the beginning of April. In this latter tract work was much retarded by the fact that no demarcation had been done, but thanks to the energetic action of the Collector and his assistants this was pushed ahead, and everything was completed more rapidly than could have been expected. Had orders been received earlier, the whole Pilibhít district might have been finished with ease, and the cost rate thus much reduced.

338. Where reserved forest areas were met with, their external limits were traversed, here and there connecting lines being run through them along the cut fire lines to join the work on to village lands beyond. The total area traversed by the party, inclusive of 332 square miles of reserved forest area traversed round, amounts to 3,005 square miles. Plots of the area traversed in Sháhjahánpur and of the Srínagar *pargana* of the Kheri district were urgently required by the local survey officers, and these amounting to 445 villages on 622 sheets were all supplied by the end of February, plots of each batch of villages being forwarded immediately when ready. In addition to the current year's work one sub-surveyor with five chain squads had to be detained

for two months revising a portion of the previous season's work, and the completion of these computations occupied two computers considerably longer.

339. At the survey stations similar marks to those employed last season were erected, *i.e.*, stones were used for the triple junctions when unmarked by platforms, also at one satellite station of each triple junction and at two intermediate stations, when the distance between triple junctions exceeded half a mile, while in the vast majority of cases, locally made pottery cylinders were used to mark theodolite stations. These last would appear in no way to answer the requirements of a *permanent* mark. In the loose sandy soil found in the districts traversed, the cylinders are easily drawn out, and a visit to the area completed last season showed that a large percentage of these marks had already vanished, and it was a universal complaint of the *patwáris* who were met with at work, that the stations could only be identified by the distinguishing trenches dug round them, the marks themselves having been up-rooted. An attempt was made to utilize wedges of burnt clay of similar size and shape to the stones, but it was impossible to get these wedges burnt through in a satisfactory manner and their use had to be discontinued. The stones would seem to fulfil the requirements of a permanent mark in every way. Altogether in the season's operations 5,308 stones and 26,671 pottery cylinders have been embedded at the various traverse stations. The expenditure of marks was thus much less than that of last year and than was expected, due to most of the trijunctions having been found permanently marked by masonry platforms, and to a large number of forest and other pillars having been found and utilized. Estimating at considerably less than last year's requirements and to avoid the disappointments, experienced last season, the full estimated requirements were ordered during last recess, About 7,000 stones remained over, and these stored at different *tahsíls* will be utilized during the coming season's work. The stones were obtained from the same native contractor at Chunár at a cost of R145 per thousand, and including the charges for carriage, their average cost is about 4 annas 8 pie per stone. The pottery cylinders were all locally made, and were obtained at an average cost of about R3 per hundred. A large number of these were broken in transit over the rough country roads. These marks were distributed all over the districts under survey at convenient centres, and were thence obtained as required by the field hands.

340. The establishment was in every way superior to that of last year. The transfer of several good men from the Bihar Party and from No. 9 Party enabled the services of inferior men to be dispensed with. Much good resulted from insisting on every surveyor old and new completing a small village circuit under European supervision, which had to be computed and proved before he was allowed to proceed to work.

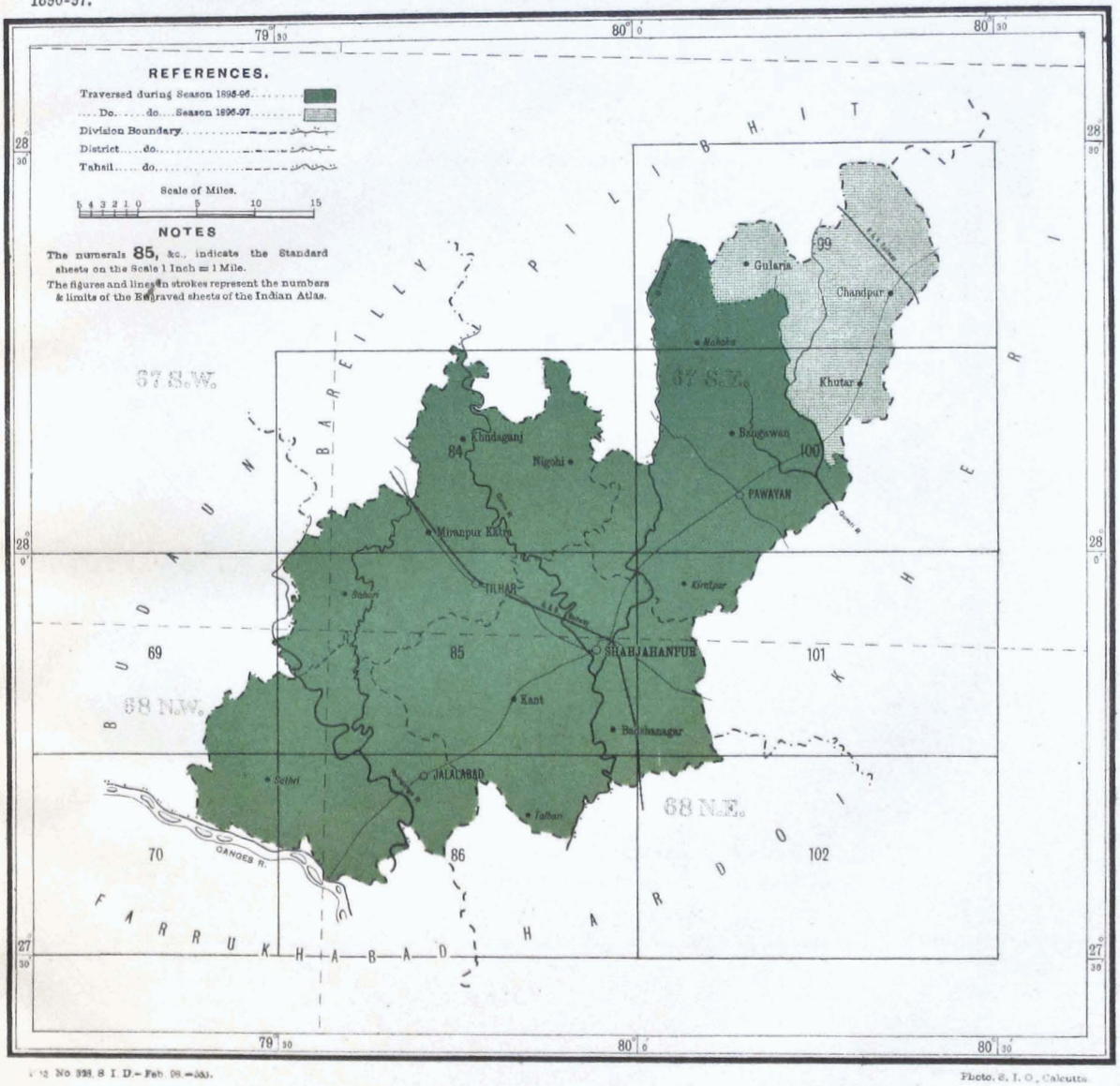
341. The demarcation in Sháhjahánpur was most imperfect resulting in much delay and incorrect survey, there being no one to point out boundaries in the jungle tracts and hence revisions had to be made in many cases. In Kheri this season the demarcation was most excellent and thanks are due to the Deputy Commissioner for the assistance always given when asked. In Pilibhít too the Collector and his assistants did every thing in their power to assist the party, and the demarcation in the Bísalpur *pargana* was excellent. In the other two *parganas* owing to lack of notice, the demarcation was imperfect, but was pushed on as fast as possible. In the Tarái portion, however, none existed, nor would the absentee proprietors aid until late, in spite of the Tahsildár's efforts to make them.

342. The line clearing squads kept well ahead in Sháhjahánpur and in the Bísalpur *pargana* of Pilibhít, having started a clear month in advance. In the remainder of Pilibhít owing to the late receipt of orders, the men never got ahead of the surveyors even when strengthened by additional squads from the Kheri camp, and in many cases the surveyor's squads had to be taken from their work and sent to assist them. The same thing happened in the last *pargana* traversed in Kheri, but the heavy jungle met with caused the retardation of the work. Generally speaking the villagers rendered ample assistance.

343. Two chains of 100 links and 93 links respectively were employed on main and sub-circuits, the results of both measurements being at once compared. A single chain of 100 links was used on the village circuits. The origin of the

N. W. P. & OUDH SURVEY.

1896-97. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT SHAHJAHANPUR.** No. 2 PARTY.



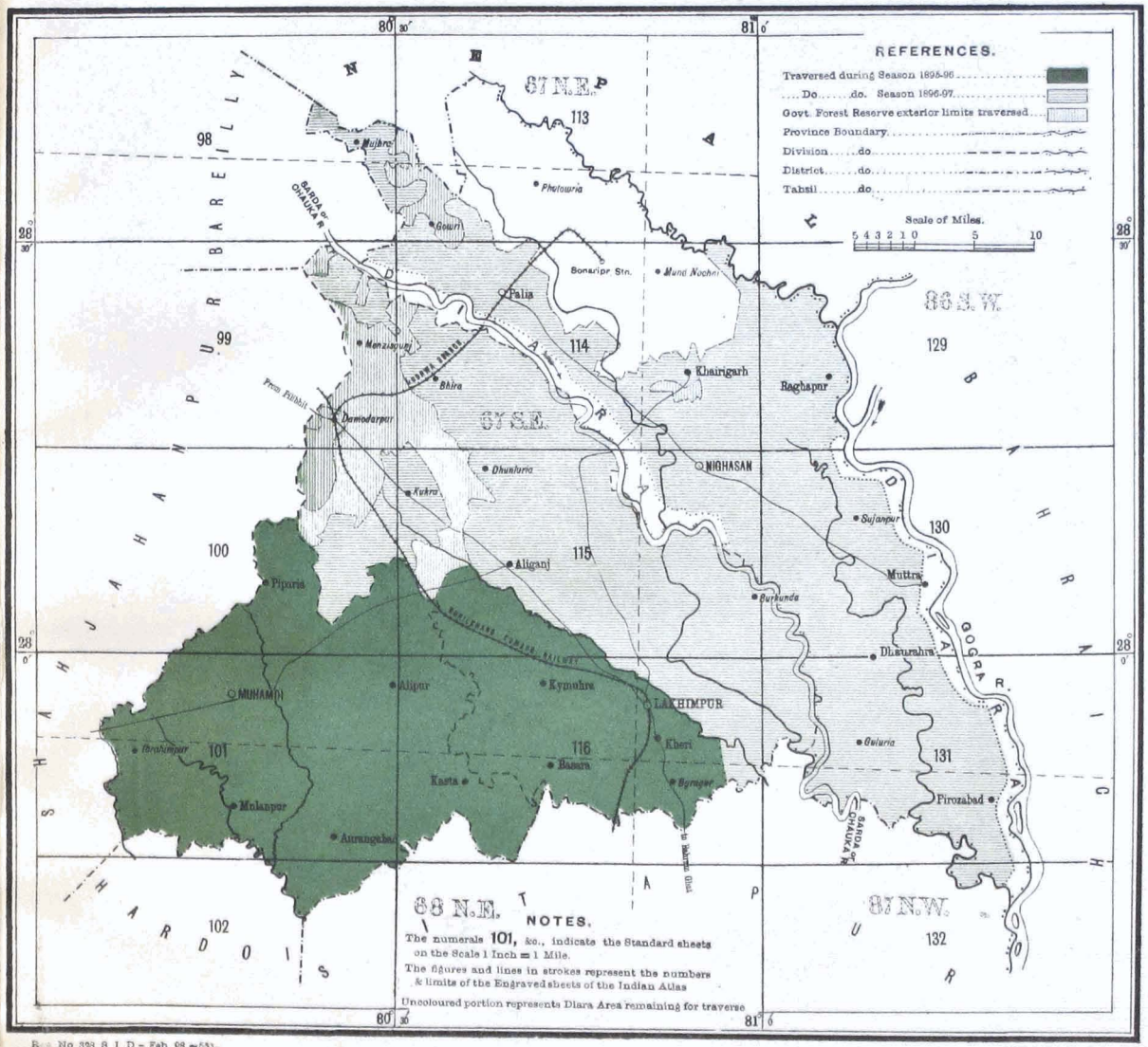
No. 338. S. I. D.—Feb. 98.—50.

Photo. S. I. O., Calcutta.

No. 313-S. 98.

N. W. P. & OUDH SURVEY.

1896-97. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT KHERI.** No. 2 PARTY.



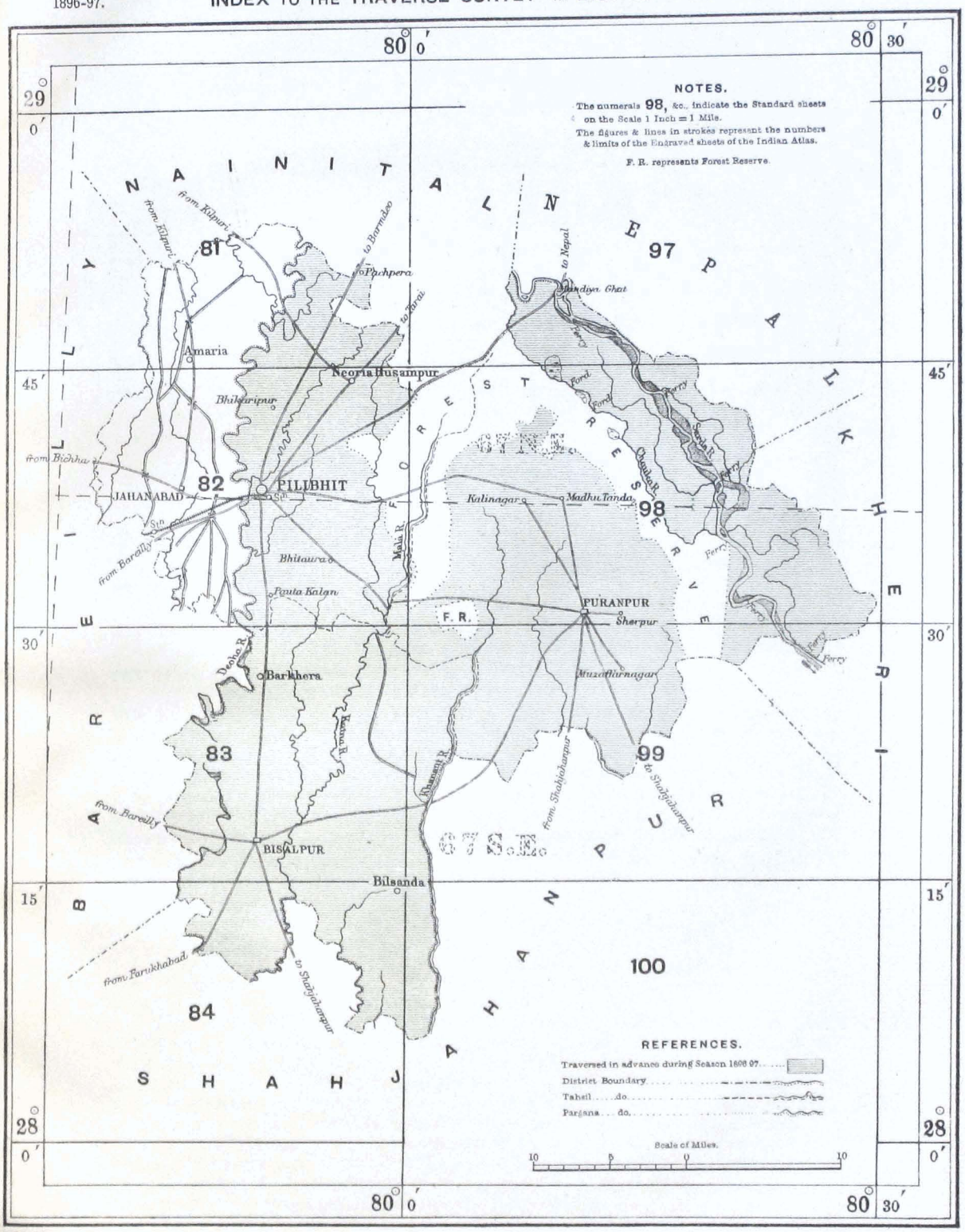
Rep. No 323 S. I. D.—Feb. 98.—551.

Photo. S. I. O., Calcutta.

No. 312-S. 98.

N. W. P. & OUDH SURVEY.

1896-97. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT PILIBHIT.** No. 2 PARTY.



Reg. No. S.O. S. I. O.—Feb. 99.—600.

Photo. S. I. O., Calcutta.

No. 314-S. 98.

survey of all three districts remained as last year, *viz.*, the intersection of the parallel of 28° North Latitude with the meridian of 80° East Longitude. To this the rectangular values of all stations on the main and sub-circuits have been referred. Observations for azimuth were taken at 255 stations to correct the angular work at about 30 stations apart, and, at nearly all these, observations to ascertain the magnetic variation were made To confine the chain errors connections were made tc 18 stations of the G. T. Survey and the values deduced from these were invariably adopted. Whenever possible the traverse work and stations of other parties in adjoining districts were utilized.

344. The following table gives particulars of the out-turn in each district:—

District.	Number of villages.	Number of sub-traverses.	Number of angles observed.	Linear miles chained.	Village area in square miles.
1	2	3	4	5	6
Sháhjahánpur . .	297	250	5,165	813	237·48
Kheri	751	1,015	21,503	4,140	(*a*) 1,599·77
Pilibhít	1,074	917	18,834	3,282	(*b*) 1,167·90
TOTAL .	2,122	2,182	45,502	8,235	3,500·15

(*a*) Includes 181·3 square miles of Reserved Forest surveyed round in block.
(*b*) „ 150·7 „ „ „ „ „ „ „

345. The average area of the village in Sháhjahánpur was 0·80 of a square mile, in Kheri 1·89 square miles, the *mauzas* in the last *parganas* surveyed being very large, and in Pilibhít the village area works out to about 0·95 square mile per village.

346. Several of the tracts surveyed are in an ordinary year very malarious and unhealthy, but owing to the scanty rainfall of the previous summer the ground had all dried up, which apparently kept off the usual malaria. There was little sickness of any kind and only two deaths were reported.

347. The computations have all been completed and bound in suitable sized volumes. Besides the computations, plots of 2,120 villages on 3,546 sheets on the 16-inch scale have been prepared and forwarded to the local survey officers. Along with these 173 sheets of congregated village plots on the 4-inch scale, showing the number of the stations and the marks embedded at each, have also been prepared and forwarded. Charts of each district on the ¼-inch scale, showing azimuth and triple junction stations on the main and sub-circuits, have been made out as a guide to the 2-inch mapping to be shortly commenced.

348. The total expenditure of the party has been R81,624. This divided among the three districts gives the expenditure incurred on account of work in each district as under:—

	R
Sháhjahánpur	6,437
Kheri	43,461
Pilibhít	31,726

The resulting cost rates for the whole party work out to R3-7-1 per square mile for stone embedding, etc., and R23-11-6 for traversing, or for the combined operations R27-2-7 per square mile. These figures include heavy transfer charges. Could a sufficient programme have been at first laid down, and thus allowed of better arrangements being made to keep the men fully employed, much more work might have been done for the same money and the rates would have been considerably less. There also remains a large stock of stones in hand, and deducting the actual cost of these, excluding rail charges (R1,015), the cost rates would only be R3-1-8 for stone embedding and R23-11-6 for traversing, or R26-13-2 per square mile for the combined operations.

349. The Officiating Deputy Surveyor-General inspected the party in recess during September.*

No. 8 Party.

350. This party was in charge throughout the season of Mr. J. S. Pemberton. The recess office was closed at Náini Tál on the 12th October and field work was started in districts Meerut, Bareilly, Bijnor and Gonda between 1st and 7th November. Recess office was reopened at Náini Tál on the 12th April. The changes in the establishment were as follows: the transfer of Mr. R. B. Smart from No. 4 Party to take the place of Mr. W. J. O'Sullivan, who died on the 12th October 1896, and of Mr. J. Murphy and Munshi Aulad Hossein from Nos. 7 and 22 Parties respectively. Mr. P. L. Causley, though borne on the list of the party from the commencement of the season to 2nd April 1897 when he was transferred to the Head-Quarters office, Calcutta, was, during the entire period, on sick leave.

Personnel.

Mr. J. S. Pemberton, Deputy Superintendent, 2nd grade, in charge.
„ W. J. O'Sullivan, Extra Assistant Superintendent, 3rd grade up to 12th October 1896.
„ R. B. Smart, Extra Assistant Superintendent, 3rd grade, from 20th October 1896.
„ J. Murphy, Extra Assistant Superintendent, 5th grade.
„ G. Rae, Sub-Assistant Superintendent, 2nd grade.
„ J. H. Murphy, Sub-Assistant Superintendent, 2nd grade, from 16th September 1897.
Aulad Hossein, Sub-Assistant Superintendent, 2nd grade, from 28th November 1896.
Mr. P. Williams, Sub-Assistant Superintendent, 2nd grade.
„ P. L. Causley, Sub-Assistant Superintendent, 3rd grade, to 2nd April 1897.
70 Sub-surveyors and others.

351. The programme for the season was as follows:—

(*a*) *District Meerut.*—The alluvial lands along the Ganges river in *parganas* Hastinapur and Kithor and the river itself, comprising 175 square miles.

(*b*) The remaining area of district Bareilly, 744 square miles, comprised in *parganas* Bareilly, Nawábganj, Sarauli south, Aonla, Sancha and Ballia and the alluvial lands in *parganas* Sarauli North, Bareilly and Farídpur.

(*c*) *District Gonda.*—1,000 square miles in *parganas* Nawábganj, Mahádewa, Gonda, Paháraput and Digsar.

(*d*) *District Bijnor.*—400 square miles in *parganas* Chándpur, Báshta, Burhpur and Nagína.

The total area for the season was thus a little over 2,300 square miles, somewhat less than the establishment was capable of performing under ordinary circumstances, but which it was thought inadvisable to reduce, in view of anticipated difficulties due to scarcity in the country and other reasons; the cost rates were necessarily increased by the limited area. The party was divided into two sections, which were in charge of Messrs. J. S. Pemberton and R. B. Smart.

District Meerut.

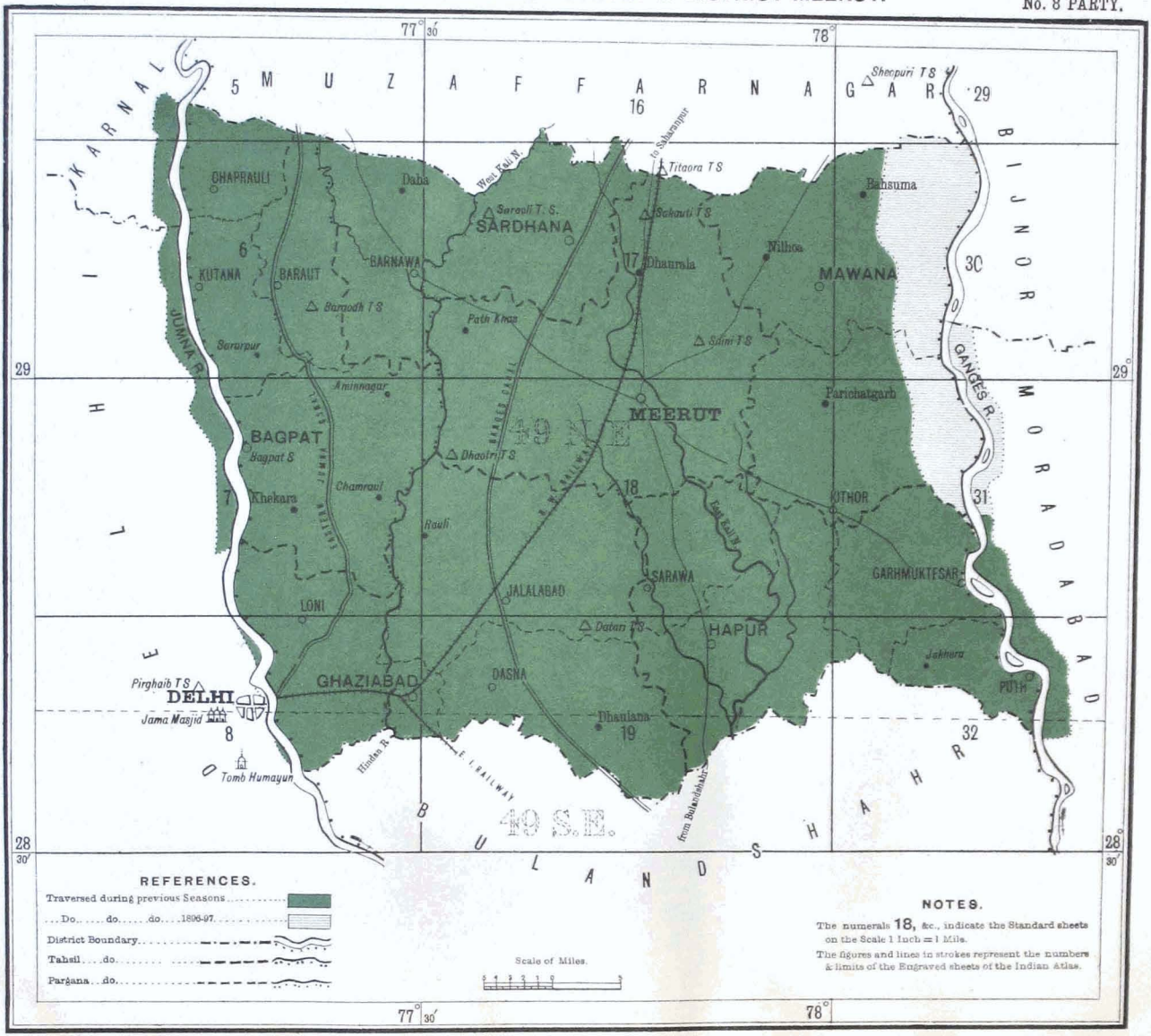
352. The area for survey in this district originally formed part of the programme for 1895-96, but had been postponed owing to the Land Records Department not being prepared to take up the cadastral survey during that season. To ensure this being completed before the next rains set in, traverse work was started about the 1st November 1896 and completed on the 28th January following. All the 16-inch skeleton plots of the area comprising 94 villages were made over to the survey officer in instalments, as quickly as they could be got ready, the last having been delivered early in March.

353. The country for the most part was covered with dense reed and grass jungle which necessitated the employment of special labour for clearing; this coupled with the almost complete absence of demarcation, interfered very much with satisfactory progress, and was a great source of trouble and delay. The ready assistance rendered by Mr. Freeman, the survey officer of the district, in allowing his *patwáris* to assist, helped most materially in completing the traverse survey in good time.

* Captain Fleming reports favourably of the work done by Messrs. Hanby and Dowman, and says that both Mr. Byrne and Jagadamba Prasad promise well. In the native establishment sub-surveyors Wali Mahomed, Ram Sarup, Inyatullah, Ahmed Husain, Basant Rai, Isswer Singh, Gokul Chand, Ghaus Mahomed and Wahid Ali, computers Manohur Lal, Mahadeo Ram, Annada Prasad Ghosh, Dharam Nath and Sheik Gazi, and writer Jagneshwer Bhuttacharjee have all been reported as having done well.

N. W. P. & OUDH SURVEY.

1896-97. **INDEX TO THE TRAVERSE SURVEY IN DISTRICT MEERUT.** No. 8 PARTY.



REFERENCES.

Traversed during previous Seasons

...Do.....do.....do....1896-97.

District Boundary

Tahsil....do.....

Pargana...do.....

Scale of Miles.

NOTES.

The numerals **18**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Reg. No. 330, S. I. D.—Dec. 97—550

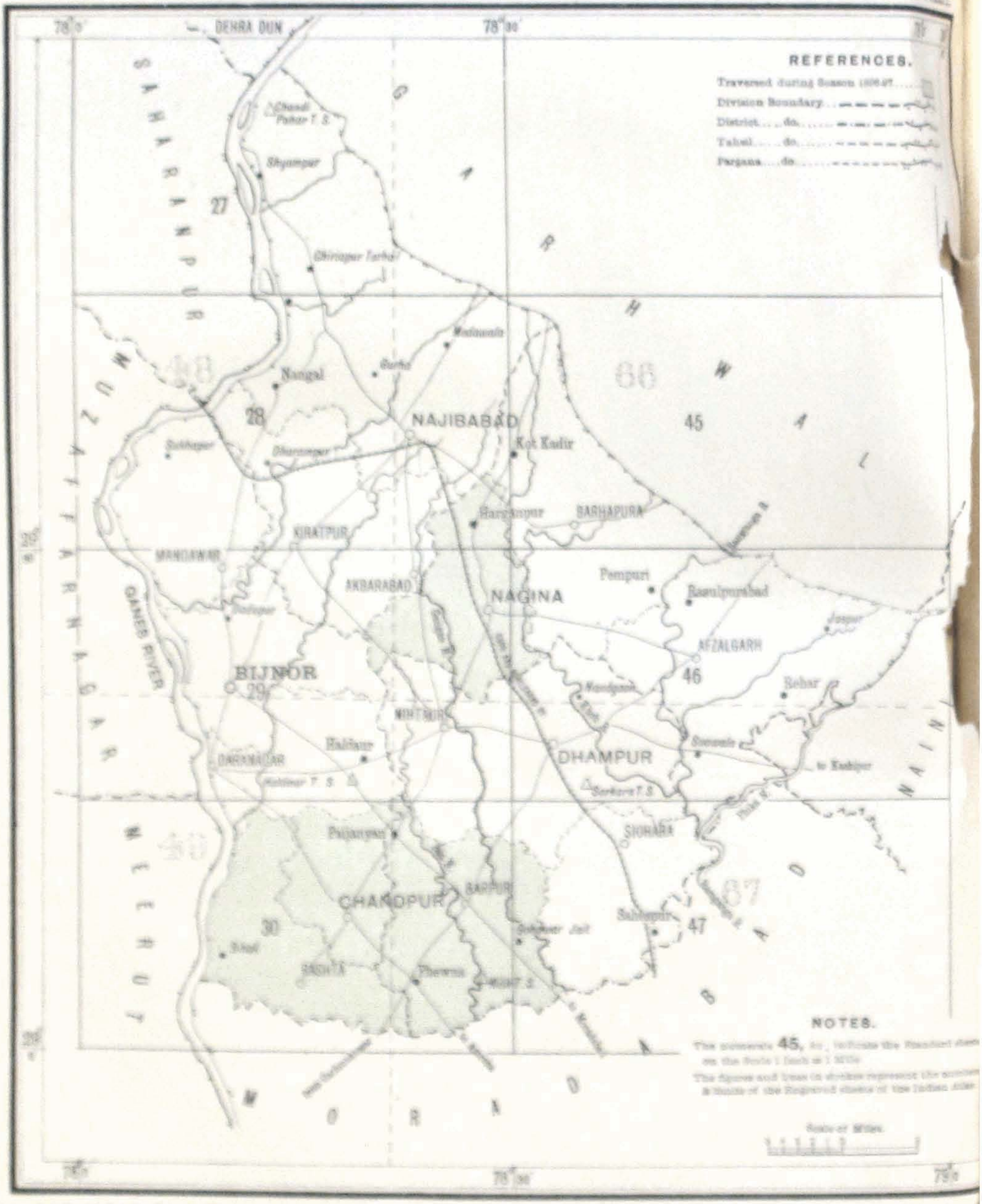
Photo S. I. O., Calcutta.

No. 476-S. 97

N. W. P. & OUDH SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BIJNOR.

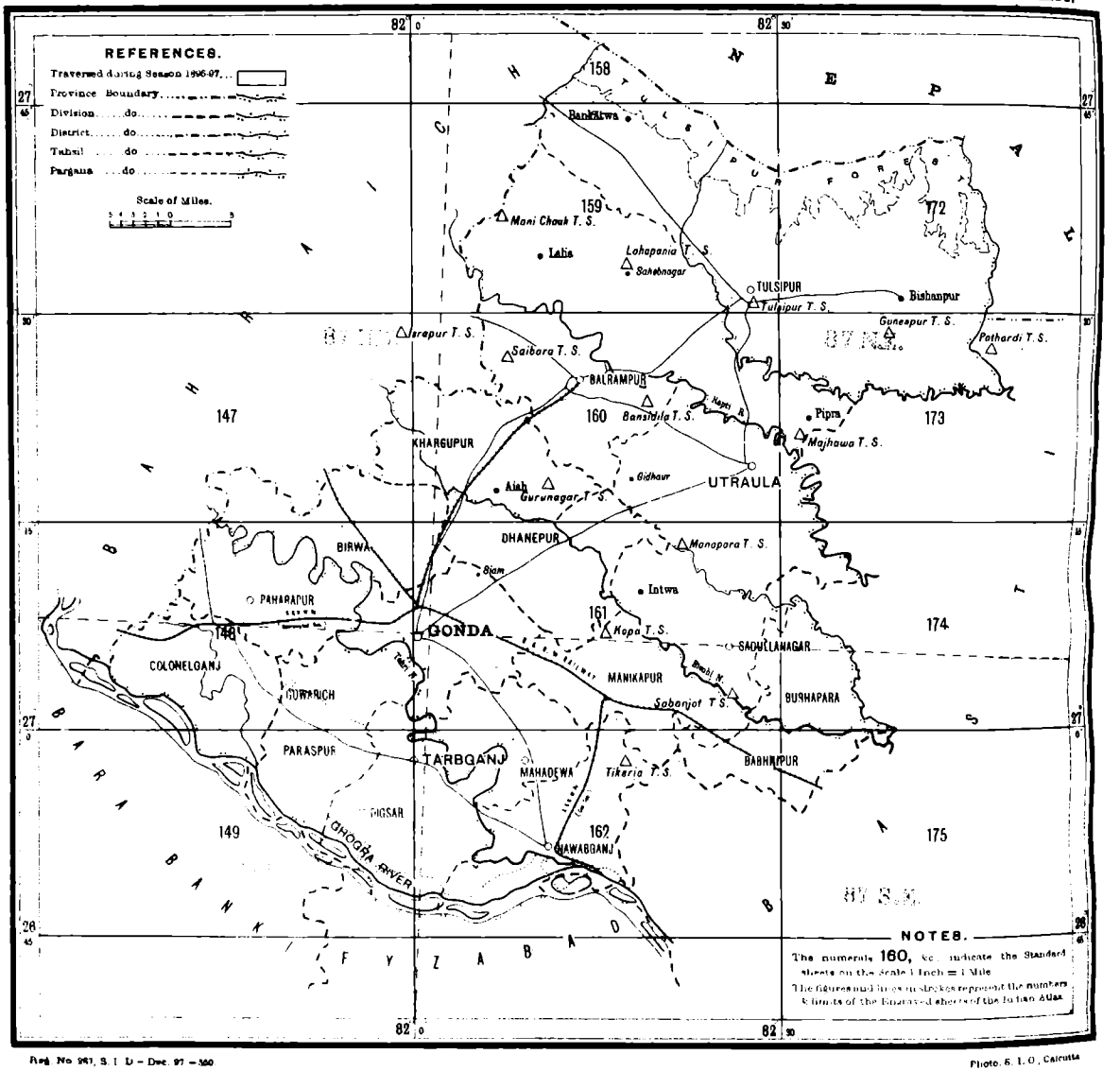
1896-97.



N. W. P. & OUDH SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT GONDA.

1896-97. No. 8 PARTY.



Regd. No. 981, S. I. D.—Dec. 97—350

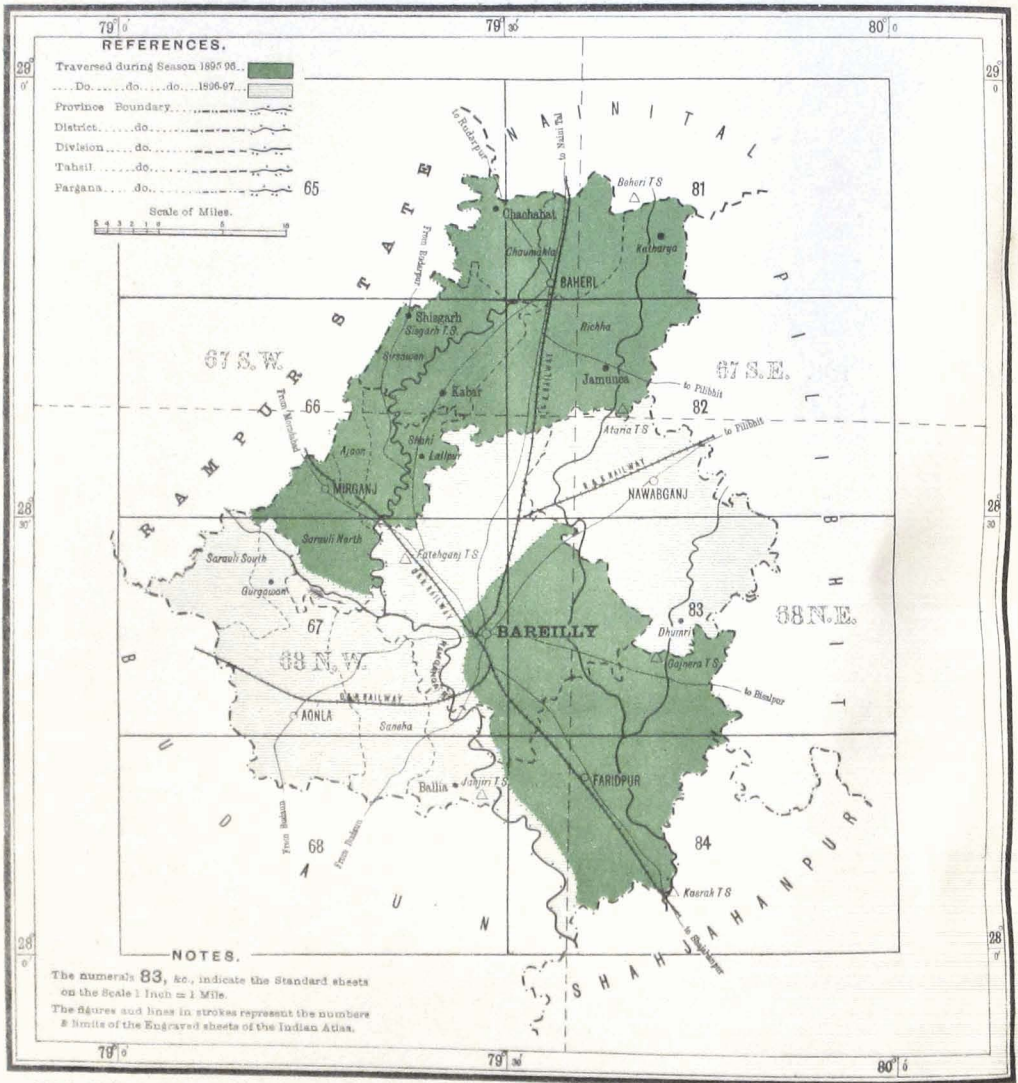
Photo. S. I. O., Calcutta

No. 474-S. 97.

N. W. P. & OUDH SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BAREILLY.

1896-97. No. 8 PARTY.



Reg. No. 328, S. I. D.—Dec. 97—550.

Photo. S. I. O., Calcutta

No. 473-S. 97.

DISTRICT BAREILLY.

354. It was in the civil station of this district that the head-quarters camp of the party was established; here all hands met for final orders and instructions, excepting only the native establishment of the camp in charge of Mr. Smart, which was ordered to assemble at Bahraich on the 1st November. The sudden death of Mr. O'Sullivan at the close of the recess season, when arrangements for taking the field were in progress, threatened some delay, but Mr. Smart very promptly took over the management of his camp and was at his post in good time.

The unsatisfactory state of demarcation and the want of assistance from *patwáris* and villagers tended to delay the work in this district.

Though there was no actual famine, there was much scarcity, as was evinced by high prices and the general condition of the very poor.

355. The first cadastral survey operations in this district by the Land Records Department, were started this season, in *parganas* Mírganj, Farídpur and Bareilly which were traversed last year. The 4-inch and 16-inch skeleton plots of this area were delivered to Mr. L. F. Berkeley the survey officer early in November.

The field work of the whole district having been completed, the camp broke up on the 10th February and moved to Bijnor.

DISTRICT GONDA.

356. Field work was started on the 7th November and brought to a close on the 26th March. The programme was slightly modified; 50 square miles of alluvial lands along the Gogra river being relinquished in *parganas* Nawábganj and Digsar, to meet the requirements of the cadastral survey, which was not to be started till the following season, and an equal area taken up in *pargana* Guwárich. The general condition of the country as regards famine, was much the same as in Bareilly, the principal difficulties being the want of assistance from *patwáris* and villagers and the unsatisfactory demarcation.

DISTRICT BIJNOR.

357. Field work was started on the 1st February and completed on the 4th April, which was the closing day of the field season for the party.

In this district 339 square miles had been traversed by the Land Records Department in 1894-95 in *parganas* Barhapura, Najíbábád and Afzalgarh under the supervision of Mr. T. F. Freeman, Deputy Collector and Survey Officer of district Meerut. This survey was carried out when it was thought no professional aid would be required in the district and that the existing *patwári* maps would answer all purposes for a new settlement. This idea was acted on, till the entire district, excepting only *parganas* Chándpur, Báshta, Burhpur and Nagína, was completed, *i.e.*, *patwári* maps were brought up to date and used for settlement purposes. Then the Board of Revenue decided to do the cadastral survey of the remaining *parganas* according to the new system, and the services of this party were called in to do the preliminary traverse.

358. The demarcation throughout the entire area traversed during the past season was decidedly defective; in parts it was imperfect and in others it was entirely wanting. The reason of this appeared to be, that orders were not issued sufficiently early by the district authorities, so as to give villagers time for erecting the required marks which, according to present orders, are mud pillars from two to three feet high plastered over. To obviate this difficulty in the future, it is suggested, in lieu of mud pillars to have only temporary marks erected immediately in advance of the traverse survey, such as bamboos or posts of sufficient height to catch the eye of the surveyor. A more permanent demarcation could subsequently be carried out to meet the requirements of the cadastral survey. The subject is of sufficient importance to call for early attention, as the want of demarcation not only causes the loss of valuable time to the surveyor, but entails a constant risk of running traverse lines farther from the boundary than is prescribed by the rules or even of omitting a boundary altogether. In connection with the subject, it may be mentioned for future reference, that the mark stones collected by the Settlement Department at several centres in districts Bareilly and Bijnor for erection at trijunction points of villages, were not embedded at the time of the traverse survey now reported on.

359 It is as well also to mention that the list of village names obtained from the Collectors' offices are invariably incomplete and often inaccurate.

The particulars of the season's outturn are given in the following table :—

Districts.	Number of Villages and River Blocks.	Number of Subtraverses.	Number of Traverse Stations.	Linear miles of Traverse.	Area in square miles.	
Meerut . . .	94	75	1,131	315	115·25	2 Main Circuits.
Do. River Blocks .	7	...	244	60	59·91	
Bareilly . . .	972	937	11,776	2,750	744·35	9 Main Circuits (including 5 supplementary circuits).
Bijnor . . .	778	457	7,326	1,684	403·10	3 Main Circuits.
Gonda . . .	1,167	1,020	16,452	3,752	1,003·63	5 Ditto.
TOTALS .	Villages 3,011 River Blocks 7	2,489	37,229	8,561	2,326 24	

360. The total expenditure for the survey year ending September 30th 1897 amounts to R67,479, and the average resulting cost rate per square mile to R29-0-3. This is in excess of both the preceding seasons, and is due to the following causes (1) extra expenditure in moving both camps from one district to another, (2) employment of extra labour in jungle-clearing in district Meerut; and (3) to the smaller area completed.

361. The following permanent marks for traverse stations were used during the season :—Stones 7,146, cylinders 23,293, baked clay marks used as substitutes for stones 606. Stones, or the substitutes above referred to, were embedded, first at trijunctions of villages where no marks were found to exist, secondly at one of three satellite stations at every trijunction, and lastly at two intermediate consecutive stations between trijunctions which were a mile or more apart. All other stations were marked by clay cylinders locally made.

The cost of each description of mark purchased during the season was as follows:—Stones, R1,998-0-0 (including railway freight), substitutes for stones R101-4-6; and cylinders R266-4-6, making a total cost of R2,365-9-0. The marks left unused and available for next season are :—Stones 1,380 and cylinders 3,800. The cost of local carriage for all descriptions of marks amounts to R2,440-11-3, being R2-1-1 per square mile; in addition to the above mile and furlong stones, masonry pillars, monoliths, etc., were taken advantage of as traverse stations. A description of every station has been noted by symbols in the traverse tables and field books.

362. The area was as usual divided into main and sub-circuits, the former invariably following *pargana* boundaries, except where alluvial lands intervened, when they were run along the high banks forming the limits of such lands. The *mauza* was the unit in the system of survey adopted, each *mauza* being sub-divided by traverses at an average distance of forty chains apart which provided a sufficient number of stations for the cadastral surveyor. Distances on main, sub and village circuits were measured with 2 chains of 100 links and 93 links respectively in all but district Gonda, where a single chain of 100 links was used for sub and village circuits. Azimuth observations were taken on main and sub-circuits at 236 points in the season's work.

