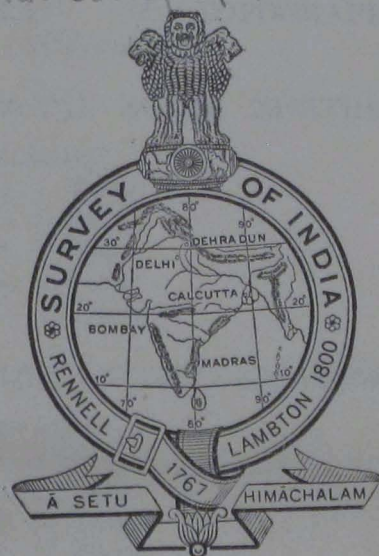


SURVEY OF INDIA

# TECHNICAL REPORT 1953

(From 1st April 1952 to 31st March 1953)

India. Survey of India Dept.



## PART I—TOPOGRAPHICAL AND OTHER SURVEYS PART II—MAP PUBLICATION AND OFFICE WORK

PUBLISHED BY ORDER OF  
BRIGADIER I. H. R. WILSON, F.R.I.C.S., M.I.S. (IND.)  
SURVEYOR GENERAL OF INDIA

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## FOREWORD

Part I of this Technical Report is prepared by Officers in charge of Units and Directors of Survey Circles. The author of any particular report is normally the Officer holding office at the end of the period covered by the report.

2. Part II is prepared by the Director. Map Publication.

3. The Report, as a whole, is edited in the office of the Surveyor General, but expresses the personal views of the authors of the various sections.

DEHRA DŪN :  
*July, 1955.*

I. H. R. WILSON,  
*Brigadier,*  
*Surveyor General of India.*



SURVEY OF INDIA  
**TECHNICAL REPORT**  
**1953**

From 1st April 1952  
To 31st March 1953

**I. INTRODUCTION AND SUMMARY**

1. **Annual Reports.**—The publication of the two Annual Reports of the Survey of India namely, the General Report and the Geodetic Report was suspended in 1942 for the duration of the war. The resumption of publication of these reports was made from the year 1947 in two separate volumes namely :—

- ( a ) *The General Report.*
- ( b ) *The Technical Report.*

The General Report is a brief narrative covering all work of the department and is intended for the information of the Government of India and non-technical readers.

The Technical Report which has superseded the Geodetic Report not only deals in detail with the geodetic and geophysical activities of the department, but also covers technicalities of survey work, drawing and map reproduction not included in the scope of the Geodetic Report.

The present Report like others covers the period of the financial year, i.e., from 1st April 1952 to 31st March 1953.

The Technical Report is arranged as follows :—

*Part I* contains Table C giving a detailed statement of areas, out-turns and cost rates of surveys together with brief description of the country surveyed. It also contains technical notes on the survey methods used, on out-turn if it varies from the normal and on other subjects of special interest to surveyors. Details of new survey methods or apparatus, if any, are included in the appendices to the technical notes.

*Part II* deals with map drawing and reproduction and allied matters

*Part III* deals with geodetic and geophysical operations with special reference to the technical aspects of the work, and to an analysis of the results. This part is published as a separate volume.

*A Supplement to the Technical Report* containing some of the information is prepared in typescript for departmental use.

## PART I.—TOPOGRAPHICAL AND OTHER SURVEYS

### II. ABSTRACT OF TOPOGRAPHICAL WORK

2. In the annual General Report of the Survey of India the abstract of topographical work is explained by three Tables A, B and C.

Table A shows the area of survey completed on various scales since 1905 as well as the approximate balance which remains to complete the contoured topographical survey of India.

Table B shows the area of revision surveys during the period under review.

Table C shows in detail the figures for areas surveyed, out-turns and cost rates of surveys, compilation and mapping by the various survey parties of the department.

Tables A and B are published in the General Report ; but Table C forms part of this Report.

In Table C, although every endeavour has been made to calculate the cost rates accurately, it is extremely difficult exactly to allocate overhead charges between the various classes of work. The cost rates shown in the Table C must, therefore, be considered to be approximate. The net cost represents the expenditure actually incurred on the work plus party overhead charges, but excludes expenditure incurred on moving the party to the field and departmental overhead charges. The overall cost is the net cost plus the cost incurred on moving the party to and from the field and departmental overhead charges. The information contained in this Table is intended to be useful to those familiar with survey organization in estimating costs in subsequent years.

The costs shown for mapping and computation are those incurred in the party, etc., offices only, except where otherwise stated. Publication charges, if required, may be ascertained from the Director, Map Publication at Dehra Dūn.

*Indexes A and C* published in the General Report also appear at the end of this Report. The progress of modern (i.e., since 1905) topographical surveys made by the department and of compilations made from our own or other material is illustrated in *Index A*. The surveys in hand, during the period under report, in connection with the various irrigation and development projects are shown in *Index C*.



TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 1 Party.—</b>				Rs.	Rs.	<b><u>NORTHERN CIRCLE</u></b>
<i>70% undulating with cultivation and villages ; 30% hilly with open forests</i>	Tractor Going Plans—4-inch scale without contours. Plane-tabling .. .. Accessory work on plane-table sections	1177	17.2	62.8	87.0	Rapid revision survey.
<i>70% undulating with cultivation and villages ; 30% hilly with open forests</i>	Rapid verification survey—4-inch scale. Plane-tabling .. ..	1350	14.9	19.7	26.7	
<i>70% undulating with cultivation and villages ; 30% hilly with open forests</i>	Plane-tabling .. ..	81	93.5	17.8	25.4	
<i>Undulating area with isolated hillocks and covered with fairly dense forest</i>	Jonk Reservoir—4-inch scale, contours at 10 feet V.I. Supplementary triangulation .. .. Air survey of detail .. .. Ground verification and ground contouring	210	75	59.9	82.8	
		85	14.4	23.6	30.7	
		85	4.8	161.8	231.4	
	<b>Delhi Rectangulation.</b>					
<i>30% built-up area ; 40% cultivated area ; 30% stony waste with broken ground and quarries</i>	Supplementary triangulation .. .. Traversing	28	40.0	43.5	63.2	
		310	72.1 linear miles	23.0 per linear mile	33.7 per linear mile	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
<b>No. 1 Party.—Contd.</b>						<b>NORTHERN CIRCLE.— Contd.</b>
	Levelling .. .. .	94.2 linear miles	62.6 linear miles	49.1 per linear mile	67.6 per linear mile	
	Rectangulation .. .. .	139.8	6.0	298.0	426.9	
	<b>Delhi Guide Map—3-inch scale, contours at 10 feet V.I.</b>					
	Supplementary triangulation .. .. .	18	19.3	121.1	176.9	
	Plane-tabling .. .. .	7	4.1	372.0	494.0	
	<b>Nāgpur Aerodrome—Landing Chart—2-inch scale, contours at 50 feet V.I.</b>					
	Triangulation .. .. .	30	32.1	48.4	65.0	
	Levelling .. .. .	14 linear miles	52.5 linear miles	93.4 per linear mile	124.9 per linear mile	
	Plane-tabling .. .. .	27	6	196.6	281.1	
	<b>Nāgpur Aerodrome—Approach Chart—<math>\frac{1}{4}</math>-inch scale.</b>					
	Verification survey .. .. .	800	269.7	4.2	5.8	
<i>Open area with scattered low hills</i>						