A total number of eleven Great Trigonometrical Survey stations were incorporated with the season's work; the results of comparison of direct distances as obtained from Great Trigonometrical survey data, and the traverses are good in all but four cases, all in district Gonda. The towers of all stations were found in a good state of preservation in all but one instance, *viz.*, Kopa Trigonometrical Station which had fallen in parts and was repaired.

The following skeleton plots on 4-inch and 16-inch scales were prepared during the season :—3,011 villages on 104 sheets on the scale of 4-inches=1 mile; and 3,011 villages in 3,899 sheets on the 16-inch scale. In addition to the above, the plots of 414 villages on the 16-inch scale in district Basti and 104 villages on the 32-inch scale in district Bahraich, were prepared for the Land Records Department. Traverse charts on the scale of 4 miles=1-inch have also been prepared of each of the districts, as indexes to the traverse tables.

363. Field inspection of parties while actually at work, was particularly attended to, and the executive officer also inspected the office of the camp at

No. 6 PARTY.

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. KAMRUP, DARRANG, NOWGONG, & SIBSAGAR, &c.

1896-97.

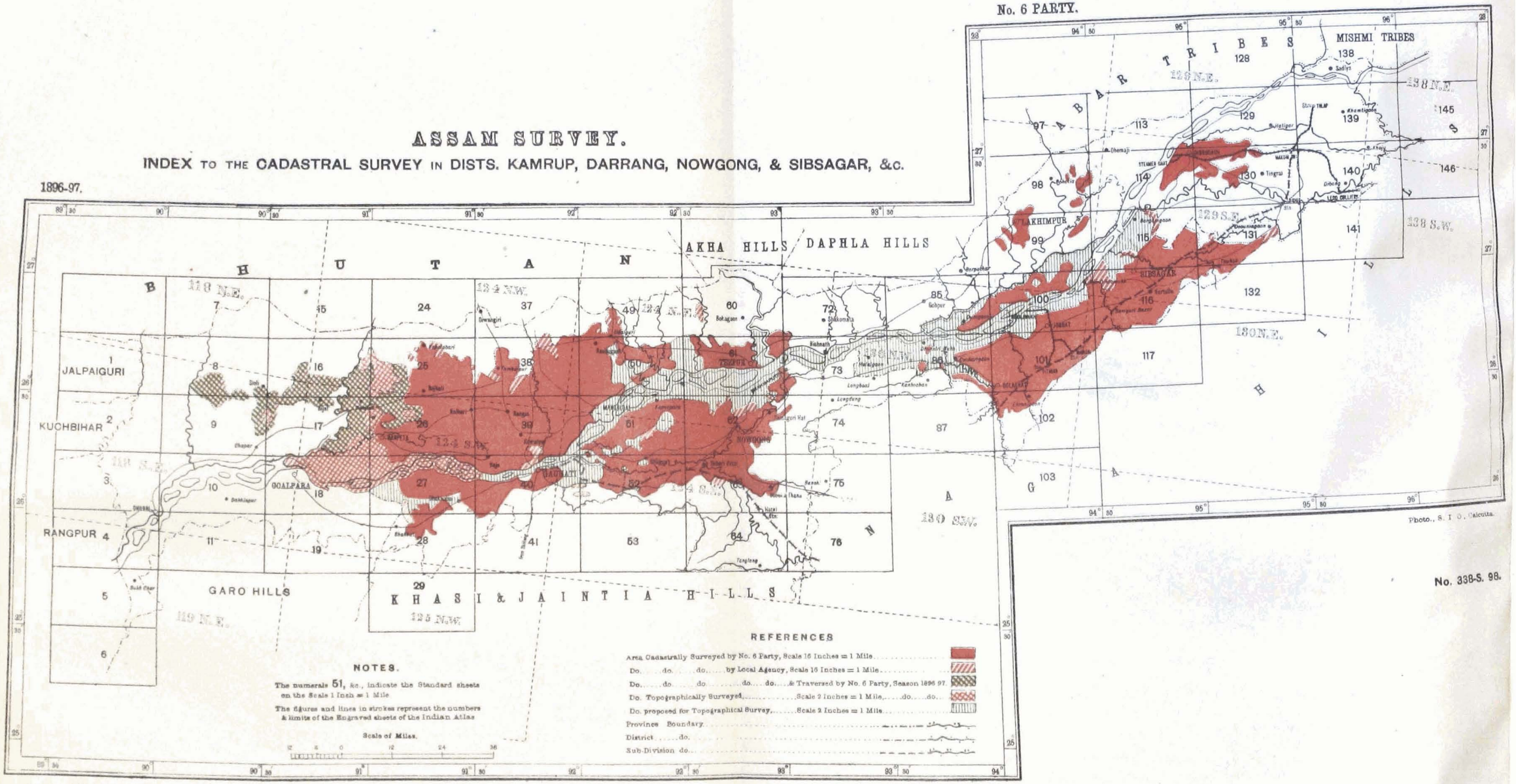


Photo., S. I. O. Calcutta.

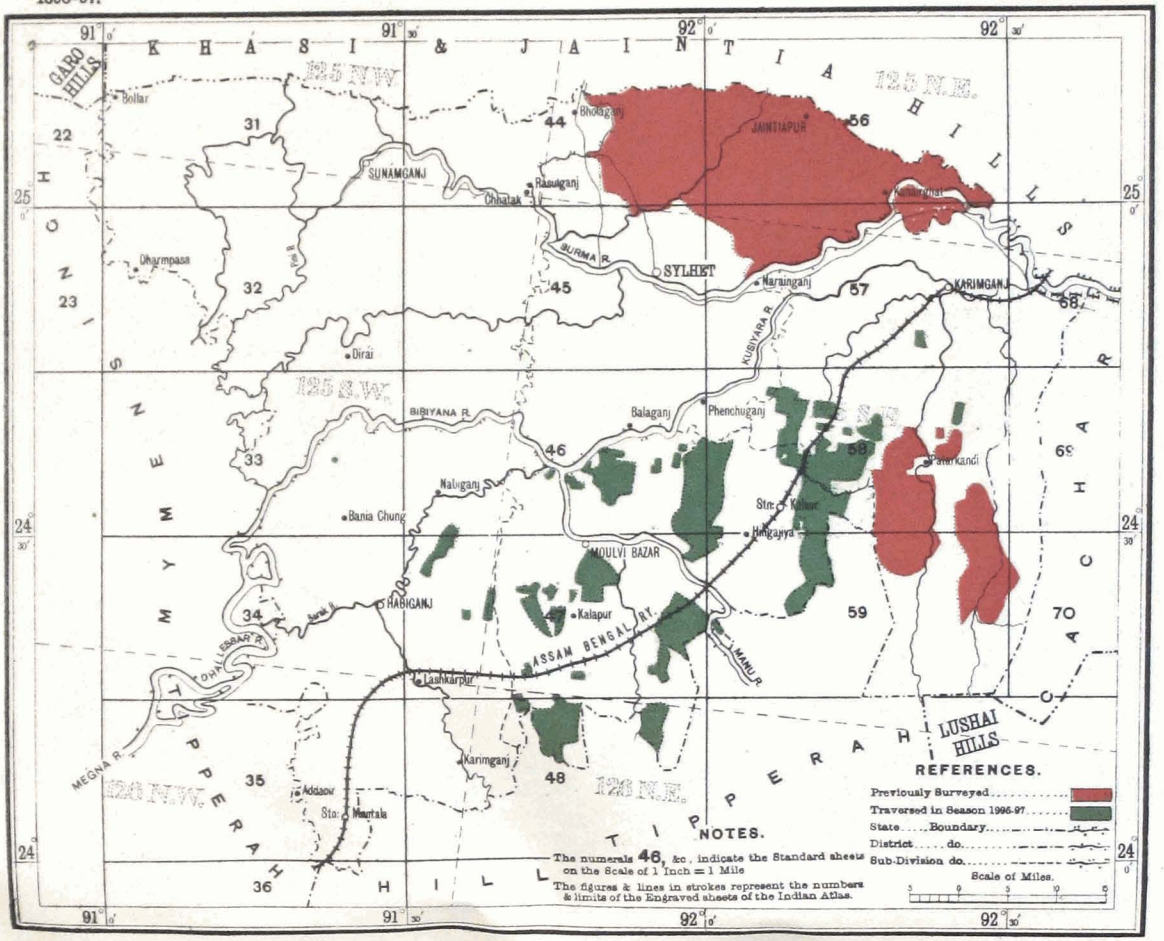
No. 338-S. 98.

Reg No. 561, S. I. D.—March 98.—50.

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. SYLHET.

1896-97. No. 6 PARTY.



NOTES.

The numerals 46, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile

The figures & lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Previously Surveyed

Traversed in Season 1896-97

State.....Boundary

District.....do.

Sub-Division do.

Scale of Miles.

Reg. No. 431, S. I. D.—Mar. 98.—550.

Photo., S. I. O., Calcutta.

No. 337-S. 98.

Gonda. The office of the party was inspected during the recess by Lieutenant-Colonel J. R. Hobday, Officiating Deputy Surveyor-General.*

ASSAM.

No. 6 Party.

364. Mr. Barrett held charge of the party until the 1st of May 1897, when he was compelled by sickness to take six months furlough, and Mr. Penrose assumed temporary charge of the party until he was relieved by Captain C. W. H. Symonds on August 25th, 1897. The head-quarters camp under Mr. Barrett left Shillong on the 16th October, and arrived at Dhubri on the 21st idem. A detachment which worked the whole season under Mr. Penrose in Sylhet left Shillong on the 5th October and commenced work at Maulvi Bázár on October 15th.

Personnel.

Mr. E. C. Barrett, Superintendent, 1st grade, in charge to 1st May 1897.
Captain C. W. H. Symonds, Officiating Deputy Superintendent, 2nd grade, in charge from 25th August 1897.
Mr. W. H. Penrose, Extra Assistant Superintendent, 5th grade, in charge from 2nd May to 24th August 1897.
Mr. F. S. Bell, Sub-Assistant Superintendent, 1st grade.
20 Permanent and 71 temporary Sub-Surveyors, Computors, etc.

365. The programme of the party comprised the traverse of about 1,500 square miles lying in the Assam Valley and the Sylhet district, and the traverse and topographical survey on the 2-inch scale of 600 square miles situated in the Assam Valley; also the revision of about 540 square miles of cadastral survey in Cachar.

366. In the tables below will be found the outturn of the party in both the Assam Valley and the Sylhet district:—

Assam Valley.

Districts.	Cadastral area surveyed by local agency.		Cadastral area to be surveyed by local agency.		Topographical survey on 2″=1 mile.	Area in square miles.
	No. of villages.	Area in sq. miles.	No. of villages.	Area in sq. miles.	Area in sq. miles.	Grand Total.
Goálpára . .	(*a*) 183	203·9	(*c*) 55	83·5	5·9	293·3
Kámrúp . .	(*b*) 260	263·0	(*d*) 26	45·9	623·3	932·2
Total .	443	466·9	81	129·4	629·2	1,225·5

(*a*) Bijni Duárs.
(*b*) Sidly Duárs, Circles 1, 2, 4 and 5.
(*c*) In *Parganas* Rupusi, Chokabandi, Dumká, Duái Bijni, Chapa Khamar.
(*d*) Bhowánipur, Hastinápur, Karijalbaden, Paka, Chapaguli.

Surmá Valley.

District.	Ordinary *ilam* lands.	Modified *ilam* lands.	Waste land grants.	Applied for grants.	Jungle-buri grants.	Permanently settled lands.	Total.
	Square miles.	Square miles.	Square miles.	Square miles.	Square miles.	Square miles.	Square miles.
Sylhet . . .	103·3	30·4	53·0	7·9	2·0	11·1	207·7

* The officer in charge reports that Mr. R. B. Smart, the senior assistant, has conducted his duties in a most satisfactory and able manner, and that Messrs. J. Murphy and G. Rae have rendered efficient service. In the native establishment Computors Latifulla Khan and Kanhaia Lal and Sub-surveyors Elahi Buksh, Hayat Mohammad, Mumtaz Ali and Ramphal as well as the English writer Sanat Kumar Chatterjee are commended.

The area traversed in Assam for local agency and for 2-inch detail survey lay in a more or less compact block in Goálpára and Kámrúp. The country to a great extent was devoid of jungle with the exception of those portions which lay along the banks of the Brahmaputra river. Here the traverse work was greatly retarded owing to its being necessary to cut lines through dense *ekra* jungle. In the Sylhet district the various description of *ilam* lands and grants were situated in the hilly and jungly country to the south-west of the district, and great difficulty was experienced in the line-cutting, especially in surveying the boundaries of grant lands.

367. A survey class was opened on January 2nd, 1897, at Maulvi Bázár, under the superintendence of Mr. Penrose, for the purpose of instructing the following officers in field-to-field surveying :—

Lieutenant Playfair, Mr. S. S. Skinner, Mr. J. F. Jackson, one Extra Assistant Commissioner, two Sub-Deputy Collectors and one selected candidate. Of these Lieutenant Playfair and one Extra Assistant Commissioner passed. The remaining five after a course of one month were exempted from further training by the Chief Commissioner.

368. In the Assam Valley the intersection of latitude 26° 30′ and longtitude 90° 30′ was assumed as the origin of survey. In Sylhet the origin of the old Jaintiá survey was preserved, namely, the intersection of latitude 24° 30′ and longtitude 90° 00′. The theodolite was set up at 22,591 stations and the aggregate length of the traverse lines amounted to 3,278 linear miles. The angular work was checked by 240 azimuths.

369. In those villages in the Assam Valley which had already been surveyed cadastrally by local agency and were traversed this season, all old marks were utilized as theodolite stations. In the villages which will be surveyed by local agency all theodolite stations were marked by a stout wooden peg, and in order to facilitate the identification of these marks, a *semal* bough was planted 5 feet magnetic north. These stations will be permanently marked by the Settlement Department. In the area traversed for 2-inch detail survey all stations were marked by pegs with the exception of old stations, which were utilized wherever they could be found. In the Sylhet district in the survey of *ilam* lands and tea grants, all new theodolite stations were similarly marked. Of these 369 in number were identified and utilized as theodolite stations. In all grant lands in Sylhet every endeavour was made to adhere to the old boundaries according to previous surveys. In the survey of *ilam* lands the boundaries were surveyed as pointed out by the Settlement Officer.

370. The revision survey of 540·5 square miles of cadastral survey completed in 1894-95 was continued during the season under report, with an establishment of 32 *amins* assisted by a settlement *munserim*; these *amins* were gradually discharged, and at the end of the season only two remained, one being employed in the Silchár town and the other in a few of the different tea grants.

371. The area surveyed topographically on the 2-inch scale in the Assam Valley has been mapped on 19 field sections.

372. The Settlement Officer has been supplied with 295 sheets plotted on 16-inch scale and also with 2-inch plots of the same sheets.

373. The following have been supplied to the Director, Land Records, Assam :—

(*a*) 571 plots of villages in the Kámrúp and Goálpára districts on the 2-inch scale.

(*b*) 176 sheets of Goálpára and Kámrúp districts plotted on 16-inch scale.

374. In the Assam Valley the attitude of the people was all that could be desired, but in the Sylhet district considerable obstruction was experienced from the native permanent settlement holders holding *ilam* and other lands.

375. The programme for the season 1897-98 consists of the following :—

Assam Valley.

(1) Topograhical survey of the Brahmaputra riverain, extending in continuation of the season's work up to Longitude 93° east, and of gaps left between previous cadastral surveys covering about 1,430 square miles.

(2) The traverse survey of 240 square miles over which local surveys have been extended between Longitude 91° and Longitude 93°.

(3) Traverse survey of certain tea grants, some already taken up, others applied for only, occupying about 90 square miles.

Sylhet District.

(1) Traverse of *ilam* lands, tea grants, etc., covering an approximate area of 200 square miles.

376. On June, the 12th, Shillong was visited by an earthquake which completely wrecked the office bungalow and all the records, furniture and instruments were covered by a mass of stones and debris. To add to the difficulties experienced by the officer in charge in rescuing all the above records, instruments, etc., the earthquake was followed by a continuous downpour of rain which lasted for 48 hours. Comparatively very few of the records and instruments were damaged, and great credit is due to Mr. Penrose and the native establishment for the energetic way in which the searching for, and rescuing of, Government property was carried out. Mr. Penrose expresses his cordial thanks for the very valuable assistance rendered him, by the Officer Commanding the 42nd Gúrkha Rifles and the Officers of the Public Works Department.

The following maps and records have been either lost or destroyed.

1. Six 2-inch standard sheets received from Calcutta.
2. One hundred of the original 16-inch sheets of Cachar.
3. The entire correspondence and a few corrections referring to the Sylhet and Cachar cadastral work.

Of these Nos. 1 and 2 will have to be re-drawn.

377. The party was inspected by Lieutenant-Colonel Hobday, Officiating Deputy Surveyor-General, during the recess at Shillong, prior to the earthquake, when the records and mapping were thoroughly examined, and proposals submitted for the retention of the party in Assam, to complete the standard mapping.*

GEODETIC.

LATITUDE OF MADRAS.

NOS. 22 AND 23 PARTIES, ASTRONOMICAL.

378. As Captain Burrard, the officer in charge of these combined parties, was under orders to take over charge of the Tidal Party in December 1896, advantage was taken of the short season thus available to investigate a discrepancy in the latitude of the Madras observatory which had come to light.

Personnel.

Captain S. G. Burrard, R.E., Deputy Superintendent, 1st grade, in charge up to 31st January 1897.
Mr. J. Eccles, M.A., Deputy Superintendent, 1st grade, in charge from 1st February to 15th March 1897.
Captain G. P. Lenox-Conyngham, R.E., Deputy Superintendent, 1st grade, in charge from 16th March 1897.
Munshi Aulad Hussein, Sub-Assistant Superintendent, 2nd grade, up to 20th November 1896.
Babu Hanuman Prasad, Sub-Assistant Superintendent, 3rd grade, from 15th November 1896.
Babu Govind Balwant Joshi, Computer.
„ Lal Singh „

379. The latitude of this point had been determined by Lieutenant Lenox-Conyngham in 1890-91 by observations taken with the zenith telescope by Talcott's method, and the resulting value judged by its probable error was all that could be desired. It was, however, subsequently pointed out by Mr. Michie Smith, the Government Astronomer, that this value differed more largely from the previously accepted one than could well be accounted for by the inferiority of earlier methods of determination. Captain Burrard was therefore instructed to proceed to Madras and reobserve the value, taking with him both the zenith telescope used by Lieutenant Lenox-Conyngham and the zenith sector which had been

*Mr. Penrose and Mr. F. S. Bell have both performed their duties satisfactorily.
The following members of the native establishment are also deserving of special mention:—
Futteh Mahomed, Jonardhan Rao, Karimullah Khan, Krishnaji Mahadeo, Srikrishto Dey, Golam Hyder Khan, Mahomed Tabrez Khan, Jowala Pershad, Shoshi Bhusan, Nasiruddin, Nilmadhab, Kedarnath, and Bahadur Singh.

previously in use in the department for the determination of latitudes. Captain Burrard built a new pillar for the zenith sector and set up the zenith telescope on the same pillar that Lieutenant Lenox-Conyngham had previously observed from. This pillar was one which had been erected and used by the American observers in 1881 when determining the difference of longitude between Madras and Singapore.

It was composed of three solid cylindrical granite blocks superimposed and cemented together and was to all appearances of ideal construction. Soon after commencing observations, it became evident to Captain Burrard that the stability of the instrument on this pillar was more than doubtful, and that the level of the instrument changed with the position of the observer. This was traced to the fact that there was no depth of foundation to the pillar, the lowest stone being merely imbedded a couple of inches in the ground. Captain Burrard minimised this unsteadiness by observing from a wooden flooring, quite detached from the pillar, but the observations taken cannot be depended on for final accuracy. It is impossible now to say in what way this unsteadiness was got rid of by the American observers, but no doubt they managed to take such precautions as to obtain satisfactory results.

Captain Burrard's observations with the zenith sector were all that could be desired; the instrument working with perfect steadiness, and the resulting latitude, *viz.*, 13° 4′ 7″·94 is in very close agreement with the previously accepted value.

A further check on this has since been obtained by Mr. Michie Smith, the Government Astronomer, by observing the altitude of the sun on the meridian over a period of several months, the observations being taken both north and south of the zenith.

Combining all the reliable results, a value for the latitude of the Madras Observatory of 13° 4′ 8″·02 is arrived at, which may be accepted as final.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

380. The direction of these operations remained in the hands of Captain C. C. D. Morice, R.E., until 15th December 1896, when having applied to revert to home service he was succeeded by Captain S. G. Burrard, R.E. Captain Burrard took three months privilege leave from July 9th, Mr. G. Belcham holding charge during his absence. The staff has been strengthened during the past year by the addition of a Sub-Assistant Superintendent.

Personnel.

Captain S. G. Burrard, R.E., Offg. Superintendent, 2nd grade, in charge from December 16th, privilege leave from 9th July to September 28th and from October 14th to October 22nd.
„ C. C. D. Morice, R.E., Deputy Superintendent, 2nd grade, in charge up to 15th December.
Mr. G. Belcham, Extra Assistant Superintendent, 1st grade, in charge from 9th July to 22nd October.
„ E. J. Connor, Extra Assistant Superintendent, 4th grade.
„ J. Bond, „ „ 4th grade.
„ J. P. Barker, Sub-Assistant Superintendent, 1st grade, joined 2nd January.

Surveyors, etc.

Dhondu Venayek, Venayek Narayen, N. V. Apte, 3 Native Mechanics, 15 Recorders and Computers.

Tidal Operations.

381. The recording of the tidal curves by the self-registering tide-gauges, their reduction and the publication of the tables of predicted tides have continued as usual during the past year. In order to present the scheme of tidal operations in a connected form a complete list of the 41 observatories is given below: of these, twenty-six have now been closed on the completion of their registrations, twelve continue working and three are to be opened during the coming winter. The seven stations, the names of which are italicised, are permanent

stations, whilst the others are minor stations at which only five years registrations are required :—

	Stations.	Automatic or Personal observations.	Date of commencement of observation.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Suez	Automatic	1897	Still working	...	
2	Perim	Ditto	...	...	...	Will open in 1898.
3	*Aden*	Ditto	1879	Still working	17	
4	Muscat	Ditto	1893	Ditto	4	
5	Bushire	Ditto	1892	Ditto	4	
6	*Kurrachee*	Ditto	1881	Ditto	16	
7	Hanstal	Ditto	1874	1875	1	
8	Navánagar	Ditto	1874	1875	1	
9	Okha Point	Ditto	1874	1875	1	
10	Porbandar	Personal	1893	1894	2	
10A	Ditto	Automatic	...	...	...	Will open in 1898.
11	Port Albert Victor (Káthiáwár).	Personal	1881	1882	1	
11A	Ditto ditto	Automatic	...	...	...	May open in 1898.
12	Bhávnagar	Ditto	1889	1894	5	
13	*Bombay (Apollo Bandar)*	Ditto	1878	Still working	19	
14	Bombay (Prince's Dock)	Ditto	1883	Ditto	9	
15	Mormugáo (Goa)	Ditto	1884	1889	5	
16	Kárwár	Ditto	1878	1883	5	
17	Beypore	Ditto	1878	1884	6	
18	Cochin	Ditto	1886	1892	6	
19	Tuticorin	Ditto	1883	1893	5	
20	Minicoy	Ditto	1891	1896	5	
21	Galle	Ditto	1884	1890	6	
22	Colombo	Ditto	1884	1890	6	
23	Trincomalee	Ditto	1890	1896	6	
24	Pámban Pass	Ditto	1878	1882	4	
25	Negapatam	Ditto	1881	1888	6	The year 1884-85 is excluded.
26	*Madras*	Ditto	1880 Restarted 1895	1890 Still working	10 2 } 12	
27	Cocanada	Ditto	1886	1891	5	
28	Vizagapatam	Ditto	1879	1885	6	
29	False Point	Ditto	1881	1885	4	
30	Dublat (Saugor Island)	Ditto	1881	1886	5	
31	Diamond Harbour	Ditto	1881	1886	5	
32	*Kidderpore*	Ditto	1881	Still working	16	
33	Chittagong	Ditto	1886	1891	5	
34	Akyab	Ditto	1887	1892	5	
35	Diamond Island	Ditto	1895	Still working	2	

	Stations.	Automatic or Personal observations.	Date of commencement of observation.	Date of closing of observations.	Number of years of observations,	Remarks.
36	Elephant Point . . .	Automatic {	1880 Restarted 1884.	1881 1888	1 5 } 6	
37	*Rangoon*	Ditto	1880	Still working	17	
38	Amherst	Ditto	1880	1886	6	
39	Moulmein	Ditto	1880	1886	6	
40	Mergui	Ditto	1889	1894	5	
41	*Port Blair*	Ditto	1880	Still working	17	

No observatories were closed during the year 1896-97. In 1897-98 it is intended to dismantle the observatory now existing at Muscat and possibly also that at Bushire, and to open new observatories at Perim, Porbandar and perhaps Port Albert Victor.

382. In addition to the automatic registrations made at the stations enumerated above, personal tidal observations to graduated staves were taken daily at the following closed tidal stations, *viz.*, Bhávnagar, Cochin, Tuticorin Colombo, Chittagong, Akyab and Moulmein. These readings were noted with the object of comparing the actual heights and times of high and low water with those predicted in the Tide Tables. No such comparisons have ever been made at Okha Point, Mormugáo, Kárwár, Beypore, Minicoy, Galle, Trincomalee, Pámban, Negapatam, Cocanada, Vizagapatam, False Point, Dublat, Diamond Harbour, Elephant Point, Amherst and Mergui since their observatories were closed, and it is not known if the predictions still continue accurate.

383. All the tidal observatories but three were inspected during the past year either by Captain Burrard or Mr. Belcham; the intended inspections of Kurrachee, Muscat and Bushire being stopped by the stringency of the quarantine regulations. No one of these stations however particularly needed inspection, and all will be visited early this season. Portable meteorological instruments were taken on the tours of inspection and compared with those working locally.

384. The tidal observatories have all worked satisfactorily with the exception of Diamond Island, where the registrations from the 21st January to the 9th March were irregular and incorrect, owing to the pipe and sluices being choked by barnacles. Free communication was eventually restored by inserting iron rods set with gimlets, but it is doubtful if the pipe will remain clear for any length of time.

The observatory clerks have performed their duties well, and the Port Officers, Port Engineers and other officials at the various stations have co-operated heartily.

385. The reduction of the observations has made good progress during the year, and the usual work in connection with the timely issue of the Tide Tables for 1898 has been satisfactorily got through. The Tide Tables now contain the predictions of high and low water at 37 ports.

The number of tides at present subjected to analysis is thirty-three, namely,

10 semi-diurnal tides,
7 diurnal tides,
7 over-tides,
4 compound tides,
2 fortnightly tides,
1 monthly tide,
1 six-monthly tide,
1 annual tide.

There is also a 19-yearly tide, but this has not yet been investigated at any of the Indian stations. At Professor Darwin's suggestion it is now proposed to evaluate the tide with a period of 427 days. Chandler, the American Astro-

nomer, has shown that there is a movement of the earth's axis of rotation round the pole in a small circle with a period of 427 days, and this change in the axis of rotation must produce a tide of that period. There are very few places in the world in which tidal observations have been carried on for a long enough time and with sufficient accuracy for the investigation, but the observations at two or three of the Indian ports are well suited for the purpose.

386. In the following statement are summarised the errors in the predicted heights and times of high and low water for the last three years.

Percentage of time predictions within 15 minutes of actuals :—

Situation and number of Stations.	Automatic.	1894.		1895.		1896.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Open Coast 10	Auto.	65	62	66	63	70	68
Riverain 2	Do.	56	55	59	55	56	55

Percentage of height predictions within 8 inches of actuals :—

Open Coast 10	Auto.	95	92	96	93	96	95
Riverain 2	Do.	66	42	74	47	63	42

Percentage of height predictions within one-tenth of mean range at springs :—

Open Coast 10	Auto.	97	95	91	89	94	90
Riverain 2	Do.	88	80	94	84	87	74

387. The station at which the predictions are most inaccurate is Bushire and this it may be remarked is the only Indian tidal station situated in an inland sea; it has however locally a very suitable site, on the open end of a peninsula unencompassed by shoals or islands, and the inaccuracies referred to must be attributed to the sea level of the gulf being irregularly affected by winds and pressure. It can hardly be questioned that the tide at Bushire is derived from the primary tide of the Indian Ocean: the Persian Gulf has an area of only 70,000 square miles and a depth never greater than 250 feet, and its waters cannot be directly affected by the sun or moon. In Lake Michigan, which is somewhat smaller than the Persian Gulf, the tidal range is only $1\frac{3}{4}$ inches and in the Mediterranean which is ten times as large it is only 12 inches, whilst at Bushire it is 4·8 feet. The anomaly however exists that the age of the tide at Bushire is less than at Muscat and that spring tide occurs at Bushire before it does at Muscat, although the tidal wave as shown on the cotidal chart reaches Muscat 12 hours earlier than Bushire. Attention is drawn to these peculiarities at Bushire as it may be found advisable this winter, if the predictions prove again inaccurate, to postpone the closing of its observatory.

Percentage of time predictions at Bushire within 15 minutes of actuals :—

	1895.		1896.	
	H. W.	L. W.	H. W.	L. W.
Open Coast Station	45	41	58	44

Percentage of height predictions within 8 inches of actuals.

	1895.		1896.	
	H. W.	L. W.	H. W.	L. W.
Open Coast Station	80	54	77	70

Percentage of height predictions within one-tenth of mean range at springs :—

	1895.		1896.	
	H. W.	L. W.	H. W.	L. W.
Open Coast Station	69	45	73	62

388. The tides of the Red Sea, another inland sea, are not well understood, and are now about to be brought under investigation. An observatory was opened at Suez in March 1897, and observations will be commenced at Perim in January 1898. The primary tide of the ocean is apparently only felt at the southern end of the Red Sea: in the Straits of Bab-el-Mandeb there is a tidal range of about 7 feet, 70 miles north of Perim it is only $2\frac{1}{2}$ feet, and at some places still further north it is imperceptible. At Massowah, Suakim and Jeddah

a single tide a day of about 18 inches at springs is said to have been observed, but at these places and throughout the northern half of the Red Sea the level of the water will vary by as much as 3 feet according to the force and direction of the prevailing wind, and in the presence of this peculiarity but little weight can be attached to the result of a few tidal observations made with no pretence to refinement. As an example of the extent to which the tides of the Red Sea may be masked by the effects of wind, it is only necessary to mention the Dædalus shoal in latitude 25° where the steamers 'Carnatic' and 'Dacca' were wrecked: from December to March during the strong southerly winds this shoal is under water at all periods of the tide, whilst throughout the summer it remains perfectly dry, the change of sea level being dependent on season. The Gulf of Suez is believed by nautical men to have a tide of its own; the moon is supposed to raise a wave in the Red Sea south of the Sinai Peninsula, and this wave advancing up the shallow narrow gulf has an enhanced effect at Suez where the tidal range of 8 feet is greater than at any other place in the Red Sea. The age of the tide when deduced from our observations will show if this theory is correct. The influence of the Red Sea tide is not felt in the Suez Canal north of the Bitter Lakes. At Suez the flood stream lasts seven hours and the ebb stream five hours, a difference said to be due to the evaporation from the broad surface of the Bitter Lakes.

389. The Tidal diagrams for June 12th were closely searched for marks of the great earthquake; at Kidderpore the first effect of the earthquake was to cause the level of the water to fall one inch between 4-53 P.M. and 4-55 P.M. Calcutta time. At 4-55 P.M. there was a sudden rise of half an inch. For the next five minutes the change in the water-level was normal, but at 5 P.M. a series of oscillations commenced, the surface of the river alternately rising and falling three inches a great number of times, in rapid succession. After the first three minutes the range of these vibrations did not exceed one inch, and their intervals of recurrence became longer, the undulatory period being perhaps as much as a minute, till at 5-21 P.M. the commotion ceased. From 5-21 P.M. to 5-54 P.M. the water-level merely underwent its normal tidal change; a slight agitation then appeared again, but this subsided at 5-56 P.M.

The earthquake made no impression on the tidal diagrams at Port Blair, Diamond Island, Madras or Bombay. At Rangoon a slight perturbation is indicated on June 12th at about 5-5 P.M. Calcutta time, but that it was caused by the earthquake, is very doubtful. Chittagong is the port that probably witnessed the greatest disturbance of sea-level, but its tidal observatory was closed in 1891.

Spirit-Levelling Operations.

390. The regular levelling operations were carried out by Mr. J. Bond who had been instructed to continue work on the great line of levels that is to connect Vizagapatam and Allahabad.

The portion of this line between Biláspur and Ráipur was completed in 1891-92, that between Ráipur and Potanghi in 1895-96 and Vizagapatam had been connected with Vizianagram in 1894-95. A gap of 60 miles between Vizianagram and Potanghi had been left unfinished in May 1896, and the northern section from Biláspur to Allahabad had not been touched.

391. In November 1896, Mr. Bond after first connecting the two ends of the Vizagapatam Base line with the main line of levels, proceeded to observe from Potanghi to Vizianagram. This work in four weeks he completed and direct connection was thus established between Vizagapatam and Biláspur.

He then moved *viâ* Calcutta to Biláspur and commenced operations on the northern section. After three months work here, he closed his field season at Katni on May 11th, 1897, by which date he had extended the line from Biláspur to within 150 miles of the terminus at Allahabad.

Branch lines were carried to five principal stations of the East Coast and Biláspur Meridional Series and to the several shafts of the Umaria Colliery.

392. The total rises and falls of the country levelled over amounted to 12,818 feet, and the total outturn which is very creditable to Mr. Bond was 291½ miles of double levelling.

The instruments were set up at 3,239 stations, and the heights of 23 embedded bench-marks, 298 ordinary bench-marks, 72 Railway bench-marks, 8

verificatory points and 5 stations of the Great Trigonometrical Survey were determined.

Accepting the value assigned by the Trigonometrical Branch office to the embedded bench-mark at Ráipur, the error generated in levelling from Vizagapatam to Ráipur, a distance of 358 miles is +0·029 of a foot.

393. During next field season Mr. Bond and his detachment are to be employed in revising the triangulation of the Gáro and Khásia Hills for the purpose of measuring the changes which it is believed have been caused by the earthquake, and the levelling operations will be held in abeyance.

394. In addition to the regular departmental work of the tidal and levelling party, a considerable amount of extra work had to be undertaken in order to furnish other departments and Local Governments with information applied for by them.

395. The recess office of this party at Poona was visited by the Surveyor-General in September 1397. The annual inspection by the Superintendent of Trigonometrical Surveys was carried out in October 1896.*

*Captain Burrard reports most favourably of Messrs. Belcham, Connor and Barker and Surveyor Dhondu Vinayek in the tidal division, and of Mr. Bond and Surveyor Vinayek Narayen in the levelling division. The staff of mechanics, sub-surveyors and computers are reported to have worked well.

Summary of the outturn of work of the

Scale of Survey.	No. of Party.	Locale of field operations.		Triangulation. Instrument used. Diameter in inches.	Area, in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Spirit-levelling operations. Miles levelled over.	Permanent bench-mark stones embedded.	Trigonometrical stations connected with.
Inches to a mile. 105·6 52·8	7	Rangoon Town . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Do. do. . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	...	...	...	...	...	...	...	...	...	...	...
66	12	Kurrachee City . .	...	...	...	...	...	...	...	...	...	...	...	...	...
32	4	Midnapore . . .	...	...	..	...	...	...	...	...	...	...	...	...	...
16	2	Kheri . . .	5	...	...	...	...	...	...	...	..	...	...	...	...
		Shahjahanpur . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Pilibhit . . .	...	...	...	...	...	...	..	...	...	...	...	...	...
	3	Shwebo . . .	...	12	...	...	...	...	...	...	...	...	...	...	...
		Yamethin . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Katha . . .	10	...	...	...	...	...	...	...	...	...	...	...	...
		Upper Chindwin .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Myingyan . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Minbu . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mandalay . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lower Chindwin .	15	...	...	...	...	...	...	...	...	...	...	...	...
	4	Noakhali . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Muzaffarpur . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Saran . . .	...	..	...	...	...	...	...	...	...	...	...	...	...
		Darbhanga . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Monghyr . . .	20	...	...	...	...	...	...	...	...	...	...	...	...
	7	Pegu . . .	...	5	...	...	...	...	...	...	...	...	...	...	...
		Toungoo . . .	...	5 & 6	...	..	...	...	...	...	...	...	...	...	...
	8	Gonda . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Meerut . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bareilly . . .	25	...	...	...	...	...	...	...	...	...	...	...	...
		Bijnor . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	Baluchistan . .	...	5	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forests) .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Nagpur and Wardha .	...	...	...	...	...	...	...	...	...	...	...	...	...
	Forest Branch.	Balaghat . . .	30	...	...	...	...	...	...	...	...	...	...	...	...
		Seoni . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chhindwara . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Raipur . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Saugor . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
	Land Records Survey.	Meerut . . .	35	...	...	...	...	...	...	...	...	...	...	...	...
		Lalitpur subdivision	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bahraich . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sitapur Alluvial Mahals	...	...	...	...	...	...	...	...	...	...	...	...	...
		Shajahanpur . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kheri . . .	40	...	...	...	...	...	...	...	...	...	...	...	...
		Bareilly . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	...	...	...	...	...	...	...	...	...	...	...
12	15	Baluchistan . .	...	8 & 6	1,940 (e)	3·2	3·4	102	4·2	0·12	1,527	0·26	...	...	...
8	3	Katha . . .	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forests) .	...	7	1,376 (f)	...	...	37	8·0	0·2	210	0·2	...	...	...
		Total .	...	...	1,376	...	...	37	...	...	210	...	...	...	...
6	15	Rawalpindi . . .	45	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1896-97.

	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area, in square miles.	Stations at which theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area, in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area, in square miles.	Villages.	Fields.	
...	5·25	2,580	10	0·6	1·38	...	52	8	...	...	...	7,084(*a*)	
...					4·58	...	53	11	...	...	...	21,118(*a*)	
...	5·25	2,580	...	...	5·96	...	105	19	...	...	...	28,202	
...	...	331	...	...	1·41	...	10	...	...	...	...	...	
...	4	225	...	...	3	...	31	8	0·27	3	8	7,860	
5	1,600	21,503	4	0·63	...	...	...	...	...	...	...	...	(*a*) Fields marked (*a*) are of detail survey, and not of record-writing.
...	237	5,165	4	0·66	...	...	...	...	...	...	...	...	
...	1,168	18,834	4	0·65	...	...	...	...	...	...	...	...	(*b*) Includes 23 villages = 146 square miles of topographical survey on 16" scale.
...	...	...	...	...	46	...	39	22	5·74	...	...	5,053(*a*)	
...	16	247	...	...	56	...	26	34	3·42	...	...	10,551(*a*)	
10	186	12,794	0·5	0·46	229	...	584	616	0·55	...	...	267,235(*a*)	(*c*) Includes 55 villages = 25 square miles of topographical survey on 16" scale.
...	46	2,420	...	...	129	...	388	317	0·33	...	...	244,535(*a*	
...	881	10,014	0·2	0·26	781	...	2,033	782	2·18	...	...	230,161(*a*)	
...	151	7,064	0·4	0·35	57	...	141	160	0·74	...	...	49,940(*a*)	(*d*) Includes 23 villages = 40 square miles of topographical survey on 16" scale.
...	...	...	...	...	2	...	3	7	0·20	...	...	6,783(*a*)	
15	482	10,080	0·03	0·42	...	...	...	...	...	...	...	...	(*e*) This includes the triangulation done for 6-inch survey in Rawalpindi.
...	226	1,559	...	...	230 (*b*)	...	447	66	1·11	84	43	48,342	
...	2	71	...	...	2	...	2	2	0·85	2	2	961	
...	60	1,050	...	...	235 (*c*)	...	1,384	385	0·32	210	330	412,843	(*f*) Includes 1,041 square miles done for 4-inch Survey. Excludes 141 square miles of triangulation done in Surat which has not yet been computed.
...	417	12,886	...	...	585 (*d*)	...	2,407	661	0·32	545	638	1,091,765	
20	...	...	...	...	1	...	...	2	2·34	1	2	232	
...	11	214	2	1·3	450	...	1,244	188	0·56	...	...	209,490(*a*)	
...	679	14,029	5	0·4	59	...	328	20	0·44	...	...	73,680(*a*)	
...	1,004	16,452	4	0·2	...	...	...	...	...	...	...	...	(*g*) Includes 10 square miles done for the 8-inch scale.
...	175	1,675	7	0·34	...	...	...	...	...	...	...	...	
25	744	11,776	3	0·19	...	...	...	...	...	...	...	...	(*h*) The triangulation includes that done for the 2" detail survey.
...	403	7,326	2	0·1	...	...	...	...	...	...	...	...	
...	...	802	8	1·0	...	...	...	...	...	...	...	...	
...	...	...	...	...	33	8	42	...	...	...	...	...	(*i*) Includes 191 square miles of forest blocks.
...	...	...	...	...	42	25	22	...	...	...	...	...	
30	...	...	...	...	35	83	...	...	...	...	...	...	(*j*) Includes 623 square miles of Traversing done for 2" detail topographical survey.
...	...	...	...	...	22	...	...	...	...	...	...	...	
...	...	...	...	...	41	...	...	...	...	...	...	...	
...	...	...	...	...	19	...	...	...	...	...	...	...	(*k*) Includes 41 square miles of reruivey of Sittang River.
...	...	...	...	...	47	...	...	...	...	...	...	...	
35	...	...	...	...	593	...	...	479	0·9	801	616	531,861	(*l*) One hundred and fifty-six square miles of overlap not included in calculating cost rates.
...	...	...	...	...	501	...	...	224	2·4	501	224	129,353	
...	...	...	...	...	914	...	...	640	0·7	841	638	1,002,471	(*m*) Includes 236 square miles of overlap survey.
...	...	...	...	...	62	...	...	47	1·1	62	47	35,090	
...	...	...	...	...	806	...	...	1,184	0·8	806	1,184	624,257	(*n*) Includes 454 square miles of overlap and riverain survey.
40	...	...	...	...	755	...	...	654	0·9	755	654	500,842	
...	...	...	...	...	694	...	...	957	0·7	515	724	464,691	(*o*) Includes 277 square miles of overlap survey.
...	8,188	153,970	...	...	7,426	...	9,090	7,447	...	5,123	5,102	5,940,136	
...	...	...	...	...	56	358	36	...	...	...	...	...	
...	...	...	...	...	2	406	...	...	...	...	...	...	
...	...	...	...	...	168	197	70	...	...	...	...	...	
...	...	...	...	...	170	...	70	...	...	...	...	...	
45	...	...	...	...	21	148	*in situ*	...	...	...	...	...	

Summary of the outturn of work of the

Scale of Survey.	No. of Party.	Locale of field operations.		Triangulation. Instrument used. Diameter in inches.	Area, in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Spirit-levelling operations. Miles levelled over.	Permanent bench-mark stones embedded.	Trigonometrical stations connected with.
Inches to a mile.															
4	9	Trichinopoly	...	6	250	2·0	2·2	38	5·9	5·9	85	3·8	...	...	...
	9	Coimbatore	...	6	1,200	4·8	4·8	...	...	...	251	1·1	...	...	...
	14	Central Provinces (Forests).	...	6	1,770	4·0	4·0	83	10·0	0·35	261	1·04	...	...	...
	17	Bombay (Forests)	...	6	...	...	...	...	...	...	...	...	...	...	...
	18	Himalaya	5	7	202(*h*)	0·64	0·64	19	3·2	0·27	449	0·24	...	...	...
	19	North Arcot, Kurnool, Salem.	...	5 & 7	1,000	2·6	2·6	143	17	0·6	319	0·67	...	...	...
	20	Burma (Forests)	...	5	...	...	...	...	...	...	...	...	...	...	...
	Forest Branch.	Saugor	...	7	327	14·2	13·1	5	...	7	...	...	...	...	...
		Raipur	...	5	...	...	...	...	...	...	...	...	...	...	...
		Nagpur	10	...	...	...	...	...	...	...	...	...	...	...	...
		Balaghat	...	...	...	...	...	...	...	...	...	...	...	...	...
		Seoni	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chhindwara	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bilaspur	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chamba	15	...	...	...	...	...	...	...	...	...	...	...	...
		Yamethin (Pyinmana)	...	5	...	...	...	...	...	...	...	...	...	...	...
		Tenasserim	...	8, 7, 5 & 4½	523	6·8	6·8	17	9·9	0·41	60	0·97	...	...	...
		Ruby Mines	...	10, 7, 5½, 5 & 4½	1,712	38·6	38·6	11	20·7	0·26	23	2·48	...	...	...
		Totals	...	...	6,984	...	...	316	...	...	1,448	...	...	...	...
2	4	Noakhali	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Goalpara	20	...	...	...	...	...	...	...	...	...	...	...	...
	6	Kamrup	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Sylhet	..	...	...	...	...	...	...	...	...	...	...	...	...
	7	Thaton	...	...	...	...	...	...	...	...	..	...	...	...	...
	12	Sind	...	8, 6 & 5	...	...	...	90	10·0	...	43	6·4	...	...	...
	15	Multan	25	5	...	...	...	...	...	...	...	...	...	...	...
	18	Himalaya	...	...	...	...	...	...	...	...	...	...	...	...	...
	20	Burma (Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	...	...	...	190	...	...	43	...	...	...	...
1	10	Upper Burma	...	6	2,503	7·5	26·4	50	10·9	0·33	297	0·82	...	...	...
	11	Do. do.	...	6	3,220	5·3	5·4	93	13·0	0·22	515	0·52	...	...	...
	15	Sind	30	...	...	...	...	...	...	...	...	...	...	...	...
	21	Upper Burma	...	8 & 6	2,967	8·0	12·1	50	10·9	0·33	297	0·82	...	...	...
	Forest Branch.	Chamba	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	8,690	...	...	193	...	...	1,109	...	...	...	...
½	15	Baluchistan	...	...	...	...	...	...	...	...	...	...	...	...	...
½	11	Upper Burma	...	6	2,000	...	...	...	...	...	...	...	...	...	...
	21	Do. do.	35	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	2,000	...	...	...	...	...	...	...	...	...	...
¼	15	Persia	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	India	37	...	...	...	...	...	...	...	...	...	291	329	5
		Totals		...	...	...	...	...	..	...	...	..	291	329	5
		GRAND TOTALS	...	...	20,990	...	...	738	...	...	4,337	...	291	329	5

Field Parties during the year 1896-97—(contd).

	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			Remarks.
	Area, in square miles.	Stations at which theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area, in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area, in square miles.	Villages.	Fields.	
...	...	2,053	0·10	0·94	121	45	18	...	...	...	...	...	
...	...	2,262	0·15	...	...	...	...	...	...	...	...	...	
...	408	2,753	10·0	...	697	79	412	...	...	...	...	...	
...	244(*g*)	1,096	0·07	1·0	522	24	35	...	...	...	...	...	
5	...	...	...	...	446(*i*)	48	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,027	81 52	25 in Arcot 192 in Salem	...	...	...	...	...	
...	512	13,100	2·8	2·7	395	189	147	...	...	...	...	..	
...	...	...	...	...	185	130	365	...	...	...	...	...	
...	11	105	...	2·2	146	113	764	...	...	...	...	...	
10	...	...	...	...	183	216	132	...	...	...	...	...	
...	...	...	...	...	133	215	19	...	...	...	...	...	
...	...	...	...	...	157	149	45	...	...	...	...	...	
...	...	...	...	...	178	216	52	...	...	...	...	...	
...	...	...	...	...	20	82	...	...	...	...		...	
15	...	...	...	...	87	70	*in situ*	...	...	...	...	...	
...	...	1,671	3·0	0·46	171	23	110	...	...	...	...	...	
...	33	1,113	6·0	...	97	227	72	...	...	...	...	...	
...	49	3,054	3·8	..	...	...	...	...	...	...	...	...	
...	1,257	27,207	...	...	4·565	...	2,388	...	...	...	...	...	
...	199	689	...	...	199	...	43	8	...	...	...	...	
20	1,133 (*j*)	22,591	3·7	0·7	6	...	...	...	...	...	...	...	
...					623	...	...	...	...	...	...	...	
...					...	...	...	...	...	...	...	...	
...	21	645	3·0	0·6	493(*k*)	3	6	...	...	...	...	...	
...	3,635	14,736	3·1	0·9	2,244(*l*)	20	34	...	...	...	...	...	
25	735	1,691	11·4	0·7	912	14	114	...	...	...	...	...	
...	...	...	...	...	364	...	...	...	...	...	...	...	
...	...	...	...	...	106	56	21	...	...	...	...	...	
...	6,023	40,352	...	...	4·94	...	218	8	...	...	...	...	
...	...	...	...	...	1,961(*m*)	5·9	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,649(*n*)	7·0	49	...	...	...	...	...	
30	...	...	...	...	1,825	3·0	163	..	...	...	...	...	
...	...	...	...	...	2,137(*o*)	5·9	*in situ*	...	...	...	...	...	
...	...	...	...	...	802	16·0	do.	...	...	...	...	...	
...	...	...	...	...	8,374	...	212	...	...	...	..	...	
...	...	...	..	...	700	0·3	...	...	...	...	...	...	
...	...	...	...	...	8,170	...	...	...	...	...	...	...	
35	...	...	...	...	3,548	...	...	...	...	...	...	...	
...	...	...	...	...	11,718	...	...	...	...	...	...	...	
...	...	...	...	...	67,000	...	...	...	...	...	...	...	
37	...	...	...		...	...							
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	15,777·25	2,24,665	...	...	1,04,987·37	...	12,160	7,482	...	5,126	5,110	59,76,198	

Statement showing the cost-rates of work executed by the

Number of party.	Nature and *locale* of field operations.	Cost-rate per square mile in rupees.											
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of									
				8″	4″	3″	1″	2″	4″	6″	8″	12″	16″	32″
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
6	Goalpara and Kamrup	...	29·3	...	...	...	...	43·7	...	...	...	...	...	...
10	Upper Burma	14·9	...	...	...	...	31·8	...	...	...	...	...	...	...
11	Ditto	9·7	...	...	...	...	46·3	...	...	...	...	...	...	...
12	Sind	...	9·1	...	...	...	...	14·2	...	...	...	...	...	...
15	Baluchistan, Rawalpindi, Persia.	12″=133·31 / 6″= 28·0 / 1″= 9·25	14·6	6·0	...	4·2	7·0	15·7	...	15·(	...	176·0	...	...
18	Himalayas	29·7	...	...	...	...	...	48·7	93·3	...	...	...	...	...
21	Upper Burma	15·5	...	...	3·5	...	21·3	...	...	...	...	...	...	...
	Forest Surveys.													
9	Madras	25·1		...	...	...	...	...	324·3	...	...	...	...	...
14	Central Provinces	7·4	17·7	...	...	...	...	...	70·5	...	...	...	...	...
17	Bombay	7·4	8·1	...	...	...	...	...	77·6	...	135·7	...	156·0	...
19	Madras	17·4		...	...	...	...	...	65·4	...	...	...	...	...
20	Lower Burma	...	81·8	...	...	...	...	51·1	169·8	...	...	...	...	...
Forest Survey Branch.	Balaghat and Seoni	...	...	...	...	..	...	...	37·0	...	...	...	...	...
	Chhindwara	...	...	...	...	...	...	...	46·9	...	...	...	...	...
	Nagpur and Wardha	...	...	...	...	..	...	...	37·4	...	...	...	...	...
	Raipur and Bilaspur	...	...	...	...	...	...	...	10·1	...	..	...	53·7	...
	Saugor, Jubbulpore, and Mandla	...	...	...	...	...	...	...	9·4	...	...	...	46·7	...
	Chamba	...	...	...	...	...	8·5	...	29·8	...	...	...	...	...
	Tenasserim	7·7	29·1	...	...	...	...	...	99·3	...	...	...	...	...
	Yamethin (Pyinmana)	...	45·1	...	...	...	...	...	105·2	...	...	...	...	...
	Ruby Mines	7·7	33·4	...	...	..	...	...	...	...	...	...	...	...
	Cadastral Surveys.													
	Shwebo	...	...	...	...	...	...	...	...	...	...	...	161·4	...
	Yamethin	...	59·6	...	...	...	...	...	...	...	...	...	74·9	...
	Katha	...	66·1	...	...	...	...	...	...	...	...	...	104·2	...
3	Upper Chindwin	...	85·6	...	...	...	...	...	...	...	...	...	130·4	...
	Myingyan	...	67·7	...	...	...	...	...	...	...	...	...	124·3	...
	Minbu	...	54·9	...	...	...	...	...	...	...	...	...	74·9	...
	Mandalay	...	...	...	...	...	...	...	...	...	...	...	75·0	...
	Lower Chindwin	...	62·1		...	...	...	...	...	...	...	...	...	...
	Noakhali	...	32·1	...	...	...	...	6·0	...	...	...	...	89·0	...
4	Midnapore	...	98·8	...	...	...	...	...	...	...	...	...	...	302·7
	Saran	...	...	...	...	...	...	...	...	...	...	...	142·0	...
	Darbhanga	...	54·3	...	...	...	...	...	...	...	...	...	78·3	...
7	Pegu and Toungoo	...	63·9	...	...	...	...	58·5	...	...	...	...	150·8	...
	Traverse Surveys.													
2	Shahjahanpur	...	23·7	...	...	..	..	...	...	...	...	...	...	...
	Kheri	...	23·7	...	...	...	...	...	...	...	...	...	...	...
	Pilibhit	...	23·7	...	...	...	...	...	...	...	...	...	...	...
8	Meerut, Bareilly and Bijnor	...	24·1	...	...	...	...	...	...	...	...	...	...	...
	Gonda	...	30·6	...	...	...	...	...	...	...	...	...	...	...

several Field Parties during the year 1896-97.

	Cost-rate per acre in annas.	Cost-rate per square mile in Rupees.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
	Cadastral survey, including traversing, detail survey and mapping.	Stone embedding.	Records (*Khanapuri*).	Completion of vernacular records, assessment statistics, etc.		
	Annas.	*R*	*R*	*R*	*R*	
...	...	...	...	...	79,540(*a*)	(*a*) Includes R3,552 expended on demarcation. Four per cent. for instruments have been added to R21,603 expended on Cachar revision survey, or cadastral mapping, statistics, etc., of Goalpara, Kamrup and Sylhet.
...	...	...	...	...	92,317	(*b*) Includes R4,858 expended on Karenni Boundary Survey and R31,511 expended on 4" survey.
...	...	...	...	...	1,23,061	(*c*) Includes R984 expended on survey of the Town of Nahan; R233 on the revision of Simla Municipal map; R2,963 on the instruction of soldier surveyors and pupils; and R12,701, on arrears of mapping.
...	...	...	...	...	94,683	(*d*) Inclusive of the 16-inch work done in these districts—22 square miles in Seoni and 35 square miles in Balaghat.
5	...	...	...	...	1,38,103	(*e*) Inclusive of the 16-inch work done in this district—41 square miles.
...	...	...	...	...	63,826(*c*)	(*f*) Inclusive of the 16-inch work done in this district—42 square miles.
...	...	...	...	...	89,383	(*g*) Inclusive of the 16-inch work done in this district—19 square miles; also R3,042 for levelling at R6·4 per mile.
						(*h*) Inclusive of the 16-inch work done in this district—47 square miles; also R1,224 for levelling in Saugor.
...	...	...	...	...	78,904	(*i*) Includes R90 expended on completion of Backerganj records.
...	...	...	...	...	89,135	(*j*) Includes R169 expended on revision survey in Orissa.
10	...	...	...	...	82,337	(*k*) Includes R3,314 extended in bringing up arrears of Champaran records.
...	...	...	...	...	87,782	(*l*) Includes R9,002 expended on Monghyr records; R4,386 on Mozaffarpur records; R591 on Gaya records; R1,527 on Palamau records and R474 on Singhbhoom records.
...	...	...	...	...	114,234	(*m*) Includes R40,031 expended on survey of Rangoon Town; R3,344 on revision survey in district Thaton. The rate of 2-inch detail survey is for District Thaton only.
...	...	...	...	...	12,853(*d*)	
...	...	...	...	...	10,262(*e*)	
15	...	...	...	...	9,697(*f*)	
...	...	...	...	...	13,330(*g*)	
...	...	...	...	...	15,161(*h*)	
...	...	...	...	...	9,731	
...	...	...	...	...	16,840	
20	...	...	...	...	21,728	
...	...	...	...	...	18,685	
...	4·03	...	...	10·8	7,923	
...	3·36	...	...	4·8	5,415	
...	4·26	...	...	6·9	37,739	
25	5·40	...	...	8·7	21,883	
...	4·80	...	...	8·3	163,199	
...	3·25	...	...	4·8	12,832	
...	1·88	...	...	4·5	159	
...	...	...	...	...	29,942	
30	3·03	2·5	36·5	22·0	20,890(*i*)	
...	10·04	...	199·3	...	2,070(*j*)	
...	3·55	...	63·0	65·6	66,897(*k*)	
...	3·31	0·5	43·5	44·0	1,30,285(*l*)	
...	5·37	5·3	...	...	1,98,796(*m*)	
35	...	3·4	...	...	6,437	
...	...	3·4	...	...	43,461	
...	...	3·4	...	...	31,726	
...	...	1·4	...	...	33,825	
39	...	2·9	...	...	33,654	

Particulars of Cadastral Surveys completed since 1895-96.

District.	Scale of survey.	Number of villages.	Number of fields.	Area surveyed.	Average size of fields.	Cost, exclusive of demarcation and charge for instruments.	Rate per square Mile.			By whom and when surveyed.
							Traverse survey.	Cadastral survey.	Cadastral survey, with Record of Rights.	
				Sq. miles.	Acre.	₹	₹ a. p.	₹ a. p.	₹ a. p	
Shwebo	16″=1 mile	975	1,454,720	2,921	1·29	402,604	46 4 11	84 7 ·9	...	Messrs. G. B. Scott, G. H. Cooke and E. J. Jackson during 1891-97.
Yamethin	16″=1 mile	1,415	734,646	1,642	1·43	242,333	60 10 7	87 2 4	...	Ditto ditto ditto 1893-97.
Pegu	16″=1 mile	370	481,265	941	1·25	165,880	47 1 10	127 9 10	...	Messrs. C. Wood and B. G. Gilbert Cooper during 1894-97.
Meerut	16″=1 mile	1,724	1,935,521	2,367	0·78	135,890	21 2 7	...	35 7 6	Traverse Survey done by Capt. J. M. Fleming and Mr. J. S. Pemberton during 1895-97. Cadastral Survey done by Land Records Surveys.
Jhansi — Lalitpur Sub-Division	16″=1 mile	751	582,480	1,806	1·98	94,096	16 13 0	...	35 5 7	Traverse Survey done by Lt.-Col. J. E. Sandeman during 1888-90. Cadastral Survey done by Land Records Surveys.
Jhansi — Gursarai and Kakarbai Estate.	16″=1 mile	68	77,853	193	1·52	8,121	20 4 5	...	28 0 0	Traverse Survey done by Lt.-Col. J. E. Sandeman during 1889-90. Cadastral Survey done by Land Records Surveys.
Sitapur (Alluvial Mahals)	16″=1 mile	145	130,644	196	0·56	...	19 10 5	...	41 14 8	Traverse Survey done by Captain J. M. Fleming during 1895-96. Cadastral Survey done by Land Records Surveys.

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

396. These Offices comprise—

(1) The Head-Quarters Offices at Calcutta.
(2) The Trigonometrical Branch Office at Dehra Dun.
(3) The Drawing Office at Simla.
(4) The Forest Survey Branch Office at Dehra Dun.

A description of the work carried on in each office is given below:—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE AND ACCOUNTS.

Superintendence.

Major-General C. Strahan, R.E., Surveyor-General of India.
Colonel J. E. Sandeman, I.S.C., Deputy Surveyor-General, in charge Revenue Branch up to 18th April 1897.
Colonel M. W. Rogers, R.E., Assistant Surveyor-General up to 3rd February 1897.
Lieutenant-Colonel J. R. Hobday, I.S.C., Assistant Surveyor-General from 4th February 1897 and Officiating Deputy Surveyor-General in charge Revenue Branch from 19th April 1897.
Major F. B. Longe, R.E., Officiating Assistant Surveyor-General from 30th April 1897.
Mr. T. A. Pope, Personal Assistant to the Surveyor-General up to 30th April 1897.
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. T. A. Milne,	Head Assistant.
„ G. C. Walker,	Head Clerk.
Babu Kalipodo Banerji,	Clerk.
„ Banimadhub Banerji,	„
„ Chuni Lal Dey,	„
„ Durga Narayan Ghose,	„
„ Ramkristo Chunder,	„
Mr. H. E. D'Cruz.	„
Babu Gopal Chunder Dass,	„
„ Kali Kristo Chunder,	„
and twelve others.	

Accounts.

Mr. C. O. Gray,	Head Clerk.
Babu Rajkrishna Mukerji,	Clerk.
Mr. E. A. Bonnaud,	„
Babu Hem Nath Dutt,	„
and seven others.	

397. The general direction of these offices remained in the hands of Major-General C. Strahan, R.E., throughout the year. The Revenue Branch Section was under Colonel J. E. Sandeman. I.S.C., up to 18th April 1897 and thereafter under Lieutenant-Colonel J. R. Hobday, I.S.C. The General and Topographical Branch Sections were under Colonel M. W. Rogers, R.E., up to 3rd February 1897, under Lieutenant-Colonel J. R. Hobday, I.S.C., from 4th February to 29th April 1897, and under Major F. B. Longe, R.E., from 30th April 1897 to the close of the year. Mr. T. A. Pope held the office of Personal Assistant to the Surveyor-General up to 30th April 1897.

The Assistant Surveyor-General reports as follows :—

Mr. T. W. Babonau, Registrar, performed with credit the duties connected with the general superintendence of the office.

Messrs. Milne and Gray, especially the latter, have carried on satisfactorily the duties of their respective posts. The Native Clerks have also done well, and among them may be specially mentioned Babus Banimadhub Banerji, Chuni Lal Dey, Rajkrishna Mukerji, and Ram Kristo Chunder.

The Officiating Deputy Surveyor-General reports that in the Revenue Branch Office Mr. G. C. Walker, the Head Clerk, and Babus Kali Podo Banerji and Norendro Nath have continued to give satisfaction in the discharge of their duties.

DRAWING OFFICE.

398. The drawing office has been under the superintendence of Mr. A. E. Spring throughout the year under report. Mr. L. J. Pocock held the post of Chief Draftsman up to the 16th May 1897, when he was relieved of his duties by Mr. W. Stotesbury.

SECTION I.—GEOGRAPHICAL, DRAWING, AND COMPILATION.

399. During the year under review the two sheets 3 S.E. and 3A.N.E. of the South-East Frontier series, mentioned in paragraph 481 of the last Annual Report, as being in progress, were suspended for the completion of the headings and footnotes of the maps of the Madras and Burma Forest Surveys submitted by the field parties, as these were urgently required by the district officials. For the same reason the progress of the eight 8-mile maps of the same series, referred to in paragraph 482 of the last Annual Report, was retarded to a certain extent, though the fair drawing of five of these sheets has been well advanced; the 5th edition of sheet No. 1 of the South-Eastern Frontier series being in course of publication, whilst sheets Nos. 9 and 10 of the same series have been published. In addition, sheets No. 15 N. W., on the 4-mile, and No. 15 (4th edition) on the 8-mile scale, of the North-Eastern Frontier series were published; whilst sheets No. 14 S. E., and parts of Nos. 23 N. E. and N. W. (in one sheet) on the 4-mile scale of the same frontier, were brought up to date with railway lines and changes to boundaries.

Personnel.

Mr. L. J. Pocock, Chief Draftsman up to 16th May 1897.
Mr. W. Stotesbury, Chief Draftsman, from 17th May 1897 (sub. *pro tem.*).

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty.

Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade, from 19th July to 1st September 1897.
Mr. T. H. Rendell, Extra Assistant Superintendent, 3rd grade, from 20th November 1896.
Mr. J. A. Barker, Extra Assistant Superintendent, 4th grade.
Mr. G. E. Parker, Extra Assistant Superintendent, 5th grade, from 23rd October 1896.
Mr. E. P. S. Hill, Extra Assistant Superintendent, 6th grade, from 28th November 1896.
Mr. S. O. Madras, Sub-Assistant Superintendent, 1st grade.
Mr. P. L. Causley, Sub-Assistant Superintendent, 3rd grade, from 3rd April 1897.
Mr. W. Green, Draftsman.
" A. J. Musgrove, "
" J. R. Adels, "
" R. C. Sinclair, "
" A. S. Bateman, "
" A. J. Rodrigues, " up to 14th March 1897.
" A. J. Wilson, Draftsman.
" C. L. Green, " (sub. *pro tem.*), from 15th March 1897.
" E. A. Knight, Draftsman.

Native Draftsmen.

Babu Purna Chandra Sen.
Munshi Muttyullah.
" Rahim Bakhsh.
Babu Sarat Chandra Chatterjee.
" Narendra Nath Mukherjee.
" Subodh Chandra Sarkar.
" Sarat Chandra Coomar and 28 others.

400. Of the standard sheets of the topographical survey of Upper Burma on the 1-inch scale referred to in paragraph 483 of last year's report, No. 314 is under publication, and No. 358 has been published. A new sheet of this series, No. 306, was completed at the Head-Quarters Office, and published as a preliminary edition.

401. The general maps in hand were:—(i) The third edition of the 32-mile map of India, which will, in all probability, be published during the coming year; (ii) A new Canal Map prepared from transfers from the 3rd edition of India on the 32-mile scale; (iii) additions to the 128-mile engraved map of India; and (iv) additions to the engraved map of Western Himálayas, the map of the North-Western Provinces and Oudh, and the map of the Punjab.

402. The provincial maps of India on the 16-mile scale have all been revised. The map of Assam for lithography as well as engraving has received additions and corrections to railway lines, and has been published; the map of Bengal, Bihár, Orissa and Chota Nágpur has been similarly treated, whilst this map and the map of Gujarát have had the hills added in brush-shading for the engravers; and the maps of the provinces of the Punjab, Rájputána Agency, Central Provinces, Sind, and Upper Burma have been brought up to date with railway lines, roads, or boundaries.

403. Four divisional maps and eleven district maps have been under revision with reference to railway lines, the boundaries, and their principal roads; and nine new district maps have been completed and published.

404. Twenty seven standard maps of the various provinces on the 1-inch scale have been published during the year, and sixty-eight have been in progress. Of the former, fourteen sheets of the Central India Agency, the Central Provinces, or of the Rájputána Agency, were completed to margin; and thirty-eight sheets of the same series were in different stages of progress. The remaining sheets were brought up to date with railway lines, or had the boundaries corrected from recent data supplied by the different Local Governments.

405. The maps in hand for the Administration Reports of the different Provincial Governments were forty-one. Thirty-six were completed and published, three were in progress, and two had the hills added in brush-shading for engraving.

406. As usual, the sheets of the Atlas of India have formed an important part of the current work performed by this section. Additions to railway lines, roads, canals, and changes to boundaries were carried out on fifty-eight sheets; additions to names and details for engraving on forty-one sheets; and five sheets were brush-shaded for engraving.

407. In addition to the preparation of the indexes for this report, the keeping up to date of the colouring of all the office copies of maps, and an increasing amount of correspondence, departmental and extra-departmental, have also formed a part of the current work of this section.

SECTION II.—REVENUE.

408. The ordinary routine work of this section consists in examining and preparing, for photo-zincography, the fair maps received from the field parties of the Revenue Branch; in bringing up to date and republishing the old maps; in the preparation of the index maps for field parties and for the General Report; in colouring maps on various scales; in tracing maps, furnishing plans and supplying data to Government officials and others. The examination of the field books, traverse, and azimuth computations, etc., on which the several Revenue Surveys are based, is also done in this section.

Personnel.

Mr. G. D. Cusson, Officiating Head Draftsman, up to 17th October 1896.
" W. Stotesbury, Head Draftsman, from 18th October to 1st December 1896.
" J. McHatton, Head Draftsman, from 2nd December 1896 to 31st August 1897.
" T. Shaw, Officiating Head Draftsman, from 1st September 1897.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty.

Mr. G. Campbell, Extra Assistant Superintendent, 5th grade.
Mr. C. S. Littlewood, Sub-Assistant Superintendent, 3rd grade, from 30th June 1897.
" H. W. Biggie, Sub-Assistant Superintendent, 2nd grade, from 17th September 1897.

Native Draftsmen.

Munshi Abdul Aziz.
" Abdur Razak.
Babu Tincori Sen.
" Bacharam Banerjee.
" Ram Chunder Sen and 20 others.

Surveyors, etc., on duty.

Babu Rhedoy Chunder Das and 2 others.

409. The old 1 inch = 1 mile maps of district Pesháwar (Punjab) have been revised as to their boundaries and interior details from the tracings of the 4-inch maps of the Settlement Survey, and have been drawn up in standard sheet form. The drawing of the maps is well advanced.

410. Four sheets in fourteen sections on the 2-inch scale of district Tavoy (Lower Burma) have been compiled from the 16-inch cadastral plans, and are being drawn for reduction to the scale of 1 inch = 1 mile.

411. Three sheets on the scale of 1 inch = 1 mile of North-Western Provinces have been completed to margin from the old 1-inch maps of district Gurgáon (Punjab) and Bhurtpur State for republication; and two sheets of district Jalpáiguri (Bengal), in eight sections, on the scale of 2 inches = 1 mile were also redrawn for reduction to half scale, and corrected to date from the materials of the latest surveys.

412. A large number of sheets of Bengal and North-Western Provinces on the scale of 1 inch = 1 mile were corrected and additions made thereto from materials either furnished by the latest surveys or supplied by district officials. The old 1-inch maps of district Chhindwára and the ½-inch maps of district Saugor (Central Provinces) were also revised and corrected from tracings on

the 16-inch scale of maps received from the Settlement Officers with a view to issuing a revised edition.

413. Two large scale plans of the cities of Dhárwár and Hubli, of district Dhárwár (Bombay), were published on the scale of 8 inches = 1 mile; and a plan of Moulmein Cantonment has been redrawn on scale 200 feet = 1 inch for publication on full scale.

414. A map of Calcutta, embracing 16 miles of surrounding country on scale of 1 inch = 1 mile, was also prepared and published.

415. In addition to the above, a large amount of mapping has, as usual, been done for other departments; a plan of Bareilly City and environs, on scale 4 inches = 1 mile, showing the British position and military operations during the siege of 1857-58, has been prepared and published on the 2-inch scale for Mr. Forrest, Director of Government Records. A skeleton map of Siálkot (Punjab) on the $\frac{1}{2}$-inch scale was also prepared for reduction to the $\frac{1}{4}$-inch scale for the Punjab Government, and also a district map of Hissar on the scale of 1 inch = 4 miles was republished for the Local Government on special requisition. A map of district Kámrúp (Assam) on the $\frac{1}{2}$-inch scale, showing the village boundaries and country surveyed cadastrally up to 1892, has been completed for the Assam Government.

416. The series of special district maps on $\frac{1}{2}$-inch scale prepared for the Government of the North-Western Provinces has now been completed.

417. The traverse computations of eleven field parties working in districts Tippera, Chittagong, Jalpáiguri, Balasore (Bengal), district Sibságar (Assam), districts Bhandára, Ráipur, Narsinghpur (Central Provinces), and districts Kyauksè, Akyab, Henzada (Burma), were examined. Traverse data, calculation of areas and such like information has, as usual, been prepared in this office and supplied to field parties and district officers. Of traverse data 654 pages were copied and supplied, and latitudes and longitudes of Revenue Survey points of districts Akyab, Jalpáiguri, Bhandára, Seoni and Bhurtpur State were calculated. A report on the character, scale, and date of survey of all the districts in the Lower Provinces, from the commencement of the Revenue Survey operations in 1830, was prepared for the Director of Land Records, Bengal. The areas by *parganas* of 18 standard sheets were calculated, as also of district Hoshiárpur, of Dhárwár City, and of the estates of the Mahárájá of Benares. The area and cost of all cadastral surveys in the North-Western Provinces for the years 1872 to 1896 were prepared. The areas of districts Balasore and Cuttack were adjusted according to revised boundaries. Twenty-nine tracings of sheets and thirty tracings of village plans were also made and supplied to district and other officers. One hundred and forty maps on various scales were coloured.

A large amount of correspondence has, as in former years, passed through this office, the number of letters dealt with being 1,317.

SECTION III.—CADASTRAL.

418. This section consisted of one Sub-Assistant Superintendent, one writer, six permanent draftsmen and six tracers who were employed in preparing the original maps of all cadastral surveys for photozincography and zincography. The maps to be examined are, on receipt of the originals, submitted to a cursory examination in order to see that the sheets are in every respect fit for reproduction.

419. In the North-Western Provinces the returns for the previous year showed 6,845 sheets of district Garhwál remaining to be published, and during the year 2,906 sheets of the same have been published, so the balance of 3,939 sheets remain to be printed during next season; of these 400 sheets have been prepared for publication.

420. In Burma the publication of the cadastral maps of the following districts have been in progress:—Meiktila, Minbu, and Sagaing in Upper Burma and Thatôn in Lower Burma. Of Upper Burma 1,597 sheets and of Lower Burma 609 sheets have been published; in addition to these 13 sheets of district Thatôn have been reprinted, and 642 original sheets have also been prepared for publication.

421. In Bengal 261 sheets of district Backergunge of Dakhin Sháhbázpur Estate have been published at the request of the Board of Revenue, but the

remaining 11 sheets of skeleton plots (1 and 2 inches=1 mile) are not to be printed.

In Assam 191 original sheets of district Cachar were received from the party during the past twelve months, and 120 sheets of the same have been published; the remaining 71 sheets have been prepared for publication; besides 3 sheets of district Darrang and 6 sheets of district Nowgong were published during the same period. Those remaining incomplete are districts Kámrúp (8 sheets), Sibságar (8 sheets) and Sylhet (45 sheets). These are mostly blocks and waste land, and under existing orders are not to be printed.

The total number of maps passed for publication during the year was 5,737, of which 5,493 were actually printed, 3,912 having been photozincographed and 1,581 zincographed. At the close of the year there were remaining to be published 5,285 sheets against 8,916 in last year, showing a decrease of 3,631 sheets.

SECTION IV.—BENGAL PROVINCIAL.

422. The cadastral maps dealt with during the year under report were those of Bihár. For Bihár 9,195 cadastral maps were received, of which 7,523 were reduced by pentagraph to the 2-inch scale for the compilation of the standard sheets; the total number of sheets dealt with in Bihár reached 10,437, of which 2,914 were received during previous years. From Orissa 4,864 cadastral sheets were received, but their reduction to the 2-inch scale has not up to date been taken in hand. The same remark applies to 727 sheets of Chittagong district.

Personnel.

Mr. T. Shaw, In charge from 1st October 1896, to 31st August 1897.
„ E. P. S. Hill, In charge from 1st September, 1897.
„ A. B. Smart, Sub-Asst. Supdt., 1st grade.
Babu Sarat Chunder Sen „ „ 2nd grade from 1st to 31st October, 1896.

Permanent Establishment.

5 Draftsmen.

Temporary Establishment.

6 Computers and Writer etc.
4 Draftsmen.

423. For Bihár 12 sheets have been outlined and completed, whilst the details of 8 more have been reduced. These are well in hand and a number of publications may be anticipated during the current year.

424. The preparation and final publication of the 2-inch standard sheets was chiefly confined to the Orissa series. The outlining of 34 standard sheets was completed; 56 had the interior details finally examined; 44 were forwarded to the Photographic Office for reduction; 60 proofs were examined and final press order for twelve 1-inch sheets was given. This last figure is low, but delay in publication has been unavoidable owing to the non-return of proofs sent to district authorities on account of boundary disputes, etc. The outlining of 10 sheets has yet to be dealt with; this will be taken in hand and completed at an early date. The publication of the remaining Orissa 2-inch sheets should be completed during the current year.

425. In letter No. 8531, dated 31st July 1893, the Government of Bengal requisitioned for a special publication on the 2-inch scale of 26 sections of the Orissa standard sheets containing irrigated areas, 21 sections were completed previously and 5 sections (in sheets 166 and 193) during the year under report.

Mr. Spring reports that Mr. Pocock and Mr. Stotesbury in their posts as Chief and officiating Chief Draftsmen, also Mr. McHatton and Mr. Shaw as Head and officiating Head Draftsmen, respectively, supervised their establishments most efficiently. Messrs. Barker, Hill and Ewing have also done very well as heads of the Examining, Bengal Drawing and Cadastral Sections, Messrs. Campbell and Madras have also done good work. The European draftsmen have been well reported on, especially Messrs. Green, Musgrove and Sinclair, and of the Native Establishment, Babus Purna Chandra Sen, Sarat Chandra Chatterji, Narendra Nath Mukherji, Subodh Chandra Sarkar, amongst others, have rendered good service.

ENGRAVING OFFICE.

426. Mr. A. E. Spring has held charge of this office throughout the year. Mr. T. B. Rodger has been on furlough during the year, and Mr. A. R. Coard has taken 12 months' furlough from September 30th.

Personnel.

Mr. A. E. Spring, Assistant Surveyor-General, in charge.
Mr. J. Fulford, Head Engraver.
„ S. M. Coard, Engraver.
„ T. B. Rodger, „ on furlough.
„ A. W. N. James, „
„ A. R. Coard, „
„ E. Earle, „
„ E. C. V. Ollenbach, „
„ L. H. Musgrove, „
„ F. R. C. Scallan, „
„ A. T. Vieux, „
„ A. E. W. Cann, „
30 Native Engravers.
2 Apprentices.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer.
„ A. E. Pilley, Assistant Copper-plate Printer and Store-keeper.

427. The outturn of work for the year in "Outline" and "Hills" is about the same as last year, but on account of the unusually large number of plates projected and borders partly divided, the outturn in "Writing" is less; still the general outturn is very good.

428. The sheets published during the year are six quarters of the Atlas of India, 14 district maps for administration reports, 16-mile map of Mysore and Coorg (with hills), index to the standard sheets of the Bombay Presidency, a new weather chart for Photo-Litho Office and two scale plates. Two brass plates have also been completed, one with an inscription of the standard bench-marks of Calcutta and the other for the Great Trigonometrical Office.

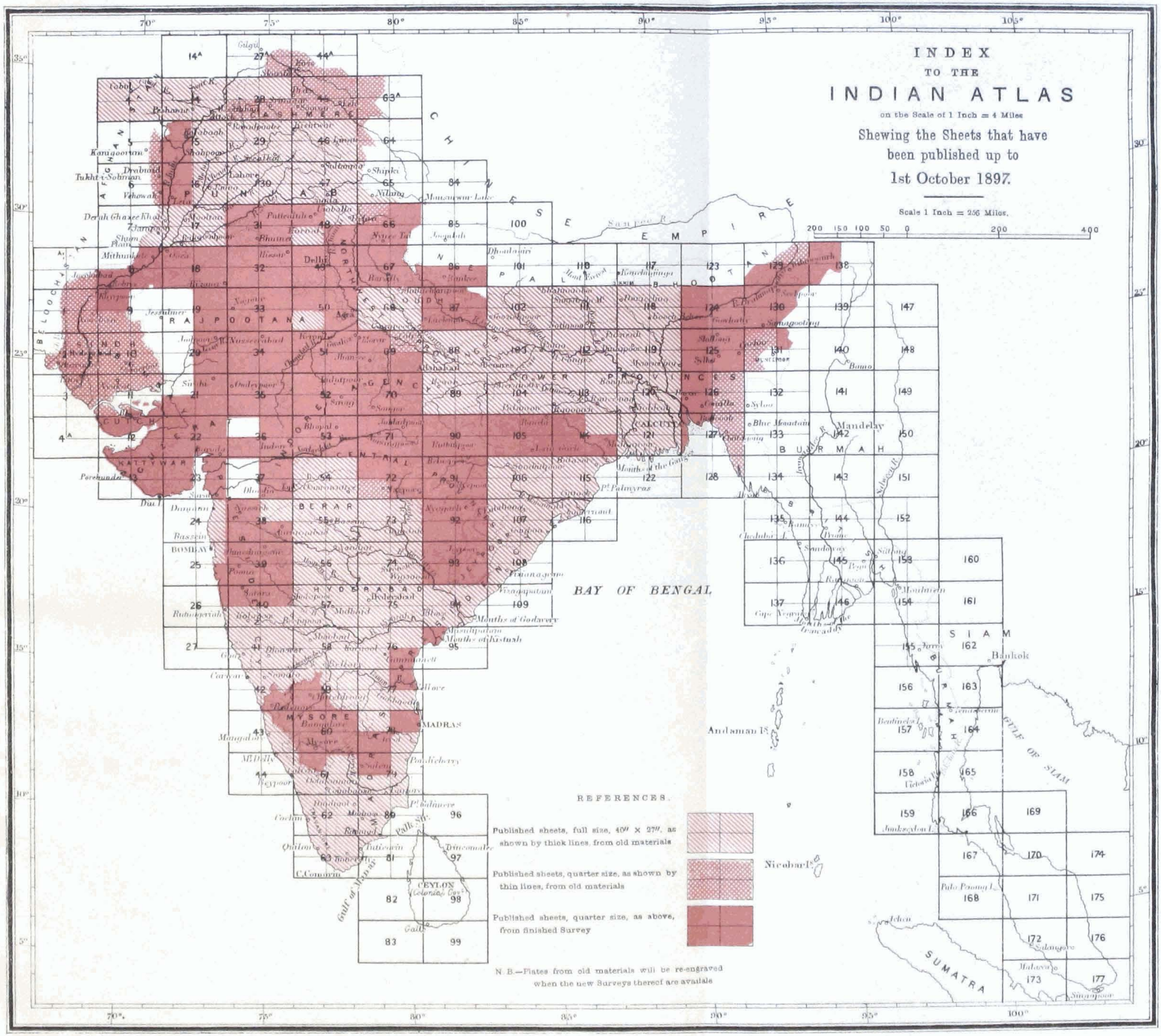
429. Fifty unpublished quarter Atlas Sheets in various degrees of progress have been in hand during the year, 93 published quarter sheets and 19 full sheets have been brought up to date as far as materials existed, and 35 Atlas sheets were projected. In all 349 plates were worked on, being 79 in excess of last year.

430. The 16-mile maps of provinces have been dealt with thus: those of Assam, Central India Agency and Mysore (without hills) have been corrected to date, the two new plates of Bengal have had a large portion of writing engraved, that of the Bombay Presidency has been filled up as material has been received, the hills on the Gujarát map are in progress, the Madras Presidency map in six sheets is well advanced, both in outline and writing, and the Punjab and Kashmír map in four sheets has been constantly in hand with corrections and additions, sheet 1 is completed with hills, and sheet 2, which is a very heavy sheet of hills, is in progress. Rájputána also has been in hand with corrections and additions.

In addition to the 14 published district maps, 23 others have been worked on, and some additional work for the new Calcutta Survey plates, 16″=1 mile, has also been commenced, a new plate of map headings for transfers has been completed, and 57 plates for Photo-Litho office have had the lettering engraved on them.

431. The Copper-plate Printing Section has printed 21,250 impressions during the year, which is slightly in excess of last year, but a larger outturn could have been done if the orders for scales from the Mathematical Instrument Office had not fallen off. The Steel Facing Section dealt with 221 plates which is also in excess of last year.*

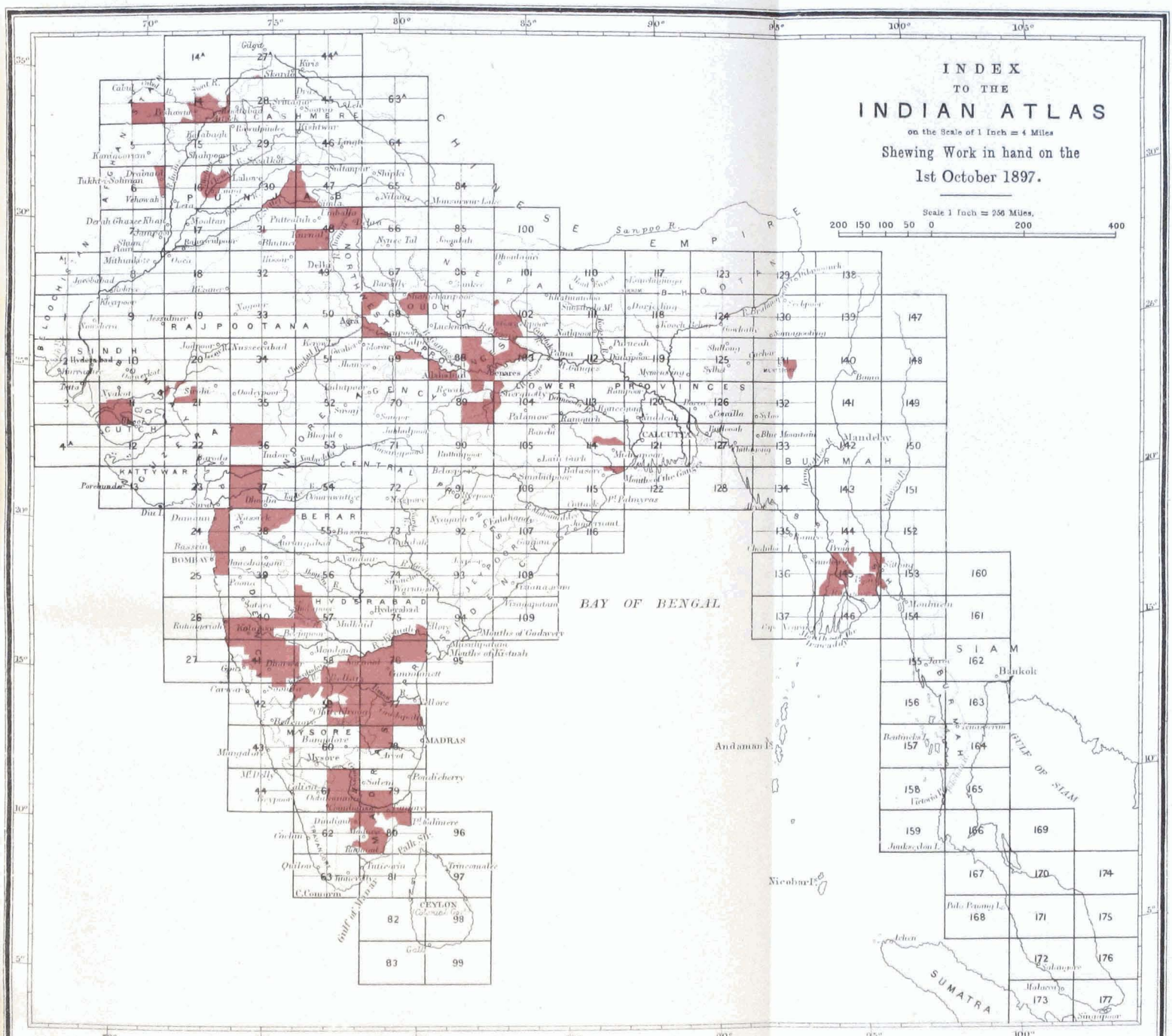
* Mr. Spring reports that the Head Engraver, Mr. Fulford, has given great satisfaction in the discharge of his duties, and he reports well of all his assistants.



Reg. No. 638, S. I. D.—Nov. 97.—650.

Litho., S. I. O., Calcutta.

No. 408-S 94



Reg. No. 808, S. I. D.—Nov. 97.—650.

Litho., S. I. O., Calcutta.

No. 407-S. 94.

Photo-etching. Survey of India Offices, Calcutta, February 1898.

THE SURVEY OF INDIA ECLIPSE PARTY.

Dumraon, January. 1898.

THE PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

432. This office remained in the charge of Colonel J. Waterhouse, S. C., until the 10th May 1897, on which date he proceeded on furlough for one month, preparatory to retiring from the Department on attaining Colonel's allowances on the 10th June. He was succeeded by Mr. T. A. Pope, who was confirmed in the post of Assistant Surveyor-General on the 10th June and held charge during the remainder of the year. Colonel Waterhouse's connection with this Office had extended over a period of thirty years, during which the processes employed in it were greatly improved and developed, and the outturn of all classes of work enormously increased. The loss of his valuable services and unique experience is greatly regretted.

The post of Head Assistant, Lithographic Branch, vacated in August 1896, on the retirement of Mr. H. L. Lepage, was permanently filled on the 31st March by Mr. R. Fogarty, who was selected in England for the post by the Secretary of State for India. On Mr. Fogarty's arrival, Mr. S. M. Coard, who had been officiating in the appointment, reverted to his permanent post in the Engraving Office. Mr. Fogarty has proved himself to be an intelligent and capable assistant, and well qualified to supervise the somewhat complicated work of the lithographic sections.

Personnel.

Colonel J. Waterhouse, S.C., Assistant Surveyor-General in charge up to 10th May 1897.
Mr. T. A. Pope, Assistant Surveyor-General in charge from 10th May 1897.

NORMAL ESTABLISHMENT.

LITHOGRAPHIC AND PRINTING DIVISION.

Mr. S. M. Coard, Officiating Head Assistant, up to 29th March 1897.
„ R. Fogarty, Head Assistant, from 30th March 1897.
„ E. Dowling, Head Draftsman, up to 9th March 1897.
„ A. J. J. Rodrigues, Draftsman, from 15th March 1897.
Babu Ambica Churn Mookerjee, Draftsman.
Munshi Abdool Hamid, Examiner, up to 12th April 1897.
„ Abdool Mujeed, Examiner, from 1st May 1897.
1 Apprentice, 28 draftsmen and 6 colorists.

Lithographic and Zinc Printing Section.

Mr. E. A. LeFranc, Head Printer.
„ D. Deas, Chromo-litho-printer.
„ S. U. Ravenscroft, Assistant Chromo-litho-printer.
„ C. Andrews, Machine Printer.
1 Apprentice, 2 machine printers, 15 litho and zinc printers, 9 machinemen, 17 spongemen, 40 pressmen, 1 paper-wetter, 2 stone grainers, 2 stone polishers, 4 zinc grainers, 1 ink-grinder, 1 engine-driver and 1 fireman.