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 1 Party.—Concl'd.</b>						<b>NORTHERN CIRCLE.—</b> <u>Cont'd.</u>
<i>High hills with fairly dense forest, scattered villages and glaciers</i>	Modern Topographical Survey— ½-inch scale, contours at 100 feet V.I. Plane-tabling .. .. .	460	78.0	43.0	63.2	
<i>Partly hilly and partly undulating ground, covered with forests; cultivated along river beds with scattered trees</i>	Gobind Sāgar (Bhākra Reservoir)— 4-inch scale, contours at 20 feet V.I. Fair mapping .. .. .	30.7	2.2	148.7	193.3	
<i>70% open forest and undulating area with cultivation and villages; 30% hilly and dense forest with high grass</i>	Punāsa Reservoir—4-inch scale, contours at 10 and 20 feet V.I. Air Survey .. .. . Fair mapping .. .. .	481 173	13.6 3.1	34.5 111.8	44.9 145.3	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
<b>No. 2 Party.—</b>				Rs.	Rs.	<b>NORTHERN CIRCLE.—</b>
<i>Mostly flat and cultivated area with broken ground near banks of streams and rivers</i>	Chambal Hydel and Irrigation Project—4-inch scale, contours at 1 foot V.I.					<u>Contd.</u>
	Triangulation	1350	167.0	11.9	16.0	
	Levelling	2382.6 linear miles	55.7 linear miles	26.2 per linear mile	35.6 per linear mile	
	Ground verification on 2-inch scale air photographs	1000	40.7	15.9	20.8	
	Ground verification of main detail on ½-inch sheets	1390	80.2	0.8	1.0	
	Air survey on 2-inch scale	420	5.4	64.0	83.2	
	Fair mapping of outline on 4-inch scale	194.5	5.0	48.7	63.3	
<b>No. 3 Party.—</b>						
<i>Partly flat and partly undulating, interspersed with ravines and covered with thorny bushes and forest</i>	Chambal Hydel and Irrigation Project—4-inch scale, contours at 1, 5 and 25 feet intervals.					
	Triangulation	2149	180.6	14.2	20.0	
	Double tertiary levelling	167.4 linear miles	32.0 linear miles	47.9 per linear mile	67.5 per linear mile	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
<b>No. 3 Party.—Concl'd.</b>	Tertiary levelling ..	sq. m. 2229.3 linear miles	sq. m. 65.3 linear miles	Rs. 14.7 per linear mile	Rs. 22.4 per linear mile	<b>NORTHERN CIRCLE.—</b> <u>Contd.</u>
	Tertiary levelling combined with tachymetric traverse	631.7 linear miles	47.7 linear miles	22.8 per linear mile	32.2 per linear mile	
	Ground verification on 2-inch scale air photographs	1129.8	79.2	11.8	16.6	
	South Bihar Irrigation Projects— 4-inch scale with contours at 1 foot V.I.	722.0	..	107.1	140.5	
<i>Flat country with few mounds, innumerable field bunds scattered trees, wells and excavated water channels</i> <b>No. 4 Party.—</b>	Fair mapping and computations ..	..	..	..	..	
	Modern Topographical survey— 1-inch and ½-inch scales, contours at 50 feet V.I.	6880	328.7	11.1	15.5	
	Triangulation and its computations	259	23.9	40.2	57.1	
	Plane-tableing ( 1-inch scale ) ..	3529	38.8	33.3	46.3	
<i>Desert of wind blown sand with sand hills varying in height from 20 to 200 feet</i>	Plane-tableing ( ½-inch scale ) ..	..	..	..	..	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work ( including scale and V.I. )	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 4 Party.—Concl'd.</b>				Rs.	Rs.	<b>NORTHERN CIRCLE.—</b> <u>Cont'd.</u>
<i>Flat cultivated plains with numerous ponds, mango gardens, water channels and marshy areas</i>	Gandak Barrage Scheme—4-inch scale, contours at 1 foot V.I. Fair mapping .. .. .	1218	8.3	43.5	68.9	
<b>No. 13 Party.—</b>						
<i>Flat plains, cultivated and fairly inhabited, with extensive patches of dhak jungle and low thorny bushes in Paitiāla and Karnāl Districts</i>	Bhākra Dam Project—4-inch scale, contours at 1 foot V.I. Triangulation .. .. . Traversing, its computations and 3,000-acre rectangulation	710 939	71.2 59.4	27.1 29.7	36.5 40.8	
<i>Extensive sandy area in Mahendragarh, Hissār and Rohiāk Districts</i>	100-acre rectangulation in :— ( a ) Mālerkotla-Nābha-Rājpura block	178	8.2	334.1	441.9	
<i>Stretch of broken and undulating ground at the foot-hills of Siwāliks in the north-east portions of Ambāla District</i>	( b ) Ambāla-Rupar block .. .. . ( c ) Dādri block .. .. . Tertiary levelling to 25 acres and its computations in :—	319 375	19.0 12.6	43.6 90.5	58.4 122.3	
	( a ) Dādri block .. .. .	247	18.8	65.6	86.7	
	( b ) Banūr block .. .. .	795	18.1	78.4	106.5	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 13 Party.—Concl'd.</b>  <i>Cultivated plains, thickly populated and heavily canalized</i>	Ground verification on 1½-inch scale	336	142.0	9.5	13.1	<u><b>NORTHERN CIRCLE.—</b></u> <u><b>Concl'd.</b></u>
	Compilation and fair mapping . .	1076	10.4	40.2	52.3	
	<b>Consolidation of Holdings.</b>					
	Triangulations and its computations	520	62.7	33.4	44.6	
	Traversing, its computations and 3000-acre-rectangulation	516	42.5	54.9	72.3	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile (or mile)		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 5 Party.—</b>						<b><u>EASTERN CIRCLE</u></b>
<i>Flat open cultivated plains interspersed with scattered trees, mango groves and swamps</i>	Original Survey—1-inch scale, contours at 50 feet V.I.					
	Traversing (without heights) ..	368.0 linear miles	52.6 linear miles	81.2 per linear mile	112.8 per linear mile	
<i>Flat open cultivated plains on the deltaic regions of the Ganges</i>	Rapid tertiary levelling ..	563.0 linear miles	67.9 linear miles	21.6 per linear mile	29.9 per linear mile	
	Ground verification including contouring on photographs	1,269.0	66.8	21.0	28.7	
Air survey ..		543.0	25.0	16.0	20.9	
<i>Flat open cultivated plains on the deltaic regions of the Ganges</i>	Revision Survey—1-inch scale, contours at 50 feet V.I.					
	Traversing (without heights) ..	21.0 linear miles	30.9 linear miles	71.5 per linear mile	104.3 per linear mile	
Rapid tertiary levelling ..	524.0 linear miles	66.3 linear miles	31.0 per linear mile	43.1 per linear mile		
Ground verification on photographs	118.0	74.5	23.9	33.6		
Air survey ..	1,186.0	54.9	5.9	7.6		

\* For explanation of 'net' and 'overall' rates see page 2.



TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 5 Party.—Contd.</b>						<b>EASTERN CIRCLE.— Contd.</b>
<i>70% tea gardens with open and flat country and 30% densely wooded land</i>	Tea Estates in Assam—16-inch scale without contours.					
	Air survey	17,983 acres	500 acres	0.6 per acre	0.8 per acre	
	Fair mapping	17,983 acres	350 acres	0.2 per acre	0.3 per acre	
	<b>Gauhāti Aerodrome Survey.</b>					
	Triangulation	11.0	33.0	45.3	64.2	} Cost includes that of computations.
	Traversing	3.0 linear miles	15.0 linear miles	91.7 per linear mile	125.7 per linear mile	
	Double tertiary levelling	25.0 linear miles	75.0 linear miles	28.2 per linear mile	39.8 per linear mile	
	Approach chart Survey ( 1½-inch scale, contours at 250 feet V.I. )	634.0	152.0	4.9	6.9	
	Landing chart survey ( 1½-inch scale, contours at 50 feet V.I. )	6.0	12.0	69.8	160.2	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
<b>No. 5 Party.—Conclid.</b>	<b>East-West Bengal Boundary Survey.</b>			Rs.	Rs.	<b>EASTERN CIRCLE.—</b> <b>Contd.</b>
<i>Low lying plains interspersed with swamps and low grass</i>	Triangulation	11	17	260.9	362.2	
	Traversing	27 linear miles	14 linear miles	182.1 per linear mile	238.2 per linear mile	
<b>No. 9 Party.—</b>	<b>Kosi Irrigation—4-inch scale, contours at 1 foot V.I.</b>					
<i>Flat open cultivated plains astride the old beds of the Kosi River, patches of jungle and scattered trees, numerous tanks, patches of low marshy lands</i>	Air survey revision and compilation	1283.5	33.1	14.0	18.2	
	Fair mapping	1283.5	16.4	26.8	34.8	Work done in recess 1952.
	Computations	1283.5	52.9	5.9	7.7	
	Combined project	1283.5	5.2	123.6	174.3	For all work carried out in the field season 1951-52 and recess 1952.
<i>Flat open cultivated plains interspersed with innumerable channels of the Kosi River, comprising of sand and sandy loams with scattered trees, mango groves and bamboos</i>	<b>Kosi Irrigation—4-inch scale, contours at 1 foot V.I.</b> Double tertiary levelling	145.6 linear miles	22.5 linear miles	42.3 per linear mile	61.2 per linear mile	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 9 Party.—Concl'd.</b>  <i>Western half of the area comprised of low hills covered with dense jungle and poor communications and eastern half comprised of undulating plains, mostly cultivated with scattered trees and groves</i>	Tertiary levelling .. .. .	1433.2 linear miles	60.5 linear miles	14.0 per linear mile	20.6 per linear mile	<b>EASTERN CIRCLE.— Concl'd.</b>  For work done in field season 1952-53.          *Low out-turn due to the hills being covered with dense jungle.
	Ground verification .. .. .	476.2	32.3	17.1	26.2	
	Computations in the field .. .. .	1578.8 linear miles	257.4 linear miles	1.1	1.5	
	<b>Upper Dâmodar Valley Survey— 6-inch scale, contours at 10 feet V.I.</b>					
	Triangulation .. .. .	1109.4	90.0*	17.6	24.6	
	Double tertiary levelling .. .. .	210.0 linear miles	15.3 linear miles	77.7 per linear mile	108.5 per linear mile	
	Tertiary levelling .. .. .	2184.0 linear miles	34.5 linear miles	19.9 per linear mile	27.4 per linear mile	
	Ground verification .. .. .	1109.4	24.1	19.1	26.4	
	Computations in the field .. .. .	2394.0 linear miles	390.3 linear miles	0.6 per linear mile	0.8 per linear mile	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile (or mile)		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 11 Party.—</b>						<b>EASTERN CIRCLE.—</b>
<i>Cultivated plains and patches of jungle covered hills and plains</i>	Orissa Cadastral Survey—16-inch scale.					<u>Contd.</u>
	Traversing	47.2 linear miles	15.6 linear miles	93 per linear mile	120 per linear mile	
	Original Survey—1-inch scale, contours at 50 feet V.I.					
	Fair mapping	417	15.2	22	27	
<i>Partly jungle covered hills and partly undulating cultivated plains</i>	Survey of Reserved Forest Boundaries in portion compiled from 4-inch Hiraakud Dam maps	147.9 linear miles	64.3 linear miles	17 per linear mile	22 per linear mile	
	<b>Mahanadi Delta Survey—4-inch scale, contours at 1 foot V.I.</b>					
	Reconnaissance of old framework	800	387	4	6	
<i>Cultivated plains with numerous water channels, canals and distributaries. Steep hillocks in north-west part of area</i>	Traversing	39.4 linear miles	18.8 linear miles	87 per linear mile	114 per linear mile	
	Double tertiary levelling	471.2 linear miles	41.0 linear miles	75 per linear mile	98 per linear mile	†Out-turn is per detachment of two levellers.

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 11 Party.—Concl'd.</b>						<b>EASTERN CIRCLE.— Cont'd.</b>
	Tertiary levelling .. ..	1982.4 linear miles	71.2 linear miles	16 per linear mile	21 per linear mile	Includes abreast levelling.
	Ground verification .. ..	808.1	66.2	15	20	
	<b>Rānchi District Forest Boundary Survey—1:25,000 scale.</b>					
<i>Jungle covered hills and partly jungle covered plains</i>	Fair mapping .. ..	2124.4	57.1	7	8	
	Plane-table traversing .. ..	888.8	26.6	44	55	
	<b>Gandak Barrage Project—2-inch scale.</b>					
<i>Open plains with numerous villages</i>	Blue-print survey .. ..	127.3	31.55	39	54	
<b>No. 12 Party.—</b>						
	<b>Andaman and Nicobar Islands— 1:25000 scale, contours at 25 feet V.I.</b>					
<i>Densely wooded hills with narrow valleys</i>	Triangulation .. ..	220	38.2	110	205	It involved very heavy jungle clearing.
	Height control .. ..	220	10.3	290	496	
	Ground verification .. ..	220	33.3	44	79	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 12 Party.—Concl'd.</b>						<b><u>EASTERN CIRCLE.—</u></b> <b><u>Contd.</u></b>
<i>Hilly and undulating ground with open and fairly dense mixed jungle</i>	Bihar Mica Belt—1:25,000 scale, contours at 25 feet V.I. Air survey .. .. .	249.1	7.0	48.8	63.4	
	Fair mapping .. .. .	249.1	6.0	54.8	71.3	
	Car Nicobar Island—1:25,000 scale, contours at 25 feet V.I. Air survey .. .. .	47.3	9.3	48.5	63.1	
<i>Undulating ground with dense forest and open patches</i>	Fair mapping .. .. .	47.3	7.0	60.6	78.8	
<b>No. 18 Party.—</b>	<b>Kopili Flood Control Scheme—4-inch scale, contours at 1 foot V.I.</b>					
<i>Half of the area was low lying plains interspersed with swamps and high grass and the remaining area was undulating and heavily wooded</i>	Traversing ( without heights ) ..	207.6 linear miles	16.4 linear miles	96.0 per linear mile	133.8 per linear mile	Low out-turn due to slow progress in dense jungle area.
	Double tertiary levelling ..	615.5 linear miles	18.2 linear miles	41.3 per linear mile	57.4 per linear mile	Low out-turn due to slow progress in dense jungle area.

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 18 Party.—Concid.</b>	Tertiary levelling . . . . .	1278.0 linear miles	17.1 linear miles	44.9 per linear mile	62.5 per linear mile	<b><u>EASTERN CIRCLE.—</u></b> <b><u>Concid.</u></b>  Poor out-turn partly due to work being carried out by trainees and partly due to slow progress in high grass and jungle area where traversing had to be carried out by Levellers having no previous plane-table traverse experience.  Poor out-turn due to slow progress in jungle and high grass area and old photography.
	Ground verification on photographs	607.0	23.6	27.6	38.4	
	Ground survey on 2-inch scale . .	17.5	5.8	114.5	158.9	
	Computation . . . . .	624.5	29.6	9.2	12.7	
	Total field work . . . . .	624.5	3.7	202.9	282.1	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile (or mile)		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 6 Party.—</b>						<b>SOUTHERN CIRCLE</b>
<i>Varies from flat coastal belt to intricate hills covered with thorny scrub, alternating with open undulating and cultivated plains</i>	<b>Kandla Port Development Surrounding Area—1:25,000 scale, contours at 25 feet V.I.</b>					
	Framework (1949-50) ..	1980	111.0	15.0	26.0	
	Photo verification (1949-50) ..	1980	33.0	15.7	34.1	
	Air survey compilation and fair drawing (1950-52)	1980	8.1	33.8	43.9	
	Complete job ..	1980	6.2	64.5	104.0	
	<b>Kandla Port Development Auxiliary Area—1-inch scale, contours at 50 feet V.I.</b>					
	Framework (1950-51) ..	595	110.8	12.3	33.0	
	Photo verification (1950-51) ..	595	33.0	15.2	32.2	
	Air survey compilation and fair mapping (1950-52)	595	53.6	4.4	5.7	
	Complete job ..	595	17.8	31.9	71.0	

\* For explanation of 'net' and 'overall' rates see page 2.



TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 6 Party.—Contd.</b>				Rs.	Rs.	<b>SOUTHERN CIRCLE.</b>
<i>Densely wooded hills, and plains with patches of cultivation</i>	<b>Kākadāpār Reservoir—4-inch scale, contour interval ranging from 5 feet to 20 feet.</b>	320	24.7	31.4	61.0	<u>Contd.</u>
	Framework ( 1949-50 )					
	Ground verification and contouring ( 1950-51 )	320	55.8	14.3	23.8	
	Corrections to air survey compilation and fair mapping ( 1951-53 )	320	4.1	74.1	96.3	
	Complete job	320	3.3	119.8	181.1	
<i>Densely wooded hills, and plains with patches of cultivation</i>	<b>Ukai Reservoir and Additional Area—4-inch scale, contour interval ranging from 5 feet to 20 feet.</b>	610	69.1	29.3	49.7	
	Framework ( 1949-51 )					
	Ground verification and contouring ( 1950-52 )	610	5.5	239.4	363.8	
	Air survey compilation ( 1950-52 )	610	9.6	34.5	44.9	
	Fair mapping ( 1951-53 )	610	4.3	50.8	66.0	
	Complete job	610	1.9	354.0	509.5	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 6 Party.—Contd.</b>						
<i>Densely forested high hills in the north, wooded undulating ground merging into cultivated plains in the south</i>	<b>Topographical surveys—1-inch scale, contours at 50 feet V.I.</b>		sq. m.	Rs.	Rs.	<b>SOUTHERN CIRCLE.— Contd.</b>
	Ground survey in sheet 46 G/14 (1951-52)	270	13.1	94.6	159.4	
<i>Varies from flat coastal belt to intricate hills covered with thorny scrub, alternating with open undulating and cultivated plains</i>	Ground survey in Sheet 46 G/16 (1951-52)	262	7.5	85.2	143.7	
	Triangulation for future surveys in Kutch (1952-53)	1680	203.2	10.6	16.0	
	Ground verification and height control (1952-53)	1196	45.4	35.1	52.4	
<i>Varies from flat coastal belt to intricate hills covered with thorny scrub, alternating with open undulating and cultivated plains</i>	<b>Topographical survey—1:25,000 scale, contours at 25 feet V.I.</b>					
	Ground verification and height control	138	27.6	25.6	38.5	
<i>Varies from flat coastal belt to intricate hills covered with thorny scrub, alternating with open undulating and cultivated plains</i>	<b>Topographical framework for future Settlement surveys.</b>					
	Triangulation and traversing (1951-52)	345	4.5	244.6	353.0	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 6 Party.—Concl'd.</b>						<b>SOUTHERN CIRCLE.—</b>
	Computations and plotting ( 1952-53 )	345	3.5	77.4	100.6	<u>Contd.</u>
	Triangulation and traversing ( 1952-53 )	867	14.2	109.0	163.7	Job still in hand.
	<b>Deesa Aerodrome Landing Chart</b> —1½-inch scale, contours at 50 feet V.I.					
<i>Sandy area with low lying hills and very sparse vegetation</i>	Framework ( 1952-53 )	30.5	55.3	28.5	43.9	
	Ground survey ( 1952-53 )	30.5	16.9	53.8	84.4	
	Complete field work ( 1952-53 )	30.5	12.9	82.3	128.3	
	<b>Approach Chart—¼-inch scale,</b> <b>contours at 250 feet V.I.</b>					
	Verification ( 1952-53 )	800.0	1200.0	1.2	1.8	
<b>No. 8 Party.—</b>	<b>Modern Surveys in sheet 47 G—</b> <b>1-inch scale, contours at 50 feet</b> <b>V.I.</b>					
<i>Steep flat-topped and low undulating hills, partly wooded</i>	Re-heighting	851.0	392.8	3.5	6.0	
	Plane-tableing	3760.0	12.4	66.5	92.2	Carried out in seasons 1950-53.