Type Printing Section.

Mr. E. De Pyvah, Head Printer, 12 compositors, 3 type printers, 3 inkmen, 3 mates, 2 machine type printers, 2 machine inkmen, 1 impositor, 1 roller-moulder and 1 boy.

PHOTOGRAPHIC AND GENERAL DIVISION.

Mr. J. Harrold, Photographer.
„ C. J. Meade, Assistant Photographer.
„ F. N. Murphy, do.
Munshi Ismail Khan, do., up to 9th November 1896.
Mr. N. J. Gonsalves, Assistant Photographer, from 1st April 1897.
Munshi Habibul Hossain, Assistant Photographer.
5 Assistant Photographers and 8 labourers.

Heliogravure Section.

Mr. A. W. Turner, Photo-engraver.
„ J. T. Meade, Assistant Photo-Engraver, up to 31st March 1897.
1 Assistant Photo-Engraver, 1 engraver, 1 Assistant Engraver, 4 copper-plate-printers, 6 pressmen, and 11 plate polishers.

Correspondence, Stores and Accounts Section.

Babu Kanny Lall Sen, Storekeeper.
Mr. A. B. Carville, Head Clerk, from 5th April 1897.
Babu Kedar Nath Ghose, Clerk.
„ Gopal Chundra Mookerjee, Clerk.
„ Surji Coomar Banerjee.
„ Rajani Kanta Chatterjee.
4 Clerks, and 1 paper-keeper.

CADASTRAL ESTABLISHMENT.

Photographic Section.

Mr. H. Haward, Head Photo-Assistant.
„ R. George, Photographer.
„ L. Lagnier, Photographer.
„ T. Lloyd, Photographer.
„ J. Vieux, Assistant Photographer.
7 Assistant Photographers, and 10 labourers.

Zinc Printing Section.

Mr. F. R. Vandyke, Zincographer.
„ J. B. Mackenzie, Zincographer.
„ P. Michael, Assistant Zincographer.
Babu Khetter Mohun Das, Clerk.
1 Clerk, 9 Zinc correctors, 9 zinc printers, 10 spongemen, 17 pressmen, and 11 zinc grainers.

Mr. E. Dowling, Head Draftsman, having obtained employment in the Public Works Department, vacated his post on the 10th March 1897, and Mr. A. J. J. Rodrigues was appointed in his place on probation. Babu Kanny Lall Sen, Head Clerk, was promoted to the vacant post of Storekeeper with effect from the 15th April 1896, and Mr. A. B. Carville was appointed Head Clerk on probation on the 5th April 1897. Munshi Abdul Hamid, Draftsman, retired on the 13th April 1897, after thirty-two years' approved service in the Lithographic Drawing Section, and his loss is much regretted. Mr. J. T. Meade, Assistant

Photo-engraver, was dismissed from the 6th July 1897, for refusing to obey orders to return to duty from furlough.

433. An abstract of the work performed in all sections of the Office during the year is given in the following table:—

General Abstract of Work done during the year 1896-97.

Classification.	Sheets or Subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.								Type Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.	Number of Copies. Coloured.	Uncoloured.	Total.	Pages or items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Heliogravure Plates.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	
																				£ s. p.
Departmental Maps, etc.	1,049	1,375	1,191	509	509	76	133,323	26,299	103,778	130,077	10,054	931,543	529,664	137	2,899	13	3,919	...	13	60,696 0 9
Cadastral Maps . .	5,634	4,056	3,971	5,645	5,645	...	133,223	...	122,293	122,293	...	...	...	...	...	...	...	...	...	69,267 15 6
Extra-Departmental Maps and Plans, etc. . .	1,197	841	632	284	595	468	587,399	117,775	482,927	600,702	...	...	...	217	568	118	68,327	...	...	83,554 14 6
Total . .	7,880	6,272	5,794	6,438	6,749	544	853,945	144,074	708,998	853,072	10,054	931,543	529,664	354	3,267	131	72,246	...	13	213,517 14 9
Total of 1895-96 . .	7,020	5,956	5,860	5,782	6,061	529	862,623	121,781	826,276	948,057	11,915	1,271,557	668,795	527	2,542	144	56,388	5	17	219,778 15 6
Differences. . .	+ 860	+ 316	− 66	+ 656	+ 688	+ 15	− 8,678	+ 22,293	− 117,278	− 94,985	− 1,861	− 340,014	− 139,131	− 173	+ 725	− 13	+ 15,858	− 5	− 4	− 6,261 0 9

434. As regards outturn, the year may be said to be a good average one. The number of original subjects dealt with (which gives a fairly accurate idea of the amount of work performed) was 7,880 or 860 in excess of 1895-96, and more than in any previous year. The number of negatives taken, and the amount of lithographic drawing on transfer paper or stone, are consequently proportionately larger than usual, though the latter class of work cannot be accurately recorded and is not shown in the above table. The outturn of the zinco. and litho. machines and presses was practically the same as last year, amounting to 853,945 pulls, as against 862,623, the deficiency representing the work of about a day and a half, which may be accounted for by the extra holidays given for the Jubilee. The outturn under this head depends largely upon whether the number of copies printed from each subject averages high or low. In the latter case, time that would otherwise be occupied in printing is lost in the more frequent changes of stone or plate required, and the outturn of work done, as represented by the number of pulls and copies made, is apparently less, though it is not actually so. During recent years, and particularly during the year under report, the average number of copies printed from each subject has been low, and a great deal of colour work has been done, necessitating more frequent changes and a smaller outturn of printed copies in proportion to the number of original subjects reproduced. The number of pulls from the machines and presses should not be taken as an index to the year's outturn of work, which may usually be much more fairly gauged by the number of original subjects taken in hand and completed. There has been a large increase in the number of departmental maps, etc., printed off, and also of cadastral sheets, but a decrease in the number of maps and plans reproduced for other departments. In the Type-printing Section there is a trifling decrease in the number of pages or items set up, and a more considerable decrease in the number of pulls and copies, the demand for departmental forms having been smaller than usual, owing to the requirements of the Department having been well supplied in advance by the large outturn under this head last year. In the Heliogravure Section, 72,246 prints were made from 131 copperplates etched by the photogravure process, an increase of 15,858 prints over the number made last year, though the number of plates etched was thirteen less. The number of hand-engraved copperplates electrotyped was thirteen, or four less than last year. In the Silver-printing Section the outturn of cyanotype prints, which form the chief work of the section, was considerably larger, though somewhat less silver-printing was done.

435. Under the head of departmental work, the following may be mentioned as comprising the most important maps dealt with during the year:—

Of general maps, the canal map of India, in six sheets, on the 32-mile scale, was completed and printed from stone in three colours. Further additions have been made to sheets Nos. 1, 2 and 4 of the third edition of the 32-mile map of India, and it is impossible yet to assign any probable date of completion of this map. The 24-mile map of Afghanistan, with hills in grey, was re-printed during the year and 1,400 copies supplied to the Map Record and Issue Office. The new chromo-lithographed map of Afghanistan on the same scale was held in abeyance pending the receipt of further additions and corrections, but these were received and put in hand immediately after the close of the year.

Of provincial maps, re-issues with additions and corrections were made of the following:— Assam, on the 16-mile scale; Punjab and surrounding countries (skeleton), on the 32-mile scale; Punjab, on the 80-mile scale; North-Western Provinces and Oudh, on the 32-mile scale; and Central Provinces, on the 32-mile scale. A map of the North-Western Provinces and Oudh, showing districts and states, was published on the 16-mile scale.

The divisional maps of Chota Nagpur and Patna, on the 8-mile scale, were re-published with additions and corrections.

New issues of the following district maps, on the 4-mile scale, compiled from the engraved atlas sheets, were made:—Bankura, Khasia and Jaintiah Hills, and Manbhum. The following were re-published:—Champaran, Twenty-four Parganas, Dacca, Gaya, Lakhimpur, Saran, Hoshangabad, Murshidabad, Bhamo and Myitkyina, and Pabna. Two-inch scale maps of Garhwal and Naini Tal, specially prepared for the North-Western Provinces and Oudh Government, were also published.

Five hundred and fifty-one sheets of standard maps of the Topographical and Revenue Surveys, on the scales of 4 inches, 2 inches, 1 inch, ½ inch and ¼ inch to the mile, have been taken in hand during the year for re-printing and for publication. One hundred and eighteen plates and one stone were printed off, including 90 sheets on the 1-inch scale, comprising 6 of Bengal, 10 of Bombay, 12 of Lower Burma, 3 of Upper Burma, 14 of Central India and Rajputana, 1 of the Central Provinces, 40 of the Indus riverain survey, 1 of Madras, 2 of the North-Western Provinces and Oudh, and one of the Punjab. Three sheets of Lower Burma, on the 4-inch scale, were also printed off. Of the transfrontier surveys, 3 sheets, including one colour plate, of the North-East Frontier, and 3 sheets, including one colour plate, of the South-East Frontier, on the 4-mile scale, besides 5 sheets on the 8-mile scale of the two latter surveys, were printed off.

The plans of cities and cantonments printed off during the year include a map, on the 8-mile scale, of Dharwar city and environs, in two sheets; a 12-inch map of the city and environs of Ajmere; a 6-inch map of Calcutta, and new editions of the 1-inch map of Calcutta and surrounding country, with table of distances, and of the 3-inch skeleton map of Simla and Jutogh. Ten sheets of the new Moulmein town survey, on the scale of 50 feet to the inch, were reproduced, but not printed; also an 8-inch map of Hubli city and environs, a 12-inch map of Cawnpore cantonment and environs, a 6-inch map of Lucknow Cantonment, and a 6-inch map of the cantonment and environs of Jullunder.

Among the miscellaneous departmental publications may be mentioned a route map for the Western Himalayas, Kashmir, Punjab and North India, with portions of Afghanistan and Baluchistan, etc., on the 32-mile scale, re-published with additions to railways; six sheets of the Burma-Siam boundary, on the 1-inch scale; a map of a portion of Tibet surveyed by Captain Deasy, on the 8-mile scale, and several sheets of the Madras forest survey on the 4-inch scale.

436. As already stated, the amount of work done for other departments shows a decrease during the year under report. The number of subjects completed and taken in hand was 1,197, as against 1,470 last year, and the total number of complete copies was 600,702, against 631,133 last year, and their value ₹83,555, against ₹86,364.

The plates for Part III of Mr. Smith's report on Fatehpur Sikri have now been completed; 46 plates were photo-zincographed and 18 plates photolithographed, and 650 copies of each printed off. The plates for Part IV were taken in hand. For the Archæological Survey, Madras, 62 inscriptions pertaining

to the monumental remains of the Dutch East India Company were photo-zincographed, but not printed off. For the Board of Revenue, North-Western Provinces and Oudh, a district map of Garhwal, on the ½-inch scale, was printed and 200 copies were supplied. For the Geological Survey Department a map of India showing distribution of corundum was lithographed, but not printed off. Three silver-prints of each of 22 plates of buildings damaged by the earthquake were made for the same department. For the Director of Land Records and Agriculture, Bengal, nine chalk drawings and four stamped patterns on cloth, illustrating a monograph on cotton fabrics, were taken in hand for lithography and 500 copies of the patterns were printed off. For the Director of Land Records and Agriculture, Burma, 40 sheets of the Moulmein town survey were photo-zincographed. For the Government of India, Revenue and Agricultural Department, 20 maps to illustrate a list of archæological remains in the Central Provinces and Berar were lithographed and 8,200 copies printed. For the Public Works Department, Government of India, a railway map of India, on the 80-mile scale, was re-printed with corrections and 900 copies supplied; 650 copies of the same map were printed for distribution to military officers under instructions from the Quarter Master General in India. Another map of India, on the 64-mile scale, in two sheets, showing railways with stations, was photo-zincographed and 4,700 copies printed for distribution. Fourteen plans and 10 diagrams, showing the method of constructing buildings less liable to damage by earthquake, were lithographed for the Calcutta Building Commission. For the Reporter on Economic Products, three drawings of Rhea plants were chromo-lithographed, and four sketches and diagrams pertaining to magnesite areas were re-printed from stone. For the Meteorological Department a large amount of work was again done, including 63 maps and charts re-printed from stone, and 205,291 copies supplied. Several maps of the country ten miles round cantonments were again prepared or re-printed during the year for the military authorities, *viz.*, Amritsar, Dinapur, Ferozepur, Jhansi, Jullunder, Indore, Lansdowne, Manipur, Multan, Nowgong, Peshawar, Meerut, Meean Mir, and Sialkot. Six diagrams showing the method of filling shells with high explosives were lithographed, and 156 copies printed for the Military Department of the Government of India. For Dr. M. A. Stein, P.H.D., a map of ancient Kashmir, and one of ancient Srinagar, reproduced from the survey of 1859-60, and showing ancient sites and names, were lithographed and 650 copies printed in two colours.

437. In the Heliogravure Section the work done was as usual all extra-departmental. Forty-seven views were photo-etched to illustrate the report of the Pamir Boundary Commission for the Foreign Department, and 6,250 copies were printed. Fourteen plates were photo-etched for the Technical Art Series, from which 11,600 copies were printed. A set of 32 ancient manuscripts from Central Asia was reproduced by the same process on 21 plates, with the sanction of the Government of India, for the Asiatic Society of Bengal, and 800 copies of each printed. As 50 copies of each were urgently required for despatch to the Oriental Congress which assembled in Paris in September 1897, it was necessary to complete the whole work, including taking the negatives and transparencies, etching and lettering the 21 plates, and printing 50 copies of each, in the space of one month, which was successfully performed, though it strained the powers of the section to the utmost. Most of the manuscripts were exceedingly difficult to reproduce, being much discoloured by age, which rendered it necessary to clean them carefully in order to obtain favourable results. Six plates were photo-etched, and 500 copies of each printed, to illustrate a report by Dr. Führer on Buddha's birthplace in the Nipal Tarai. Twenty plates were prepared for Part III of the Moghal Architecture of Fatehpur Sikri, for the Archæological Survey of the North-Western Provinces and Oudh. Twelve plates of Crustacea and Mollusca, to illustrate the zoology of the R.I.M.S. *Investigator*, were etched, and 250 copies of eleven of them were printed. For the Indian Museum Notes 8 plates were etched and 4,310 copies printed. Two plates of a copper-plate grant of Ratnapala, and three of a similar grant of Bala Varman, were etched for the Asiatic Society of Bengal, but not printed. Specimens of recent work executed by the photo-etching process will be found in the frontispiece, which is an enlargement from one of the negatives of the recent total eclipse of the sun taken by the Survey of

India eclipse detachment at Dumraon in January last, and in the illustration at page 87, which represents the eclipse party at work. The view of the Manshai Bridge, Cooch Behar State Railway, showing the effects of the earthquake of the 12th June last, which will be found at page i of the Appendix, is another specimen of the same process.

438. Successful trials were made during the year of the "Enameline" half-tone and line block process, which established its utility for the preparation of type blocks, as well as in the reproduction of miscellaneous subjects in which a high degree of finish is not essential. Though undoubtedly less convenient in many respects than the photogravure process, it has the great advantage that the blocks can be printed in the type machine, at the rate of several hundred copies per day. Since the close of the year under report the process has been employed with excellent results, which amply repay the time spent in working it out. Full details of the process are given in Mr. Pope's report in the Appendix. At page xxviii of the Appendix is given a specimen of enameline work. It is a view of the ruins of the Commissioner's Cutcherry at Gauhati, and is one of a series of views reproduced to illustrate Mr. R. D. Oldham's report on the earthquake. The smaller illustration on page xxx is a reduction from a pen-and-ink drawing of a ceiling panel at Fatehpur Sikri, printed from an enameline block set up with the type. It is a fair specimen of the application of the process to line subjects.

439. During the year, a scheme for the reorganisation of the office, abolishing progressive salaries, and placing the entire establishment, together with the photo-zinco and type-printing staff of the Trigonometrical Branch Office at Dehra, in one list for the purposes of promotion, was worked out by Mr. Pope and submitted to the Surveyor-General. It is hoped that it will receive the sanction of the Government and come into force early in the ensuing year.*

MAP RECORD AND ISSUE OFFICE.

440. During the year under review the charge of this office continued to be held by Mr. T. A. Pope up to the 31st March 1897, when he was relieved thereof by Mr. A. E. Spring.

Personnel.

Mr. T. A. Pope, Deputy Superintendent, 1st grade, in charge up to 31st March 1897.
" A. E. Spring, Deputy Superintendent, 2nd grade, in charge from 1st April 1897.
" F. A. D'Rozario, Head Clerk,
" H. R. Vallis, Map-Curator and 17 other clerks.

441. The number and value of maps issued during the year are as follows:—

Maps issued.	Number.	Value.
General maps to Government officials	96,306	68,658
Ditto to Private individuals	10,853	11,772
Ditto to India Office, London	3,746	5,226
Ditto to Agents	1,503	2,290
TOTAL	1,12,408	87,946
Cadastral maps to Government officials	94,922	69,981
GRAND TOTAL	2,07,330	1,57,927

*Mr. Pope reports well of the work done by all his principal assistants, *viz.*, Messrs. Fogarty, LeFranc, Vandyke, Deas, Mackenzie, and DePyvah, in the Litho., Zinc and Type-printing Sections, and Messrs. Haward, Turner, Harrold, George, Lagnier and Lloyd, in the Photographic Sections, all of whom have worked to his entire satisfaction. Among the junior assistants, the following are specially mentioned:—Messrs. Ravenscroft, Michael, Andrews, Murphy, Vieux, Gonsalves, DeSilva and Francis.

Of the native assistants, Babus A. C. Mookerjee and Dino Nath Dass, and Munshis Abdul Mujid, Mahomed Yasin, Enayetullah and Hyder Ali, draftsmen; Habibul Husscin, Abdul Rahman, A. C. Bhattacharjee, Preonath, Abdul Wadood, and Abdul Ali, assistant photographers, are commended. Babu Kanny Lall Sen, head clerk and accountant, has continued to give entire satisfaction, and Babus Kedar Nath Ghose, G. C. Mukerjee, S. K. Banerjee, R. K. Chatterjee and N. N. Mukerjee, clerks, are also deserving of mention.

There has been a considerable increase in the number and value of maps issued during the year when compared with last year's total :—last year they were 2,00,416 and ₹1,06,702, whereas this year they rose to 2,07,330 and ₹1,57,927 ; shewing an increase of 6,914 in number and ₹51,225 in value.

The amount realized from cash sales was ₹24,659 ; *viz.* :—₹11,772 from private individuals, ₹1,740 from agents and ₹11,147 from Government officials ; shewing an increase of ₹1,152 over the cash receipts of the year preceding.

In the Revenue Section 651 applications were received from private individuals for extracts from original records of the Revenue Surveys, and 2,838 for certified copies of village plans, tracings and traverses, which realized a sum of ₹8,695.

The details of work are given in the following statement and show a small decrease below last year's figures :—

Details.	Number.
Applications received for maps	4,152
Letters issued in reply	3,110
Cash and credit map sale bills	1,764
Invoices and receipts issued for published maps	2,877
Ditto ditto cadastral maps	186
Ditto ditto extracts from original records	318
Packets, parcels and local despatches	5,315
Ditto ditto received in office	630
Packages despatched by rail and steamer	344
Ditto received ditto ditto	52
Maps coloured for sale and issue	26,865
Ditto for other departments	2,055

A list of the maps and charts published during the year, copies of which have been stored in this office, will be found at page 99.*

MATHEMATICAL INSTRUMENT OFFICE.

442. The charge of the office was held by Colonel M. W. Rogers, R.E., from the beginning of the financial year until the 3rd February 1897 when he retired from the service and was relieved by Lieutenant-Colonel J. R. Hobday, I.S.C.

Personnel.

Colonel M. W. Rogers, R.E., Assistant Surveyor-General, in charge from 1st April 1896 to the 3rd February 1897.

Lieutenant-Colonel J. R. Hobday, I.S.C., in charge from the 4th February 1897 to 31st March 1897.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker

Mr. T. R. Theakston, Assistant ditto.

Store Branch.

Mr. M. C. Belletty, Instrument Store Keeper.

Babu Womesh Chunder Chowdhry, Material Store Keeper.

Office Establishment.

Mr. W. Campagnac, Head Clerk.

„ W. R. Tulloch, 2nd Clerk.

Six clerks and three temporary clerks.

443. All the figures in this report refer to the financial year, *i.e.*, from 1st April 1896 to 31st March 1897. During this period the number of serviceable instruments received into store was 61,558 and their value was ₹2,59,405, whilst the number of those issued from store was 50,727 valued at ₹2,68,704. In the subjoined statement these figures are compared with those of the preceding year. There has been a decrease both in number and value of instruments received and issued, owing to the demand for instruments from railways and other large works being less this year than the previous one.

	1895-96.	1896-97.	Increase.	Decrease.
Number of instruments received	89,022	61,558	...	27,464
Value of ditto	288,055	259,405	...	28,650
Number of instruments issued	96,673	50,727	...	45,946
Value of ditto	354,890	268,704	...	86,186

* Mr. Spring reports that Mr. D'Rozario has continued to perform his duties, which are somewhat arduous and varied, to his entire satisfaction. Mr. H. R. Vallis, Map Curator, has as usual rendered excellent service, and Messrs. J. A. Vallis, S. A. Hazra and the other assistants have also worked satisfactorily.

From this table it will be seen that the number of serviceable instruments in store has increased by 10,831 and their value by ₹18,482.

444. In the following statement are shown the principal sources from which the serviceable instruments were received :—

Sources of receipt.	Number.	Value.
		₹
From England on indent	16,046	92,368
By purchase in the local market	12,117	31,674
Manufactured in the workshop	7,045	22,908
Returned to store by public officers	8,865	15,055
From repairable stock after repair	17,474	97,277
From other sources	11	123
TOTAL .	61,558	2,59,405

The number of the instruments received from England on indent has increased by about 5,000 while their value has decreased by about ₹11,000. This is mainly due to the fact that no indents for the large expensive instruments such as levels and theodolites have been made for three years, all such instruments having been supplied from the repairable stock, which is being put into serviceable order by the establishments sanctioned for their repair. The value of instruments purchased in India has decreased by about ₹9,600. The number and value of instruments issued has decreased by 45,946 in number and ₹86,186 in value. The instruments manufactured in the workshop have also been reduced this year. Their class and value will be found in Table C in the Appendix. This is owing to the demands on this office from various departments being less this year than the previous one.

445. The number of instruments taken from the repairable stock and rendered serviceable by the workshop is larger in number than last year, and their value when repaired is in excess of that of the last three years. During the year under report the office has received into store 20,857 repairable instruments valued at ₹82,453, compared with 11,547 valued at ₹77,323 in the previous year. The total number of instruments from the repairable stock which were rendered serviceable was 17,474 and their original value was ₹64,162. These were repaired in the workshop at a cost of ₹33,116 and transferred at the enhanced value to the serviceable stock. The repairable stock has thus been increased by 3,383 valued at ₹18,291. This result is due to large returns of instruments into store by public officers, the number being so large as to defy the best efforts of the workshop to reduce the stock of repairable instruments, although as shown above the number and value of the instruments rendered serviceable has considerably increased this year, but it is expected that when the new extra establishment for repairing theodolites has been in full operation for a longer period, the value of the repairable stock on hand will begin to steadily decrease.

446. The conversion of old pattern levels and theodolites, alluded to in paragraph 553 of last year's report, has been steadily continued, and during the year under report 65 levels of obsolete patterns have been converted into serviceable instruments and issued.

447. During the year the number of indents complied with was 1,313 being exactly the same as last year. They were of the usual description and were submitted from all parts of India.

448. The cash payments for charges under ₹50 amounted to ₹31,128, being less than the previous year.

449. The gradual increase of repairable instruments has been represented in all the reports for many years, and in 1887 the Government of India sanctioned

an extra establishment costing R150 per mensem to help the office, which establishment was made permanent in 1890; and again in 1889 a further grant of R120 per mensem was sanctioned which was to be employed in converting levels of obsolete patterns into serviceable instruments, and again in 1895 a further grant of R220 per mensem was sanctioned to further increase the establishment for converting levels. Since the commencement of these grants 336 levels and 53 theodolites have been converted and issued, and all indents for such instruments on England have been discontinued.

450. The value of the English indents for the last five years is shown in the following table, which gives some indication of the saving which is being effected by the utilisation of the extra grant for repairing instruments—

Year.	Value of English Indent.
	£
1893-94	13,875
1894-95	12,981
1895-96	5,208
1896-97	5,079
1897-98	3,995

451. Table A (in the Appendix) shows the amount of debits against various offices and departments for instruments supplied and for work done. It also exhibits the credits for all instruments and materials returned to store. The value of the issues and repairs executed on book debit was R2,47,980, being R81,873 less than last year. This amount includes the value of instruments purchased with the extra departmental grant of R25,000, out of which R24,933 was expended. The credits for instruments returned into store amounted to R97,731, which is a decrease on the previous year. The grand total of the value of supplies including the cash sales is R2,79,108, or about a lakh of rupees less than last year.

452. The number of principal instruments repaired in the workshop is 4,227 or about 400 more than last year. The total number of instruments of all kinds repaired amounts to 5,284, or about 500 in excess of last year.

453. The profit and loss account of the workshop will be found in the Appendix, the result of the operations showing a nominal profit of R29, from which it appears that the rates for work are fairly correct.

454. Considerable labour has devolved on this office due to the mobilisation of the armies in the field on the North-West frontier, but no delay has arisen, and all indents have been promptly complied with.*

* Lieutenant-Colonel Hobday, I.S.C., reports that Mr. Bolton has conducted the general management of the Mathematical Instrument Office with commendable zeal and ability, and his services are deserving of every praise. Mr. Theakston, his Assistant, is an intelligent, hardworking and efficient officer. He officiated for Mr. Bolton during that officer's temporary absence on privilege leave for three months to his entire satisfaction.

In the correspondence and store branch, Messrs. Campagnac, Belletty and Tulloch have performed their duties efficiently, and among the native assistants the following are deserving of special mention: Babu Durga Churn Ghose, Gossain Das Roy, Shib Chunder Ghose and Narain Chunder Banerjee, clerks, and Womesh Chunder Chowdhry, material storekeeper.

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

455. Lieutenant-Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys, was in charge of the office from the beginning of the year till the 20th September 1897, when he proceeded on privilege leave. During his absence Captain G. P. Lenox-Conyngham, R.E., carried on the Superintendent's duties. Mr. J. Eccles, M. A., went on furlough on the 17th March 1897, and Captain Lenox-Conyngham held charge of the technical offices up to the 20th September, when he made them over to Mr. H. W. Peychers. Lieutenant H. H. Turner, R.E., on his appointment to the department, was posted to this office on the 22nd April 1897 and transferred to No. 24 Party on the 1st August 1897.

Personnel.

Superintendence.

Lieut.-Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys.
Mr. J. Eccles, M.A., Deputy Superintendent, 1st grade, in charge Computing Office up to 16th March 1897.
Captain G. P. Lenox-Conyngham, R.E., Deputy Superintendent, 1st grade, in charge Computing Office from 17th March to 19th September, and in charge of Trigonometrical Branch Office from 20th September 1897.
Mr. H. W. Peychers, Extra Assistant Superintendent, 1st grade, in charge Computing Office from 20th September 1897.

(1) *Computing Section.*

Lieut. H. H. Turner, R.E., Assistant Superintendent, 2nd grade, from 22nd April to 1st August 1897.
Mr. H. W. Peychers, Extra Assistant Superintendent, 1st grade.
„ A. D. L. Christie, „ „ „ 2nd grade.
Babu Amba Prasad and 8 other Computers, 2 Copyists and 2 Writers.

(2) *Printing Section.*

9 Compositors and 2 Distributors.

(3) *Photo-Zincographic Section.*

Mr. J. S. Manuel, Zincographer, on sick leave.
„ G. A. LeFranc, Officiating Zincographer.
1 Photographer, 6 Plate correctors, 5 Retouchers, 4 Zincprinters, 12 Assistant Zincprinters, 1 Accountant, 1 Storekeeper, and 1 Despatcher.

(4) *Correspondence Section.*

Mr. J. Burbridge, Head Clerk, and 3 clerks.

(5) *Stores, Workshops and Observatories Section.*

1 Writer, 1 Head artificer and 3 Artificers.

(6) *Drawing Section.*

Mr. C. H. McA'Fee, Extra Assistant Superintendent, 3rd grade.
„ J. A. Higgs, „ „ „ 6th grade, from 4th March 1897.
4 Draftsmen, 1 Surveyor, 3 Assistants and 8 Apprentice Draftsmen.

(7) *Solar Photographic Section.*

Mr. C. F. Guthrie, Assistant Solar Photographer, up to 1st July 1897.
„ R. W. Foster, „ „ „ from 2nd July 1897.

(8) *Training School.*

Khan Bahadur Abdul Guffar, Surveyor, up to 30th June 1897.
Muhammad Zakaria, Surveyor, from 1st July 1897.

Mr. A. E Wackrill, A.M.I.C.E., Superintendent of Trigonometrical Surveys, Ceylon, joined this office on the 27th September 1897, in order to become acquainted with the methods of observing and computing, as well as with all details in connection with field and office work obtaining in the Survey of India Department.

The office is divided into the following sections :—

(1) Computing.
(2) Printing.
(3) Photo-Zincographic.
(4) Correspondence.
(5) Stores, Workshops, and Observatories.
(6) Drawing.
(7) Solar Photographic.
(8) Training School.

(1) *Computing Section.*

456. Five instalments of field records were received during the year and stored as usual. In all sixteen requisitions for data and twenty-two indents for forms were complied with. The heights of the Indus Delta triangulation were recomputed, finally adjusted and entered in the pages of the co-ordinate list, this completes the work. A revision of the heights of the principal and secondary stations of the Great Arc Series, Section 18° to 24°, Bider and Jubbulpore series, was necessitated owing to sensible discrepancies being disclosed by the extension of the lines of spirit-levelling. A considerable amount of help was afforded in finishing off the reduction of Electro-Telegraphic Longitude observations for

1894-95. The preparation of press copy and examination of press proofs were carried on as hitherto; the outturn of these is given under the next section A considerable amount of work was involved in the reduction of the observation taken by Captain Deasy in his explorations in Tibet. Nine triangulation charts of the Punjab and Central Provinces surveys, and one of spirit-levelled heights, besides one other, were compared and examined. The meteorological observations were continued as usual.

(2) *Printing Section.*

457. The following is the progress made:—

(*a*) Pamphlet of spirit-levelled heights No. 7 C. P. (revised edition), completed.

(*b*) Hand-Book of Professional Instructions for the Topographical Branch (second edition), published.

(*c*) Tidal volume, 52 pages printed.

(*d*) Synoptical volumes of the Great Arc Meridional series, Section 8° to 18° and Indus Delta triangulation, 66 pages printed.

In addition to the above, a large amount of work was done in printing the letter-press for charts, headings and foot-notes for maps, and 25,000 copies of professional and other forms were printed.

(3) *Photo-Zincographic Section.*

458. The Zincographer being absent the whole year through ill health, the extra work of the section devolved on the Assistant Zincographer.

A great deal of extra work was thrown on this section during the last two months of the year on account of the demand for maps for the frontier expeditions, 8,846 pulls were made in twelve days. The usual routine of map publication was carried on and no arrears remain.

(4) *Correspondence Section.*

459. This has been conducted as usual.

(5) *Stores, Workshops and Observatories Section.*

460. Equipments for the survey detachments to accompany the Tochi, Malakand and Mohmand Field Forces and the Tirah Expeditionary Force were packed and despatched. The work in the observatories was done as usual.

(6) *Drawing Section.*

461. The map of portion of Tibet, on scale 1 inch = 8 miles, surveyed by Captain Deasy was completed, and the new maps of Dehra Dún Municipality, Simla Revisionary Survey and Mussooree and Landour were published. As the mapping of No. 18 Party was very much in arrears, assistance was rendered by this section in preparing the 4-inch sheets for reduction to half scale, and in extracting the *mauza* areas from fourteen of the 4-inch sheets. The outturn will be found fully detailed in the appendix.

(7) *Solar Photographic Section.*

462. The work of this section was conducted as usual, experiments with dry plates being also undertaken with a view to their use during the rains.

(8) *Training School.*

463. Eight pupils were entertained and instructed in topographical surveying. They were finally examined and posted to the various field parties requiring them.

The offices were inspected by the Surveyor-General in April, July and September 1897, and he was quite satisfied with the working of the several sections.*

III.—DRAWING OFFICE, SIMLA.

464. On the 13th of October 1896 Colonel Sir Thomas Holdich, Superintendent, 1st grade, made over charge of the Simla Drawing Office to Mr. Atkinson and left Simla for Ceylon on special duty; thence he proceeded on privilege leave to England.

Personnel.

Colonel Sir T. H. Holdich, K C I.E., C.B., R.E., Superintendent, 1st grade.
Mr. G. W. E. Atkinson, Officiating Deputy Superintendent, 2nd grade.
" W. J. Cornelius, Extra Assistant Superintendent, 4th grade.
" R. R. Dickinson " " " 6th "
" F. E. Warde, Sub-Assistant Superintendent, 2nd "
" F. Rozario, Surveyor.
" H. Sindon, Draftsman.
Munshi Jafir Khan "
Mr. W. Manly "
and three other draftsmen and one writer.

On Colonel Holdich's return from England, he resumed the charge of the Simla Drawing Office on the 6th April.

465. Owing to alterations in the Army Head-Quarters Offices, orders were issued during the early part of the year to move the Simla Drawing Office into "Clermont," where the office continued throughout the winter months, returning to the old rooms in the Army Head-Quarters' building during April last.

466. The office has been fully occupied throughout the year, and it is satisfactory to note that the six sheets of Persia on the 16-mile scale have been finished and are now passing through the press at Dehra.

467. The office was inspected by the Surveyor-General in July.†

IV.—FOREST SURVEY BRANCH OFFICE, DEHRA DÚN.

468. The general direction and supervision of the head-quarters offices of the Forest Survey Branch remained throughout the year in the hands of Mr. W. H. Reynolds. The following branches of work were dealt with:—

i. Correspondence and accounts of the several provincial forest survey detachments.
ii. Computations and areas of the several field detachments.
iii. Up-keep of the Forest Department map records.
iv. Compilation and drawing of special maps for the Forest Department.
v. Training of surveyors.
vi. Other miscellaneous work for the Forest Department.

469. The up-keep of the provincial map records was maintained throughout the year. The alterations of the forest boundaries notified from time to time in the several Provincial Gazettes, have received attention, and the records have been revised accordingly, and all new tracts gazetted as state forests, have been located on the best available maps. The details of this branch of the work have been fully described in previous annual reports, hence it is not necessary to record them again, nevertheless this work continues to grow heavier year by year, as new tracts, especially in Burma, continue to be brought under forest management, and other forest tracts, more particularly in the Central Provinces, are disforested for agricultural purposes.

470. For the several Provincial Forest Departments a vast amount of map drawing has been got out of hand during the year. Seventy-eight special maps on various scales were prepared for the Forest Department, seventeen are in the press, and thirty-seven are in the different stages of progress. Of the 4-inch

* Mr. Peychers reports very highly of the work done by his Assistants, Messrs. Christie, McA'Fee, Higgs, LeFranc and Foster, and speaks well of the computers, draftsmen, accountant, and head writer of Computing Section.

The Superintendent reports very favourably of the assistance rendered him by Messrs. Christie and McA'Fee, also of the services rendered by Mr. J. Burbridge, the Head Clerk, and Babu Hira Singh, the second clerk of his office.

† The officer in charge, Simla Drawing Office, reports that Mr. Cornelius has maintained the same good character for work which has marked his career throughout, and that Mr. Dickinson is a painstaking and diligent assistant. Of the draftsmen it is said that they have all worked well, Messrs. Sindon and Rozario and Jafir Khan being specially mentioned. The services of the writer Ganga Ram are also specially brought to notice.

standard sheets of forest tracts surveyed by the Forest Survey Branch, 101 were published, 65 are in the press and 214 are in hand: many of the latter are nearly ready for the press. Two 1-inch standard sheets were also published and one is in the press and three 2-inch sheets are in progress.

471. A large amount of work of a miscellaneous nature was also turned out during the year. Under this head might be noted the colouring of 2,148 printed maps of various scrts, and the preparation of 345 tracings for various Forest and District Officers. To 124 printed maps, information was added regarding the distribution offorests, and 1,848 printed maps, on various scales, were cut up and mounted in book form for the use of the Forest Department and other branches of the Provincial Administrations.

472. During the year 28 men were instructed in surveying, *viz.*, 3 in the use of the theodolite, 21 in plane-tabling and 4 in the use of the spirit-level.*

* Mr. Reynolds speaks in the highest terms of Mr. Descubes; he is full of zeal and energy, is systematic and hardworking, and is a most excellent assistant. Mr. Watson is also reported as being a steady, reliable, and hard-working office hand.

Of the native establishment, Tulsi Ram, Mahomed Hassain, and Munzar Ahmed are spoken of as being good draughtsmen.

LIST OF MAPS AND CHARTS PUBLISHED AT CALCUTTA DURING THE YEAR 1896-97.

Title.	Scale.	Number of sheets.	Remarks.
Atlas of India.	In. M.		
Sheets Nos. 44 and 68	1=4	2	With additions and corrections to 1893.
Sheets Nos. 73, 107, 113, and 120	1=4	4	With additions to 1896.
Sheets Nos. 76 and 112	1=4	2	With additions to 1895.
Sheets Nos. 78 and 80	1=4	2	With additions to 1894.
Sheets Nos. 1A S.E.; 2 N.E.; 3 N.W.; 3 S.E.; 9 S.W.; 10 S.E.; 35 N.E.; 35 N.W.; 49 N.W.; 69 N.E.; 70 N.W.; 72 N.E.; 87 S.W.; and 130 N.E.	1=4	14	With additions to 1895.
Sheets Nos. 13 N.W. and 22 S.E.	1=4	2	With additions to 1890.
Sheets Nos. 13 N.E.; 33 S.W.; 33 S.E.; 91 N.W.; 124 S.W.; and 127 N.E.	1=4	6	With additions to 1893.
Sheets Nos. 20 N.E.; 32 S.W.; 33 N.W.; 34 N.W.; 51 S.W.; 53 S.E.; 53 S.W. and 72 N.W.	1=4	8	With additions to 1891.
Sheets Nos. 22 S.W. and 51 N.E.	1=4	2	With additions to 1889.
Sheets Nos. 21 N.E.; 27A N.E.; 36 S.W.; 40 N.W.; 78 S.W.; 79 N.W. and 125 S.E.	1=4	7	
Sheets Nos. 27A S.E.; 53 N.E.; 53 N.W.; 67 N.E.; 67 N.W.; 72 S.E.; 105 N.E.; 126 N.W.; 126 S.E. and 131 S.W.	1=4	10	With additions to 1896.
Sheet No. 31 N.E.	1=4	1	With additions to 1897.
Sheet No. 44A S.W.	1=4	1	With additions to 1892.
General Maps.			
Portion of Tibet, explored by Captain Deasy	1=8	2	
Provincial Maps.			
Assam	1=16	1	With additions and corrections to 1896.
Assam	1=16	1	With additions and corrections to 1897.
Central Provinces	1=32	1	With additions to railways to March 1896.
North-West Provinces and Oudh, showing Districts and States	1=16	2	
North-West Provinces and Oudh	1=32	1	With additions to March 1896.
Punjab	1=80	1	With additions to 1896.
Punjab and surrounding countries (skeleton)	1=32	1	With additions and corrections to railways, etc., to July 1896.
Divisional Maps.			
Chota Nagpur	1=8	2	
Patna	1=8	2	With additions and corrections to January 1897.
District Maps.			
Bankura	1=4	1	
Bhamo and Myitkyina	1=8	1	With additions and corrections to boundaries to 1896.

Title.	Scale.	Number of sheets.	Remarks.
District Maps—*continued.*	In. M.		
Champarun	1=4	1	With additions and corrections to boundaries, etc., to January 1896.
Dacca	1=4	1	2nd edition. With additions and corrections to roads to July 1896.
Garhwal	1=2	6	
Gya	1=4	1	With additions and corrections to boundaries and railways to 1896.
Hoshangabad	1=1	13	With additions and corrections to July 1895.
Khasia and Jaintia Hills	1=4	1	
Lakhimpur	1=4	1	With additions and corrections to boundaries and railways to August 1896.
Manbhoom	1=4	1	
Murshidabad	1=4	1	With additions to February 1897.
Naini Tal	1=2	2	
Pabna	1=4	1	With additions and corrections to May 1897.
Saran	1=4	1	3rd edition. With additions and corrections to March 1896.
24-Parganas	1=4	1	With additions and corrections to July 1896.
Standard Maps.			
Bengal.			
Sheet No. 138	1=1	1	Preliminary edition.
Sheet No. 294	1=1	2	2nd edition.
Sheets Nos. 139, 246 and 391	1=1	3	
Bombay.			
Sheets Nos. 209, 246, 301, 302, 327, 329, 337 and 349	1=1	8	
Sheet No. 243	1=1	1	With additions and corrections to September 1896.
Burma (Lower).			
Hanthawaddy District—Sheets Nos. 277 $\frac{S.W.}{4}$ and 278 $\frac{N.W.}{2}$ (in one)	4=1	1	
Hanthawaddy and Pegu Districts—Sheet No. 278 $\frac{S.W.}{2}$	4=1	1	
Pegu District—Sheet No. 278 $\frac{S.W.}{4}$	4=1	1	
Sheets Nos. 181 and 182	1=1	2	2nd edition.
Sheets Nos. 420, 425, 426, 427, 428, 475 and 479	1=1	7	
Sheet No. 184	1=1	1	With additions and corrections to January 1897.
Burma (Upper).			
Sheet No. 126	1=1	1	
Sheets Nos. 306 and 358	1=1	2	Preliminary edition.

Title.	Scale.	Number of sheets.	Remarks.
STANDARD MAPS—*continued.*	In. M.		
Central India and Rajputana.			
Sheet No. 260	1=1	1	2nd edition. With additions to railways to 1896.
Central Provinces.			
Betul District—Sheets Nos. 24 S.E./4; 25 N.E./4 and 25 S.E./2	4=1	3	2nd edition.
Sheets Nos. 25 S.E./4; 27 S.W./3; 35 S.E./1; 35 S.E./3; 35 S.W./3; 35 S.W./4; 36 N.E./1; 36 S.W./1; 36 S.W./2; 36 S.W./3; 36 S.W./4; 36 S.E./1 and 36 S.E./3 (in one), and 37 N.W./2	4=1	13	
Hoshangabad and Betul Districts—Sheets Nos. 24 S.E./2; 35 N.E./3 and 35 N.E./4 (in one) and 35 S.W./3	4=1	3	2nd edition.
Sheet No. 35 N.W./4	4=1	1	
Damoh District—Sheets Nos. 61 N.E./4; 62 S.W./3 and 4 and 62 N.W./4 (in one) 63 S.E./3; 81 N.E./3; 81 S.E./1; 81 S.W./4; 82 N.W./1 and 82 N.W./2 (in one); 83 S.W./1 and 84 N.W./1	4=1	9	
Sheet No. 51	1=1	1	With additions to roads to 1896.
Gujarat.			
Sheet No. 29	1=1	1	
Indus Riverain.			
Sheets Nos. 18; 33; 34; 35; 36; 49; 50; 51; 52 and 53	1=1	10	
Sheets Nos. 18 and 35 (in one), 33, 34, 36, 49, 50, 51, 52 and 53	1=1	9	Skeleton.
Madras.			
Sheet No. 24	1=1	1	2nd edition.
North-Western Provinces and Oudh.			
Sheet No. 63	1=1	1	2nd edition.
Punjab.			
Hoshiarpur District—Sheet No. 265 S.W./3	4=1	1	
Kalsia State Forests—Sheet No. 314 S.E./2	4=1	1	
Kangra District—Sheets Nos. 264 S.W./1; 265 N.W./1; 265 N.W./2; 265 N.W./3 and 265 —/4	4=1	5	

Title.	Scale.	Number of sheets.	Remarks.
Standard Maps—*concluded.*			
Punjab—continued.	In. M.		
Kangra and Hoshiarpur Districts—Sheets Nos. 265 $\frac{S.W.}{1}$; 265 $\frac{S.W.}{2}$ and 265 $\frac{S.W.}{4}$	4=1	3	
Patiala State Forests—Sheet No. 290 $\frac{N.E.}{4}$ . . .	4=1	1	
Kangra District—Sheet No. 265 N.E.	2=1	1	
Kangra District and Mundi State—Sheet No. 285 S.E. .	2=1	1	
Simla District—Sheet No. 311 S.W.	2=1	1	
North-Eastern Frontier Series.			
Sheet No. 15 S.E.	1=4	1	7th edition.
Sheet No. 15 N.W.	1=4	1	
Sheet No. 15	1=8	1	4th edition.
South-Eastern Frontier Series.			
Sheet No. 2 N.E.	1=4	1	6th edition. With additions to boundaries and roads to February 1896.
Sheet No. 4 N.W.	1=4	1	6th edition.
Sheet No. 4 S.W.	1=4	1	7th edition. With additions and corrections to September 1896.
Sheet No. 6 N.E.	1=4	1	
Sheets Nos. 9 and 10	1=8	2	
Plans of Cities and Cantonments.			
Simla	16=1	8	Revised to 1896.
Ajmere in Rajputana	12=1	7	With additions and corrections to April 1896.
Dehra Dun Municipality and Cantonments . . .	12=1	3	2nd edition.
Dharwar City and Environs, 1894-95	8=1	2	
Calcutta	6=1	1	
Sanitaria of Simla and Jutog	3=1	1	Skeleton. With additions to 1897.
Calcutta and surrounding country, with table of distances .	1=1	1	
Ditto ditto ditto .	1=1	1	2nd edition.
Index Maps.			
To the standard sheets of Central India and Rajputana, Sheets Nos. 1 and 2	...	2	With additions and corrections to 1897.
To the standard sheets of the Central Provinces . . .	...	1	With additions and corrections to 1897.
To the standard sheets of the Bombay Presidency . .	...	1	With additions and corrections to 1897.