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net Rs.	*Overall Rs.	
<b>No. 8 Party.—Contd.</b>						<b>SOUTHERN CIRCLE.— Contd.</b>
<i>Broad valleys with dense trees and bamboos and narrow open cultivated patches</i>	<b>Bhadra Reservoir—8-inch scale, contours at 10 feet V.I.</b>					
	Planimetric control and compu- tations	115.0	30.3	49.1	64.7	
	Height control .. .. .	56.0	11.5	307.1	410.4	Includes cost of ground verification on photographs.
	Air survey compilation and mapping	50.1	0.47	314.4	408.7	Excludes charges incurred on personnel under training.
<i>Low hills, partly wooded, with terraced cultivations</i>	<b>Bombay Oil Refineries—12-inch scale, contours at 2 feet V.I. in plains and 5 feet V.I. in hills.</b>					
	Air survey compilation .. .. .	4.5	0.82	325.8	423.5	For details only.
	Supplementary triangulation .. .. .	9.0	5.6	230.5	305.5	
	Height control .. .. .	6.6	3.2	210.9	282.1	
	Ground verification and contouring	4.5	0.79	1510.2	2172.4	
	Plane-tableing .. .. .	2.0	0.20	5679.5	7992.4	
	Boundary demarcation .. .. .	3.5 linear miles	4.0 linear miles	201.1 per linear mile	377.7 per linear mile	Carried out during monsoon.
	Fair mapping .. .. .	5.5	0.33	665.3	864.9	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V.I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 8 Party.—Concl'd.</b>						<b>SOUTHERN CIRCLE.—</b> <u>Cont'd.</u>
<i>Foreshore</i>	Thorium-Uranium Factory— 12-inch scale, contours at 2 feet V.I. in plains and 5 feet V.I. in hills.	0.2	0.54	2215.0	3575.0	
<i>Low wooded hills and foreshore...</i>	Plane-tabling Fair mapping	0.7	0.36	585.7	761.4	
<i>Cardamom, coffee and tea plantations</i>	Miraflores Estate—16-inch scale, contours at 20 feet V.I. Plane-tabling Fair mapping Complete job	1.0	0.3	2030.0	2862.6	
	Verification Survey—1-inch scale.	1.0	0.18	1221.0	1587.3	
<i>Densely wooded high and low hills with open undulating coastal plains</i>	Verification of communications	1.0	0.11	3251.0	4449.9	
		1857.0 linear miles	243.3 linear miles	3.7 per linear mile	4.9 per linear mile	

\* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work ( including scale and V.I. )	Area sq. m.	Out-turn per man per month	Cost rate per sq. mile ( or mile )		REMARKS
				*Net	*Overall	
<b>No. 17 Party.—</b>						<b>SOUTHERN CIRCLE.—</b> <u>Concl.</u>
<i>40% hilly wooded area and 60% undulating area</i>	<b>Topographical Survey—1-inch scale, contours at 50 feet V.I.</b> Triangulation for ground survey ..	274	96.7	Rs. 19.5	Rs. 27.0	
	Traverse for ground survey ..	67 linear miles	23.7 linear miles	91.7 per linear mile	126.0 per linear mile	
	Triangulation and traverse computations	548	..	2.9	3.8	
	Ground survey ..	1924	18.0	56.2	81.5	
	<b>Mahi Project—4-inches to 1 mile scale, contours at 1 foot V.I.</b>					
<i>Plains with thick vegetation</i> ..	Double tertiary levelling ..	117 linear miles	20.3 linear miles	63.7 per linear mile	88.4 per linear mile	
	Tertiary block levelling ..	1550 linear miles	51.4 linear miles	17.4 per linear mile	25.0 per linear mile	
	Stone laying and ground verification on 4-inch air photographs	430	16.4	90.6	124.9	

\* For explanation of 'net' and 'overall' rates see page 2.

### III. TECHNICAL NOTES, NORTHERN CIRCLE

3. **Summary.**—During the period under report the following units were under the administrative control of the Director, Northern Circle :—

- No. 1 Party.
- No. 2 Party.
- No. 3 Party.
- No. 4 Party.
- No. 13 Party.
- No. 2 Drawing Office  
and Photo-Zinco Office.

A résumé of the various survey operations carried out by the above mentioned units has been given in the General Report 1953.

#### No. 1 PARTY

4. **General.**—The party was employed on the following surveys :—

- ( *i* ) Surveys for 'Tractor Going Plans' on 4-inch scale.
- ( *ii* ) Air survey of Punāsa Reservoir area on 4-inch scale.
- ( *iii* ) Air survey of Jonk Reservoir area on 4-inch scale.
- ( *iv* ) Original ground survey on  $\frac{1}{2}$ -inch scale.
- ( *v* ) Original ground survey on 2-inch scale and black-print survey on  $\frac{1}{4}$ -inch scale for the Landing and Approach Charts of Nāgpur Aerodrome.
- ( *vi* ) Ground survey on 3-inch scale for the Delhi Guide Map.
- ( *vii* ) Rectangulation.

For other work carried out by this party see Supplement to General Report 1953.

5. **Technical Methods.**—( *i* ) *Tractor Going Plans.*—The methods used for this type of work have been described in the Technical Report for the year 1952 ( pages 21-23 ).

( *ii* ) *Punāsa Reservoir.*—The technical methods used for this survey have already been described on pages 23 and 24 of the Technical Report for 1951. The work carried out during this year completed the job which was started during field season 1949-50.

( *iii* ) *Jonk Reservoir.*—Maps on the scale of 4 inches to 1 mile with contours at 10 feet vertical interval were required by the Central Water and Power Commission, New Delhi. The surveys in connection with this project were carried out by air and ground methods.

( a ) *Control*.—The planimetric control for air survey on 2-inch scale and height control for ground contouring on 4-inch scale were provided by triangulation based on previous topographical triangulation for position and Hunter Short Base for scale.

( b ) *Survey*.—Air Survey of detail only was carried out on 2-inch scale by the normal radial-line method. The air survey sections were then enlarged and blue-prints on 4-inch scale obtained on which ground verification and ground contouring were done. As the area was covered with fairly dense jungle, contouring had to be done by height traverses.

( iv ) *Original ½-inch Survey*.—Ground survey on ½-inch scale with contours at 100 feet vertical interval was carried out for departmental mapping in the Bandarpūnch area in degree sheet 53 I. The area for survey consisted of high mountains between 4,000 feet and 22,720 feet above mean sea-level.

Normal plane-tabling methods based on existing trigonometrical control were applied.

( v ) *Landing and Approach Charts*.—In connection with the preparation of Landing and Approach Charts of Nāgpur Aerodrome according to the specifications laid down by the International Civil Aviation Organization, original ground survey on 2-inch scale with contours at 50 feet vertical interval and black-print revision survey on ¼-inch scale were carried out.

Control for 2-inch survey was provided by supplementary triangulation. Normal plane-tabling methods were used for survey.

The technical methods used for this type of survey have been described in the Technical Reports for the years 1950 and 1951.

( vi ) *Survey for Delhi Guide Map*.—Ground survey on 3-inch scale with contours at 10 feet vertical interval was carried out by normal methods.

( vii ) *Rectangulation*.—Rectangulation was required in Delhi State for the Superintending Engineer, West Jumna Canal and the Delhi Development Officer in connection with irrigation planning and consolidation of holdings respectively.

The technical methods used were the same as for Bhākra Dam Project Surveys and have been described in the Technical Report for 1947 ( pages 26–28 ).

## No. 2 PARTY

6. **General**.—A portion of the party continued to be employed on the survey and mapping of the Chambal Hydel and Irrigation Project which was started during field season 1951–52.

The Chambal River or Charmanvati, as the ancients used to call it, is the largest river in Madhya Bhārat and Rājasthān.



It is the only major river in India which flows from South to North, having its origin in the Vindhya Range south of Mhow, and meeting the Jumna River after flowing a distance of over 600 miles. The scope of development in the valley is limited to the construction of three dams with a power station at each, while there is more than one suitable site below Kota for a barrage. It is anticipated that the barrage with canals will irrigate over a million acres of land. The maps prepared in connection with this project will be used mainly for planning the alignments of canals and distributaries.

For other work carried out by this party see Supplement to General Report 1953.

7. **Technical Methods.**—(a) *Control.*—The methods used for providing planimetric and height control for the survey have been described in the Technical Report for 1952 ( page 23 ).

In order to provide sufficient height control for contouring at 1 foot vertical interval, bench-marks of a semi-permanent nature were made on existing natural or artificial objects or embedded stones along the tertiary level lines at approximately  $\frac{1}{2}$ -mile intervals. These bench-marks together with other spot heights every 8 to 12 chains apart were accurately pricked on 2-inch vertical photographs. The levelled heights of these bench-marks and spot heights provided the requisite control for interpolation of the contours.

(b) *Survey.*—Ground verification was carried out on 2-inch vertical air photographs. Air survey on 2-inch scale was carried out by the normal radial-line method and the ground verified information was incorporated on the air survey sections. Contours at 1 foot interval were interpolated and the air survey sections were inked up in black for contours and white for other detail.

The air survey sections were then enlarged to the 4-inch scale and blue prints obtained for the fair drawing of the outline only. Contours were not fair drawn again but the contour plates prepared after enlargement of the air survey sections were used for final printing.

The final maps were printed in black for outline, brown for contours and yellow for cultivation.

### No. 3 PARTY

8. **General.**—The party was employed on the following survey jobs :—

- ( i ) South Bihār Irrigation Project for the Government of Bihār.
- ( ii ) Chambal Hydel and Irrigation Project for the Government of Madhya Bhārat.
- ( iii ) Dūdhi Government Estate for the Government of Uttar Pradesh.

9. **Technical Methods.**—( i ) *South Bihār Irrigation Project.*—The methods used for this survey have already been described in

the Technical Report for 1952 ( page 24 ). During the period under report fair mapping of the remaining sheets was completed.

( ii ) *Chambal Hydel and Irrigation Project*.—Maps on the scale of 4 inches to 1 mile with contours at 1 foot vertical interval and cultivation limits were required for planning of Irrigation Channels. The terrain, however, was not suitable for 1 foot contouring throughout and, accordingly, the specification for contours was changed to—

( a ) 1 foot in flat areas

( b ) 5 feet in undulating areas

and ( c ) 25 feet in hilly areas.

Bench-marks of a semi-permanent nature were also required to be made at approximately  $\frac{1}{2}$  mile intervals in flat and undulating areas.

The technical methods used were described in the Technical Report for 1952 ( page 23 ). In dense jungle areas, however, where accurate identification on photographs was not possible, tertiary levelling with tachymetric traverse was carried out. This traverse was later plotted on the air survey sections on 2-inch scale.

( iii ) *Dūdhi Government Estate*.—The Government of Uttar Pradesh required for revenue purposes, maps on the scale of 16 inches to 1 mile for each village of Dūdhi Estate with boundary pillars and cultivation limits. The forest areas of the estate were required to be surveyed and mapped on 4-inch scale with 50 feet contour interval for the Forest Department of Uttar Pradesh.

Shortly after a start had been made with the reconnaissance for triangulation the job was cancelled by the indenter.

#### No. 4 PARTY

10. **General**.—The party was employed on the following jobs :—

( i ) Fair mapping of Gandak Barrage sheets on 4-inch scale.

( ii ) Original ground survey on 1-inch scale in sheet 44 K/6 and on  $\frac{1}{2}$ -inch scale in sheets 44 D/SE, 44 D/SW, 44 H/NW and 44 K/SW.

( iii ) Triangulation for 1-inch and  $\frac{1}{2}$ -inch surveys in degree sheets 40 I, 40 M, 44 D, 44 K and 45 A.

11. **Technical Methods**.—( i ) *Gandak Barrage Scheme*.—The technical methods for this survey have been fully described in the Technical Reports for the years 1950, 1951 and 1952. The work carried out during this year involved completion of fair mapping only.

( ii ) Original ground survey on 1-inch and $\frac{1}{2}$ -inch scales	} Normal departmental methods were used for these jobs.
iii ) Triangulation	

## No. 13 PARTY

12. **General.**—Throughout the year the entire party remained employed on irrigation and settlement survey work for the Bhākra-Nāngal Project in degree sheets 44 M, N ; 53 B, C, D, F and G and 3,000-acre rectangulation for the Directorate of Consolidation of Holdings ( Punjab ) in selected areas of Amritsar District in degree sheets 44 I and M. In addition, 1½-inch scale verification survey was done in two 1-inch sheets in degree sheet 53 B.

13. **Technical Methods.**—( i ) *Bhākra-Nāngal Project survey work.*—A description of this work appears on pages 26 to 28 of the Technical Report, 1947. One small improvement introduced in the working drill this field season was employing individual Sub-Rectangulators as Rectangulator-cum-Tertiary Levellers in their own compact areas of work. This change was welcomed by the individuals who thereby got an opportunity to learn a second trade and ensured during the levelling operation that the numbering on each 100-acre stone was correct. The familiarity of their working squads with the area previously visited provided useful reconnaissance data for later levelling operations. This contributed towards improving the overall out-turn of the camp, apart from adding interest to the work.

Average out-turns of progress achieved during the year against forecast figures anticipated in the preceding year ( vide Technical Report, 1952 ) are tabulated below :—

Type of work	Out-turn per man per month			Party's expected average out-turns for planning programme in future in PEPSU and Punjab
	Forecast range, based on reports of the past years		Actually achieved during 1952-53	
	From	To		
	Sq. miles	Sq. miles	Sq. miles	
( <i>Field work</i> )				
3,000-acre rectangulation ..	50·9	62·1	59·4	60·0 sq. miles.
100-acre rectangulation ..	12·0	13·0	12·8 overall	12·5 sq. miles ( or 2/3rd of a 12,000-acre sheet ).
25-acre levelling ..	20·0	22·0	18·1 only	18·75 sq. miles ( or one full 12,000-acre sheet ).
( <i>Recess work</i> )				
Compilation and mapping	..	7·6	10·4	10 to 11 sq. miles.

( ii ) *Consolidation of Holdings surveys* consisted of topographical framework for 3,000-acre rectangulation based on triangulation control, provided immediately ahead of traverses

required for corner locations of the 3,000-acre rectangles. The rate of progress was slower than the average achieved in Bhākra-Nāngal area on account of the employment on the job of semi-trained and re-employed staff.

Splitting down the main rectangles to 1 and 5-acre holdings would be done by District Revenue Staff of the *patwāri* type.

(iii)  $1\frac{1}{2}$ -inch *Verification survey* was carried out on grey-prints of the existing outline originals of the relevant 1-inch sheets using the same method as described in the Technical Report, 1952 ( page 26 ).

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#### IV. TECHNICAL NOTES, EASTERN CIRCLE

14. **Summary.**—This report deals with the technical work of the following parties :—

No. 5 Party.

No. 9 Party.

No. 11 Party.

No. 12 Party.

No. 18 Party ( from 1st November, 1952 ).

During this period No. 18 ( Boundary Survey ) Detachment dealt with routine matters only relating to the examination of the Indo-Pak. boundary sheets prepared in the U.K. The detachment was disbanded on the 24th October, 1952. No. 18 Party was raised in Shillong on the same date for employment on Surveys in Assam.

For the first time departmental surveys of the Andaman and Nicobar Islands on 1 : 25,000 scale were taken up during the year under report.

#### No. 5 PARTY

15. **General.**—The party was employed on the following jobs :—

( a ) Original and revision survey of departmental 1-inch sheets in West Bengal.

( b ) Survey for Landing and Approach Charts of Gauhāti Aerodrome in Kām̄rūp District of Assam.

( c ) Large scale air survey and fair-mapping of tea estates in Assam.

( d ) Fixing co-ordinates of Indo-Pākistān boundary pillars.

16. **Technical Methods.**—*Original survey of departmental 1-inch sheets.*—Combination, for original survey, was carried out by slotted-template on 2-inch scale based on control points, provided by theodolite traverse lines of minimum accuracy of 1 : 5,000. Normal departmental air survey methods were employed for detail survey on the air survey sections.

Detail such as wells, mosques, temples, post offices, etc., positions of which were to be well fixed on the ground, were eventually pricked on the 2-inch vertical air photographs. Classification of roads, perennial streams, village names, and all other information, necessary for the departmental 1-inch sheets, were picked up on the ground. Changes of detail, that developed subsequent to air photography, were also recorded. Colour traces, on the scale of photography, were maintained for the whole area. Depth of water-table in the wells was also measured, the density of such measurements being one per 2 square miles.