Title.	Scale.	Number of sheets.	Remarks.
Statistical Maps.	In. M.		
Canal map of India, 1897	1=32	6	
Railway map of India	1=48	4	Railways brought up to 31st March 1897.
India showing Railways	1=64	2	Corrected to 31st December 1896.
India showing Railways	1=80	1	With corrections to 1897.
Administration Report Maps.			
Bannu, Cawnpore, Champaran, Chindwara, Darbhanga, Dinajpur, Goalpara, Gurdaspur, Gujranwalla, Jalpaiguri, Jessore, Jhang, Jullundur, Khulna, Mandla, Multan, Nimar, Rawal Pindi, Rungpur, Sarun, Saugor, Seoni, Shahabad, Sonthal Parganas, Wardha	1=8	25	
Naini Tal	1=10	1	
Balaghat, Kangra	1=12	2	
Chanda, Gurhjat States, Lohardaga, Sambalpur	1=16	4	
Upper Burma	1=64	1	With additions and corrections to 1896.
Miscellaneous.			
Alapalle reserved forest; Palmaner Taluk; North Arcot District, Madras	4=1	1	
No. 122 Varatanapalle reserved forest and Varatanapalle extension proposed reserve; Krishnagiri Taluk; Salem District, Madras	4=1	1	
No. 124 Vallemalai reserved forest, Palur Taluk; North Arcot District, Madras	4=1	1	
Burma-Siam boundary. Sheets Nos. 1 to 6	1=1	6	
Bajour and adjacent countries	1=4	2	
Parts of Sheets Nos. 23 N.W. and 23 N.E. of the North-East Frontier (country round Myitkhina)	1=4	1	
Waziristan	1=4	1	
Route map for the Western Himalayas; Kashmir, Punjab and Northern India; with portions of Afghanistan and Baluchistan, &c.	1=32	1	With additions to railways to 1896.
Map showing the path and limits of totality of the total Eclipse of the sun in India on the 21st January 1898	1=64	1	
Conventional signs to be used on Topographical maps	...	1	With additions and corrections to 1896.
Conventional signs to be used on Topographical maps	...	1	With additions and corrections to 1897.
Triangulation Charts.			
Central Provinces. Sheets Nos. 62, 65, 66 and 81	1=2	4	
Gujrat Survey. Degree Sheet No. 1 (Northern portion), seasons 1884-87	1=2	1	
Gujrat Survey. Degree Sheet No. 1 (Southern portion), seasons 1884-87	1=2	1	
Gujrat Survey. Degree Sheet No. VII (Northern portion), seasons 1884-89	1=2	1	
Gujrat Survey. Degree Sheet No. VII (Southern portion), seasons 1877-78-81-82 and 1887-88	1=2	1	
Punjab Survey. Sheets Nos. 311; 314 and 336	1=2	3	

Title of Map.	Scale.	Number of sheets.
STANDARD MAPS.	In. M.	
BURMA.		
Fyinmana Forest Survey.		
Sheets Nos. 223 N. E./1, N. E./2, N. E./3, N. E./4, S. E./1, S. E./2, S. E./3, S. E./4; 224 N. E./1, N. E./2; 270 S. W./3, S. W./4; 271 N. W./1 and N. W./2	4=1	14
Salween-Ataran Forest Survey.		
Sheets Nos. 477 N. E./4 and S. E./2 (parts of); 549 N. W./3, S. W./1, S. W./3 & 4; 550 N. W./2, N. W./4 (part of), S. W./2, S. W./4, S. E./1 and part of S. E./2, S. E./3, S. E./4; 551 N. W./2, N. E./3 and part of N. W./4 . . .	4=1	13
CENTRAL PROVINCES.		
Bhandára Forest Survey.		
Sheets Nos. 94 S. E./1, S. E./3, S. E./4; 95 N. E./1; 96 N. E./2; 116 N. W./3, S. W./1; 117 N. W./2 (part o), N. W./3, N. W./4, N. E./3 and S. E./1, S. W./2, S. W./4, S. E./3 and 118 N. E./1 and 118 N. W./2	4=1	15
Bálághát Forest Survey.		
Sheets Nos. 91 S. E./2, 92 N. E./3 and part of N. E./1; 112 N. W./2; 113 N. W./1 and N. W./3	4=1	5
Jubbulpore Forest Survey.		
Sheet No. 109 S. W./2	4=1	1
Narsinghpur Forest Survey.		
Sheets Nos. 47 S. E./3 and 48 N. E./1 (parts of); 49 S. E./4, 50 N. E./2, 67 S. W./3 and 68 N. W./1 (parts of); 50 N. W./2 & 4 and N. E./1 & 3 (parts of); N. W./4, N. E./3 and S. E./1 (parts of); 66 N. W./2 (part of), N. E./1, N. E./4 (part of), S. W./2 (part of); 67 N. E./4 (part of), S. E./1, S. E./2, S. E./3, S. E./4; 68 N. E./2, N. E./4; 86 S. W./4 and 87 S. W./2 (parts of); 87 N. W./1, N. W./3, N. W./4 and S. W./2 (parts of) and S. W./1	4=1	20
Nágpur-Wardhá Forest Survey.		
Sheets Nos. 73 N. W./1, N ./2; and 93 N. W./1	4=1	3
Ráipur Forest Survey.		
Sheets Nos. 188 N. E./3, S. E./1, S. E./2; 189 N. E./2, N. E./4; 206 N. E./4 (part of), S. W./4 and 207 N. W./2, S. E./1, S. E./2, S. E./3; 207 N. E./1, N. E./3 & 4; 210 N. W./1, N. W./2, N. W./3, N. W./4; and S. W./1 and S. W./2 (part of) .	4=1	18

Title of Map.	Scale.	Number of sheets.
STANDARD MAPS—*contd.*		
NORTH-WESTERN PROVINCES AND OUDH.	In. M.	
Gonda Forest Survey.		
Sheets Nos. 158 S. E./1 (part of); 159 N. E./4; 172 N. W./2, N. W./3, N. E./3, S. W./1 and S. W./2 and S. E./1 (parts of)	4=1	7
Kheri Forest Survey.		
Sheets Nos. 113 S. W./4; 114 N. W./2, N. E./1, N. E./3, N. E./4 and S. E./1 .	4=1	6
Lalitpur Forest Survey.		
Sheets Nos. 41 S. E./2, S. E./4; 42 N. E./2, N. E./4; 43 S. E./3 and part of S. E./4; 44 N. E./4 and part of N. E./3; 59 S. W./1 and part of S. W./3; 60 N. W./4 (part of), S. W./1 & 2 (parts of); 61 S. E./2 & 4 (parts of); 62 N. W./3, and S. W./4	4=1	12
PUNJAB.		
Bashahr Forest Survey.		
Sheet No. 332	1=1	1
Index Maps.		
Index to the Forest Survey in the Bahraich, Gonda and Gorakhpur Division .	1=16	1
„ „ „ „ Bundelkhand Division	1=8	1
„ „ „ „ Salween-Ataran Division	1=32	1
„ „ „ „ Pyinmana District	1=8	1
„ „ „ „ Chamba State	1=8	1
Index showing progress of Forest Surveys in the Central Provinces . . .	1=32	1
Charts.		
Bashahr Forest Survey Chart of Triangulation, Sheet No. 333	1=1	1

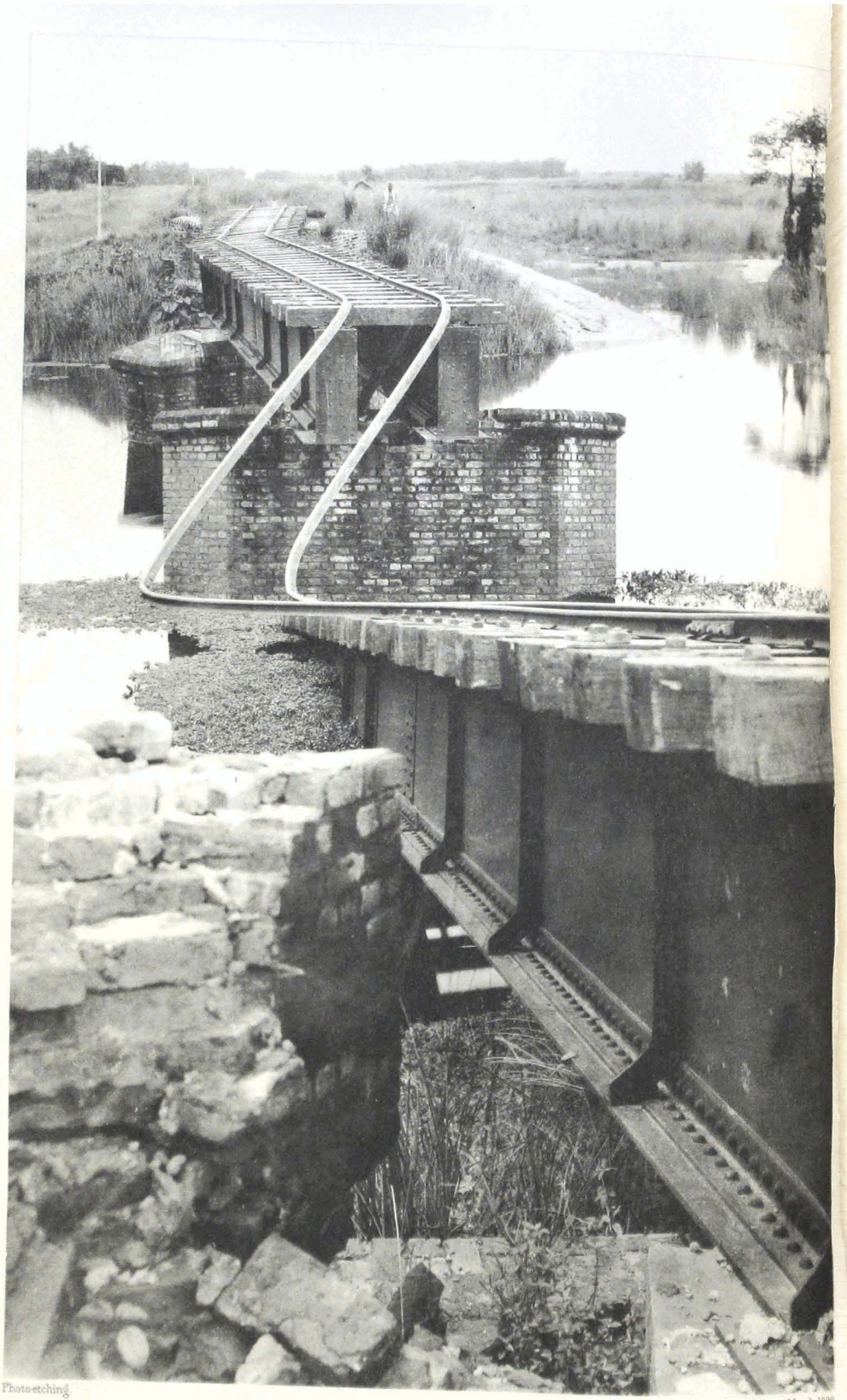


Photo-etching.

Survey of India Offices, Calcutta, March 1898.

MANSHAI BRIDGE, COOCH BEHAR STATE RAILWAY.

After the earthquake of 12th June 1897.

From a photograph by Messrs Kapp & Co

APPENDIX

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

BALUCHISTAN.

Statement of the outturn of work executed by No. 24 Party during season 1896-97.

Description of Details.	
Number of stations newly fixed	7
„ „ figures completed	3
Length of series in miles completed	75
„ „ approximate series in miles in advance	33
Area of triangulation in square miles	1380
Average triangular error in seconds	0″·44
Astronomical azimuth of verification	1
Average probable error of angles in seconds	0″·17
Number of principal stations selected in advance	3
„ „ station platforms constructed	8
„ „ stations placed under official protection	...
„ „ „ the elements of which have been computed	7
Area embraced by the triangulation to points exterior to main triangulation in square miles.	1,200
Number of secondary points fixed	7
„ „ stations and points the heights of which have been determined.	14
Number of miles of rays and paths cleared	...
„ „ preliminary charts of triangulation	2
„ „ hill tops cleared of jungle	...
Mean co-efficient of refraction	·066

Extract from the Narrative Report of CAPTAIN J. M. BURN, *R.E., Officiating Deputy Superintendent, 1st grade, on the Trigonometrical Operations in South-East Balúchistán.*

The season has been an exceptional one, owing to the somewhat peculiar and at times often dangerous circumstances under which we have had to carry out the work. It was towards the end of the season 1895-96 that the Jam of Las Bela died, and as our work was to commence this year in the Jam's territory, the thorny question of the succession to the title became one of more than ordinary interest to us. When we left Bela last year in April, the second son of the Jam was in temporary rule, but during the recess season the elder son was, by the orders of the Government, installed on the *gaddi*. He, however, soon began to have serious differences with the Political Agent, and the result was that I had to make my movements dependent on those of the Political Agent of South-East Balúchistán, a matter, as it turned out, of considerable difficulty. For about a month before our start, I got a letter at Mussooree from the Political Agent saying he would leave Kurrachee definitely on October 28th, and, as I had made all my arrangements accordingly, it was not with any feeling of pleasure, when in the middle of October I suddenly got the information that the start was to be made on October 23rd. The result of this was that I only had three days in Kurrachee to make all the arrangements for the coming field season.

As the country we had to traverse could produce absolutely no supplies of any kind that my *khalásis* could live on, the difficult and irksome task of getting together enough food for about 200 men for six months was thus rendered all the more troublesome. However, in three days I had everything ready, and on 23rd October I crossed the frontier into Balúchistán, only to find however, as the first march was done independently, that the escort for the Political Agent had been unable to leave Kurrachee on the fixed day, owing to the insufficiency and inferiority of the camels that had been supplied for its use. As only a few months before we had traversed the same ground, *viz.*, from Kurrachee to Las Bela, without any escorts at all, it seemed somewhat strange to see 200 men of the 3rd Balúch Regiment marching along with us and the Political Agent with his personal escort of some 50 Sind Horse.

Nothing eventful happened on our march of eight days to Bela, but to make matters the safer, all the men in camp were practised at falling into their places in case of any night alarm, and our camps were pitched with precautions in case of any attack.

By November 1st we reached Bela, and outside the city were met by the new Jam and all his numerous followers, amongst the latter being a hundred men, armed with all sorts of strange and quaint weapons, attended by about the most novel band I have ever seen, who were just able to twang out a tune, which after some consideration one assumed must be "God save the Queen."

On arrival at Bela, the first thing we had to do was to get our camp into a thoroughly defensible state, for no one knew what the events of the next few days might not bring forth. I put my *khalásis* on to throwing up a small redoubt close to the camp, in which all the powder, which was taken from the city, was to be stored.

* * * * * * *

By November 12th, we were ready to start operations. I went off towards (from Bela) the eastern stations of Kuliri and Piaro, where we closed last year. Messrs. Hickie and Prunty I sent off to the western stations of Gird and Goko, to place the lamp squads on these hills and make the necessary arrangements for the water supply of the men on these hills, for the water in both cases was some eight miles from the mark, so consequently had to be brought daily by camels.

By 19th November I had finished Kuliri H. S., and was just finishing off Piaro H.S. (where I observed an azimuth) when, in the midst of most favourable weather, on November 28th, I got a letter from Mr. Prunty to say his work had been completely stopped and the whole country ahead was unfriendly. This was far from pleasant reading, but there was nothing to be done except that I should myself push forward, and see what soft words could accomplish.

By December 5th I got out to a place called Mach, half-way between Bela and Jháu, having in the meantime been again enlivened with a letter from Mr. Hickie, to very much the same purport as the one I had lately received from Mr. Prunty. I met both of the above Assistants at Mach, and discussed matters with them. I found here that a son-in-law of Sardar Saffar Khan of Jháu had been out at our Mach camp, but that he had evidently been playing his own game entirely, and, far from helping us, had even been doing underhand things to thwart us in our work. I never had the satisfaction of an interview with this gentleman, for when he heard I was coming into camp, he cleared out and I never had a chance again of seeing him. I at once sent off Rahim Khan (the responsible Jamadar sent from Kalát) to Jháu with a carefully but strongly worded letter to Saffar Khan. Briefly, I wrote to this effect, "My work has been stopped. You are the "responsible man in these parts, and I decline absolutely to discuss matters with any one "else except you. If you won't come here, then I must come to you. I shall pitch my "camp at Jháu, and simply tell the Government that you alone are responsible for any "loss of money that occurs, probably about a lakh of Rupees." Just as I was on the point of starting for Jháu, I was suddenly taken very ill with what I at first thought

was going to be cholera, but it turned out to be only the effects of a bad chill, but for three days I was unable to move; however, no delay really occurred, for Sardar Saffar Khan actually did come out to meet me. It would be as well here if I gave you a short description of this man, for he played an important part in our affairs this past season.

This man is the Chief Sardar in the Jháu district, while his elder brother is the head man of the influential tribe of the Bizenjhaos, and lives at Nál, an important town north of Bela. Saffar Khan is not, I believe, on very good terms with the political authorities of Kalát. He is an old man, and has all his life, from what I heard from Captain Le Mesurier, shewn a decided antipathy to all Europeans and has never been known to voluntarily help them in any way if he could avoid doing so. Consequently when he arrived in my camp, I was agreeably surprised.

I was confident that if I could only once get face to face with him, I would soon get him to do what I wanted, and as events have shewn, I was correct in my surmise. When I sent for him to talk over matters, I met him with as much ceremony as I could, asked him to come and sit down in the largest tent I had at my disposal, and for the next few hours we had an animated discussion.

To have no misunderstandings, I myself first spoke what I had to say in English to my recorder; this was given in Hindustani to Rahim Khan, and he in his turn translated my words into Balúchí. I first of all carefully explained the objects of our survey, and its entirely non-political character, that I was glad to meet him face to face, for I could now ask him point blank whether he meant to help me or not. He here expressed his willingness to do anything I wanted. I then said that what I wanted was, that he should give to each of my working squads one really influential man to accompany them, and each lamp squad should have one or two men, to be obtained locally, who would remain with or near the squad until the work was done, and who would have to personally guard the men of the squads. These details were all satisfactorily arranged, and the rate of wages for the services to be rendered settled, when he in his turn asked some favours of me.

First that I should pardon his son-in-law Mir Omar Khan for the unsatisfactory way he had lately been behaving, and that I should not indent on him for any camels or supplies, as he had none of either to spare. I agreed to these conditions, and after a few amicable remarks our meeting ended.

It was a satisfactory one, and I felt somewhat pleased, for I believe I am the only European that he has ever gone out of his way to assist at all, and the only pressure I could bring to bear on him was purely of a moral kind. We all marched off again from Mach to our respective stations, and the rest of the season, when in Jháu territory, had no more bother to speak of with any of the inhabitants.

The third station I observed at was Gird H. S. It was with considerable difficulty that a path was made up this hill, for it is precipitous on almost every side. However one was obtained, but it was with a feeling of distinct relief that I got the instrument, and myself, down the hill again, all safe and sound.

On the way to Goko H. S., the next station, I went *viâ* Bela, and was lucky enough to be able to halt there and spend Xmas day amongst genial friends, a thing I have not been able to do for a good many years now. I finished off Goko by January 6th and then went on to the central station of Dosar or Dileki. I had a great deal of trouble and worry with this station, for to begin with, the ground round about the hill belonged to a most unruly fellow of the name of "Rozi." Mr. Hickie, who built the station, never saw him. I from Goko sent off a messenger to Rozi to tell him to send me a guide. He sent a guide, but evidently told him to take good care he did not take me by the only practical route which went to Rozi's village, but to make me come, with my camels, if possible, by a track only fit for unloaded men. After two days' marching and making about eight miles of path, I found myself at the foot of a range, towering some 2,000 feet above me, nearly all solid rock at a sharp incline, over which the guide said we must go. I at once went up the hill, from the top of which I could see Rozi's *got* or village only a few miles away, but saw at once I couldn't possibly make a path, even for half-laden camels, under three or four days, so I came down that hill determined to have it out with the guide. When I got hold of him, I made him a prisoner, and said I would send him into Bela to the Political Agent. I thoroughly frightened him, and the result was that I got at the truth, and that the facts were that he was a comparative stranger to the country and had only been temporarily stopping with Rozi. He knew there was another way, but swore he had never traversed it. Next morning we retraced our steps, and I had one of the hardest marches I have ever had. To go only some three miles in a straight line, we certainly covered over 25, over about as bad ground as it was possible for camels to go. I kept ahead the whole day, with a small squad of men, repairing the track as fast as I could.

About midday, just as we were on the worst bit of the road, crossing over a range about 2,500 feet high, it began to rain heavily, and we were soon all soaked. We could only get the camels along by continually throwing down fine sand on the slippery rock so as to give the animals a foothold. I had about 30 camels with me, but the going was so bad, that on that march, two laid down, absolutely refused to move on and finally died where they lay. On getting to Dosar H. S., I immediately sent off for Rozi, who after some delay, turned up in my camp with a few of his followers, all armed to the teeth, evidently mistrusting my intentions. However, I was again able to persuade him of my entirely pacific work, but soon found out that he wanted to be considered quite independent of the other Chiefs around him, and what he really wanted was to get some

money out of me. I consequently promised him that I would reward him with the sum of R50 if he undertook that my squad on the hill should, later on, be sent into Jháu without having suffered any molestation. He at once jumped at these terms, which were finally faithfully carried out on both sides. I sent the observatory tent and some of the kit up the hill on January 13th, meaning to go up myself next day. Most fortunate it was that I did not go up, for about midday it began to blow very hard and by the evening a cyclone was blowing, and the temperature fell rapidly. It froze hard that night, so much so that the water in the bath room of my tent was frozen solid. Next morning things were even worse, and knowing the men on the hill must have had an awful night of it, I called for some volunteers, and went up the hill myself. It was all I could do to get up, for the force of the wind was tremendous and the cold intense. When I got up I found that the observatory tent had been blown down, and had fared somewhat badly (of course the instrument was not up), while all the men I had sent up the day before were lying in a half unconscious state, huddled up together under a blown down shouldari. I got the observatory tent at once collected together, and took it, and all the men, down the hill to our camp at the foot as quickly as possible. This intense cold continued for another two or three days, but the violent wind had raised such a thick dust that I could not begin observing at this station until January 20th, and could not get to the foot of Washapi H. S., the next station, until the end of the month.

The path between these two stations, nearly every inch of it having been made by us, went over some very bad ground, for Washapi is another almost inaccessible hill, absolutely precipitous on its western face, and most difficult to approach from the east, for the only way of getting up is to clamber over huge boulders in the bed of a stony nulla coming down from near the top of the hill. Had my observatory tent been blown over to the west on this hill, it would have gone down a sheer precipice for a thousand feet. What with clouds and mist, and then hazy weather, owing to the dust thrown up by the wind, I could only get the observations done after much delay and trouble, and did not leave this station until February 8th, when I marched on to Jháu, where my head-quarter camp was. I found that there were only the ruins of an old village here, and that though Saffar Khan had lived here at one time, he was living now some eight miles to the north. However, I had a secondary station here, and as it lies close to the main track between Las Bela and Kej, the point here obtained, visible from four principal stations, should be a useful one.

The next two stations were Buzgalaband and Hazarbuzi, both lying to the west of the Jháu plain, but owing to most vexatious and wearisome delays, caused by the dust for ever being thrown up by an ever persistently blowing south-westerly wind, it was not until March 13th that I was able to leave Hazarbuzi, when matters were beginning to get somewhat critical, for unless I could get the observations finished at Kappar by March 21st, the date on which I had made up my mind some time before as the day on which all work must absolutely cease, if I were to get the men into Ormára by April 10th, in time to catch the steamer for Kurrachee, then the quadrilateral on the diagonal Washapi-Kappar would not be finished this season, much delay and difficulty would be caused next year, and the outturn for 1896-97 would be a very small one. I got to Kappar from Hazarbuzi in a forced march of one day, the men being some 18 hours on the march, and got a clear day to start work on, but next day the wind arose again, and one could barely see a few yards on account of the all-pervading dust. However, after some anxious nights of it, spent in vainly trying to see the lamps on the surrounding stations, I was, to my immense relief, able to finish off the eastern angles at Kappar by March 20th; but it was quite impossible to get the angles to the west done, so this station must be visited again this coming season, work starting again on the base Hazarbuzi-Kappar. I got into Ormára by April 2nd, being delayed somewhat on the long march of 13 days from Kappar to Ormára by fever, which kept me to my bed for a few days. Here I had a good deal to do one way and another in arranging for the storing away of our kit until next season, and for the embarkation of the party in a British India steamer, which embarkation was safely effected on April 10th. The steamer could only anchor some five miles from shore, and it was rather anxious work getting all the men and kit out to the steamer in safety, but no casualty occurred. The difficulty of rationing the men has been one that has caused me much anxiety this past season, but I am glad to say we never ran short for a single day, but I had too much left over at Ormára which my *khalásis* could not eat up. Fortunately however, owing to the fact that this port had established a ten-days quarantine on all arrivals from Kurrachee, I was able to dispose of the surplus rations at the prices I had given for them, to a local *bania* there.

On the whole I found it fairly easy to get along with all the inhabitants of Balúchistán, whom I met on my work. They are an independent set of fellows, all very lazy and indolent, but almost without exception extremely poor, and at the same time very avaricious, so if one wants anything done, one can generally get it done, if patience and tact be exercised, providing one shews one is willing to pay for their services. They have been willing enough to sell us sheep and goats whenever required at rather enhanced rates.

The Jamadar Rahim Khan whom the Political Agent of Kalát sent me was certainly of great assistance. He knew all about the local Sardars, and the sections of the tribe they belonged to, so that, backed up by the *perwanas* he had from Kalát, he was generally able without much bother to get the services of local men to shew the forward parties the way to the hills and so on. He brought, however, some utterly useless sowars with

him, some mounted on miserable ponies, quite incapable of keeping up on a march with a riding camel.

I had about a dozen of these men originally, but I dismissed two summarily for gross disobedience of orders, one ran away, and another resigned, so that their numbers were considerably reduced by April. Throughout the whole season the quality of the water available was a source of much annoyance. When camped near any fairly big river with running water, such as at Bela and at Jháu, it was all right, but in other places it was often very bad indeed, full of salts, which often had a very deleterious effect on one.

The health of the men has on the whole been fairly good, though I regret to have to record the death of 7 men, 4 during the field season and 3 during the recess season, the results, I am afraid, of the unavoidable privations they had to undergo.

The fact was that when the men joined, a good many of them had not had an honest square meal for months owing to the famine, and consequently began gorging when they could get as much atta as they liked, with the result that dysentery was pretty common at the beginning of the season. However, at the close of the season all the men were about as fit as they could be, shewing a marked difference to what they were six months before. The party reached Kurrachee by the middle of April, and Mussooree by the end of the same month.

Extract from the Narrative Report by LIEUTENANT W. M. COLDSTREAM, *R. E., Officiating Deputy Superintendent, 2nd grade, on the Survey Operations with the expedition into the Southern Chin Hills, season 1896-97.*

The general plan of the operations in the Southern Chin hills for the winter of 1896-97 was as follows:—

Three columns of 100 men each were to enter the hills by different routes and concentrate on the Eastern slopes of the Arakan Yomas at the Chin village of Myaing, at which place the subsequent movements of the columns were to be decided on.

No. 1 column was to start from the Burman village of Laungshe in the Pakôkku district, whence a comparatively good road suitable for pack animals led to Chatwe (Chindwe) in the Môn valley a few marches south of the rendezvous.

No. 2 column was to start from Mindat-sakan, a military post some 30 miles north of Laungshe on the Chin border, and to work through the high hills of the Mount Victoria range to the Môn valley, halting when necessary to exact punishment for the raid on Mindat-sakan of the previous year.

No. 3 column was to start from Paletwa in Arakan and to reach Myaing by a route through the Arakan hill tracts.

The date of rendezvous at Myaing was settled for the beginning of January.

The survey party consisting of myself with Sub-Surveyors Abdul Rahim, Ramsabad and Mowni Ram with 30 followers, was disposed as follows:—Sub-Surveyor Abdul Rahim was to accompany the Arakan column, while I accompanied the 2nd (or Mindat-sakan) column, keeping one sub-surveyor with me and sending the other with No. 1 (the Laungshe) column.

On arrival at Pakôkku on the 11th November, I ascertained that Mr. Ross the Political Officer of No. 2 column, intended to leave Mindat-sakan on the 1st December, and that the 1st column was to start from Pakôkku for Laungshe within a few days. By the 10th Mr. Ross, I.C.S., Lieutenant Barnard, Commanding the Escort, Lieutenant Fleming, 100 Sikhs of the Military Police, the survey party and 200 coolies had collected at Mindat-sakan, and on the 11th we started. I made a detour to visit and observe at Bawkung Tung or Mount Kitchen, a hill of 8,000 feet elevation, some 7 miles off the main route. Up to this date, the 12th of December, the work was heavily handicapped by the thick masses of cloud which shrouded the higher peaks, and only lifted very occasionally for short periods. After this, however, until the middle of January, when the usual Burman haze began, the weather was clear and in every way favourable for survey work.

I rejoined the main body on the 13th, and by the 22nd we reached Tawim. At this village I again left the main body, and after two stiff marches arrived within a mile of the summit of Mount Victoria: as my party had to rejoin the main body at a village (M'leng) to which the distance from Mount Victoria was not known, I could only spend one day on the summit. Although at the site of my station shortly after dawn, it was midday before the sepoys and *khalasis* had sufficiently cleared the hill for me, to commence observing and when darkness came on I had not obtained as many observations as I had hoped for. That night we bivouacked at the summit, but unfortunately the next morning proving cloudy no more work was possible and after a long downhill march we rejoined the main body at M'leng in the afternoon. On this trip the sepoys and followers suffered considerably from the cold, Mount Victoria being 10,100 feet in elevation, and we had 8 cases of fever and 2 of dysentery in the party, which consisted of 20 sepoys, 7 *khalasis* and 27 coolies.

From M'leng I remained with the main body until we reached Myaing on the 3rd January, where we found the Arakan column with Mr. Greenstreet and Captain Rigby. The Laungshe column marched in the same day, and I was glad to find that the surveyors with each party had mapped in a large extent of country. I again left the force taking all 3 surveyors with me, and we visited a couple of peaks on the Arakan Yoma

range and obtained a sufficient number of points to start the surveyors afresh. On the 10th of January we left Myaing, Lieutenant Langtry's column returning to Chindwe to explore and survey in the country south of that place and east of the Arakan Yomas.

Mr. Greenstreet's party accompanied them as far as Chindwe, and then returned to Paletwa by a route 15 to 20 miles south of the one it had come by. Sub-Surveyor Abdul Rahim again accompanied Mr. Greenstreet and mapped a large extent of country on the way and after the return to Paletwa to the north of that place.

Mr. Ross' party returned to Mindat-sakan by a slightly different route to the one it had come by, Captain Rigby from Mr. Greenstreet's column accompanying it. We arrived at Mindat-sakan on the 30th of January and on the 9th of February started again to explore the upper waters of the Môn river and the unmapped country to the north. Before leaving I sent instructions to Sub-Surveyor Ramsabad, on the return of No. 1 column, to join me, on our column leaving the hills in the 2nd week of March at Tilin, a Burmese village, 30 miles north of Mindat-sakan. Captain Rigby and I also wrote for permission to re-enter the hills again in March to survey what we could of the Baungshe country and the Myittha river drainage.

On the 17th February we arrived at a camp near Pulumtung (8,900 feet) on the Môn-Maw watershed; here we were delayed by bad weather for a couple of days. At Pulumtung a temporary base was formed under Lieutenant Fleming, while the remainder of the column explored the Môn and Thet valleys on our way to Twidin (Tinkring), to which place Lieutenant Fleming was to move his base along the watershed. I was fortunate during this reconnaissance to be able to climb, among other hills, a very commanding peak in the Yoma range Tai Teh Tung (8,800 feet) from which I obtained an excellent view over the Arakan hill tracts and the country our columns had traversed. In the Môn valley we had expected to meet with some resistance, but we met with none, although at one large village of 100 houses (M'chum) the men turned out with their bows and spears and threatened to obstruct our advance. On the advanced guard fixing bayonets and marching towards them, they dispersed and we heard no more of their objections to our presence. We met Lieutenant Fleming's party at Twidin and halted three days to enable us to ascend Maw Bim Tung (8,990 feet), one of the highest peaks in the neighbourhood from which I had hoped to begin the extension of my triangulation to the north over the Baungshe country. In this however I was disappointed, as owing to the dense haze little could be seen to the north.

On the 5th of March we left Twidin for Tilin, which we reached on the 10th. Here our party divided, Mr. Ross and Lieutenant Fleming with a small escort returning to Mindat-sakan by a road across the Maw, Yaw and Maung valleys, while Captain Rigby, Lieutenant Barnard and myself waited at Tilin for orders regarding the final expedition we had applied for permission to make.

Orders arrived on the 17th, and Mr. Duncan, the Political Officer who had accompanied the 1st column, was sent in political charge of our party. As the season was already advanced and the rains approaching, it was not found possible to attempt all we had hoped to do, but on this expedition we explored a considerable part of the unmapped portions of the Maw and Myittha drainages and passed through the hitherto unvisited villages of the Welaung Chins. We returned by Daidin and the Myittha river valley to Minywa which we reached on the 19th April, and the column immediately started for Pakôkku.

The total area of country mapped on the ¼ inch scale was 8,170 square miles, of which 2,000 square miles were triangulated. All three sub surveyors worked hard and, in spite of the rather rough time they had, and the difficulties of the country, did all that could be effected with the time and routes at their disposal.

The main feature of the Southern Chin country is the high mass of hills round Aisatung where the Arakan Yoma range splits into two branches on either side of the Môn river drainage. The peaks at the sources of the Môn are all over 8,000 feet elevation and run up to 9,100 feet. They give rise to the sources of the Myittha, Maw, Maurg, Thet and Môn rivers on the north east, east and south sides.

Mount Victoria (10,100 feet), the highest peak in the Chin country, if not in Burma, is not on the Arakan Yoma range, but forms the culminating point of the eastern offshoot above referred to.

The best roads in the country are those leading along the summits of the Aisatung, Mount Victoria range and along the ridges of the spurs descending on either side. On the summit of the ranges the roads lead through oak, pine and rhododendron forest, alternating with open park like clearings, the grazing ground of herds of bison, the old tracks and other traces of which are to be seen every where in the higher hills. Along this range water is fairly plentiful, there being apparently a line of springs at intervals of from ½ to 4 miles apart about 500 feet below the summits. By combining several of these water sources there is no doubt a sufficiently copious water supply could be obtained for a sanitarium, when it is decided to have one in these hills.

The inhabitants of the Southern Chin hills, though obviously of the same stock, differ considerably in the different valleys. The Baungshes inhabit the upper drainage of the Myittha. The Welaung Chins those of the Rong, a southern tributary of the Myittha. The Yaw, Maung and Che valleys are inhabited by Chinbôks, while a similar but distinct people occupy the scattered villages on the west bank of the Môn. These last are easily distinguished by the curious coils of lacquered cane which worn round the waist form

with a small strip of cloth the principal clothing of the men. This strip of cloth about 1 to 2 inches wide is decidedly more modest in dimension than in effect. Captain Rigby of the Intelligence Department and Mr. Ross, I.C.S., made a thorough study of the various peoples and their politics, but I do not think they discovered any regular tribal combinations among the Chin villages such as exist among the tribes on the North-Western Frontier of India. The higher hills are very scantily populated. The inhabitants of the few hamlets are great *shikaris* and have collections of bison, sambhar, serow and boar's heads on the gables of their houses that many English sportsmen would envy.

I was much indebted to Captain Rigby for his assistance to my work and to Mr. Ross for the correct spelling of names and for the assistance he gave me by conforming the movements of the column as much as possible to survey requirements.

The following notes are from a report by Sub-Surveyor Abdul Rahim :—

Arriving at Akyab on the 19th November, Abdul Rahim reported himself to Mr. Greenstreet, who made the necessary arrangements for him and his six *khalasis* to accompany the Arakan column. On the 21st December Mr. Greenstreet's party arrived at Myaing, and as the two columns from the Pakôkku district were not expected till the first week in January, Mr. Greenstreet employed the intervening time in visiting the neighbouring Chin villages west of the Yoma range, Captain Rigby and Abdul Rahim accompanying him with a small escort, while the main body were encamped at Myaing. On the 31st December, Mr. Greenstreet and his party returned to Myaing, and on the 3rd January the 1st and 2nd columns marched in.

The three columns left Myaing on the 9th, Abdul Rahim again accompanying the 3rd column under Mr. Greenstreet. The return journey was made by the Lower Lemru Guard, the surveyor being left behind with a small escort for a few days to survey in the neighbourhood of the Seng Chaung.

On the 4th February, Abdul Rahim received a letter from Mr. Greenstreet asking him to proceed to Paletwa, and on his arrival at that place Mr. Greenstreet arranged for him to survey within the limits of the Arakan administration. He accordingly worked his way to the Kyauk Pine Daung range, where he ascended the highest summit and then down the Kaladan river and up its tributary the Pi Chaung, mapping in the eastern slopes of the range, forming the boundary between Arakan and Chittagong using the points of Mr. O'Donel's triangulation.

On the 10th April he finally arrived at Paletwa, having completed during the season 4,608 square miles of quarter inch reconnaissance work.

Abdul Rahim describes the country of the Arakan hill tracts as consisting of "a series of elevated plateaus, great rolling grassy downs separated by deep valleys and intersected by parallel ranges the general direction of which is north and south . . . . . the general summits of the plateaus being 1,000 to 3,500 feet elevation." The roads were merely tracks running along the rocky beds of the rivers.

Apparently throughout the country west of the Lemru different dialects of one language are spoken, while on the east of that river to the Yomas the tribes have different languages. In religion and dress the people seem to approach the Eastern Chins, the further they are from the semi-civilized administered districts. Like the Eastern Chins they tattoo the faces of their women, and have few if any prejudices regarding what they eat. They burn their dead making the ceremony an occasion for two or three days feasting and heavy drinking. Some of the tribes erect flat tables of slabs of rock at the site of the burning, while others, after collecting in an earthen jar the remnants of bones and ashes, bury them in the village graveyards, and, instead of the stone tables, erect miniature models of houses in which food and drink are placed for the use of the departed spirit.

Marriage is arranged by the parents of each party on the man having first instigated his parents to approach those of the girl on the subject. Two wedding feasts are held, the first at the bridegroom's house and the second two days later at the bride's.

Rice is cultivated by most villages either on irrigated lands or on the hill sides in Taungyas (hill side fields); pumpkins, Indian corn, millet, pulse, cotton and tobacco are also grown by the wilder tribes. The Arakanese and Chaungthas cultivate sugarcane, vegetables and melons in addition. Each village makes its own clothes and cotton blankets. Rice and tobacco are exported, and Abdul Rahim also states that there is some trade in ivory and rhinoceros' horns.

The valleys are generally feverish for Europeans and Natives of India, but the hills are probably fairly healthy.

Extract from the Narrative Report of CAPTAIN G. P. LENOX-CONYNGHAM, *R. E., Deputy Superintendent, 1st grade, on the determination of the* LATITUDE OF MADRAS OBSERVATORY, *season 1896-97.*

The report consists mainly of extracts from notes written by Captain Burrard before giving over charge of the Astronomical Parties, with some additions having reference to the final results of the computations.

Captain Burrard says :—

"My original intention had been to observe four complete nights with the zenith telescope, and eight with the zenith sector, four of the latter by the Talcott method and

four by the sector method. But the programmes were so broken into by passing clouds, that I eventually observed for eight nights with the zenith telescope and for five with the zenith sector (sector method). Mr. Michie Smith took observations on five nights with the zenith sector on the Talcott method. The number of observations taken was:—

110 pairs, Talcott method, zenith telescope, by myself.
58 pairs, Talcott method, zenith sector, by Mr. Michie Smith.
101 double observations, sector method, zenith sector, by myself.

Description of Stations.

"I set the zenith telescope upon the same pillar that Captain Lenox-Conyngham observed from, and I built a brick pillar for the zenith sector on the prime vertical thirty feet east. This brick pillar had the usual foundation two and a half feet deep, and proved most satisfactory, remaining perfectly steady from hour to hour and from night to night: the levels of the zenith sector were not affected by movements of men in the tent.

"Captain Conyngham's pillar consisted of three solid cylindrical granite blocks, superimposed and cemented together, which were brought to India and erected by the American longitude observer in 1881, and which are mentioned in the official account of the American longitude work, as having been used at their China stations. This pillar was to all appearances of ideal construction, was situated in the most suitable position for our work, and was of just the right dimensions for our zenith telescope.

"On December 22nd, when I commenced observations, so many things were going wrong that I did not notice any particular instability of level, but on December 23rd I saw that it was very unsteady: it seemed as if the bubble would generally begin to move at the moment, when I was about to read it. Mr. Michie Smith was present and we attributed this movement to the heat from the hand lamp, whose rays are thrown on to the level at the instant of reading; on December 24th, however, we found that, though the hand lamp did have some slight effect, the chief cause of the movement was my action in rising from the observing seat after an intersection and transferring my weight from the seat to my feet. One of the new observatory tents, which have no flooring, was in use, but the pillar had been insulated with dry sand.

"Further tests showed us that this massive granite pillar was affected by every movement in the tent, and on digging for better insulation we unexpectedly discovered that, though it rose to a height of 2½ feet above the level of the ground, it only sank to a depth of a few inches below, and was without any foundation. The three granite cylinders are each a foot high, and the joints between them are easily visible above ground: the Government Astronomer had always thought, that a fourth and possibly a fifth cylinder were buried underground as a foundation, and he expressed great surprise at the discovery that the pillar consisted merely of the three visible blocks.

"The idea may occur to others, as it did to me, that the identity of the American station has possibly been mistaken. The erection however of this granite cylinder is well authenticated historically, and its centre is situated so exactly on the primary meridian of Madras, that its astronomical origin cannot for one moment be doubted. At this distance of time it is impossible to say how this unsteadiness was got rid of by the American observers, though there can be no doubt that at the time of their observations it must have been in a satisfactory condition.

"Though I stopped all movements in the tent and sat myself to observe in such a position that to read the level I had only to rise without moving my feet, the bubble almost invariably started off when I rose. I tried reading the level by reflection in a hand-mirror without rising from my seat, but this device failed as I was apt to touch the instrument. On December 25th I constructed a wooden flooring and the level then became fairly steady, though on occasions it would still move at my rise from the observing seat, and its steadiness never equalled that of the zenith sector.

"A peculiar feature of the unsteadiness was that *in the long run* the granite pillar was remarkably steady, for I had never to re-adjust the level of the instrument even from night to night. If any one went near the pillar, the level would be temporarily altered, but it would immediately recover if he went away. In fact the granite behaved much as it would have done if it had been standing on a raft floating in a pond: its general level in that case might remain unaltered for days and weeks and months, but if an observer stepped on to the raft, the pillar would incline towards him: if he moved about on the raft, the level of the pillar would alter with his movements, and it would reassume its normal position as soon as he went away: it would remain steady as long as he remained absent.

"That level unsteadiness could produce a systematic error throughout six whole nights seems hardly reasonable; yet at Madras I am inclined to think that it may have done so, because in nine cases out of ten the bubble movement at the moment of reading was towards the north: it would have been easier to decide this point if our zenith telescope had carried two levels as the American instruments do.

"This report is written before the results have been worked out, and before I know whether my final value will disagree with Captain Conyngham's or not.

"It will be interesting to see whether the construction of the flooring affected the results; I do not anticipate much effect, because from the very first I made a point of

rapidly noting the bubble's position at the very instant of rising and of recording that position only."

The results having now been computed I append a table, including three other values, *viz.*, that given in the Nautical Almanac, which was the result of a large number of observations taken in the observatory; a value determined by Downing from direct and reflex observations made by Taylor, and a value quite recently obtained by Mr. Michie Smith by solar observations with the zenith sector.