Rapid tertiary levelling lines were run, emanating from and closing on existing secondary levelling bench-marks to provide a net-work of spot heights in the area to a density of one height per 10 square miles. Maximum permissible error, allowed in this case, was 0.25 of a foot per mile. Positions of all spot heights were pricked on the photographs.

From these spot heights positions of contours were located and followed with the help of clinometers. Points, nearly 400 yards apart, on every contour, were located on the ground and marked on the photographs. The contours were later completed under stereo-fusion, with the help of above height control.

*Revision survey of 1-inch sheets.*—The following methods were tried in course of revision of 1-inch sheets by air survey :—

(i) Comparison of the old detail with the new on the film positive of the existing survey and correction of the discordant detail only, by fitting the photographs on unchanged points of detail.

(ii) Resection of the principal point of each photograph on the film positive of existing survey with the help of unchanged detail and survey of detail by intersection from the principal points.

(iii) Air survey on blank Kodatrace, combination being carried out by the principal-point-radial-line method, based on reliable detail of existing survey.

(iv) Air survey on blank Kodatrace, combination being carried out by slotted-template method, based on reliable detail of existing survey.

Out of the above mentioned 4 methods, the last one was adopted for certain sheets.

*Survey of Landing and Approach Charts of Gauhati Aerodrome.*—The Survey was carried out according to the specification of the International Civil Aviation Organization, as amended in 1952. Revision survey on the blue print of modern 1-inch map on 1½-inch scale was resorted to for the Landing Chart survey. The geographical position of the Aerodrome Reference Point was fixed by triangulation and its height, through single and double tertiary levelling, from the nearest precision bench-marks. The heights of conspicuous obstructions and hazards in the Landing Chart area were obtained by reading vertical angles with the help of a theodolite from positions, connected by tertiary levelling, with the Aerodrome Reference Point.

For the Approach Chart survey the existing ¼-inch maps were revised on the ground with special care to the survey of positions and heights of all obstructions, likely to endanger the safety of an aircraft approaching the aerodrome.

*Air survey and fair mapping of tea estates.*—Combination was carried out by slotted-template on 16-inch scale based on plan control points provided by theodolite traverse lines of minimum

accuracy of 1 : 5,000. Information which could not be interpreted from the photographs was picked up on the ground. Contours were not required to be surveyed.

*East-West Bengal Boundary Survey.*—The geographical positions of the boundary pillars were fixed by triangulation using Hunter Short Base and emanating from G.T. Station or by theodolite traverse emanating from and closing on G.T. Stations.

### No. 9 PARTY

17. **General.**—The party was employed on the following surveys :—

- (a) Air revision and mapping for 4-inch Kosi Irrigation surveys to meet the requirements of the Central Water and Power Commission for the planning of an extensive system of irrigation canals covering the area.
- (b) Double and single tertiary levelling and ground verification for subsequent air revision and mapping for further 4-inch Kosi Irrigation surveys.
- (c) Provision of planimetric control by triangulation, height control by double and single tertiary levelling and clinometer, and ground verification for subsequent 6-inch air survey compilation for the Dāmodar Valley Corporation.
- (d) Rapid ground revision of communications and main details of portions of 1-inch maps which were not covered by large scale irrigation surveys.

18. **Technical Methods.**—(a) *Kosi Irrigation.*—Air photography was on the 2-inch scale. Air revision of 2-inch enlargements on Kodatrace of existing 1-inch maps of the area was carried out as follows :—

- (i) Principal points of the photographs were resected on the enlargements with the help of the reliable 1-inch detail identified on photographs. In open areas where points from 1-inch maps were not available or where the detail had changed considerably, e.g., near the main Kosi bed, the normal method of minor control plotting was employed for obtaining the position of principal points of photographs.
- (ii) Detail was chalked on a new set of photographs with the aid of ground verified photographs, and 2-inch enlarged purple prints on Kodatrace were corrected for detail from these photographs.
- (iii) All the bench-marks pricked on the photographs by the Levellers in the field were intersected on the purple prints and the spot height points were transferred on to Kodatrace.

- ( iv ) Contours at 1 foot vertical interval were interpolated from the mesh of bench-mark and spot heights.
  - ( v ) Fair-drawing was done on two separate Kodatrace originals for outline and contours. The maps were published in three colours : steel grey for detail and names, light brown for contours and yellow for cultivated areas. Blue was shown for water areas only for 2 sheets on which the main Kosi River appeared.
  - ( vi ) The technical method followed for field work was the same as reported in the Technical Report, 1952 ( page 32 ).
- ( b ) *Upper Dāmodar Valley Surveys.*—
- ( i ) For the planimetric control of the 6-inch air survey, minor triangulation was carried out to supplement the existing triangulation data in the area and an overall density of approximately one point in 2 square miles in open areas and one point in 4 square miles in jungle areas was attained. The triangulation was connected to existing G.T. and minor triangulation and was controlled by Hunter Short Base extensions for scale and *Polaris* observations for bearing at the start and close of work. All triangulation stations and points were pricked on 2·5-inch air photographs ( contact prints ) of the area by the triangulator on the ground.
  - ( ii ) The method of providing height control for contouring at 10 feet vertical interval was the same as described in the Technical Report, 1951 ( page 34 ) except that tertiary levelling was carried out along lines about 50 chains apart instead of 30 chains, and clinometric heights about half a mile apart were given to prominent points in between two levelling lines from pricked spot heights. In dense jungle where pricking of spot height positions was difficult, horizontal angles between back and forward staff positions were also observed for subsequent plotting. Stadia readings were used for calculating distances. Clinometric heights to tops, saddles and changes of features in hills were given by ground verifiers.
- ( c ) *Accuracy.*—The average closing error attained in triangulation for Dāmodar area was 1 : 28,000 in scale and about 10" in bearing. The average closing error attained for tertiary levelling for Kosi and Dāmodar areas was ·02 feet and ·04 feet per mile respectively. This was quite adequate for 1-foot generalized contours in the Kosi area and 10-foot contours in the Dāmodar area.



19. Notes on Out-turn.—(a) The out-turn of levelling was low in the Dāmodar area due to :—

- ( i ) Six new Topo Trainees, Type 'B' having been recruited just before the beginning of the field season and employed on levelling after training for about a fortnight.
- ( ii ) Western portion of the area being covered with dense jungle.
- ( iii ) Communications being very poor in the western part of the Dāmodar area.
- ( iv ) To complete the allotted field work, personnel had to work till the middle of May when it was very hot, and field work for levelling was restricted to cooler hours of the morning only.

( b ) The out-turn for ground verification was satisfactory being about 2 square miles per working day.

#### No. 11 PARTY

20. General.—The party carried out the following field work :—

- ( i ) Planimetric control, height control and ground verification for subsequent air survey, in a part of the Mahānadi Delta area.
- ( ii ) Survey of forest boundaries on 1 : 25,000 scale in Rānchi District of Bihār.
- ( iii ) 2-inch survey of a part of Gandak commanded area in Champāran District of Bihār.
- ( iv ) Completion of planimetric control for 16-inch cadastral survey ( by air survey methods ) of ex-State of Athgarh.
- ( v ) Verification of reserved forest boundaries in a portion of Mahānadi ( Hirākud ) project area.

21. Technical Methods.—( i ) *Mahānadi Delta area.*—The surveys were for planning purposes by Central Water and Power Commission. Requirements being 4-inch scale maps with 1-foot contour interval, work was undertaken on 2-inch scale for subsequent enlargement to 4-inch.

A reconnaissance of the area was made to find the old triangulation and traverse stations and points. Some of these were found to be still existing on the ground. Their positions were pricked on the 2-inch air photographs of the area. Theodolite traverse was run in those parts of the area where the density of the existing old points was not sufficient.

Lines of double tertiary levelling to connect the existing benchmarks of primary and secondary level lines were run. The area was divided into convenient blocks to enable the final tertiary lines to be

run between the bench-marks of the double tertiary lines, approximately 10 miles apart. The tertiary level lines were run in the general direction of the run of the strips of the air photographs, at intervals of roughly 55 chains. For this purpose, guide lines, 55 chains apart, were drawn in blue on the air photographs and the Levellers kept close to these lines as identified on the ground. Semi-permanent bench-marks mostly at intervals of about half a mile along the lines, were established at the bases of trees, on culverts, mile stones, etc. In addition, levelled spot heights were observed for points situated about 10 chains away on both sides of the lines of levelling, the distance between the consecutive positions of such "abreast" points being about half a mile. Positions of the bench-marks were pricked on the air photographs. Clinometer readings were also taken from convenient staff positions to prominent objects situated on high mounds and in river beds. These were also pricked on the photographs. In this manner, a uniform mesh of heights covering the whole area was obtained, to provide control for 1-foot contouring. Information regarding classification of roads, mile stones, culverts, canals, distributaries, relative heights, cultivation limits, vegetation, temples, mosques, etc., was recorded on colour traces. Village lists on the prescribed form were kept. Names of the more important villages were underlined in the village lists.