	Observer and method.	Resulting Latitudes.
1	Value in Nautical Almanac from many observations taken in observatory .	13° 4′ 8″·1
2	Downing from Taylor's observations	8″·04
3	Lenox-Conyngham with zenith telescope on unsteady pillar	8″·80
4	Burarrd with zenith telescope on unsteady pillar	8″·34
5	Burrard with zenith sector on steady pillar	7″·94
6	Michie Smith with zenith sector by Talcott method	7″·25
7	Michie Smith with zenith sector by solar observations	8″·01

Result No. 6 Mr. Michie Smith assigns but little weight to, and it may be disregarded.

Assuming therefore that the mean of 1, 2, 5 and 7 is the true value we have 13°—4′—8″·02.

Now the correction to the latitude on account of change in the readings of the level between the observations of the first and second stars of a pair—

$$= + \tfrac{1}{4} \Sigma (N\text{-}S)$$

If therefore N is generally larger than it should be, the correction will be too large algebraically and the resulting latitude too large. Captain Burrard says above that "the bubble movement at the moment of reading was in nine cases out of ten towards the north." That is to say, the N reading was generally too large, and would have been larger still if the reading had not been promptly taken. Now I recollect when observing at Madras that I occasionally noticed that the bubble was moving, but I failed to attribute this to its true cause, and thought that the level was sluggish, and that the bubble had not yet come to rest, and therefore waited till it did so. It is clear therefore that one would be justified in expecting Captain Burrard's result to be somewhat larger than the truth and mine considerably larger, and this is exactly what has been found. Captain Burrard's error is +0″·32, and mine +0″·78. It is interesting to note also that the mean of Captain Burrard's observations taken before he had a floor made was 0″·14 greater than the mean of those taken subsequently.

This evidence, taken together with Captain Burrard's remark as to the observed direction of motion of the bubble, proves conclusively that the unsteadiness of the pillar did produce a systematic error in the observed value of the latitude. This result is unexpected and very difficult to understand; the practical deduction to be made is however obvious, namely, that very great care must be paid to the proper insulation of pillars, and that no faith can be put in probable errors as a test of accuracy unless all unsteadiness has been carefully guarded against. It will be noticed that among the sets of observations mentioned above, there is no satisfactory set by the Talcott method. It is very desirable that an opportunity should be taken of observing with the zenith telescope on a properly constructed pillar.

Captain Burrard then adds a discussion of the micrometer value, he says:—"Colonel Herschel's value of the zenith sector micrometer was 0″·428871, but its accuracy has never been tested by the Talcott method. It will be seen from the redeterminations in my observatory Memo Book that at Madras this value was too small: after I left Madras, further redeterminations were made by Mr. Michie Smith, and he obtained the value 0″·42987.

"The value of the zenith telescope micrometer has been determined by Captain Conyngham many times and is known more accurately than that of the sector: Captain Conyngham's original method of determination was to intersect circumpolars at elongation at known intervals of time, but this method is very liable to errors from refraction,

and he obtained his final value 0″·693556 from an exhaustive treatment of his latitude results. This year I tried a new method and after many determinations obtained the mean value 0″·693401. (An examination of the results where this value was used points to an error of +0″·000266, so that the value should be 0″·693290.)

"I selected two stars differing by a few minutes in Right Ascension and by about one degree in declination, and intersected them in succession on the meridian without touching the telescope between the intersections. The micrometer value was deduced by comparing their known difference of declination with the micrometric measurement corrected if necessary for level: if the stars are well selected, their errors of place are likely to be systematic and not accidental, and the former class have no effect if the two stars are situated together.

"In the case of the sector value an uncertainty exists in the third place of decimals, but in the telescope value the third place is well known, and it is the fourth place that is doubtful. As these values have to be multiplied by 2,000 or 3,000 divisions, the latitude by single pairs will differ by 2″ or 3″ according to which value is adopted for the sector, and by 0″·3 or 0″·5 according to which value is adopted for the telescope.

"In the Indian Survey no satisfactory plan has yet been devised of dealing with the micrometer value, and our observers have never shown the same confidence in their Talcott results as the Prussians and Americans do.

"During actual field operations there is no time to spare for experiments, and these must be made in the recess or not at all. Up to date our efforts have been directed towards attaining a micrometer value, which will suit all observations and all stations; our failure has been probably due, partly to the value being affected by temperature, and partly, to its want of uniformity at different parts of the thread. Variation with temperature and want of uniformity could both be tested with a tappet and chronograph by revolving the micrometer eye-piece through 90°, and thus making the horizontal wire vertical, and by then taking star transits over the wire at every 500 divisions of the micrometer scale."

In order to reduce the amount of work thrown on the micrometer screw, three wires have now been fixed to the sliding frame, about 1,000 divisions apart, and a star will in future be intersected with that wire which lies nearest to it.

The intervals between these wires can be determined very carefully beforehand, and its value will of course be independent of any irregularity in the screw, and will also be less affected by temperature, for the sliding frame is of brass, the same material as the tube of the telescope, and should therefore expand or contract in the same ratio. The micrometer screw being of steel does not do so.

All effect of error in the adopted value of the micrometer can, as has been pointed out in previous reports, be eliminated by carefully choosing the pairs such that the sums of the additive and of the subtractive micrometer correction should be equal, but as Captain Burrard remarks:—'No one who has not had actual experience can realise the difficulty of selecting pairs to balance, and the shorter the programme the more difficult the task. In his recently published account of the Survey of South Africa, Dr. Gill contends that it is useless to observe for latitude at an ordinary station for more than one night, and recommends a return to the Walker-Herschel group system of latitudes. His conclusions are unassailable; but if his recommendations be adopted, the difficulty of finding pairs to balance over only one night's work will be so great, that unless satisfactory means be devised of dealing with the micrometer value, a return to the sector method of observing will be our ignominous but only alternative."

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

Statement showing the work performed during the year 1896-97.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ATLAS OF INDIA.	In. M.		
Sheets Nos. 3 N. W., 5 S. E., 8 S. E., 8 S. W., 10 S. E., 10 N. W., 10 S. W., 11 N. E., 11 N. W., 11 S. W., 12 S. E., 21 S. E., 23 N. W., 31 N. E., 31 S. E., 31 N. W., 33 S. E., 33 S. W., 36 N. E., 37 S. W., 39 S. E., 40, 40 S. W., 43, 49 N. E., 52 N. E., 53 N. W., 54, 59 S. W., 67 S. E., 68 S. W., 69 S. E., 71 N. E., 71 S. E., 72 N. E., 72 N. W., 88, 89 S. E., 90 N. W., 90 S. W., 91 S. E., 91 N. W., 91 S. W., 92 N. W., 92 S. W., 94, 106, 114, 115, 118, 119, 120, 124 N. E., 124 N. W., 127 N. W., 129 N. E., 129 S. E., and 130 N. E.	1=4	58	Additions made to railways, roads, canals and changes to boundaries.
Sheets Nos. 14 S. E., 41 N. E., 41 S. E., 41 S. W., 42 N. E., 48 S. W., 58 N. E., 58 S. E., 58 N. W., 58 S. W., 59 N. E., 62 N. E., 62 S. E., 78 N. W., 79 N. E., 79 S. E., 79 S. W., 80 N. E., 80 N. W., 80 S. W., 141 S. E, 141 S. W., 142 N. E., 142 S. E., 142 N. W., 142 S. W., 144 N. E., 144 S. E., 144 N. W., 144 S. W., 145 N. E., 145 S. E., 145 N. W., 145 S. W., 153 N. W., 153 S W., 157 N. E., 163 S. W., 164 N. W., 164 S. W., and 165 N. W. . .	1=4	41	Additions made to names and details for engraving.
Sheets Nos. 27A N. E., 27A S. E., 37 N. W., 65 & 78 N. W.	1=4	5	Hills brush shaded, for engraving.
GENERAL MAPS.			
India (2nd edition) (Engraved) ,	1=32	6	Additions to date.
Do. (do.) (Litho) .	1=32	6	Ditto.
Do. (shewing canals) (Photo.) .	1=32	6	Ditto.
Do. (3rd edition) (Litho). .	1=32	6	Compilation in progress.
Do. (shewing railways) (Photo.)	1=48	4	Railways to date.
Do. (Engraved) . . .	1=128	1	Ditto.
Do. (do.) skeleton .	1=128	1	Additions to date.
Do. (do.)	1=128	1	Hills brush shaded, for engraving.
Do. (do.)	1=256	1	Railways to date.
Map of Western Himálayas (Engraved)	1=32	1	Additions to date.
Punjab	1=32	1	Completed and published.
North-Western Provinces and Oudh	1=32	1	Additions to date.
PROVINCIAL MAPS.			
Assam (Litho.) . . .	1=16	1	Additions to railways to date.
Do. (Engraved) . . .	1=16	1	Ditto to date and published.
Bengal, Bihár, Orissa and Chotá Nágpur (Litho) . .	1=16	2	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I.—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PROVINCIAL MAPS—*contd.*	In. M.		
Bengal, Bihár, Orissa and Chotá Nágpur (Photo.)	1=16	2	Additions to date and published.
Bengal, Bihár, Orissa and Chotá Nágpur (Engraved)	1=16	2	Hills brush shaded, for engraving.
Bombay Presidency (Engraved)	1=16	1	Additions to date.
Central Provinces (Litho.)	1=16	2	Ditto ditto.
Gujarát (Engraved)	1=16	1	Hills brush shaded, for engraving.
Mysore and Coorg (Engraved)	1=16	1	Completed and published.
Punjab (Litho.) (skeleton)	1=16	4	Additions to railways.
Do. (Engraved)	1=16	4	Ditto to date.
Ditto (do.)	1=16	4	Compilation in progress.
Rájputána Agency (Engraved)	1=16	2	Additions to railways.
Sind (Litho.)	1=16	1	Ditto to date.
Upper Burma (2nd edition)	1=16	2	Corrections to boundaries.
DIVISIONAL MAPS.			
Chittagong (Photo.)	1=8	2	Additions to date.
Chotá Nágpur (do.)	1=8	2	Completed and published.
Patna (do.)	1=8	2	Ditto ditto.
Tenasserim (do.)	1=8	4	Additions to date.
DISTRICT MAPS.			
ASSAM—			
Lakhimpur	1=4	1	Completed and published.
BENGAL—			
Bánkurá, Dacca, Gayá, Mánbhúm, Murshidábád, Pabná, 24-Parganás, Rájsháhí, Sáran	1=4	9	Completed and published.
Bográ, Jalpáiguri, Malda, Monghyr, Nadiá	1=4	5	Additions and corrections to date.
Champáran, Darbhanga	1=4	2	Compilation in progress.
BURMA—			
Bhamo	1=8	1	Additions to date.
PUNJAB—			
Jhelum and Ráwalpindí	1=4	2	Additions to date.
Hissár	1=4	1	Ditto ditto.
STANDARD MAPS.			
BENGAL—			
Sheets Nos. 125 and 126	1=1	2	Additions to date.
BOMBAY—			
Sheet No. 199	1=1	1	Additions to date.
Sheet No. 246	1=1	1	Completed and published.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
CENTRAL INDIA AND RÁJPUTÁNA—			
Sheets Nos. 67, 108, 109, 118, 134, 135, 168, 211, 213, 227, 235, 238, 249, 258, 260, 278, 282, 287, 303, 307, 312, 324, 331, 378, 379, 408, 410, 411, 418, 420, 421, 441, 449, 450, 471, 472, 472, 475 and 476 .	1=1	38	In progress.
Sheets Nos. 121, 175, 176, 177, 201, 223, 226, 230, 255, 257, 259, 261, 262 and 264 .	1=1	14	Published.
Sheets Nos. (161, 162, 194, 195) in one sheet, and (159, 160, 192, 193) in one sheet . .	1=2	2	Ditto.
CENTRAL PROVINCES—			
Sheets Nos. 28, 35, 50, 52, 67 and 68	1=1	6	In progress.
Sheet No. 51 . . .	1=1	1	Completed and published.
MADRAS—			
Sheet No. 49 . . .	1=1	1	Brought up to date.
Sheets Nos. 24, 26, 27, 57, 73, 77, 107, 108, 137, 138 and 139	1=1	11	Additions to date.
NORTH-WEST TRANS-FRONTIER—			
Sheet No. 28 S. E. . .	1=4	1	Completed and published.
PUNJAB—			
Sheet No. 243 . . .	1=1	1	Additions to date.
UPPER BURMA—			
Sheets Nos. 306 and 358 .	1=1	2	Completed and published.
Sheet No. 314 . . .	1=1	1	In progress.
UPPER BURMA (NORTH-EAST FRONTIER SERIES)—			
Sheet No. 15 N. W. . .	1=4	1	Completed and published.
Sheet No. 15 (1th edition) .	1=8	1	Ditto ditto.
Sheet No. 14 S. E. . .	1=4	1	Additions to railways to date.
Parts of sheets 23 N. E. and N. W.	1=4	1	Additions and corrections to date.
UPPER BURMA (SOUTH-EAST FRONTIER SERIES)—			
Sheets Nos. 4 S. W. (7th edition) and 6 N. E. . .	1=4	2	Completed and published.
Sheets Nos. 9 and 10 . .	1=8	2	Ditto ditto.
Sheets Nos. 3 S. E. and 3 A N. E. . . .	1=4	2	In progress.
Sheets Nos. 1 (5th edition), 4 (2nd edition), and 5 . .	1=8	3	Ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ADMINISTRATION REPORT MAPS.	In. M.		
Assam	1=48	1	Completed and published.
Punjab	1=80	1	Ditto ditto.
Upper Burma	1=64	1	In progress.
ASSAM—			
Goálpárá	1=8	1	Completed and published.
BENGAL—			
Champáran, Darbhanga	...	...	
Dinájpur, Jalpáigurí, Jessore . Khulná, Patná, Rangpur, Sáran, Sháhábád and Sonthál Parganás	... 1=8	... 11	Completed and published.
Lohárdagá	1=16	1	Ditto ditto.
CENTRAL PROVINCES—			
Bálághát	1=8	1	Completed and published.
Bastár	1=16	1	Hills, brush shaded.
Chándá	1=16	1	Completed and published.
Chhindwárá	1=8	1	Ditto ditto.
Garhját States	1=16	1	Ditto ditto.
Mandlá	1=8	1	Ditto ditto.
Nimár	1=8	1	Ditto ditto.
Sambalpur	1=16	1	Ditto ditto.
Saugor	1=8	1	Hills, brush shaded.
Seoní	1=8	1	Completed and published.
Wardhá	1=8	1	Ditto ditto.
NORTH-WESTERN PROVINCES—			
Mirzápur	1=12	1	Completed and published.
Náini Tál	1=10	1	Completed and published.
PUNJAB—			
Bannu	1=8	1	Completed and published.
Gujránwála	1=8	1	Ditto ditto.
Gurdáspur	1=8	1	Ditto ditto.
Gurgáon	1=8	1	Additions and corrections to date.
Jhang	1=8	1	Completed and published.
Jullundur	1=8	1	Ditto ditto.
Kángra	1=12	1	Ditto ditto.
Karnál	1=8	1	Ditto ditto.
Lahore	1=8	1	Ditto ditto.
Ludhiána	1=8	1	Additions to date.
Pesháwar	1=8	1	Completed and published.
Ráwalpindi	1=8	1	Ditto ditto.
INDEX MAPS.			
Provincial Indexes	Various	10	Brought up to date.
Index to the Standard Sheets of Bengal	1=52	1	Additions and corrections to date.
Index shewing the Survey Operations by the Survey of India Department in North and South Lushai Hills Districts	1=52	2	Prepared a tracing on vellum cloth.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
INDEX MAPS—*concld.*	In. M.		
Index to the Standard Sheets of Upper and Lower Burma .	1=32	2	(*a*) shewing publications of 1-inch sheets. (*b*) „ scales of different surveys.
Index to the Standard Sheets of Madras	1=48	1	Additions and corrections to date.
Index to the Standard Sheets of Assam	1=48	1	Corrections to boundaries and railways.
Index to the Standard Sheets of Bombay Presidency . .	1=64	1	Additions to railways.
PLANS OF CITIES AND CANTONMENTS.			
Simla and Jutogh . . .	6=1	1	Additions to date.
Plan of Mooltan-City . .	6=1	8	Corrections.
Plan of Nusseerabad Cantonment	6=1	1	Ditto.
Plans of Kasauli, Subáthu, and Umballa Cantonments . .	12=1	3	Ditto.
Plan of the City and Environs of Ajmere	12=1	7	Ditto.
Plan of the City of Calcutta .	16=1	9	Additions and corrections.
Plan of Quetta Cantonment .	16=1	4	Ditto ditto.
Plans of Solon, Dagsháí and Jutogh Cantonments . .	24=1	3	Corrections.
WORK DONE FOR OTHER DEPARTMENTS.			
MISCELLANEOUS.			
Map of Mandalay Station Yard	1=400 ft.	1	Prepared for the Consulting Engineer to the Government of India.
Ten miles radius map of Lansdowne	1=1	1	Prepared.
Map of country 12 miles around Indore	1=1	1	Ditto for Lieutenant D. H. Cameron.
Map of Patná Division (12 sets)	1=8	24	Coloured for the Famine Commission.
Map of Upper Burma . .	1=32	2	Ditto for Mr. Irwin.
Map of India	1=96	1	Inserted names and heights for the Sanitary Commissioner.
MAPS, COLOURED, ETC.			
Maps on various scales . .	...	1,997	For Surveyor-General's Office.
Ditto ditto . .	...	90	For other Departments.
TOTAL .	...	2,087	

DRAWING OFFICE, CALCUTTA.

SECTION I—*concluded.*

Statement of work—concluded.

DESCRIPTION OF WORK.	Number of sheets.
Maps examined.	
Atlas sheets	87
General maps	18
Provincial maps	25
Divisional maps	2
District maps	2
Standard maps	85
Plans of Cities and Cantonments	11
Administration Report maps	31
Index maps	11
Statistical and Extra-Departmental maps	7
Miscellaneous maps	94
Originals and office copies of various maps with additions and corrections in territorial boundaries and public works	566
Tracing prints prepared for Atlas reductions	24
Tracings of roads, canals and railways from originals supplied by P. W. D.	18
Engraved proofs of Atlas sheets in various stages	171
„ of General and Provincial maps, including index charts	28
„ of large scale plans	2
„ of Administration Report maps	40
„ of Statistical maps	5
Litho. proofs of General and Provincial maps, including index charts	25
„ of Atlas sheets and district maps, transferred from copper-plates	39
„ of Statistical and Extra-Departmental maps	6
Photo. proofs of standard and various other maps	311
Colouring of maps for various purposes	550
Projection and examination of graticules and plotting of points	156
TOTAL	2,314

N.B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the printed catalogues of maps as to additions and corrections up to date, examination of the proof sheets of the "Survey of India Department Notes," as to the correct orthography of geographical names and various other minor works have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II.—REVENUE DRAWING AND COMPILATION.

Statement showing the work performed during the year 1896-97.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS.	In. M.		
PUNJAB.			
Indus Riverain Survey.			
Sheets Nos. 18, 33, 34, 35, 36, 49, 50, 51, 52 and 53 . . .	1=1	10	Proofs passed; press order given.
Sheets Nos. 24, 25, 26, 27, 40, 41, 42, 43, 45, 79, 80, (60 and 81) and 98	1=1	13	Fair maps corrected for re-photography. Proofs passed; press order given.
Sheets Nos. 23, 46, 47, 48, 59, 68 and 99	1=1	7	Fair maps corrected and sent to press for re-photography; proofs sent out to local officials for corrections up to date.
Skeleton Maps of the Indus River showing old course.			
Sheets Nos 33, 34, 35, 36, 49, 50, 51, 52 and 53 . . .	1=1	9	Proofs passed; press order given.
District Hazára.			
Sheet No. 12	2=1	2	Fair maps corrected for reduction to half scale.
District Pesháwar.			
Sheets Nos. 51, 52, 78, 79, 105, 106, 107 and 134 . . .	1=1	8	Compiled from the old sheets with additions from tracings received from the district officials. Drawing and typing in progress.
Sheets Nos. 80 and 108 . .	1=1	2	Partly traced from the old sheets and partly added from 4-inch and 2-inch tracings received from the district officials.
NORTH-WESTERN PROVINCES AND OUDH.			
Districts Náini Tál and Garhwál			
Sheet No. 63	1=1	1	Proofs passed; press order given.
Districts Meerut and Morádábád.			
Sheet No. 31	1=1	1	Under publication.
Districts Saháranpur, Muzaffarnagar and Meerut.			
Sheets Nos. 13 and 16 . .	1=1	2	Fair maps corrected and proofs returned to press for correction.
Sheets Nos. 6, 10, 14, 15 and 19	1=1	5	Fair maps corrected, proofs sent out to local officials for corrections up to date.
Sheet No. 18	2=1	4	Fair maps being corrected.
Districts Aligarh, Muttra and Agra.			
Sheets Nos. 23, 35 and 38 .	1=1	3	Fair maps corrected, proofs sent out to the district officers for corrections up to date.
Sheets Nos. 24, 25 and 37 .	2=1	12	Fair maps corrected and sent to press, and proofs under correction.

DRAWING OFFICE, CALCUTTA.

SECTION II.—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*			
NORTH-WESTERN PROVINCES AND OUDH—*contd.*	In. M.		
Districts Jaunpur, Benares and Mirsápur.			
Sheets Nos. 168 and 171 . .	1=1	2	Fair maps corrected, proofs returned to press for correction.
Sheet No. 169	1=1	1	Fair map corrected, proof sent out to the district officer for correction up to date.
Districts Ghásípur, Benares and Mirsápur.			
Sheets Nos. 195, 196 and 197 .	1=1	3	Ditto ditto.
Districts Basti, Gorakhpur and Ghásípur.			
Sheets Nos. 188, 189, 203, 205, 208, 209, 220 and 221 . .	1=1	8	Ditto ditto.
Portion of the Náini Tál (Kumáun Bhábar) District.			
Sheets Nos. 46 $\frac{\text{N. E.}}{2, 4}$; $\frac{\text{S. E.}}{2}$; 63 $\frac{\text{N. W.}}{1, 3, 4}$; $\frac{\text{N. E.}}{3}$; $\frac{\text{S. W.}}{1, 2, 3, 4}$; $\frac{\text{S. E.}}{1, 3, 4}$; 64 $\frac{\text{N. E.}}{1, 2, 3, 4}$; $\frac{\text{S. E.}}{2}$; 250 $\frac{\text{S. W.}}{3}$; and 251 $\frac{\text{N. W.}}{1, 2, 3, 4}$; $\frac{\text{S. W.}}{1, 2, 3, 4}$; $\frac{\text{S. E.}}{1, 3}$ . . .	4=1	30	Fair maps corrected, proofs sent out to the district officer for correction up to date.
District Pilibhit.			
Sheets Nos. 1 to 12 . .	1=1	12	Additions and corrections made to boundaries, roads, etc.
District Agra.			
Sheets Nos. 1 to 9 . . .	1=1	9	Ditto ditto.
District Budáun.			
Sheets Nos. 33, 34, 50, 51, 52, 67, 68, 69, 70, 84 and 85 . .	1=1	11	Ditto ditto.
Districts Muzaffarnagar, Meerut and Bulandshahr.			
Sheets Nos. 5, 6, 7, 8, 17, 18, 19, 30, 31 and 32 . . .	1=1	10	Ditto ditto.
OUDH.			
Sheet No. 136 . . .	1=1	1	Printed map touched up, corrected and sent to press for reproduction.
Sheets Nos. 122, 123, 136, 137, 138, 139, 150, 151 and 152 .	1=1	9	Additions and corrections made to roads and boundaries.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*			
BENGAL.	In. M.		
District Darjeeling (including British portion of Sikkim).			
Sheets Nos. 269 and 270 . .	2=1	8	Drawn for reduction to scale 1-inch to a mile (2nd edition). Proof of the former sent to press for correction and of the latter in hand.
Districts Darjeeling and Jalpáiguri.			
Sheet No. 294	1=1	1	Proof passed ; press order given.
District Hooghly.			
Sheets Nos. 4, 6 and 8 . .	1=1	3	Additions and corrections made to roads and boundaries.
District Dinájpur.			
Sheets Nos. 9, 10, 11, 12 and 13 .	1=1	5	Ditto ditto.
District Malda.			
Sheets Nos. 1 to 8 . . .	1=1	8	Ditto ditto.
District Rájsháhi.			
Sheets Nos. 2, 3, 5 and 6 . .	1=1	4	Ditto ditto.
District Mymensingh.			
Sheets Nos. 347, 348 and 389 .	1=1	3	Proofs examined and corrected up to date.
Sheet No. 391	1=1	1	Proof passed ; press order given.
BOMBAY.			
Sheets Nos. 161, 166, 243, 302, 327, 329 and 337 . . .	1=1	7	Proofs passed ; press order given.
Sheets Nos. 164, 183, 192, 201 and 301	1=1	5	Proofs examined and sent to press for correction.
Sheets Nos. 195, 206, 231 and 232 (in 4 sections each) . .	2=1	16	Fair maps corrected and sent to press for reduction by photography to scale 1-inch=1 mile for replenishing stock.
Sheets Nos. 328, 349, 350 and 351 (in 4 sections each) . .	2=1	16	Fair maps examined with field sections, corrected and sent to press for reduction by photography to scale 1-inch=1 mile.
Sheets Nos. 208, 209, 210, 243 and 244	1=1	5	Additions and corrections made to roads and boundaries.
LOWER BURMA.			
Sheets Nos. 181, 182, 184, 281 and 284	1=1	5	Proofs passed ; press order given.
Sheet No. 179	1=1	1	Proofs sent to officials for correction.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*concld.*	In. M.		
LOWER BURMA—contd.			
Districts Amherst and Thatón.			
Sheets Nos. 420, 425, 426, 427, 428 and 479	1=1	6	Proofs passed ; press order given.
Sheet No. 374 (in 4 sections)	2=1	4	Fair maps corrected and sent to press for reduction to scale 1-inch=1 mile.
Sheets Nos. 421, 422, 371, 376 and 377 (in 4 sections each)	2=1	20	Fair maps examined with 16-inch plans, corrected and sent to press for reduction to 1-inch scale.
District Tavoy.			
Sheets Nos. 486, 487, 488 and 489	2=1	14	Compiled from 16-inch plans ; drawing and typing in progress.
UPPER BURMA.			
District Minbu.			
Sheet No. 126	1=1	1	Proofs passed ; press order given.
Sheets Nos. 128 and 129	1=1	2	Proofs examined and returned to press for correction.
Sheets Nos. 89, 90, 127, 130, 174 and 175	1=1	6	Proofs under examination.
PARGANÁ MAPS.			
BENGAL.			
District Gayá.			
Sheets Nos. 3, 8, 13, 14, 15, 16, 17, 18, 19, 21, 22 and 23	1=1	12	Proofs passed ; press order given.
District Monghyr.			
Sheets Nos. 7 and 14	1=1	2	Printed maps touched up, corrected and sent to press for reproduction.
District Sháhábád.			
Sheets Nos. 13 and 14	1=1	2	Proofs passed ; press order given.
District Sáran.			
Sheets Nos. 15 and 19	1=1	2	Ditto ditto.
District Purnea.			
Sheets Nos. 11, 12, 14, 15, 17 and 18	1=1	6	Additions and corrections made to roads and boundaries.
District Backergunge.			
Main Circuits Nos. 7 and 8	1=1	2	Printed maps touched up, corrected and sent to press for reproduction ; proofs passed ; press order given.
District Mánbhúm.			
Main Circuits Nos. 5, (6, 7 and 10), 9 and 14	1=1	4	Ditto ditto.
District Mymensingh.			
Main Circuits Nos. (17 and 13)	1=1	1	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PARGANA MAPS—*concld.*	In. M.		
BENGAL—*concld.*			
District Dacca.			
Main Circuits Nos. 7 and 8	1=1	2	Printed maps touched up, corrected and sent to press for reproduction; proofs passed; press order given.
District Nadiá.			
Sheet No. 5	1=1	1	Ditto ditto.
Sheets Nos. 1, 2, 4 and 6	1=1	4	Additions and corrections made to roads, boundaries, etc.
District Bográ.			
Sheets Nos. 1 to 8	1=1	8	Ditto ditto.
District Khulná.			
Sheets Nos. 1 to 7	1=1	7	Ditto ditto.
District 24-Parganás.			
Dihi Panchánogram.			
Grand division 1, Sub-division 3	99 ft.=1 inch.	1	Printed maps touched up, corrected and sent to press for reproduction; proofs passed; press order given.
Grand division 2, Sub-division 5 Sec. ii		1	
Grand division 3, Sub-division 13		2	
Grand division 3, Sub-division 23 Sec. ii			
Grand division 6, Sub-division Q 1st, Q 2nd		2	
Grand division 6, Sub-division M, Sec. 1		1	
Grand division 6, Sub-division A		1	
CENTRAL PROVINCES.			
District Chhindwárá.			
Sheets Nos. 1 to 12	1=1	12	Corrected to date from tracings received from the district officials.
ASSAM.			
District Sibságar.			
Sheet No. 6	1=1	1	Corrected to date; proofs passed; press order given.
DISTRICT MAPS.			
PUNJAB.			
Jhang	1=2	4	Additions and corrections made to roads, boundaries, etc.
Hissár	1=4	1	Corrected; proofs passed; press order given.
Siálkot (Skeleton)	1=2	1	Examined and sent to press for reduction to half scale.
NORTH-WESTERN PROVINCES AND OUDH.			
Garhwál	1=2	6	Proofs passed; press order given.
Bahraich	1=4	1	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
DISTRICT MAPS—*concld.*			
CENTRAL PROVINCES.			
Nágpur and Wardhá	1=2	4	Proofs passed ; press order given.
Saugor	1=2	6	Additions and corrctions made to boundaries and interior details from the 16-inch scale tracings received from the Settlement Officer.
PLANS OF CITIES AND CANTONMENTS.			
Dhárwár	8=1	2	Proof passed ; press order given.
Hubli	8=1	2	Fair map corrected and sent to press for reproduction.
Bareilly (shewing the British position and the Military operations in 1857-58)	4=1	1	Drawn; proof passed, press order given on 2-inch scale.
Cawnpore	12=1	9	Corrected to date and sent to press for reproduction.
Calcutta	6=1	2	Proofs passed and sent to press for correction.
Calcutta	3=1	1	Proof passed and press order given.
Calcutta $\frac{G}{2,3}$; $\frac{H}{4,5,6}$; $\frac{L}{1,2,3,4}$; $\frac{M}{2,10,12,15}$; $\frac{N}{1,8 \text{ and } 11 \text{ to } 20}$; $\frac{O}{1,2,3,13 \text{ to } 16}$; $\frac{O}{18 \text{ to } 21}$; $\frac{Q}{3 \text{ to } 22}$; $\frac{P}{11,15}$ and $\frac{R}{23}$	1=50 feet	65	Reprints ordered.
Moulmein Town (in 69 sheets)	1=50 feet	40	Proofs passed ; press order given.
Ditto ditto	ditto	29	Fair maps corrected and sent to press for reproduction.
Cantonment of Moulmein	1=200 feet	1	Redrawn ; sent to press for reproduction.
MISCELLANEOUS MAPS.			
Calcutta and Suburbs (in 4 sections)	3=1	4	Proofs passed ; press order given.
Calcutta, country 15 miles around	1=1	1	Drawn ; sent to press for reproduction, ; proof passed ; press order given.
TRIANGULATION CHARTS.			
Half degree sheets, Nos. 1, 7, 8 and 9 (in 2 sections each) of Gujarát Survey	1=2	8	Proofs passed ; press order given.
Degree sheets, Nos. 10 and 14 (in 8 sections each) ditto	1=1	16	Fair maps corrected and sent to press for reduction to ½-inch scale.
INDEX MAPS.			
For Administration Report	Various.	6	Drawn and sent to press.
Ditto ditto	ditto	11	Corrected to 1897 and sent to press.
TRACINGS (ON CLOTH).			
Tracings of Sheets	,,	30	These plans and tracings have been prepared for Government officials and other departments.
Village plans	,,	339	
MAPS COLOURED.			
Maps on various scales	...	140	For office use.
Ditto ditto	...	11,161	Colouring examined for stock in M. R. I. O.

DRAWING OFFICE, CALCUTTA.

SECTION II—*concluded.*

Statement of work—concluded.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Tippera, Season 1890-91.	
„ Chittagong „ 1888-89.	
„ Kyauksè „ 1889-90.	
„ Jalpáigurí „ 1889-90.	
„ Sibságar „ 1889-90.	
„ Akyab „ 1884-85.	
„ Balasore „ 1893-94.	
„ Bhandára „ 1889-90.	
„ Ráipur „ 1893-94.	
„ Narsinghpur „ 1886-88.	
„ Henzada „ 1889-90.	
Traverse data, etc., supplied.	
District Sagaing, along Lower Chindwin, (18 pages) .	To O. C. No. 3 Party.
„ Mandalay, along unsurveyed portion (36 pages)	Ditto ditto.
„ Kheri, along Nepál Territory, (7 pages) .	To O. C. No. 2 Party.
„ Pilibhít, along Nepál Territory . . .	Ditto Ditto.
„ Basti, along District Gorakhpur, (23 pages) .	To O. C. No. 8 Party.
„ Tippera along Bay of Bengal with charts (12 pages)	To O. C. Noákháli Detachment.
Eastern Boundary of Dakhin Sháhbázpur (8 pages) .	Ditto ditto.
Backergunge villages (40 pages)	To Collector.
Village Traverses (72 pages) . . .	To public officers.
Triangulation data of District Násik . . .	To Superintendent, Bombay Revenue Survey.
„ „ Buxa Cantonment . .	To Executive Engineer, Military Works Division.
„ „ District Seoní . . .	To Superintendent, Forest Surveys.
Field Area Statements of District Minbu (21 pages) .	To Superintendent, Land Records and Agriculture.
„ „ District Prome (14 pages) .	To Deputy Commissioner.
„ „ District Amherst (102 pages)	Ditto ditto.
„ „ District Akyab (248 pages)	Ditto ditto.
„ „ District Purí (23 pages) .	To Settlement Officer.
Values and description of all G. T. S. Stations in District Nadiá (10 pages)	To Collector.
Calculated latitudes and longitudes of Revenue Survey points in Districts Akyab, Jalpáigurí, Bhandára, Seoní and Bhurtpore State. Prepared a scale of contours 25 feet apart on 4-inches to the mile for Captain Hodgson. Calculated two tables for reducing slopes to horizontal values. Calculated areas by Tahsils and Parganás of standard sheets Nos. 6, 13, 16, 31, 38, 169, 171 and 209, North-Western Provinces; sheets Nos 294 and 337, Bengal; sheets Nos. 164, 166, 206, 327, 347, 349 and 351, Bombay; and sheet No. 319 Punjab. Calculated the area of the City and Environs of Dhárwár and revised the area of District Hoshiárpur by summation of villages. Adjusted the areas of Districts Cuttack and Balasore according to revised boundaries. Plotted Kála Chitta Pahár, District Ráwalpindi, on 4-inch scale. Prepared and submitted a report on the character, scale and date of survey of all the districts in the Lower Provinces of the Bengal Presidency since the commencement of Revenue Survey Operations in 1830	

Description of Work.	Remarks.
Traverse data, etc., supplied—concld for the Bengal Government. Prepared a statement showing area, cost and season of cadastral survey of the districts in North-Western Provinces from 1872-73 for the Board of Revenue, North-Western Provinces. Computation and plotting of a group of Murshidábád villages for preparation of a congregated 4-inch village map for the Collector. Inserted traverse stations on the 16-inch cadastral maps of District Garhwál with extracts from traverse volumes for relaying of boundaries for the Deputy Commissioner. Calculated the area of the estates of the Mahárájá of Benares by summation of villages. Supplied the Officer in Charge, No. 2 Party, with the numbers of villages of the old 4-inch survey of Districts Gonda and Bahraich. Prepared statements for the General Report, checked annual statements received from executives, and did a large amount of miscellaneous work.	

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of publication of Cadastral Maps on the 30th September 1897.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS RECEIVED.			MAPS PUBLISHED.				
	Up to 30th September 1896.	Added during past 12 months.	Total up to 30th September 1897.	Up to 30th September 1896.	By Surveyor General's Office during past 12 months.	Total to 30th September 1897.	Remaining to be published.	
North-Western Provinces.								(a) These figures are liable to alteration until publication has been completed.
Agra	2,942	...	2,942	2,942	...	2,942	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,601	...	1,601	1,601	...	1,601	...	
Bánda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,571	...	5,571	5,571	...	5,571	...	
Benares	2,052	...	2,052	2,052	...	2,052	...	
Bijnor	31	...	31	31	...	31	...	
Dehra Dún	701	...	701	701	...	701	...	
Fyzábád	14	...	14	14	...	14	...	
Garhwál	9,100	...	9,100	2,255	2,906	5,161	3,939	
Gházípur	4,021	...	4,021	4,021	...	4,021		
Gorakhpur	8,615	...	8,615	8,615	...	8,615	...	
Hamírpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,583	...	3,583	3,583	...	3,583	...	
Jhánsi	1,661	...	1,661	1,661	...	1,661	...	
Kumáun (Bhábar)	332	...	332	332	...	332	...	
Morádábád and Tarái	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzápur	3,794	...	3,794	3,794	...	3,794	...	
Rámpur Estate	1,356	...	1,356	1,356	...	1,356	...	
Tarái	862	...	862	862	...	862	...	
TOTALS	59,090	...	59,090	52,245	2,906	55,151	3,939	
Burma.								
Akyab	2,785	...	2,785	2,785	...	2,785	...	
Amherst	3,664	...	3,664	3,664	...	3,664	...	
Bassein	3,437	...	3,437	3,437	...	3,437	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Katha	...	56	56(a)	...	...	...	56	
Kyaukse	801	...	801	801	...	801	...	
Mandalay	781	...	781	781	...	781	...	
Meiktila	722	1,139	1,861(a)	722	647	1,369	492	
Mergui	1,071	...	1,071	1,071	...	1,071	...	
Minbu	1,384	63	1,447(a)	724	723	1,447	...	
Prome	847	...	847	847	...	847	...	
Rangoon Town and Index	20	...	20	20	...	20	...	
Sagaing	2,286	...	2,286	1,487	227	1,714	572	
Tavoy	763	...	763	763	...	763	...	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	...	
Thatôn	1,048	152	1,200(a)	497	609	1,106	94	Exclusive of 13 sheets of Thatôn (Municipality) reprinted.
Thôngwa	3,749	...	3,749	3,749	...	3,749	...	
TOTALS	30,713	1,410	32,123	28,703	2,206	30,909	1,214	
Bengal and Orissa.								
Backergunge	...	261	261(a)	...	261	261 (b)	...	Published by order of the Board of Revenue, Lower Provinces.
Cuttack Town	86	...	86	86	...	86	...	
Muzaffarpur	1	...	1	1	...	1	...	
Patná and Gayá	3,054	...	3,054	3,054	...	3,054	...	
Purí (Khurda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Sháhábád	4,924	...	4,924	4,924	...	4,924	...	
TOTALS	12,630	261	12,891	12,630	261	12,891	...	
Assam.								
Cachar	...	191	191(a)	...	120	120	71	
Darrang	1,074	...	1,074	1,074	...	1,074	...	Exclusive of 3 sheets reprinted.
Kámrúp	2,218	...	2,218	2,210	...	2,210	8	
Lakhimpur	346	...	346	346	...	346	...	
Nowgong	1,277	...	1,277	1,277	...	1,277	...	Exclusive of 6 sheets reprinted.
Sibságar	2,050	...	2,050	2,042	...	2,042	8	
Sylhet	213	...	213	168	...	168	45	
Sylhet (Jaintia)	651	...	651	651	...	651	...	
TOTALS	7,829	191	8,020	7,768	120	7,888	132	
Central Provinces.								
Ráipur	43	...	43	43	...	43	...	
TOTALS	43	...	43	43	...	43	...	
GRAND TOTALS	110,305	1,862	112,167	101,389	5,493	106,882	5,285	

Abstract of work performed during 1896-97.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for Zincography.	Proof sheets examined previous to press order.	Coloured and subsequently examined.	
North-West Provinces	2,710	725	3,277	...	Scale 32-inches=1 Mile.
Burma	2,024	690	2,049	...	Do. 16 ,, =1 ,,
Bengal	137	125	270	...	Do 16 ,, =1 ,,
Assam	159	41	141	...	Do. 16 ,, =1 ,,
TOTALS	5,030	1,581	5,737	...	

DRAWING OFFICE, CALCUTTA.

SECTON IV.—BENGAL PROVINCIAL.

Statement showing progress of 2-inch mapping during 1896-97.

PROVINCE.	Total number of sheets.	Graticules projected.	Stations plotted.	Details reduced by pentagraph to 2-inch scale.	Names of villages, streams, etc., typed.	Outlining completed.	Footnotes, margins, etc., completed.	Examined.	Finally examined	Sent to Photographic office for reduction to 1-inch scale.	Proofs examined.	Final press order given.
ORISSA.												
Previously reported	124	100	87	85	80	80	58	80	58	44	28	...
Completed during year including Khurdá	...	24	34	29	34	34	56	34	56	44	60	12
TOTAL .	124	124	121	114	114	114	114	114	114	88	88	12
BIHÁR.												
Previously reported	116	52	41	13	12	12	...	...	...	...	...	...
Completed during the year . .	...	15	18	20	16	12	...	...	...	...	...	...
TOTAL .	116	67	59	33	28	24	...	...	...	...	...	...

ENGRAVING OFFICE, CALCUTTA.

Statement showing the work performed during the year 1896-97.

Title of Map.	Number of plates.	Outline square inches.	Number of letters cut.	Hills, sand, lakes, square inches.	Remarks.
Atlas of India.					
Scale 1 inch = 4 miles.					
Quarter sheets, new, completed .	6	8	2,860	54	
Ditto in progress .	50	878	69,571	506	
Additions and corrections to published quarter sheets . .	93	777	71,047	206	
Ditto ditto full sheets	19	131	18,293	291	
New quarter sheets projected, etc.	35	...	2,802	...	
General Maps.					
On various scales . . .	5	104	19,062	...	
Provincial Maps.					
On scale 1 inch=16 miles and 32 miles	27	1,076	36,924	260	
On various scales for Administration Reports . . .	2	...	680	...	
District Maps.					
On various scales for Administration reports . . .	37	325	24,657	233	
Index maps	3	...	1,571	...	
Plans	4	45	949	33	
Charts	3	33	5,800	5	
Miscellaneous subjects . .	65	7	51,994	...	
Total .	349	3,384	306,210	1,588	

Copper-plate Printing.

Impressions taken	20,240
Proofs pulled	493
Transfers pulled	517
Total .	21,250

Steel Facing.

Double elephant plates, steel faced	19
Ditto „ removed	14
Quarter sheets „ faced	104
Ditto „ removed	40
Miscellaneous plates „ faced	26
Ditto „ removed	18
Total	221

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of MR. T. A. POPE, *Assistant Surveyor-General, Season 1896-97.*

OUTTURN.—The outturn of work for the year is somewhat over the average of the past few years. A considerably larger number of subjects was dealt with than usual. The actual amount of work done by the presses, as measured by the number of pulls, is practically the same as last year, though the final number of printed copies is less. Full details of the outturn in each section will be found in the appended statements.

ORIGINAL SUBJECTS.—The number of original subjects received for reproduction and either completed or partially so during the year was 7,880, or 860 more than in the previous year. This number is considerably in excess of any year in the past. The increase is entirely under the head of departmental and cadastral maps, the number of subjects received from other departments showing a decrease as compared with last year, though well up to the average. The number of subjects lithographed was 612, of which 56 were departmental and 556 extra-departmental, against 46 departmental and 536 extra-departmental last year. The remaining 7,268 were either reproduced by various photographic processes or zincographed, and include 993 departmental, 5,634 cadastral, and 641 extra-departmental. The actual number of maps, etc., received during the year was 7,496, of which 930 were departmental, 5,666 cadastral, and 900 extra-departmental. The number completed in all respects was 7,361, of which 609 were departmental, 5,518 cadastral, and 1,234 extra-departmental.

LITHOGRAPHIC DRAWING SECTION.—This section remained under the charge of Mr. S. M. Coard, of the Engraving Office, until the 31st March 1897, when he was relieved by Mr. R. Fogarty, who arrived from England under an agreement with the Secretary of State to assume the post of Head Assistant, Litho Branch. Mr. Fogarty rapidly mastered the rather complicated details of the work of his branch, for which his previous training and experience have specially fitted him. He is in every respect well qualified for the post, and has shown tact and judgment in his management of the staff of native draftsmen and others under his supervision. The total number of new drawings, or additions, etc., made to maps on stone during the year was 515, of which 26 were departmental and 489 extra-departmental.

LITHOGRAPHIC PRINTING SECTION.—The number of subjects printed from stone was 612, or 118 more than last year; of these, 56 were departmental and 556 extra-departmental, against 38 departmental and 458 extra-departmental last year. The number of pulls from stone was 572,719, of which 45,505 were departmental and 527,214 extra-departmental, while the number of copies was 555,525, of which 45,120 were departmental and 510,405 extra-departmental. Sergeant Vandyke, R.E., held charge of the section, under Mr. Fogarty's supervision, throughout the year, and has continued to show himself a very steady and efficient assistant.

ZINC PRINTING SECTION (Normal).—The number of zinc plates printed during the year was 1,104, of which 509 were departmental and 595 extra-departmental. The number of pulls was 148,003, of which 87,818 were departmental and 60,185 extra-departmental, and of complete copies 175,254, of which 84,957 were departmental and 90,297 extra-departmental. The figures for last year were, number of plates printed 1,140 (355 departmental, 785 extra-departmental); number of pulls 178,919 (76,445 departmental, 102,474 extra-departmental); number of completed copies 249,171 (74,071 departmental, 175,100 extra-departmental). Mr. E. A. LeFranc continued in charge of the section and managed the work very efficiently.

ZINC PRINTING SECTION (Cadastral).—During the year, plates of cadastral maps of the Bengal, North-Western Provinces, Assam and Burma surveys were printed off to the number of 5,645, the number of pulls being 133,223, and of copies of complete villages, 122,293. Last year, 4,921 plates were printed, the pulls being 121,584, and complete copies 111,430. The figures show a large increase of work during the year under report. Mr. J. B. Mackenzie held charge throughout the year and gave entire satisfaction.

TYPE PRINTING SECTION.—The work in this section shows a decrease during the year, owing to the smaller demands from the head-quarters offices and field parties for departmental forms, the printing of which forms the greater part of the work of the press. There was a large outturn in the preceding year, which supplied all requirements in advance for some time. The number of pages or items set up was 10,054, or 1,861 less than last year; the number of pulls was 931,543 (340,014 less than last year), and of copies 529,664 (139,131 less than last year). Mr. DePyvah, the Head Type Printer, continued to perform his duties to my satisfaction.

NEGATIVE SECTION.—The number of negatives taken during the year was 6,272, or 316 more than in the previous year. Of these, 1,375 were of departmental maps, etc., 4,056 cadastral, maps, and 841 extra-departmental subjects. Last year the figures were, 968 departmental, 3,696 cadastral, and 1,292 extra-departmental, or a total of 5,956. No alteration was made in the processes employed, and there is nothing special to record. Mr. H. Haward, Head Assistant, Photographic Branch, was in charge of the section throughout the year, and managed it to my entire satisfaction. Arrangements were made at the close of the year to increase the supervising power and responsibility exercised by

Photo-Block. Survey of India Offices, Calcutta, February 1898.

COMMISSIONER'S CUTCHERRY, GAUHATI.

After the Earthquake of 12th June 1897.

Mr. Haward, by placing all the photographic sections under him, so as to assimilate his status in the office to that of the Head Assistant, Litho Branch. The effect of this change will be reported on next year.

PHOTO-TRANSFER PRINTING SECTION.—There is a slight falling off in the number of photo-transfer prints made during the year, which was 5,794, against 5,860 last year. Of these, 1,191 were departmental, 3,971 cadastral, and 632 extra-departmental. Last year the figures were, 1,020 departmental, 3,696 cadastral, and 1,144 extra-departmental. Mr. Harrold continued in charge and performed his duties efficiently. No changes were found necessary in the processes employed.

SILVER PRINTING SECTION.—In this section, 3,267 cyanotype or blue prints were made during the year, being 725 in excess of last year. The number of silver prints was 527, or 173 less than last year. Mr. C. J. Meade continued in charge of the section.

HELIOGRAVURE SECTION.—There is again a large increase of printing work to be recorded in this section, though the number of plates photo-etched was slightly less than in the previous year, *viz.*, 131, as against 144. The number of prints made in the copperplate machine and presses was 72,246, or 15,858 in excess of last year,—a result only attained by keeping the printing staff working at high pressure throughout the year. The number of hand-engraved plates photo-electrotyped was thirteen, or four less than last year.

The Enameline Process.—It is believed that the strain on the copperplate presses will be relieved to some extent by the introduction of the "Enameline" half-tone photo-block process, to which reference was made in the Annual Report for 1894-95. Mr. Turner, Photo-engraver, has spent considerable time during the latter part of the year in experimenting upon this process, with results which warrant the belief that, for the less fine kinds of works, it will answer as well as the photogravure process, while it has the great advantage that the blocks can be printed easily and with great speed in the type machine. The following is a description of the process as it has been worked out by Mr. Turner.

The Negative.—A reversed negative is required, and it must be taken through a ruled glass screen, as described for other photo-block processes in previous annual reports. Wet collodion plates have been used hitherto and have proved quite satisfactory, but trials made on Ilford special process plates show that these are more suitable and convenient, and a supply of them has been indented for. The quality of the finished block depends almost entirely on the quality of the negative, and this is regulated by the distance of the screen from the sensitive plate, the size and shape of the stop used in the lens, the quality of the light and the nature of the subject under reproduction. Given a suitable negative the other stages of the process present but little difficulty. For half-tone subjects the negative should have good contrasts and be dense in the high lights, but not sufficiently so to block up the grain of the ruled screen.

The Copperplate.—Electro-deposited copper has been used up to the present, and has proved useful and convenient for the purposes for which we have so far used the process. If it should come into more extended use in the future, as is now certain, the ordinary commercial copperplates, as used in Europe, would in some respects be more suitable. With improved arrangements for cutting and mounting the plate a much thicker plate than has been used would be an advantage. To prepare the plate for coating, it must first be thoroughly cleaned by rubbing it with a mixture of chalk made into a paste with equal parts of liquor ammonia and water, applied with a pad of cotton wool. It is then washed well under a stream of water and flooded with a dilute solution of nitric acid (about 1 in 40) and again washed. It is now, while still wet, ready for coating with the sensitizing solution, which is made up as follows:—

Fish glue (Lepage's clarified)	1½ ounces.
Isinglass	20 grains.
Bichromate of ammonia	120 ,,
Water	4 ounces.

The bichromate is first dissolved in the water, and the isinglass added; this, after a few minute's soaking, is dissolved by the application of a gentle heat. The fish glue is next added, and the whole brought into solution by stirring with a glass rod. It is then filtered through four thicknesses of muslin and is ready for use. The solution will keep for a considerable time and seems to improve somewhat after a few days' standing. Mr. Turner has used it continuously for over ten days, but cannot with his present experience say to what limit it may safely be kept.

The moist copperplate is now placed in a "whirler", or any arrangement by which it can be rapidly revolved, face downwards, over a gas stove or other convenient source of heat. The sensitizing solution is poured over the plate, driving the moisture in front of it, and drained off from the right hand lower corner. It is then flowed over a second time and the surplus drained back into the stock solution. The plate is held face downwards over a heated surface, and rapidly revolved until it is dry. This gives a perfectly even coating of the sensitizing solution, and only occupies a few minutes. It is now ready for printing, which should be done while the plate is still warm.

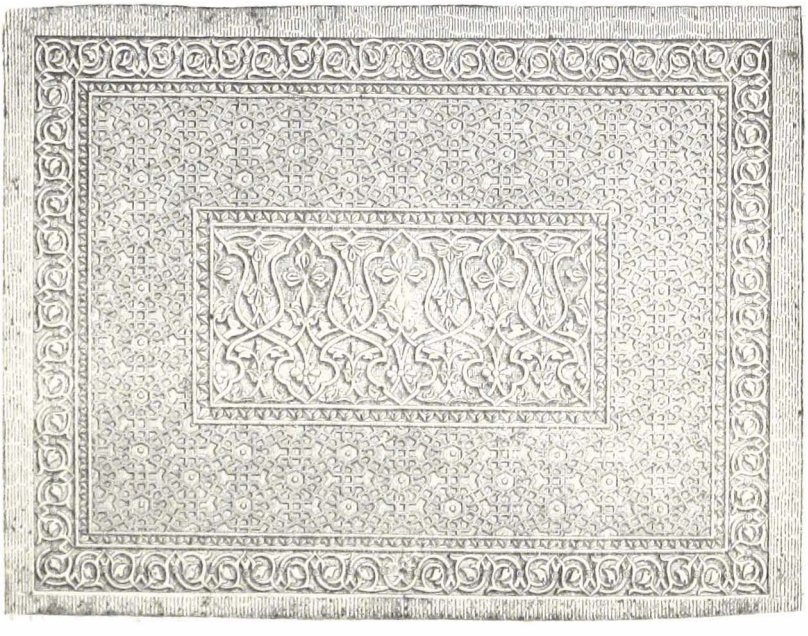
Printing, developing and enamelling.—Perfect contact between the copperplate and the negative is a *sine qud non* in this process, and this can only be obtained by well distributed and great pressure in the printing frame. The copperplate must be perfectly

level, and care must be taken that there is no dust between the plate and negative. Special printing frames are made for this purpose, but so far only temporary arrangements have been used to secure this object. The exposure varies from four to eight minutes, approximately, in the sun. After removal from the printing frame the plate is washed for a few minutes in cold water and then placed in a dish containing a solution of an aniline dye (preferably methyl violet). This renders the image visible, and it can now be judged whether the exposure and the contact between the negative and plate are right. The plate is then rinsed well in cold water, dried off with spirits of wine, and is ready for burning, which gives to the delicate, aniline-dyed gelatine image the properties of an enamel, from which the name of the process is derived.

The copperplate is placed in a suitable holder over a Bunsen gas stove, face upwards, and heated gradually from the back of the plate. The first effect of the heat is to volatilize the dye and so cause the image to disappear. The copper then tarnishes in the lights to a reddish brown, leaving the shadows of the image light. By further heating the plate the gelatine image turns gradually to a rich brown colour, while the surface of the copperplate becomes of a silver grey tint. The plate must now be removed and allowed to cool.

Etching the plate.—This operation is performed in a strong solution of perchloride of iron, which may be of a strength of 45 Baume. With a good image, well burnt in, it can be etched the full printing depth without any danger of under-biting, and will stand from 30 to 45 minutes in the etching solution, which should give a good printing plate without any necessity for re-biting. The plate should not be rocked during the etching, but can be taken out of the bath at intervals of five or ten minutes and washed under a tap to enable the progress of the etching to be examined. The depth to which the etching can be carried is purely a matter of judgment, but in this process far greater latitude is admissible than in any of the numerous others which have been tried in the Office. The plate, after it is etched sufficiently deep, is simply washed in water, cut to size, and mounted type-high.

At the close of the year under report the process had hardly emerged from the experimental stage, but since that time considerable demands for line and half-tone blocks have been received, and we have been able to use it successfully in complying with them, and there is now no doubt that it will form a permanent and most useful addition to the processes employed in the office, besides relieving the strain on the copper plate printing presses. The illustration facing this page is a fair example of the results obtained, and the block printed below illustrates the adaptation of the process to line subjects.



Mr. A.W. Turner has been in charge of the section throughout the year. He is entitled to much credit for the skill with which he has worked out the Enamelino process, and for the care and attention he has bestowed upon the photogravure and other important work carried on in the section.

MACHINERY.—No prolonged stoppage occurred to the machinery during the year, and all worked well and smoothly. Inconvenience was again felt for want of water whenever the boiler had to be cleaned, and though no steps have yet been taken to procure a

second boiler, this should not be delayed much longer, as in the event of a breakdown the delay to the work would be serious.

A new double demy Express litho. and zinco. printing machine, by Messrs. Furnival & Co. of Reddish has been indented for, the necessity for which was explained in paragraph 529 of the annual report for last year. This machine is well known as a strongly built, smooth running and first class registering machine, and the size is one that can conveniently be used for small work, as well as for printing a sheet 36″ × 24.″ This size will be of great service to the Office, as by helping with the smaller work it will leave the two larger machines (Quad Crowns) free for the printing of double elephant and atlas size work, of which there is generally sufficient to keep both running continually. An extra set of inking rollers has been ordered for the new machine, as it will be largely used for printing colour work.

During the past year some inconvenience has been felt for want of beds for printing thin zinc plates, and these have also been indented for. At present the beds in the office consist of one double elephant bed, another large odd size, two imperials and one foolscap. A new double elephant bed is required to enable the two large machines to be employed on that size of work simultaneously if necessary. As a large proportion of the work done is imperial size, another bed of that size is necessary to enable the two large machines and the new one to be employed, when required, on work of that size at the same time. Lastly, a new foolscap size bed is required so that the new machine and the present small machine can be employed together on foolscap size work. Owing to the want of these beds, large plates have on several occasions had to be cut down to fit the smaller beds when work was urgently required, and sometimes, when this has been impossible, urgent work has had to be kept standing till the required bed was at liberty.

A spare set of high and low pressure pistons for the engine are urgently required to replace those now in use in case of an accident. The old ones already show signs of wear, having been in continuous use for nine years, and if it were impossible to replace them in case of emergency, the whole work of the Office would be suspended indefinitely. These have now been indented for.

THE ECLIPSE OF 1898.—In June 1897 I received instructions to organize a small party from the Photographic Branch of this office, to proceed to Bihar in January 1898 to obtain photographs of the corona at the total solar eclipse on the 22nd of that month. The old photo-heliograph used by Colonel Tennant at Dodabetta, on the Nilgiris, to observe the total eclipse of 1871, and again by Colonel Waterhouse at Camorta, in the Nicobars, in 1875, was still available, and it has been put in thorough order in the Mathematical Instrument Office, where also a driving clock, furnished by the Trigonometrical Branch Office at Dehra Dún, was adjusted to it. The lens used on previous occasions was not available, but a similar one, by Dallmeyer, of suitable capacity, is in use in the office and will answer perfectly. I have been in correspondence with Captain Hills, R.E., Secretary of the Joint Permanent Eclipse Committee, and with Mr. C. Michie Smith, Government Astronomer, Madras, on the subject of the precautions to be taken to ensure success, and have read all the available literature on the subject, including nearly every published report upon previous solar eclipses, and was thus able to formulate a programme for the forthcoming eclipse, which, given good weather, should ensure the success of our observations in January next. Buxar was at first the place chosen as an observing station, but on its becoming known that the centre of the zone of totality would pass some miles to the east of that place, I decided to establish my camp at Dumraon, where Mr. Chas. Fox, the Manager of the Maharani's Estates, has kindly volunteered, on behalf of the Maharani, to give me all needful assistance.

REORGANIZATION OF THE OFFICE.—Shortly after I assumed charge of the office, I was instructed by the Surveyor-General to prepare a scheme having for its object the grading of the entire establishment of the office (excepting the clerical staff) in one list for the purposes of promotion, in order to abolish as far as possible the system of progressive salaries which has hitherto obtained. The scheme was also to provide for the amalgamation of the photo-zinco. and type-printing staff of the Trigonometrical Branch Office at Dehra Dún with the establishment of this office. The preparation of this scheme occupied a large share of my attention during the latter part of the year, and before its close it was completed and forwarded to the Surveyor-General for approval and submission to the Government of India.

PHOTOGRAPHIC AND

Abstract of Departmental work

Specification.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies. Coloured.	Uncoloured.	Total.
Departmental Maps, Plans, etc.										
General Maps	2	...	...	...	46	4	13,775	1,000	2,865	3,865
Provincial Maps	14	24	24	6	4	13	3,263	500	1,029	1,529
Divisional Maps	8	4	4	2	4	...	800	...	800	800
District Maps	47	64	66	36	51	18	9,442	...	9,472	9,472
Plans of Cities and Cantonments	72	118	87	36	118	...	9,750	...	9,750	9,750
Standard Maps	551	733	517	214	118	1	19,050	...	17,783	17,783
Index Maps	40	129	138	88	57	4	36,585	24,574	4,758	29,332
Atlas Sheets	2	...	...	...	...	2	158	...	156	156
Technical Charts	...	...	...	...	4	...	100	...	100	100
Miscellaneous Maps, Plans, etc.	300	303	355	127	105	18	15,457	125	24,871	24,996
Transfers and Proofs	...	...	...	...	...	...	1,625	...	1,935	1,935
Departmental Forms	13	...	...	...	2	16	23,318	100	30,259	30,359
Type Printings	...	...	...	...	...	...	...	...	...	...
Totals (Normal)	1,049	1,375	1,191	509	509	76	133,323	26,299	103,778	130,077
Cadastral Maps.										
Bengal—										
Photo-zincographs	124	124	124	135	135	...	3,510	...	3,510	3,510
Zincographs	138	...	...	138	138	...	3,588	...	3,588	3,588
Totals	262	124	124	273	273	...	7,098	...	7,098	7,098
North-Western Provinces—										
Photo-zincographs	2,305	2,305	2,276	2,332	2,332	...	30,316	...	30,316	30,316
Zincographs	668	...	...	668	668	...	8,684	...	8,684	8,684
Totals	2,973	2,305	2,276	3,000	3,000	...	39,000	...	39,000	39,000
Assam—										
Photo-zincographs	140	140	109	98	98	...	4,987	...	4,987	4,987
Zincographs	41	...	...	41	41	...	2,173	...	2,173	2,173
Totals	181	140	109	139	139	...	7,160	...	7,160	7,160
Burma—										
Photo-zincographs	1,487	1,487	1,462	1,502	1,502	...	46,436	...	46,436	46,436
Zincographs	731	...	...	731	731	...	22,599	...	22,599	22,599
Totals	2,218	1,487	1,462	2,233	2,233	...	69,035	...	69,035	69,035
Transfers and Proofs	...	...	...	...	...	...	10,930	...	...	...
Totals (Cadastral)	5,634	4,056	3,971	5,645	5,645	...	133,223	...	122,293	122,293

LITHOGRAPHIC OFFICE.

done during the year 1896-97.

Type Printing.			Silver and other Printing.		Heliogravure & Electro-typing.				Value.	Remarks.
Pages or Items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Heliogravure Plates.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.		
									Rs. A. P.	
...	...	...	...	...	...	...	...	...	3,457 1 6	
...	...	...	...	...	...	...	...	...	1,137 11 9	
...	...	...	...	...	...	...	...	...	389 7 9	
...	...	...	...	41	...	...	...	...	4,976 2 3	
...	...	...	...	184	...	...	...	...	4,716 1 6	
...	...	...	...	2,238	...	...	...	...	18,451 15 3	
...	...	...	...	101	...	...	...	...	3,796 7 9	
...	...	...	...	...	...	...	...	...	452 0 0	
...	...	...	...	...	...	...	...	...	47 3 0	
...	...	...	137	135	13	3,919	...	13	9,530 10 0	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	1,478 10 0	
10,054	931,543	529,664	...	...	...	...	...	...	12,261 10 0	
10,054	931,543	529,664	137	2,699	13	3,919	...	13	60,695 0 9	
...	...	...	...	...	...	...	...	...	1,966 0 6	
...	...	...	...	...	...	...	...	...	1,097 1 6	
...	...	...	...	...	...	...	...	...	3,063 2 0	
...	...	...	...	...	...	...	...	...	30,186 0 0	
...	...	...	...	...	...	...	...	...	3,887 12 9	
...	...	...	...	...	...	...	...	...	34,073 12 9	
...	...	...	...	...	...	...	...	...	2,161 3 3	
...	...	...	...	...	...	...	...	...	522 12 0	
...	...	...	...	...	...	...	...	...	2,683 15 3	
...	...	...	...	...	...	...	...	...	23,331 4 6	
...	...	...	...	...	...	...	...	...	6,115 13 0	
...	...	...	...	...	...	...	...	...	29,447 1 6	
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	69,267 15 6	

PHOTOGRAPHIC AND

Statement of Work done for other

Departments, etc.	Sheets or Subjects.	Negatives and transparencies.	Photo-Zincographic and				
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.
Adjutant General in India	8	...	...	...	8	10	12,185
Agent to the Governor General, Central India and Rajputana	1	...	...	...	...	3	180
Agent and Chief Engineer, Bombay, Baroda and Central India Railway	4	4	4	3	9	1	18,150
Agent and Chief Engineer, Bengal and North-Western Railway	18	13	13	11	11	4	1,500
Archæological Surveyor, North-Western Provinces and Oudh	8	8	2	...	...	1	500
Architectural Surveyor, North-Western Provinces and Oudh	99	99	20	1	13	5	11,700
Asiatic Society, Bengal	62	58	...	...	...	7	8,860
Assistant Adjutant General, Mhow District	2	...	...	...	1	1	1,000
,, Lahore District	...	...	...	...	4	...	1,700
Board of Revenue, Bengal	24	...	...	...	29	13	10,945
,, North-Western Provinces and Oudh	...	...	...	...	6	...	1,200
Calcutta Municipality	2	11	11	3	3	1	1,300
Chief Commissioner, Assam	6	...	...	...	12	6	11,945
,, Central Provinces	1	...	...	...	...	3	900
Chief Engineer, Bengal, Public Works Department	14	5	5	1	15	8	3,962
Chief Engineer, Punjab, Public Works Department	3	4	4	1	1	2	600
,, ,, Irrigation Works	10	4	4	6	12	4	11,900
,, East Indian Railway, Allahabad	47	45	45	21	18	...	2,372
,, Indian Midland Railway	1	...	...	...	...	2	200
Chief Commissioner, Coorg	1	...	...	...	4	1	150
Chief Commissariat Officer, Lahore Command	1	...	...	...	...	1	12
Collector of Customs, Calcutta	7	...	...	...	...	10	5,250
,, Muzaffarpur	1	...	...	1	1	6	800
Commissioner, Ajmere-Merwara	...	...	...	...	1	...	200
,, Patna	1	...	...	...	5	1	600
,, of Excise, Bengal	5	...	...	...	...	7	3,430
,, ,, Punjab	2	...	...	...	...	4	860
,, of Police, Calcutta	1	...	...	...	...	2	2,128
,, Salt, Abkari, etc., Madras	1	...	...	...	5	1	2,220
Commissary General, Bengal Command	...	...	...	...	...	...	...
,, General-in-Chief	9	...	...	...	...	2	240
Comptroller General, India	2	1	...	...	...	...	...
Conservator of Forests, Bengal	2	...	...	...	...	1	20
Deputy Adjutant General, Bengal	5	2	2	1	1	1	162
,, ,, Madras	...	...	...	...	1	...	50
Deputy Assistant Adjutant General, Allahabad District	1	2	2	1	1	...	200
,, Peshawar District	1	2	2	1	3	...	450
Deputy Commissioner, Hissar	1	4	4	1	1	...	100
,, Ludhiana	1	...	...	...	...	1	50
,, Pegu	1	...	...	...	1	...	300
,, Umballa	1	...	...	...	...	1	100
Deputy Consulting Engineer to Government of India for State Railways	45	53	53	29	25	11	7,840
Deputy Post Master General, Rajputana	1	...	...	...	2	...	262
Director General of Military Works	16	30	30	11	12	...	4,125
,, of Telegraphs	8	...	...	...	...	9	4,520
Director, Geological Survey of India	30	1	...	...	...	14	5,315
,, Land Records and Agriculture, Assam	1	...	...	1	1	1	340
,, ,, Bengal	6	2	...	...	4	9	6,528
,, ,, Burma	30	84	84	30	40	...	480
,, ,, Gwalior State	2	...	...	...	...	2	3,000
,, ,, Punjab	2	2	2	1	...	1	1,005
,, Military Education, India	7	...	...	...	10	7	5,100
,, Public Instruction, Bengal	4	...	...	...	2	2	2,392
,, Royal Indian Marine	23	23	...	...	...	...	...
Engineer-in-Chief, Eastern Bengal State Railway	15	...	...	...	2	9	526
,, North-Western Railway	4	...	...	...	...	4	2,200
,, Rohilkhand Province	...	...	...	...	6	...	300
,, Singia-Madaripur Chandpur Railway Survey	4	22	22	12	12	...	600
Examiner of Accounts, Eastern Bengal State Railway	1	...	...	...	...	1	200
,, of Telegraph Accounts	...	...	...	...	1	...	200
Executive Engineer, Burma State Railway	2	...	...	...	...	1	100
,, Eastern Bengal State Railway	1	...	...	...	...	2	150
General Officer Commanding Assam District	1	1	1	1	1	...	50
General Officer Commanding Meerut District	...	...	...	...	2	...	50
Carried over	557	480	310	137	286	183	169,404

LITHOGRAPHIC OFFICE.

Departments during the year 1896-97.

Lithographic Printing.			Silver and other Printing.		Heliogravure and Electrotyping				Value.		
Number of copies.											
Colored.	Uncolored.	Total.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-Blocks.	Electrotypes.	£	a.	p.
4,620	635	5,255	...	...	...	...	...	...	1,878	5	0
60	...	60	...	...	...	...	...	...	174	14	0
2,000	150	2,150	...	...	...	...	...	...	1,208	9	3
...	1,900	1,900	...	...	...	...	...	...	562	4	0
...	1,000	1,000	...	...	6	3,006	...	...	891	8	0
...	42,250	42,250	20	170	40	12,590	...	...	6,835	6	9
2,600	3,920	6,520	...	130	27	14,377	...	...	5,189	5	0
...	1,000	1,000	...	...	...	...	...	...	51	4	0
...	1,700	1,700	...	...	...	...	...	...	427	13	0
9,265	...	9,265	...	...	...	...	...	...	1,899	8	0
...	1,200	1,200	...	...	...	...	...	...	399	1	0
...	1,300	1,300	...	...	...	...	...	...	443	7	3
1,480	6,025	7,505	...	...	...	...	...	...	805	1	0
300	...	300	...	...	...	...	...	...	55	15	0
850	3,462	4,312	...	1	...	...	...	...	1,012	3	0
...	600	600	...	...	...	...	...	...	329	3	0
...	16,150	16,150	...	...	...	...	...	...	1,177	6	0
...	4,330	4,330	...	...	...	...	...	...	909	0	6
100	...	100	...	...	...	...	...	...	27	14	0
30	...	30	...	...	...	...	...	...	49	0	0
...	12	12	...	...	...	...	...	...	114	0	0
3,675	...	3,675	...	...	...	...	...	...	638	15	0
100	100	200	...	...	...	...	...	...	117	11	6
...	200	200	...	...	...	...	...	...	13	8	0
100	...	100	...	...	...	...	...	...	101	13	0
2,450	...	2,450	...	...	...	...	...	...	322	13	0
430	...	430	...	...	...	...	...	...	112	0	0
1,064	...	1,064	...	...	...	...	...	...	234	3	0
370	...	370	...	...	...	...	...	...	223	3	0
...	...	...	12	...	...	...	...	...	4	8	0
...	1,080	1,080	...	...	...	...	...	...	402	1	0
...	...	...	1	1	...	...	...	...	10	0	0
...	40	40	...	...	...	...	...	...	9	10	0
...	312	312	...	...	...	...	...	...	116	11	0
...	50	50	...	...	...	...	...	...	12	7	3
...	200	200	...	...	...	...	...	...	82	5	0
...	450	450	...	...	...	...	...	...	149	0	3
...	100	100	...	...	...	...	...	...	87	0	3
...	50	50	...	...	...	...	...	...	38	10	0
...	300	300	...	...	...	...	...	...	82	15	0
...	100	100	...	...	...	...	...	...	78	0	0
50	9,720	9,770	...	...	...	...	...	...	1,635	4	6
...	131	131	...	...	...	...	...	...	196	13	0
...	4,525	4,525	...	...	...	...	...	...	1,130	15	9
...	3,370	3,370	...	...	...	...	...	...	999	0	0
1,025	780	1,805	72	46	1	601	...	...	860	2	0
...	340	340	...	...	...	...	...	...	45	11	6
2,000	528	2,528	...	...	2	1,002	...	...	561	1	0
...	480	480	...	...	...	...	...	...	1,781	8	0
...	6,000	6,000	...	...	...	...	...	...	422	1	0
...	1,005	1,005	...	...	...	...	...	...	70	4	0
2,100	...	2,100	...	...	...	...	...	...	999	13	0
2,392	...	2,392	...	...	...	...	...	...	180	13	0
...	...	...	...	...	13	2,763	...	...	1,287	8	0
297	388	685	...	...	...	...	...	...	244	15	0
...	2,200	2,200	...	...	...	...	...	...	833	0	0
...	300	300	...	...	...	...	...	...	111	14	6
...	450	450	...	...	...	...	...	...	418	1	0
...	200	200	...	...	...	...	...	...	28	4	0
...	400	400	...	...	...	...	...	...	6	11	6
...	200	200	...	...	...	...	...	...	67	0	0
75	...	75	...	...	...	...	...	...	29	7	0
...	50	50	...	...	...	...	...	...	34	9	6
...	50	50	...	...	...	...	...	...	17	7	9
37,433	119,733	157,166	105	348	89	34,339	...	...	39,240	11	0

Statement of Work done for other

Departments, etc.	Sheets or Subjects.	Negatives and transparencies.	Photo-Zincographic and				
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc plates printed.	Stones.	Pulls.
Brought forward	557	480	310	137	286	183	169,404
General Officer Commanding Punjab Frontier Force	1	2	2	1	...	...	...
Government of India, Revenue and Agricultural Department	34	30	...	...	16	7	10,230
Government of India, Finance and Commerce Department	1	2	2	1	1	...	24
Government of India, Foreign Department	26	5	5	3	11	19	1,068
,, Home Department	1	...	...	...	...	10	3,000
,, Military Department	12	6	2	1	...	6	142
,, Public Works Department	26	2	2	...	28	22	30,194
Government of Bengal, Revenue and General Department	...	...	...	...	...	2	26,770
Government of Bengal, Financial Department	...	...	...	...	...	...	686
,, Judicial and Political Department	...	...	...	...	...	2	24
Government of Bengal, Marine Department	20	...	...	...	12	8	3,920
,, Public Works Department, Irrigation Branch	15	18	55	24	24	12	9,110
Government of North-Western Provinces and Oudh, Public Works Department	1	2	2	1	1	...	300
Government of Punjab, Public Works Department	1	...	...	...	...	1	505
,, Revenue Department	...	...	...	...	...	1	300
Indian Museum	...	...	...	...	...	...	...
Indian Famine Charitable Relief Fund Office	1	2	...	...	...	...	...
Inspecting Officer, Central India Imperial Service Cavalry	1	3	3	1	1	...	75
Inspector General of Artillery in India	5	...	...	...	...	6	2,200
,, of Civil Veterinary Department	2	...	...	...	1	2	620
Inspector General of Police, Bengal	10	7	7	3	5	14	11,480
Marwar State	8	12	12	8	...	...	...
Meteorological Reporter, Government of Bengal	4	...	...	...	1	4	20,109
,, ,, Government of India	59	1	1	1	41	22	148,760
Narayanganj Municipality	1	...	...	...	...	8	800
Natural History Society, Bombay	1	...	...	...	...	2	2,000
Officer Commanding Belgaum District	...	...	...	...	...	...	1,800
,, Bundelkhand District	3	8	8	4	4	...	510
,, Lahore District	3	6	6	2	9	1	620
,, Hyderabad contingent	1	1	1	1	...	...	...
Photographic Society, India	5	6	...	...	...	...	...
Port Commissioners, Calcutta	5	32	32	13	13	...	1,250
Port Officer and Registrar of Wrecks, Calcutta	6	2	2	1	1	7	977
Principal, Dacca College	...	...	...	...	...	...	150
,, Civil Engineering College, Sibpur	...	...	...	...	...	...	...
Quarter Master General in India	7	2	8	2	25	11	16,279
Reporter on Economic Products, Government of India	7	...	...	...	3	7	21,500
Resident, Western Rajputana State	9	16	16	8	...	1	50
Revenue Surveys, Batu Gajah, Straits Settlements, Perak	...	...	...	1	1	—	10
Royal Survey Department, Siam	15	47	47	22	25	...	1,570
Sanitary Commissioner, Assam	2	...	...	...	...	2	900
,, ,, Bengal	11	5	4	...	5	4	6,390
,, ,, Central Provinces	...	...	...	...	1	...	275
,, ,, Hyderabad Assigned Districts	11	...	...	...	10	6	3,200
,, ,, India	9	2	...	...	...	16	5,400
,, ,, North-Western Provinces and Oudh	3	...	...	...	—	4	1,852
Secretary for Berar to the Resident at Hyderabad	22	...	...	...	1	2	1,000
,, Calcutta Building Commission	21	...	...	...	...	6	296
,, Lady Dufferin's Fund	2	2	1	...	...	2	3,000
,, Transport Committee, Rawal Pindi	2	8	8	2	...	2	680
Station Staff Officer, Sialkot	...	...	...	...	1	...	100
Settlement Officer, Cuttack	...	...	...	...	...	...	...
Superintendent, Archæological Survey, Madras	63	41	41	16	...	...	...
Superintendent, Campbell Medical School and Hospital	1	...	...	...	...	1	164
,, Forest Surveys, Dehra Dun	...	...	...	...	...	8	2,280
,, Government Printing, India	142	44	13	4	25	41	55,785
,, Stationery, Calcutta	6	...	...	...	5	4	9,483
,, Telegraph Stores	2	...	...	—	1	1	3,670
Superintending Engineer, Sone Circle	6	6	6	3	3	...	225
Traffic Superintendent, Eastern Bengal State Railway	1	...	...	...	...	1	200
Special Work done for Trade private individuals	42	41	36	24	34	10	3,429
Transfers and Proofs	...	...	...	...	...	...	2,633
Total	1,197	841	632	284	595	468	587,399

LITHOGRAPHIC OFFICE.

Departments during the year 1896-97.

Lithographic Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.
Number of copies.									
Colored.	Uncolored.	Total.	Silver Prints.	Blue prints.	Heliogravure Plates.	Heliogravure Prints.	Photo.-Blocks.	Electrotypes.	
									£ s. p.
37,433	119,733	157,166	105	348	89	34,339	...	...	39,240 11 0
...	...	...	...	...	...	...	...	...	34 8 0
8,200	2,030	10,230	...	31	14	11,614	...	...	3,593 9 0
...	24	24	...	...	...	...	...	...	34 10 6
238	528	766	...	...	...	6,250	...	...	2,121 11 6
600	...	600	...	...	...	...	...	...	134 3 0
30	156	186	...	12	...	...	...	...	173 13 0
3,094	21,928	25,022	...	...	...	...	...	...	4,289 2 0
18,346	...	18,346	...	...	...	...	...	...	1,193 14 0
686	...	686	...	...	...	...	...	...	30 7 0
12	...	12	...	...	...	...	...	...	2 13 0
4,190	...	4,190	...	...	...	...	...	...	501 12 0
2,040	3,050	5,090	...	53	...	...	...	...	1,709 11 9
...	300	300	...	...	...	...	...	...	70 9 0
...	505	505	...	...	...	...	...	...	127 13 0
...	300	300	...	...	...	...	...	...	29 1 0
...	...	...	40	...	...	4,310	...	...	553 14 0
...	...	...	...	...	1	201	...	...	64 8 0
...	75	75	...	...	...	...	...	...	104 10 6
200	1,600	1,800	...	...	...	...	...	...	176 8 0
...	620	620	...	...	...	...	...	...	89 0 0
4,400	42	4,442	...	...	...	...	...	...	691 9 3
...	...	...	...	...	...	...	...	...	218 0 0
146	10,020	10,166	...	...	...	...	...	...	279 10 0
20,530	174,595	195,125	...	...	...	...	...	...	4,349 2 3
...	100	100	...	...	...	...	...	...	2,032 0 0
1,000	...	1,000	...	...	...	...	...	...	57 8 0
600	...	600	...	...	...	...	...	...	175 1 0
...	430	430	...	...	...	...	...	...	289 1 0
...	420	420	...	...	...	...	...	...	346 3 0
...	...	...	...	...	...	...	...	...	20 0 0
...	...	...	...	...	6	8,231	...	...	561 0 0
...	1,250	1,250	...	...	...	...	...	...	1,099 14 3
133	578	711	...	...	...	...	...	...	310 15 0
...	150	150	...	...	...	...	...	...	29 1 0
...	...	...	...	6	...	100	...	...	12 0 0
1,940	2,659	4,599	...	...	...	...	...	...	2,129 8 3
...	19,350	19,350	72	...	...	...	...	...	2,387 8 3
...	50	50	...	...	...	...	...	...	369 8 0
...	10	10	...	...	...	...	...	...	10 14 0
...	1,670	1,670	...	...	...	...	...	...	1,287 11 6
...	900	900	...	...	...	...	...	...	164 3 0
3,550	710	4,260	...	1	...	...	...	...	712 12 0
...	275	275	...	...	...	...	...	...	38 2 0
2,200	...	2,200	...	...	...	...	...	...	763 4 0
1,450	...	1,450	...	...	1	251	...	...	791 7 0
380	1,092	1,472	...	...	...	...	...	...	214 8 0
...	9,200	9,200	...	...	...	...	...	...	211 2 0
...	1,186	1,186	...	...	...	...	...	...	269 7 0
1,500	...	1,500	...	2	...	...	...	...	341 13 0
...	340	340	...	...	...	...	...	...	420 14 0
...	100	100	...	...	...	...	...	...	22 12 0
...	...	...	...	2	...	...	...	...	2 8 0
...	...	...	...	82	1	1	...	...	649 0 0
...	164	164	...	...	...	...	...	...	13 8 0
285	...	285	...	...	...	...	...	...	471 3 0
4,392	86,723	91,115	...	31	1	601	...	...	4,936 13 0
...	9,555	9,555	...	...	...	...	...	...	576 0 0
...	4,460	4,460	...	...	...	...	...	...	128 11 0
...	225	225	...	...	...	...	...	...	94 12 6
...	200	200	...	...	...	...	...	...	215 2 0
200	3,449	3,649	...	...	5	2,429	...	...	1,570 13 0
...	2,175	2,175	...	...	...	...	...	...	.....
117,775	482,927	600,702	217	568	118	68,327	...	...	83,541 10 6

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Details of Issues and Receipts from Provinces and Departments during the financial year 1896-97.

PROVINCES AND DEPARTMENTS.	VALUE OF			
	Receipts.	Issues.	Debits.	Credits.
	₹	₹	₹	₹
Assam	21	6,667	6,646	...
Bengal, Civil	12,715	68,258	55,543	...
„ Military, Bengal Command	666	2,288	1,622	...
„ „ Punjab „	7,130	13,223	6,093	...
Bombay, Civil	1,140	3,111	1,971	...
„ Military	6	946	940	...
Burma	5,747	22,716	16,969	...
Central India	1	...	...	1
„ Provinces	320	10,914	10,594	...
Foreign States, Berar	...	239	239	...
Forests	131	1,789	1,658	...
Geological Survey and Museums	...	372	372	...
Guaranteed Railway, East Indian Railway	...	6,112	6,112	...
Indian Midland Railway	...	68	68	...
Land Revenue, Coorg	...	77	77	...
Madras, Civil	6,688	7,174	486	...
„ Military	8	239	231	...
Marine	259	1,455	1,196	...
Meteorological Department	...	1,421	1,421	...
Mint	157	...	...	157
North-Western Provinces and Oudh	1,902	13,212	11,310	...
North India Salt Revenue	215	421	206	...
North-Western State Railway, Public Works Department	2,561	11,968	9,407	...
Public Works Department, Military Works	836	4,810	3,974	...
Public Works Department, Baluchistan Railway Branch	328	...	...	328
Port Blair	...	286	286	...
Punjab	12,609	13,993	1,384	...
Rajputana-Malwa Railway	...	71	71	...
„ Public Works Department and Central India	...	543	543	...
Survey Department (Field Parties)	41,741	43,954	2,213	...
Ditto ditto Head Quarters' Offices, Calcutta and Dehra Dun	2,550	11,653	9,103	...
TOTAL	97,731	2,47,980	1,50,735	486
NET DEBIT	...	...	1,50,249	...
CASH SALES	...	...	31,128	...
GRAND TOTAL			1,81,377	...

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the Local Market during 1896-97.

SPECIFICATION.	No.	Value.	
		R	*a.*
Instruments.			
Barometers, aneroid pocket, ordinary	6	397	8
Boards, drawing or sketching, cavalry pattern	40	1,350	0
Cards for prismatic compasses	4	2	0
Cases, leather and morrocco spare	163	577	8
Chronographs, watch pattern	3	75	0
Clinometers, Watkin's pattern	6	165	0
Clocks	7	188	8
Compasses, bow dividers electrum spring	12	24	0
" " ink, brass, single jointed	24	108	0
" " " " double jointed	6	45	0
" " " electrum single jointed	36	189	0
" " " " double "	6	51	0
" drawing, ordinary, brass, 6"	12	33	0
" " hair spring, electrum, 5"	12	72	0
" magnetic, pocket, in brass case	6	90	0
" " rectangular, 2" and 2½"	61	427	0
" " " 5"	80	1,040	0
" " " 6"	42	630	0
" Napiers	20	350	0
" prismatic, S. R. 3½"	3	225	0
" " S. R. 4"	3	270	0
" proportional, brass, 6"	7	122	8
" " electrum, 6"	6	110	4
Covers for planetables	132	738	14
Curves, French, wooden, sets	1	7	8
" Railway Cardboard, small, sets	1	19	8
Glasses, binocular, large	3	200	0
" " small	5	225	0
" magnifying or reading in metal frames 2" or 3"	4	18	0
" " " " " 3½" to 4½"	6	30	0
Ghat tracers	1	53	12
Haversacks	100	150	8
Hydrometers, Syke's, brass floats, sets	6	405	0
Hygrometers, Mason's	6	90	0
Instruments, drawing, brass, 1st sort	2	130	0
" " " 2nd "	12	600	0
" " " 3rd "	6	144	0
" " electrum, 1st "	2	150	0
Levels, reflecting, Abney's	14	588	0
Level, spirit, in metal case	7	224	0
" " " " 4" to 7"	14	17	12
" " wooden " 8" to 14"	12	16	0
" " " " 11" to 15"	39	89	4
Machine, map printing, ordnance	6	285	0
Pens, drawing, ivory handles	200	600	0
" double or road	6	36	0
Pins for chains, ordinary	7,000	437	8
" for maps, brass	144	9	0
" for maps, electrum	288	18	0
Protractors, brass, circular, plain, 6"	2	53	0
" electrum, semi-circular plain	2	51	0
" rectangular, ivory, 6"	28	147	0
" " wooden, 6"	29	61	2
Rules, flat, ebonite, plain, 6"	99	49	8
" " " 12" and 18"	24	21	0
" parallel bar, wooden, 6"	35	35	0
" " " " 12"	6	18	0
" " on rollers, brass, 6" and 9"	3	51	0
Carried over	8,810	12,311	8

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the Local Market during 1896-97—contd.

SPECIFICATION.	No.	Value.
		£ a.
Instruments—concld.		
Brought forward .	8,810	12,311 8
Rules, parallel bar, wooden 15″ and 18″	11	392 8
,, ,, ,, ,, 2′ to 3′	4	243 0
,, ,, ,, ,, 3½′ to 4½′	2	220 0
,, ,, ,, electrum, 6″ to 9″	5	90 0
Scales, architects, ivory universal, 12″	5	50 0
,, diagonal, wooden	1,000	562 8
,, offsets, single, ivory	150	75 0
,, ,, ,, wooden	36	13 8
,, plotting, sets, wooden	12	216 0
,, ,, single ,, ...	48	121 8
Set squares, sets ebonite	20	162 0
,, ,, single, ebonite	102	218 4
Set squares, single, wooden	11	18 10
Slide Rules	3	98 0
Squares optical	90	585 0
Stands for Prismatic Compasses	6	105 0
,, for Planetables, military	18	324 0
,, for Theodolites, transit Railway	1	50 0
Staves, levelling, Sopwith's telescopic	305	4,575 0
Sundials	6	150 0
Tapes, measuring, metallic, 50′	780	3,418
,, metallic of sizes	3	21 0
Telescopes, various of sorts	12	144 0
Theodolite transit with complete, v.c. Ry : 5″	1	525 0
Thermometers, chemical or Traveller's from 0° to 400° . .	12	87 0
,, minimum, self registering	6	96 0
,, oven	6	300 0
Trunks' mule	12	162 0
Umbrellas, surveying	67	1,005 8
Watches, common	100	3,975 0
Type-writers	1	456 0
TOTAL .	11,645	30,771 4
Books.		
Hints to Travellers	1	7 3
Manual of Surveying, Thuillier's	2	24 0
Nautical almanacs	90	180 0
Tables Log, Shortredes, Sines, etc.	9	206 4
,, traverse, Boileaus	12	108 0
TOTAL .	114	525 7
Sundries.		
Brushes, stencil	60	30 0
Glasses, ink bottles	108	40 8
Scale, letter weighing	2	41 12
Sketch, block	2	4 8
Type wheel	1	10 8
Presslers borers for hardwood	[illegible]	133 0
Carried over .	[illegible]	260 4

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the Local Market during 1896-97—concld.

SPECIFICATION.	No.	Value.
		₹ a.
Brought forward .	181	260 4
Stencil, ink, black	24	12 0
Punching Machine	1	19 4
Eyelet hole, brass	80	32 8
Rubber, elastic bands, for cavalry board	60	15 0
India rubber tubing	8	20 0
Letters, spare dogs Yost	1	10 8
Lactometers	3	7 8
TOTAL .	358	377 0
TOTAL OF BOOKS .	114	525 7
TOTAL OF INSTRUMENTS	11,645	30,771 4
SUM TOTAL .	12,117	31,673 11

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1896-97.