(ii) The 1 : 25,000 forest boundary sheets were prepared by direct tracing on Kodatrace of the plane-table sections on which the boundaries were surveyed in the field season 1951-52. Each sheet was prepared by tracing two plane-table sections forming either the north half or the south half of a 1-inch sheet. Information regarding the classification of the forests was obtained from the local Forest Department and typed on the originals. Master appliqué slips for headings and footnotes of the sheets were prepared for pinning up in position on all the originals before photography in the printing office. An insertion and deletion guide was submitted with each sheet. These guides showed the corrections to the blue-print detail and contours astride the forest boundaries as surveyed on the ground. On the final maps, the 1 : 25,000 enlargements of the existing detail of 1-inch maps, corrected with the help of the guides mentioned above, are printed in steel grey, contours in brown, and the forest boundaries and other forest information are surprinted in green.

The method employed for surveying on 1 : 25,000 scale the forest boundaries in Rānchi District was the same as followed in the previous year, but the blue-print detail and contours were corrected not only astride the forest boundaries but at other places also, wherever changes were detected during the course of the survey.

(iii) In the Gandak Barrage area contouring was not done for the 2-inch blue-print survey. 1-foot contouring of the area will be done at the time of mapping, with the help of the close network of

levelled spot heights that had been provided in the previous field season.

( *iv* ) The method for providing planimetric control in a part of the ex-State of Athgarh was the same as described in detail in the Technical Report for 1952 ( pages 33 to 36 ).

( *v* ) The verification survey of the reserved forest boundaries in a part of the Mahānadi ( Hirākud ) area was done by plane-table traverse on copies of the 2-inch vertical air photographs of the area. Since the boundaries ran generally along the base of the hills, the photographs were used in the same way as plane-table sections, care being taken not to use rays from points which were situated in the hills, for making the fixings. Measurements from nearby points, identifiable on the photographs, were taken to check the position of the fixings. The box magnetic compass was used in plane-table traversing.

**22. Miscellaneous.—Communications.**—Numerous water channels, canals and their field distributaries in the Mahānadi Delta area slowed down the movement of camps. While it was possible to use canal roads for motor vehicles it was not permissible for bullock carts to go on them. Boats were, therefore, the only means of transport in the eastern part of the area, but because the boat journeys were dependent on the tides in the streams and creeks, it sometimes took two or three days to cover a journey of about 15 miles. The boats too, were not always readily available.

The two weapon carriers attached to the camp, were of great help to the inspecting officers and for occasional shifting of the camps of the personnel, in spite of very frequent break-downs. Bullock cart transport was easily available in Athgarh area, Gandak Commanded area and Mahānadi ( Hirākud ) area, but in the wooded hills of Rānchi forests *mazdoors* had to be engaged for the conveyance of baggage, etc.

*Notes on Out-turn.*—In the Mahānadi Delta area, besides the poor communications, especially in the eastern part of the area, late arrival of the air photographs was a major cause of low out-turn. Another factor affecting the out-turn was that 4 of the Levellers were new recruits who had first to be trained and then employed on productive work. The average out-turn per month after the arrival of the photographs, was satisfactory.

The out-turn was much below expectation for Rānchi District Forest Boundary survey mainly because of the very late and slow clearance of the forest boundaries, which was the responsibility of the local Forest Department.

The out-turn in the other camps was normal.

#### NO. 12 PARTY

**23. General.**—The party was employed on air surveys of Bihār Mica Belt project and of Car Nicobar Island and ground control for 1 : 25,000 air survey of Andaman and Nicobar Islands.

24. **Technical Methods.**—(i) *Andaman and Nicobar Islands.*—The planimetric control was provided by minor triangulation based on G.T. Stations fixed by Geodetic and Training Circle in 1950–51. This provided well-fixed points both along the sea coast as well as in the interior. Height control was mainly carried out by *clinometric levelling* which gave accurate results, but its progress was extremely slow due to the area being hilly and covered with dense jungle. Height control by barometric traverses was also tried by the 'Leap-Frog' method, but had to be abandoned, as the traverses failed to give consistent results. In open areas clinometric heights to approximate ground levels near prominent trees were also used.

The accuracy of ground control was :—

Triangulation	.. .. .	1 : 15,500
Height control—Clinometric levelling	..	±7 feet

*Clinometric Levelling.*—Due to steep hills covered with thick forest, levelling with an ordinary level, or theodolite set at 0° was not practicable. The operation was started from the top of a hill from a point where the height was known. The plane-table with a clinometer was set on it. A *Khalāsi* would then take a levelling staff down the slope to such a place where the 0° reading of the clinometer could be read off on the feet graduations of the levelling staff or to similar marks made on a bamboo pole. The plane-table would then be removed and set up at the place occupied by the staff and the operation repeated till another point of known height was reached. The levelling errors could then be distributed equally between intermediate stations. Stations easily identified on photographs were pricked on them. It was a laborious but a very accurate and the only method possible in these jungles.

(ii) *Bihār Mica Belt.*—Air survey of areas covered by sheets 72 L/2 and 6 was carried out by methods described in the Technical Report for 1951 (page 37). As regards areas falling in 72 L/10, rigorous air survey was carried out by the principal-point-radial-line method.

(iii) *Car Nicobar Islands.*—Rigorous air survey on 1 : 25,000 scale was carried out to departmental specifications.

25. **Miscellaneous.**—*Notes on Out-turn and costs.*—In case of ground control for Andaman and Nicobar Islands, the out-turn was below expectation, due to the extremely difficult terrain, lack of communications and other essential facilities. Height control of required density was, however, increasingly difficult to provide and a lot of time was wasted.

Costs involved seemed a bit excessive but in fact, compare very favourably with the expenditure incurred for ground surveys executed by survey parties in the past, over similar terrain in Burma.

#### No. 18 PARTY

26. **General.**—The Party was employed on Surveys in connection with the Kopili Flood Control Project to meet the

requirements of the Assam Government. Maps were required on 4-inch scale with generalized contours at 1 foot vertical interval.

27. **Technical Methods.**—(a) *Planimetric control* for air survey combination was provided by a network of theodolite traverse lines emanating from and closing on traverse stations fixed in 1948–49. Connection was made to previous topographical triangulation for check. Astronomical bearings controlled the traverse.

(b) *Heights.*—(i) Double tertiary levelling lines were run to follow the traverse lines as in (a) above along the perimeter of the area and were connected to old (1948–49) double tertiary bench-marks. Check levelling (double tertiary) lines were run along the old double tertiary lines of 1948–49 and a new set of bench-marks were fixed where the old ones were found to be destroyed or disturbed. A network of double tertiary lines was also provided inside the area, thus keeping the lines of height framework about 4 miles apart on an average.

(ii) Single tertiary levelling in the form of roughly parallel lines (north–south) were run half a mile apart between bench-marks fixed by double tertiary levelling, providing spot heights and semi-permanent bench-marks at 10 chain and half mile intervals respectively. In the southernmost area where the country is undulating and covered with dense jungle, the tertiary lines were run mostly along foot-paths. It was decided with the consent of the indenter, to contour this particular area at 5 feet vertical interval instead of 1 foot.

(c) *Ground Verification of details on photographs.*—Details which could not be easily identified on photographs, classification of roads and tracks, names and relative heights, etc., were picked up in the field by Plane-tablers. As the area had developed considerably since the photographs were taken (in February 1948), most of the detail had to be picked up by plane-table traverse on the photographs.

(d) *Ground Survey.*—The area which had no photo cover was surveyed on the ground on 2-inch enlarged blue-prints of the existing 1-inch maps of the area using the control mentioned in paras (a) and (b) above. 1-foot contouring was done on the ground using the improvised clinopole. Depending on the nature of country, the contour interval varied from 5 feet to 25 feet.

(e) *Accuracy.*—The following was the accuracy demanded from the personnel in the field :—

(i) Traverse — 1 : 2,000.

(ii) Double tertiary levelling — 0·009 foot per mile.

(iii) Single tertiary levelling — 0·05 foot per mile up to a maximum of 0·5 foot in a line above 6 miles.

Actual average errors were :—

(i) Traverse — 1 : 4,200.

(ii) Double tertiary levelling — 0·005 foot per mile in 360·6 miles.

( iii ) Single tertiary levelling — 0·05 foot per mile in 1,278 miles.