SPECIFICATION.	No.	Value.
		£ a.
Instruments.		
Bars, standard, steel	9	288 0
Boards, drawing, deal	90	1,139 0
Chains, iron, 66 feet	540	1,890 0
„ steel	131	1,285 0
Clinometers, survey pattern	34	1,020 0
„ wooden, with shade scales	12	18 0
Compasses, magnetic, rectangular, 5 inch	43	559 0
„ „ „ 6 inch	51	813 0
Curves, railway, card board, large, sets	1	27 8
Glasses, copying or tracing	9	330 0
Hold-alls, leather	102	1,734 0
Ink rollers	2	5 0
Instruments, drawing, brass, 3rd sort	1	11 0
Lamps, referring	12	72 0
Levels, water	12	192 0
Map, printing machine, Ordnance	1	40 0
Pin lifters	6	3 0
Plane tables, deal, survey pattern	272	1,850 0
„ „ „ Military „	1	75 0
Pluviometers, Symon's	1	13 0
Rods, measuring	450	823 12
Rules, flat, wooden, plain, 2 feet and 2 feet 6 inch	7	25 0
„ parallel, on rollers, brass, 15 inch and 18 inch	6	180 0
„ sight, brass	1	16 0
Scales, card board, miscellaneous	800	200 0
„ diagonal, card board	2,000	375 0
„ engineering, metal	24	461 1
„ offsets, single, wooden	50	9 6
„ plotting, sets, ivory	2	103 4
„ „ single, metal	1	5 0
Sheets, celluloid	1,250	877 0
Squares, optical	1	6 8
Stamps for conventional signs	15	39 8
Stands for Heliotropes	60	960 0
„ „ Theodolite Transit Railway 5 inch	1	40 0
Staves, levelling, Roorkee, double	50	1,237 0
„ „ telescopic, Sopwith's	162	4,117 8
Stencil plates, various	548	1,142 14
Telescopes, spare, for Range Finders	4	27 7
TOTAL	6,762	22,010 12
Books.		
Traverse Indicator card by Reynolds	50	125 0
Sundries.		
Boxes, deal wood and mahogany, with locks	1	3 15
Boxes of sorts	15	37 8
Table	1	40 0
Top for raingauge, with bottle	1	6 0
Carried over	18	87 7

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1896-97—concld.

SPECIFICATION.	No.	Value.
Sundries—contd.		ℛ a.
Brought forward .	18	87 7
Scales, plotting, brass, 2 inch square, with 2 scales, wooden, marked in chains	10	25 0
Screws, brass, with washers, for plane tables	6	15 0
Scales, 2 inch square, brass	10	25 0
Numbers for chains	100	18 12
Zinc tickets	64	2 2
Brass screws for plane tables	2	3 0
Ferrotype frames	1	80 0
Numbers for chains, brass	5	5 0
Brass plates	1	375 0
Trestles for drawing boards	2	20 0
Instrument for measuring range	1	100 0
Clamping screws	3	5 8
Winged „	2	4 0
Staves, levelling	5	5 0
Knife and 4 screws	3	1 8
Compass. eyepiece		
Capstan bar		
TOTAL .	233	772 5
TOTAL BOOKS .	50	125 0
TOTAL INSTRUMENTS .	6,762	22,010 12
SUM TOTAL .	7,045	22,908 1

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in Workshop during the financial year 1896-97.

SPECIFICATION.	Number.
Anemographs of sorts	4
Anemometers of sorts	22
Balance, chemical	1
Barometers of sorts	113
Boards of sorts	3
Callipers, sliding	1
Camera	1
Cards of sorts	50
Chains of sorts	72
Chronographs of sorts	12
Chronometers of sorts	9
Chrono-micrometers	3
Circumferentors	2
Clinometers of sorts	64
Clocks of sorts	9
Compasses, beam	3
„ bow ink or pen of sorts	83
„ „ pencil of sorts	2
„ „ spring of sorts	5
„ dividers	4
„ drawing of sorts	532
„ magnetic, rectangular, of sorts	70
„ marine	3
„ prismatic of sorts	129
„ proportional	8
„ surveying	19
„ of sorts	7
Cord and reel	36
Curves	2
Declinometers	2
Eidographs	1
Galvanometer	1
Ghat tracer	1
Glasses, binocular, of sorts	55
Heliographs	27
Heliotropes	12
Hydrometers	39
Hygrometers	4
Indicator	1
Instruments, drawing, mathematical, of sorts	105
Lamps of sorts	6
Lenses, reading	3
Levels of sorts	187
Mekometers	83
Magnet bar	1
Micrometers	2
Microscopes	2
Mining dial	5
Mirror	4
Pens, drawing	185
Pins of sorts	7
Plane tables	14
Planimeters	13
Prickers, ivory handles	1
Protractors	4
Quadrant, gunner's	2
Quintant, sounding	8
Rain-gauges	4
Range Finders	17
Carried over	2,065

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in Workshop during the financial year 1896-97. —concld.

SPECIFICATION.	Number.
Brought forward	2,065
Rules of sorts	162
Scales of sorts	167
Scott's sights, B. L. telescopic	119
Sextant of sorts	18
Squares, optical	251
Stands for compasses of sorts	79
,, for camera	1
,, for circumferentor	2
,, for curve ranger	1
,, for levels	89
,, for mining dials	3
,, for plane tables	18
,, for theodolites	65
,, for sextants	1
,, for heliographs	11
Station pointer	2
Staves, levelling, of sorts	180
Stencil plates	3
Tacheometer	1
Tapes of sorts	542
Telemeters of sorts	26
Telescopes of sorts	217
Theodolites of sorts	120
Thermometers of sorts	100
Time piece	2
Type writers	20
Vanes wind	1
Watches of sorts	21
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED	4,227
TOTAL OF MINOR INSTRUMENTS REPAIRED	1,057
TOTAL OF ALL INSTRUMENTS REPAIRED	5,284

MATHEMATICAL INSTRUMENT OFFICE.

Profit and Loss Account of the Workshop for the financial year 1896-97.

DEBITS.			CREDITS.		
	℞	a.		℞	a.
To Workshop establishment (less proportion debitable to the Store Branch for cleaning and adjusting serviceable instruments, . .	37,513	13	By repairs for public officers on book debit 11,587 11		
„ One-third of office establishment	2,731	8	„ repairs for public officers on payment 9,287 4		
„ Pay of Material Storekeeper for the whole year . .	780	0		20,874	15
„ Workshop contingencies as distinguished from materials purchased . . .	3,351	0	„ repairs for stock . .	33,115	10
„ Value of materials :—			„ Manufacture for stock—		
For ordinary work . .			Instruments . .	22,530	1
„ general worhshop use .	22,855	2	Packing cases . .	1,276	4
„ manufacture of packing cases . . .			„ Manufacture of material .	4,808	0
„ Paid for repairs . .	259	12			
„ Wear and tear of plant .	851	2			
„ Half of rent at ℞600 per mensem	3,600	0			
„ Printing and stationery .	360	0			
„ Four per cent. on value of tools and plant amounting to ℞1,36,221-11 . . .	5,448	14			
„ Half of taxes, rates, etc. .	877	0			
„ Liability for pensions .	3,948	0			
„ Profit	28	11			
TOTAL .	82,604	14	TOTAL .	82,604	14

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

Narrative Report of Mr. H. W. Peychers, Extra Assistant Superintendent, 1st grade, in charge Computing Office, Season 1896-97.

Regular monthly magnetic observations have been taken since January 1897. The results are tabulated with those taken here previously, and appended to this report.

The second edition of the Hand-Book of Professional Instructions for the Topographical Branch was completed and issued.

Mr. A. E. Wackrill, Superintendent of Trigonometrical Surveys, Ceylon, joined the office on the 27th September, with the view of acquainting himself with the methods of observing and computing, as well as with all details in connection with field and office work obtaining in the Survey of India Department.

Mr. E. Vredenburg, B.L., B. SC , A. R. C. S., Assistant Superintendent of the Geological Survey of India, was instructed in plane-tabling and triangulation during October 1896.

The following changes took place in the *personnel* of the office during the year : —

Mr. J. A. Higgs, Offg. Extra Assistant Superintendent, 6th grade, was posted to the Drawing Section from 4th March. Mr. J. S. Manuel, Zincographer, was absent on sick leave throughout the year, and Mr. G. A. LeFranc officiated for him. Mr. C. F. Guthrie, Assistant Solar Photographer, who had been on sick leave since 7th January, died on the 1st July, and Mr. R. W. Foster, of the Photo-zincographic Section, was appointed to officiate in his place. Khan Bahadur Abdul Gulfar, Instructor, Training School, retired on the 1st July; Muhammad Zakaria, Surveyor, was transferred from No. 14 Party to take his place.

The cost of the Computing Section under its various class heads and the percentages thereof, together with those of the three preceding years, are given in the following statement :—

CLASS.	COST IN RUPEES.	PERCENTAGE OF COST.			
	1896-97.	1896-97.	1895-96.	1894-95.	1893-94.
1. Records, Library	883	3·0	2·9	3·4	1·4
2. Accounts, Returns, Correspondence	1,893	6·4	5·2	8·1	7·1
3. Supply of data, etc.	247	0·8	1·7	2·7	3·0
4. Computations	4,450				
5. Preparation of Press copy	7,511	79·9	78·5	75·8	78·6
6. Examination of Press proofs	11,715				
7. Ditto of charts	578	1·9	2·9	1·4	0·6
8. Protection of stations	1,002	3·4	3·3	2·2	1·2
9. Miscellaneous	952	3·2	4·4	4·3	6·2
10. Meteorology, etc.	408	1·4	1·1	1·9	1·3
11. Extra-departmental work	...	...	...	0·2	0·6
TOTAL	29,639	100	100	100	100

From the above table it will be seen that the working power of this section has been distributed much in the same way as in the preceding years.

The following is an account of the work done under the several classes shown in the foregoing table.

CLASS 1.—RECORDS, LIBRARY, etc.—Five fresh instalments of field records were received during the year; these, together with those already in the office, have received the usual care and attention. The three standard copies of the library catalogue have been kept up to date.

CLASS 2.—ACCOUNTS, RETURNS AND CORRESPONDENCE.—In this is included the preparation of indents, estimates, monthly detailed and abstract progress reports, annual reports, stock returns of office stores, and various other items.

CLASS 3.—SUPPLY OF DATA.—Sixteen requisitions for data and twenty-two indents for forms were received and complied with : in all about 25,000 copies of professional and other forms were issued during the year.

CLASS 4.—COMPUTATIONS.—The following are the details :—

Indus Delta Secondary Triangulation.—The heights were recomputed, finally adjusted and entered in the pages of the co-ordinate list, this completes the work.

Electro-Telegraphic Longitudes.—Help afforded in the reduction of observations for 1894-95: a pair of computers was engaged for nearly two months.

Revision of heights of principal and secondary triangulation of the Great Arc, Section 18°-24°, Bidar and Jubbulpore Series.—This revision was necessitated by the extension of lines of spirit levels across these series which showed sensible discrepancies in the published values.

Bider Synoptical Volume.—Triangles to certain points re-adjusted, and their latitudes, longitudes and azimuths computed.

Experimental Computations.—Formulæ investigated and examples prepared illustrating the computations of latitude, longitude and azimuth for south latitude and for longitude west of Greenwich.

Captain Deasy's Exploration in Tibet.—Computations completed.—This occupied two pairs of computers for 3½ months; the work done is as follows:—

One hundred and sixty deductions of astronomical azimuths, 140 of latitude, 225 of time, 280 of latitude, longitude and azimuth, 300 of triangles, 150 of barometrical heights and 410 of trigonometrical heights.

CLASS 5.—PREPARATION OF PRESS COPY.—This requires the abstracting and entering in suitable tables of the final results of several calculations for publication: all these compilations are twice compared, once against the original field records, and once against the final computations prior to being sent to the press. The details of the work done are as follows:—

(*a*) *Southern Trigon-Great Arc Meridional Series, Section 8°-18°.*—The final revision of the co-ordinate list, about half done.
(*b*) *Indus Delta Secondary Triangulation.*—Co-ordinate list completed.
(*c*) *Bider Longitudinal Series—Synoptical Volume.*—Revised for second edition.

CLASS 6.—EXAMINATION OF PRESS PROOFS.—This requires the utmost care and attention in comparison and examination in the several stages of first, second and form proofs. Most of the matter printed is numerical, or depending on numerical data, hence it necessarily involves a strictly critical examination, which can only be given by men specially trained to this style of work.

The printing of the following works has been completed during the year:—

(1) Spirit-levelled Heights No. 7 C. P. (revised edition).
(2) Hand-Book of Professional Instructions for the Topographical Branch (second edition).

The tidal volume was proceeded with, 52 pages were examined and printed off. The Synoptical volume of the Great Arc Meridional Series, section 8° to 18° and that of the Indus Delta Triangulation were also in hand; 66 pages of these were printed off. The printing of both these synoptical volumes is likely to be completed by next year. About 25,000 copies of professional and other forms were printed. The total amount of work executed will be seen by reference to the tabular statements of the Printing Section.

CLASS 7.—EXAMINATION OF CHARTS.—Comparison and examination of the following completed:—

Triangulation charts of Punjab Survey sheets Nos. 311, 314 and 336.
Triangulation charts of the Central Provinces Survey sheets Nos. 61, 62, 65, 66, 81 and 85.
One chart for the spirit-levelled heights No. 7 (second edition), and another chart.

Three final charts of the Great Arc Meridional Series, section 8° to 18°, and two of the Indus Delta Triangulation are in hand.

CLASS 8.—PROTECTION OF STATIONS.—The usual professional work in connection with the protection of survey stations and certain of the bench marks in the North-Western Provinces and Bengal was performed. During the year 569 stations have been repaired by the District Officers at a cost of ₹1,929-5-5; twenty districts out of 347 from which reports are due failed to submit them.

CLASS 9.—MISCELLANEOUS.—In this are included various duties which cannot be fairly assigned to any of the other classes, such as the following:—

(*a*) The examination and despatch of the printed papers to the Survey of India Office, Calcutta, for safe custody.
(*b*) The examination of all bound volumes and pamphlets prior to issue, and the preparation of the distribution lists and presentation labels for the same.
(*c*) The preparation of examination papers for the Provincial Service of the Survey of India Department, of which 80 sets were prepared and despatched, and 62 examined; the results were tabulated and submitted to the Surveyor-General.

CLASS 10.—METEOROLOGY AND GENERAL SCIENCE.—As hitherto, a complete set of meteorological observations was taken daily throughout the year, and monthly and

annual abstracts prepared. The meteorological results are given in the following tabular statements :—

Mean Monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1896-97	77·29	77·36	77·24	76·91	76·40	75·80	75·15	74·71	74·55	74·76	75·98	76·77
	Mean 1881—96	76·77	76·81	76·62	76·03	75·49	74·88	74·31	74·03	74·00	74·33	75·57	76·55
12·8	1896-97	79·99	78·91	77·29	74·97	73·00	71·75	71·91	73·57	75·73	77·42	79·50	79·91
	Mean 1881—96	79·39	78·03	75·79	73·21	71·51	70·68	71·29	73·08	75·19	77·19	79·12	79·68
6·4	1896-97	80·48	76·99	72·26	67·47	66·33	67·79	71·38	77·42	81·06	82·02	82·03	81·49
	Mean 1881—96	79·67	75·75	71·15	67·24	65·43	67·09	71·51	76·75	80·21	81 30	81·41	81·21
3·2	1896-97	79·19	73·27	66·77	62·44	61·94	67·22	75·48	84·27	85·62	84·37	82·53	82·34
	Mean 1881—96	78·12	71·65	65·51	61·88	61·24	66·69	75·43	81·97	84·66	83·35	82·05	81·69
1·1	1896-97	77·82	69·87	61·14	58·40	60·11	67·82	77·86	89·31	88·99	85·33	82·47	81·84
	Mean 1881—96	76·06	67·49	60·10	57·29	58·56	67·61	78·73	85·86	87·73	84·15	82·34	81·64
Thermometer in shade.	1896-97	82·93	73·22	66·46	64·83	68·18	76·53	88·68	95·76	92·93	83·61	80·55	82·38
	Mean 1881—96	80·38	73·37	67·76	64·08	66·91	78·64	89·82	93·81	89·92	82·47	80·67	82·54

Mean velocity in miles of the Winds which blew at Dehra Dún during the twelve months of 1896-97 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Mean.
0 to 1	1·48	0·77	0·29	0·83	0·50	0·94	1·90	0·97	1·37	0·50	0·26	0·57	0·87
1 „ 2	0·77	0·47	0·23	0·90	0·61	0·94	1·40	0·97	1·27	0·67	0·29	0·37	0·74
2 „ 3	0·68	0·40	0·23	0·67	0·57	0·61	1·07	0·80	0·90	0·70	0·29	0·47	0·62
3 „ 4	0·45	0·37	0·16	0·53	0·75	0·84	1·57	0·67	0·97	0·50	0·26	0·27	0·61
4 „ 5	0·39	0·23	0·16	0·53	0·46	0·55	1·33	0·57	0·83	0·53	0·13	0·17	0·49
5 „ 6	0·45	0·27	0·10	0·73	0·39	0·55	0·73	0·37	0·80	0·47	0·19	0·10	0·43
6 „ 7	0·26	0·07	0·10	0·63	0·43	0·48	0·67	0·40	0·50	0·23	0·26	0·10	0·34
7 „ 8	0·23	0·03	0·10	0·60	0 54	0·61	0·50	0·50	1·17	0·43	0·29	0·13	0·43
8 „ 9	0·42	0·10	0·16	0·73	0·46	0·65	1·10	0·67	1·10	1·32	0·65	0·43	0·65
9 „ 10	0·52	0·13	0·39	1·19	0·71	1·35	1·33	1·20	1·77	1·77	0·84	0·70	0·98
10 „ 11	1·03	0·83	0·97	1·37	1·36	2·58	2·10	2·39	2·53	1·71	1·32	0·73	1·58
11 „ 12	1·65	1·37	1·55	1·67	1·86	3·16	2·83	2·32	2·60	1·68	1·19	0·73	1·88
12 „ 13	1·61	1·73	1·77	1·87	2·29	3·03	3·73	2·83	2·60	1·80	1·61	1·10	2·19
13 „ 14	2·06	1·57	1·74	2·40	2·61	3·84	4·37	4·03	3·80	2·27	1·77	1·27	2·64
14 „ 15	1·90	1·60	1·77	1·97	2·64	3·90	4·40	4·17	3·73	2·17	1·55	1·17	2·58
15 „ 16	1·39	1·40	1·32	1·90	2·57	3·42	4·20	4·70	3·07	2·00	1·32	0·83	2·34
16 „ 17	0·94	0·70	0 68	1·57	2·57	3·26	4·00	3·97	3·30	1·97	1·10	0·60	2·06
17 „ 18	0·39	0·23	0·19	1·37	1·57	2·32	3·37	3·30	3·43	1·57	0·48	0·37	1·55
18 „ 19	0·74	0·33	0·.6	1·03	0·57	1·42	2·17	2·07	1·67	1·37	0·74	0·23	1·04
19 „ 20	1·29	0·73	0·19	0·60	0·82	0·94	1·83	1·30	1·23	0·77	0·58	0·23	0·88
20 „ 21	1·68	0·90	0·45	0·70	1·14	1·03	1·30	1·40	1·00	0·47	0·55	0·23	0·90
21 „ 22	1·55	0·77	0·58	0·77	0·96	1·26	1·80	1·40	1·00	0·70	0·55	0·33	0·97
22 „ 23	1·97	0·90	0·48	0·80	1·04	1·10	1·53	1·87	1·37	0·23	0·29	0·50	1·01
23 „ 24	1·48	0·77	0·48	0·67	0·82	1·48	1·50	1·53	0·93	0·23	0·32	0·73	0·91
Sums	25·33	16·67	14·15	26·03	28·24	40·26	50·73	44·40	42·94	26·06	16·83	12·36	...
Average	1·06	0·69	0·59	1·08	1·18	1·68	2·11	1·85	1·79	1·09	0·70	0·51	...

Monthly Meteorological Results of Observations taken at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún.

Year and Month.	Barometer reduced to 32° Fah. — At 10 A.M. — Highest.	Barometer reduced to 32° Fah. — At 10 A.M. — Lowest.	Barometer reduced to 32° Fah. — At 10 A.M. — Monthly mean.	Barometer reduced to 32° Fah. — At 4 P.M. — Highest.	Barometer reduced to 32° Fah. — At 4 P.M. — Lowest.	Barometer reduced to 32° Fah. — At 4 P.M. — Monthly mean.	Hygrometer. — 10 A.M. — Monthly mean humidity.	Hygrometer. — 4 P.M. — Monthly mean humidity.	Thermometer. — Dry Bulb. — Highest maximum in air.	Thermometer. — Dry Bulb. — Lowest minimum in air.	Thermometer. — Dry Bulb. — Monthly mean in air.	Thermometer. — Wet Bulb. — Lowest minimum.	Rain. — Number of days it fell.	Rain. — Fall in inches.	Wind. — Most frequent direction.	Cloud. — At 10 A.M.	Cloud. — At 4 P.M.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	°	°	°	°	°	°					
1896.																	
October	27·818	27·597	27·739	27·722	27·533	27·644	42	35	89·3	52·8	70·8	48·1	1	0·00	Calm	1·6	1·4
November	27·909	27·673	27·787	27·815	27·570	27·691	52	44	80·5	47·2	62·5	44·5	3	0·44	"	2·8	2·9
December	27·964	27·691	27·858	27·850	27·652	27·760	54	44	74·5	38·6	54·8	35·2	4	0·49	Calm & S.	1·7	2·2
1897.																	
January	27·969	27,613	27·802	27·859	27·560	27·708	68	54	73·1	40·6	55·4	39·0	10	2·44	S.W. Calm W. &N.W.	5·4	5·3
February	27·843	27·605	27·728	27·731	27·519	27·636	54	39	82·6	40·1	56·9	39·0	5	1·27	W.S.W. & Calm.	2·7	3·0
March	27·809	27·517	27·657	27·693	27·427	27·556	40	29	88·2	48·1	65·8	41·7	5	0·77	Calm S.W. & N.W.	4·5	4·9
April	27·763	27·492	27·643	27·641	27·368	27·545	30	19	103·4	54·0	76·6	48·8	4	0·77	W.	2·9	3·5
May	27·598	27·388	27·491	27·546	27·294	27·397	26	20	106·5	63·5	85·0	53·3	2	0·74	W.S.W. & N.	1·7	3·2
June	27·544	27·221	27 398	27·496	27·151	27·298	48	39	105·8	65·1	83·5	57·8	11	3·41	S.E., W. & N. W.	4·1	3·5
July	27·497	27·254	27·396	27·394	27·184	27·312	76	72	97·3	69·5	79·6	65·3	23	23·02	S. E. & N.W.	6·4	6·8
August	27·609	27·282	27·451	27·486	27 204	27·359	84	83	90·8	70·2	77·0	68·3	28	30·45	Calm & S. E.	8·6	8·7
September	27·715	27·407	27·570	27·618	27·325	27·480	77	74	88·8	67·1	76·3	64·0	13	9·29	Calm	4·6	5·8

TYPE-PRINTING SECTION.—As will be seen from the annexed statement, the greater part of the work done consisted in printing forms, professional and others, for the department, and in setting up the large number of headings, foot-notes, etc., required in the Drawing Section in connection with the publication of maps.

Statement of work done during 1896-97.

SPECIFICATION OF PRINT.	No. of pages.	Total No. of pulls.	No. of copies of each page.	VALUE.
				£
Professional volume	52	8,080	500	1,514
Synoptical volumes	66	7,440	350	1,917
Topographical Hand-Book (second edition)	50	6,810	400	1,055
Pamphlets of spirit-levelled heights	118	7,490	350	2,018
Letter-press for charts, map headings, foot-notes	266	6,700	...	2,728
Forms	268	88,850	...	5,878
Magnetic pamphlet	12	590	75	299
Miscellaneous	71	23,110	...	1,650
Extra-departmental work	160	4,190	...	145
	1,063*	153,260	...	17,204

* Equal to 1,110 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1892-93.	1893-94.	1894-95.	1895-96.	1896-97.
Pages composed	2,195	1,638	1,219	1,135	1,110

An analysis of the pages composed in 1896-97 is as follows :—

PROFESSIONAL VOLUME	Tidal Volume	104
SYNOPTICAL VOLUME	Great Arc Meridional Series, Section 8° to 18° and Indus Delta Triangulation	97
MISCELLANEOUS	Spirit-levelled heights	118
	Letter-press for charts, maps, headings, foot-notes	160
	Forms, orders, memoranda, etc.	423
	Miscellaneous	40
	Extra-departmental work	99
	Topographical Hand-Book	50
	Magnetic Pamphlet	19
	TOTAL	1,110

PHOTO-ZINCOGRAPHIC SECTION.—In August and September, a great deal of extra work was thrown on this section owing to the heavy demand for maps for the frontier expeditions. As the demand was urgent, the whole strength of the section was devoted to this work, and by working overtime 8,846 pulls were made in twelve days.

The following tables exhibit the value and outturn of the work done by this section :—

Abstract of Departmental work done during the year 1896-97.

Specification.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic Printing.							Silver and other Printing.		Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Number of copies.			Silver prints.	Blue and other prints.	
							Coloured.	Uncoloured.	Total.			
												₹ a.
Standard maps . . .	162	219	315	145	179	23,890	6,143	11,526	17,669	2	...	9,989 3
Index maps . . .	8	2	7	5	5	1,690	570	575	1,145	...	...	169 0
Technical charts . .	16	15	30	27	17	8,446	1,810	301	2,111	...	7	807 15
Miscellaneous maps and plans.	197	75	85	33	45	5,666	1,610	3,627	5,237	12	133	2,639 7
Transfers and proofs . .	...	...	...	...	...	918	...	...	...	...	...	...
Totals .	383	311	437	210	246	40,610	10,133	16,029	26,162	14	140	13,605 9

Statement of work done for other departments, etc., during the year 1896-97.

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic Printing.							Silver and other Printing.		Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Number of copies.			Silver prints.	Blue and other prints.	
							Coloured.	Uncoloured.	Total.			
												₹ a.
Forest Survey . . .	135	227	240	139	136	16,237	1,280	11,797	13,077	...	...	6,662 11
Quarter Master General .	2	...	...	...	...	8	...	8	8	...	...	8 8
Military Department . .	1	1	1	1	1	35	...	35	35	...	...	23 12
Other Departments . .	3	1	...	2	2	200	...	115	115	...	15	43 12
Totals .	141	229	241	142	139	16,480	1,280	11,955	13,235	...	15	6,738 11

Table showing the amount realized from other departments, etc., by book debit and cash sales during 1896-97.

Departments, etc.	By book debit.	By cash sales.	Total.
	₹ a.	₹ a.	₹ a.
Forest Department	.....	171 6	171 6
Forest Survey	7,082 1	104 9	7,186 10
Quarter Master General	2,554 6	96 0	2,650 6
Military Department	112 6	400 6	512 12
Other Departments	187 12	344 15	532 11
Private individuals	.....	201 15	201 15
Totals . .	9,936 9	1,319 3	11,255 12

CORRESPONDENCE SECTION.—The work in this section has been carried on as usual.

STORES, WORKSHOPS AND OBSERVATORIES SECTION.—Equipments for the Survey Detachments to accompany the Tochi, Malakand and Mohmand Field Forces and the Tirah Expeditionary Field Force were packed and despatched. In the observatories, the usual time observations were taken, the chronometers rated and kept in order, and other miscellaneous work done, including the magnetic observations already mentioned.

SOLAR PHOTOGRAPHIC SECTION.—The usual wet plate process was employed for taking Solar negatives, but experiments were also commenced in using dry plates—Cadett's and Thomas' Lantern plates, such as are employed at Greenwich.

Their use is a great advantage in the rainy season when the glimpses of the sun are short and uncertain, but the results are not so clear and good as those by the wet collodion process. It will however be always advisable to have some in hand for use during the rains.

The details of the work of this section are given below:—

Table showing the number and character of negatives.

1896-97.	NUMBER OF DAYS.				NUMBER OF NEGATIVES.										NUMBER OF WORKING DAYS WHEN PHENOMENA WERE	
		Failures.			Solar Phenomena.								TOTAL.			
	When negatives were taken.	From bad weather.	From various causes.	TOTAL.	Spots and faculæ.		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	31	...	...	31	50	...	...	...	5	...	...	...	55	...	31	...
November	27	3	...	30	47	...	...	...	...	...	...	...	47	...	27	...
December	29	2	...	31	54	...	...	...	...	...	...	...	54	...	29	...
January	21	10	...	31	39	...	...	...	...	...	...	...	39	...	21	...
February	24	4	...	28	43	...	...	...	...	...	...	...	43	...	24	...
March	28	3	...	31	50	...	...	...	...	...	...	...	50	...	28	...
April	28	2	...	30	45	...	...	...	4	...	...	...	49	...	28	...
May	30	1	...	31	42	...	...	...	13	...	...	...	55	...	30	...
June	30	...	...	30	39	...	...	...	15	..	...	...	54	...	30	...
July	21	10	...	31	31	...	...	...	..	...	...	...	31	...	21	...
August	20	11	...	31	31	...	...	...	...	...	...	...	31	...	20	...
September	27	3	...	30	45	...	...	...	...	...	...	...	45	...	27	...
TOTAL	316	49	...	365	516	...	...	...	37	...	...	...	553	...	316	...

Five hundred and fifty-three silver prints of the 8-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table showing the visibility of Sun at Dehra Dún and Greenwich.

YEAR.	AT DEHRA DÚN.			AT GREENWICH.		REMARKS.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days on which sun was invisible.	YEAR.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	*From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	98	61	1886	199	
1887-88	328	91	38	1887	188	
1888-89	315	71	50	1887-88	205	
1889-90	330	78	45	1888-89	182	
1890-91	303	99	62	1889-90	212	
1891-92	304	100	62	1890-91	224	
1892-93	292	100	73	1891-92	219	
1893-94	304	100	61	1892-93	220	
1894-95	343	100	52	1893-94†	230	†Year ending 10th May 1894 obtained from the report to the Board of Visitors.
1895-96	324	100	41	1894-95	Not obtainable.	
1896-97	316	100	49	1895-96		
Mean	308	...	57	...	201	

Synopsis of the results of the Monthly Magnetic Observations taken at the Trigonometrical Branch Office, Dehra Dún. The measures of Intensity are all expressed in C. G. S. units.

Year and Month.	Magnetic Elements.							Remarks.
	Declination East.			Horizontal Intensity.	Dip North.		Total Intensity.	
1867	°	′	″		°	′		With unifilar magnetometer No. 17 and Dip circle No. 44.
January . . .	2	54	12	0·33604	41	27·6	0·44839	
June . . .		...		·33619		30·3	·44891	
July . . .		...		·33561		31·2	·44824	
August . . .		...		·33593		26·1	·44808	
September . .		...		·33582		29·5	·44833	
October . . .		...		·33600		27·3	·44831	
November . .	3	3	17	·33639		29 7	·44912	
December . .		...		·33634		28·9	44896	
1868								
January . . .	3	2	14	0·33634	41	27·4	0·44878	
February . . .		...		·33635		27·1	·44875	
March . . .		...		·33656		25·2	·44882	
April . . .		...		·33573		30·0	·44826	
May . . .		...		·33569		33·0	·44856	With unifilar magnetometer, No. 16 and Dip circle No. 43.
June . . .		...		·33614		29·3	·41873	
July . . .		...		·33685		34·0	·45023	
August . . .		...		·33625		28·7	·44880	
September . .	3	3	4	·33608		32·5	·44901	
October . . .	3	2	13	·33551		30·0	·44796	
November . .		...		·33632		30·9	·44915	
December . . .		...		·33616		35·0	·44942	
1869								
January . . .		...		0·33643	41	32·2	0·44946	
February . . .		...		·33636		31·3	·44925	
March . . .		...		·33621		28·1	·44868	
September . .	3	5	10	·33466		35·4	·44746	
November . .	3	6	44	·33644		32·1	·44946	
1897								
January . . .	2	49	39	0·33659	42	40 2	0·45778	
February . . .	2	48	42	·33730		42·1	·45898	
April . . .	2	48	17	·31901*		41·0	·43396*	
May . . .	2	50	4	·33667		46·5	·45866	With unifilar magnetometer No. 19 and Dip circle No. 43.
June . . .	2	48	15	·34032		50·5	·46413	
July . . .	2	48	42	·33646		38·8	·45743	
August . . .	2	45	22*	·33656		45·6	·45840	
September . .	2	48	10	·33695		45·2	·45888	

Observations unsatisfactory.

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement showing the work performed during 1896-97.

TITLE OF MAP.	Number of sheets.	Scale.	REMARKS.
General Maps.		In. M.	
Map of portion of Tibet explored by Captain H. H. P. Deasy, 16th Lancers, in 1896	2	1=8	Completed. Final press order given.
Standard Maps.			
Dehra Dún and Siwáliks, sheets Nos. 1, 2 and 3	3	1=1	Corrections for 2nd edition. In hand.
Level sheets, Nos. 67, 74 and 88	3	1=2	Compilation in hand.
Punjab Survey, sheets Nos. 246 N. E., 264 S. E., 265 S. E., 285 S. W., and 286 N. W.	20	1=$\frac{1}{4}$	Corrections completed for reduction to half scale. Final press order given.
Punjab Survey, sheets Nos. 264 N. E., 265 N. W., 265 S. W., 286 S. W., 308 N. W., 313 N. W., 313 S. W., and 336 N. W.	32	1=$\frac{1}{4}$	Corrections for reduction to half scale in hand.
Plans of Cities and Cantonments.			
Dehra Dún Municipality and Cantonment (2nd edition)	3	1=$\frac{1}{12}$	Completed. Final press order given.
Simla Revisionary Survey, sheets Nos. 1, 2, 3, 4, 5, 6, 7 and 8	8	1=$\frac{1}{16}$	Completed for reduction to two-thirds scale. Final press order given.
Mussooree and Landour Guide Map	1	1=$\frac{1}{8}$	Completed additions and corrections to 1896. Final press order given.
Index Maps.			
Triangulation Chart of India	1	1=96	Brought up to date for Annual Report.
Index to illustrate survey operations by No. 18 Party in the Himálayas	1	1=20	Ditto ditto
Index to illustrate survey operations by No. 14 Party in districts Damoh, Biláspur and Sambalpur	3	Various	Ditto ditto
Index to the Charts of the Principal Triangulation of the Makrán Longitudinal Series	1	1=48	Completed for reduction to half scale. Final press order given.
Charts.			
Triangulation Chart of Great Arc Series, Sections 8° to 18°	4	1=4	In hand.
Nos. 43 and 44, Preliminary Charts of Indus Delta Coast Triangulation	2	1=4	In hand.
Chart of Triangulation, sheets Nos. 61, 62, 65, 66, 81 and 85 (Central Provinces)	6	1=2	Completed headings and foot notes. Final press order given.
Chart of Triangulation of Punjab Survey, sheets Nos. 311, 314 and 336	3	1=2	Ditto ditto.
Spirit-levelling operations No. 7, Bombay Presidency (revised edition)	1	1=8	Corrections completed for reduction to half scale. Final press order given.
Miscellaneous.			
Tidal maps of Colombo, Madras and False Point	3	Various	Completed. Final press order given.
Tidal maps of Tuticorin, Galle, Amherst, Minicoy, Rangoon, Pámban Pass, Bombay, Dublat, Hanstal and Diamond Harbour	10	Various	In hand.
Part of North-West Frontier (skeleton)	1	1=16	Completed. Final press order given.
Other maps	15	Various	Touched up for photography, and completed as regards headings and foot-notes. Final press order given.
Ditto	1	1=16	Completed. Final press order given.
Maps coloured	2,478	Various	

Statement showing the work performed during 1896-97.

MAPS EXAMINED.

	No. of Sheets.
Standard original maps	101
Charts	9
Miscellaneous maps	22
Photographic proofs of standard sheets and other maps	238
TOTAL	370

N.B.—In addition to the above, other miscellaneous duties have been performed, such as completing Central Provinces, Punjab Survey, Sind Survey Sheets and Spirit Levelling Operation Charts, etc., in respect of headings, foot-notes, symbols, etc., for press; taking out and checking areas of villages, their cultivation, forests, etc., of 14 Punjab Survey sheets; taking out areas of portions of Mussooree Settlement, and of the Dehra Dún Municipality for the Superintendent, Dehra Dún; examination of and custody of records; making all the despatches of maps, etc., etc., etc.

Statement of work done for other departments during 1896-97.

TITLE OF MAP.	Number of sheets.	Scale.	REMARKS.
		In. M.	
Standard Maps.			
Forest Surveys	114	1=¼	Completed headings, foot-notes and references. Final press order given for Forest Department.
Ditto	1	1=1	Ditto ditto.
Index Maps.			
Forest Surveys	6	Various	Ditto ditto.
Charts.			
Forest Surveys	1	1=1	Ditto ditto.

C. I. C. P. O.—No. 13 S. G.—9-7-98—450.

1898.

File No. 66 of 1898.

Serial No. 2.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND SURVEYS.

RESOLUTION.

No. 3—66—2.

Dated Simla, 17th August 1898.

SUBJECT.

Resolution on the operations of the Survey of India Department during the year 1896-97.

G. C. Press, Simla.—No. 510 R. & A. D.—19-8-98—720.

Extract from the Proceedings of the Government of India, Department of Revenue and Agriculture, No. 3—66—2, dated the 17th August 1898.

READ—

The General Report on the operations of the Survey of India Department during the year 1896-97.

RESOLUTION.

The field operations of the Survey of India Department for the year ending 30th September 1897 were carried on by twenty-one parties and one detachment.

The various classes of work on which these parties and the detachment were engaged are shown below :—

	Number of parties employed.	Number of detachments employed.
1. Trigonometrical	1	...
2. Topographical	6	...
3. Traverse	2	...
4. Topographical and Traverse	1	...
5. Forests (excluding Forest Survey Branch)	5	...
6. Cadastral	3	1
7. Scientific	3	...
TOTAL ...	21	1

Thus ten whole parties, a portion of another party, and a detachment were employed on remunerative work connected with land and forest revenue, as compared with eleven parties and two detachments so employed in 1895-96.

2. The aggregate area surveyed on all scales during the year was 104,987 square miles, against 63,653 square miles in 1895-96, an increase of 41,334 square miles, due to the large amount of reconnaissance completed in Upper Burma and elsewhere.

3. The party employed on trigonometrical operations continued the principal triangulation of the Makrán Longitudinal Series from Kuliri and Piaro in Longitude 66° 30′ westwards over a direct distance of about 75 miles, comprising 3 figures and embracing an area of 1,380 square miles.

4. Topographical operations were carried on in Upper Burma, Sindh, Baluchistan and the Himalayas and also in portions of Assam, Burma, Bengal and the Punjab. The survey of the Layari quarter of Kurrachee on the scale of 80 feet = 1 inch was completed, while the large scale (48 inches = 1 mile) survey of the town of Nahan in the Punjab was begun. The total area topographically surveyed was 14,460 square miles against 19,798 square miles in the previous year. The decrease is due to the fact that the ½ inch survey of No. 15 Party was almost finished last year and consequently only 700 square miles were executed against 11,307 in that year.

5. Forest surveys were continued in the Central Provinces, the Bombay and Madras Presidencies and in Lower Burma.

In the Central Provinces the detail survey of the forests in the Damoh District was brought to a close, while operations were begun in the district of Bilaspur, and in the Bombay Presidency the 4-inch detail survey in the Poona District was completed. In the Madras Presidency the outturn of work was short, but this was due to the inexperience in topographical work of a traverse party transferred from the Central Provinces. In Lower Burma 395 square miles on the 4-inch scale and 106 square miles on the 2-inch scale were completed in the Toungoo District. The Himalaya Party also surveyed an area of 191 square miles on the 4-inch scale in Sirmur, Patiala, Kullu and Kangra. The Forest Survey Branch continued operations in the Central Provinces, the Punjab and Burma and in addition started a new survey in the Ruby Mines District. The outturn of work for the past two years is given below :—

	1895-96.	1896-97.
(1) Imperial Parties	3,202	3,260
(2) Forest Survey Branch	1,712	1,563

The decrease under (2) is not explained.

The cost rate in the Central Provinces has been reduced, whilst for Bombay and Lower Burma there is a slight increase. In Madras the increase has been considerable, but this was due to exceptional circumstances which are fully explained in the report.

6. Cadastral operations by Imperial parties were carried on by one party and one detachment in Bengal, one party in Upper Burma, one party in Lower Burma and by local agency in the North-Western Provinces and Oudh under the general superintendence of the Deputy Surveyor-General, Revenue Branch. Owing to the famine it was found necessary to modify the programme in Bengal. In Burma the survey of the Town of Rangoon was completed. The local agency in the North-Western Provinces and Oudh completed the survey and record writing of the Meerut District and of the Lalitpur Subdivision. The total area surveyed in the different Provinces amounted to 7,190 square miles, of which 4,225 square miles in the North-Western Provinces and Oudh were executed by local agency. The decrease in the total area completed as compared with last year's return (8,609 square miles) is due to the curtailment of the programme in Bengal on account of famine and a similar curtailment in Burma, where survey operations had outstripped the settlement work.

7. Two parties were employed on traverse operations in the North-Western Provinces and Oudh and one party in Assam. The total area traversed during the year was 6,135 square miles compared with 9,089 square miles in the previous year. The decrease is apparently due to the reduction of the number of traverse parties from three to two during the year.

8. Observations were taken during the year for redetermining the value of the latitude of Madras and the result combined with a value obtained by Mr. Michie Smith, the Government Astronomer, Madras, aad two previous values gave a mean value for Madras of 13° 4′ 8″ ·02 north latitude.

9. Tidal observations with self-registering tide gauges were continued by one party at twelve stations in India, Burma, the Persian Gulf, the Andaman Islands and the Red Sea. It is intended to discontinue the series of observations at Muscat and Bushire and to open new observatories at Perim, Porbandar and Port Albert Victor. Spirit-levelling was continued from Potanghi to Vizianagram and from Bilaspur to Katni within 150 miles of the terminus at Allahabad, giving a total outturn of 291½ miles of double levelling.

10. In Upper Burma an area of 11,718 square miles was geographically surveyed, while 2,000 square miles of triangulation were also completed. The aggregate areas geographically surveyed during the year on the Eastern and Western Frontiers amounted to 78,718 square miles.

11. The work done in the various head-quarters offices has been satisfactory. In the Drawing Section progress has been made in the completion of the maps of the North-Eastern and South-Eastern Frontiers. The general maps of India on various scales have received additions and corrections, and the second edition of the 32-mile map of India has as far as possible been brought up to date. A new canal map of India on the 32-mile scale and also a railway map of India on the 48-mile scale are in course of publication. The provincial maps on the 16-mile scale and 58 Atlas sheets have been revised, while 5,493 cadastral sheets have been prepared for publication.

12. In the Engraving Office the preparation of the quarter sheets of the Atlas of India was continued, and fourteen district maps for administration reports, the index to the standard sheets of the Bombay Presidency, a new weather chart and the provincial map on the 16-mile scale of Mysore and Coorg with hills were completed Progress was also made in the completion of the provincial maps of Bengal, Bombay, Madras, Assam, Central India Agency, Rajputana and Mysore (without hills).

13. In the Photographic and Lithographic Office the outturn of work was again satisfactory, and, though there was a slight falling off in the amount of work done for other Departments and the total value of the work, the number of original subjects dealt with showed a considerable increase. The progress made in the Heliogravure Section, more especially in the production of half tone and line blocks for machine printing, is very creditable. Arrangements were made by this office to obtain photographs of the corona at the solar total eclipse.

14. The total number of maps issued from the Map Record and Issue Office was 207,330 and the value Rs. 1,57,927, an increase of 6,914 in number and Rs. 51,225 in value over the figures of 1895-96.

15. There was a decrease of nearly a lakh of rupees in the value of instruments issued from the Mathematical Instrument Office, due mainly to a smaller demand on account of railways and other large works. The number of instruments rendered serviceable, however, showed an increase of 9,310 in number and Rs. 5,130 in value. The conversion of repairable instruments into serviceable ones has been the means of reducing the amount of the indents for instruments manufactured in England from over £13,000 in 1893-94 to less than £4,000 in 1897-98.

16. The Survey Training School established at Dehra in June 1896 for training surveyors in field work before being attached to survey parties has given satisfactory results.

17. The Survey of India Department continued throughout the year under the administration of Major-General Strahan, and the Government of India desire to acknowledge his efficient management of the Department and the value of the work done in all Branches.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor-General of India, the Inspector-General of Forests, the Local Governments and Administrations noted on the margin, and to the Foreign, Military and Public Works Departments.

Madras.
Bombay.
Bengal.
North-Western Provinces and Oudh.
Punjab.
Burma.
Central Provinces.
Assam.
Coorg.
Berar.

Ordered also that this Resolution be published in the Supplement to the *Gazette of India*.

[True Extract.]

T. W. HOLDERNESS,

Secretary to the Government of India.