28. Miscellaneous.—*Notes on Out-turn.*—The following factors affected the out-turn adversely to a great extent :—

- ( i ) Old photographs — Photographs were taken in February 1948. Since then the area had developed considerably thus making interpretation of detail on photographs difficult.
  - ( ii ) The camp was too big for one Camp Officer with a probationer Class II Officer as assistant properly to supervise. Most of the staff had no previous experience of surveying in thickly jungle-clad country. Close supervision and instruction on productive work to maintain reasonable out-turn was therefore required.
- and ( iii ) Bad communications, and dearth of labour in the harvesting season.
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## V. TECHNICAL NOTES, SOUTHERN CIRCLE

29. **Summary.**—During the period under report, the following units were under the administrative control of the Director, Southern Circle :—

- No. 6 Party.
- No. 8 Party.
- No. 10 Party.
- No. 17 Party.
- No. 4 Drawing Office.

Brief reports of the various survey operations carried out by the above mentioned field units have been given in the General Report, 1953. As the technical aspect of survey work is to be described in this Report, no reference is made here to the activities of No. 10 Party employed on work of a purely routine nature.

### No. 6 PARTY

30. **General.**—The party was employed on fair mapping of the Ukāi and Kākādāpār Reservoir areas during recess. During the field season the party was employed on providing framework for future settlement and topographical surveys, ground verification and heighting on vertical air photographs for departmental surveys and the survey of the Deesa Aerodrome and surrounding areas for the preparation of Aeronautical ( International Civil Aviation Organization ) Charts.

31. **Technical Methods.**—( a ) *Framework for future settlement surveys.*—The job, undertaken for the Settlement Officer, Kutch, consisted of :—

- ( i ) field measurements for providing a framework along or close to village boundaries for future surveys,
- ( ii ) the computations of the field measurements and recording them on *patrak* forms—forms which give details of all field measurements, computations and areas, and
- ( iii ) plotting of the computed co-ordinates of points—on or near the village boundaries—on to gridded “plot sheets”.

The area of work for 1952–53 was divided into blocks, of approximately 70 square miles each, bounded by main traverses of 1 in 3,000 accuracy. They were run by crinoline chains and connected to geodetic stations in the vicinity. The traverses for village boundaries were run to a minimum accuracy of 1 in 500. They were based on the main traverses and served to connect the boundary pillars established by the Settlement authorities. The

actual boundary on the ground, being unknown to the Traversers, was not fixed by the Survey of India ; the Settlement authorities will, at a later date, demarcate and fix the boundary in relation to the network of points established by the Survey of India. The village traverses, however, closely follow the village boundaries to enable the latter to be fixed conveniently by elementary surveying methods.

In hilly areas traversing was neither possible nor economical. It was, therefore, found expedient to resort to theodolite resections using correctly identified and well defined stations, supplemented generously by triangulation.

( b ) *Topographical surveys by air methods.*—Taking advantage of the air cover available in sheet 41 E, the air-cum-ground method was adopted for the survey of six departmental one-inch sheets. Photography was on 2-inch scale for sheet 41 E/3 and on 1 : 25,000 scale for the rest of the sheets. In plains, contours, being few, were directly inked on the photographs ; elsewhere sufficient clinometric heights were fixed, using triangulated data, to enable the rest of the contouring to be completed during recess. The photographs were verified on the ground for classification of roads, other communications, names and all doubtful items of detail. The usual air survey methods will be employed to compile the map during the following recess.

( c ) *Triangulation.*—Triangulation to provide control for 1-inch surveys was carried out in the area of eight 1-inch sheets of 41 A and E. Due to the existence of a sufficient number of geodetic bases to start and close the series conveniently, neither fresh bases nor azimuths were measured. All the triangulated stations and most of the intersected points were identified and marked on photographs.

*Aeronautical Charts.*—The survey of the Landing and Approach Charts for the Deesa Aerodrome in sheet 45 D was carried out in accordance with the specifications for such surveys by plane-table methods.

*Fair mapping.*—The number and lay-out of the Ukāi maps were altered to accommodate the additional area demanded by the indenter. The whole area was, therefore, redrawn on Kodatrace in a series of nineteen sheets ( as against six in the old lay-out ). The poor quality of waterproof black ink, combined with the inexperience of the men in handling Kodatrace, left much to be desired in the quality of the resultant fair sheets. As an experimental measure one of the contour originals was drawn completely with brown waterproof ink which appeared to flow easily and hence could be used in swivel pens. This original took 20% less man-days than a similar sheet drawn in black, and the printed proofs indicate that it reproduced satisfactorily.

The fair mapping of the Kākadāpār Reservoir sheets continued to present considerable difficulties, about which mention was made in the Technical Report, 1952 ( page 39 ). The air survey sections



supplied to the party varied considerably from the accepted departmental standards, and laborious and painstaking corrections were made to make them acceptable.

### No. 8 PARTY

32. **General.**—The party was employed on the following departmental and extra-departmental surveys and mapping :—

- ( a ) 1-inch mapping of sheets 47 G/9, 10, 11, 13, 14, 15.
- ( b ) 1-inch blue-print survey of sheets 47 G/1, 2, 3, 5, 6, 7, 8 and 4, 12, 16.
- ( c ) 1-inch verification survey of communications in sheets 48 J, K, N, O and 57 C.
- ( d ) 4-inch air survey and mapping of Tungabhadra Project.
- ( e ) 8-inch air survey and mapping of Bhadra Reservoir.
- ( f ) 12-inch mapping of Bombay Oil Refineries.
- ( g ) 12-inch ground survey and mapping of an extension of Bombay Oil Refineries area in Bombay State for the Standard Vacuum Refining Company of India Limited.
- ( h ) 12-inch ground survey and mapping of an extension of Bombay Oil Refineries area in Bombay State for the Thorium-Uranium Factory required by the Atomic Energy Commission of the Government of India.
- ( i ) 16-inch mapping of Miraflores Estate.

33. **Technical Methods.**—The method adopted for the air survey and mapping of Tungabhadra Project, ( d ) above, has been described in the Technical Report, 1947 ( page 49 ). The mapping of 1-inch sheets and Miraflores Estate, ( a ) and ( i ) above respectively, was carried out by normal methods. The method used for the survey of Bombay Oil Refineries has been described in the Technical Report, 1952 ( page 42 ). The surveys of the extension area of Bombay Oil Refineries and the Thorium-Uranium Factory were carried out by normal ground survey methods based on the planimetric and height-control, fixed for the survey of Bombay Oil Refineries in the previous field season. The method used for 1-inch verification survey was the same as described in the Technical Report, 1952 ( page 43 ). The methods used for the other surveys and mapping are given below :—

( a ) *1-inch blue-print survey.*—Old maps of pre-1905 surveys were mosaiced on the modern lay-out on 1-inch scale using the re-computed old triangulation data as control. The survey was carried out on zinc-mounted blue-prints on 1-inch scale, obtained from the above mosaics, by normal ground survey methods. The main streams and form-lined hill features on the blue-prints were found to be generally accurate except at a few places, where they were out in position by as much as 10 chains. In the beginning, since all the Plane-tablers were inexperienced, a rigorous check

was carried out before accepting the old detail. Towards the latter half of the field season, selected Plane-tablers were allowed to accept the main details, e.g., streams and hill ridges on the blue-print after checking them at salient points.

The method adopted for the re-computations of co-ordinates and heights of the old topographical triangulation has been described in the Technical Report, 1951 ( pages 41 and 42 ). Where the old triangulation heights referred to the tops of trees they were checked and refixed by the Camp Officers by observing vertical angles with a theodolite and computing them from distances taken from 1-inch plane-table sections, before they were used by the Plane-tablers.

( b ) *1-inch verification survey.*—The office copy corrections to communications were verified on 1-inch unmounted published sheets by normal ground methods. In addition to the corrections marked on the office copies, many other corrections to main power lines, roads and town extensions were found on the ground and were verified. Each Plane-tableter was provided with 2 bicycles to convey him, his plane-tableting equipment and one *khalāsi* to facilitate quick movement in the field. In the hilly area the Plane-tablers found it strenuous to cycle along the hill roads and rugged tracks, which they covered at an average rate of 30 miles per day.

( c ) *Bhadra Reservoir.*—The air survey compilation was carried out in 13 sheets on the mean scale, 8·4 inches to 1 mile, of the photo enlargements by normal air survey methods and the maps published on scale 8 inches to 1 mile. At the request of the Special Chief Engineer, Mysore, the revenue holdings and their numbers were printed in blue on these maps to facilitate assessment of area of revenue land that would be submerged by the proposed reservoir. The information regarding the revenue holdings and their numbers was supplied by the Special Chief Engineer on a blue print on Kodatrace of the combined outline and name original of each sheet.

#### No. 17 PARTY

34. **General.**—The party was engaged on the following technical work, during the year :—

( a ) One-inch original ground survey of sheets 46 N/9 to 15 in Madhya Bhārat.

( b ) Completion of field work pertaining to the 4-inch survey of Mahi Project Commanded Area.

35. **Technical Methods.**—( a ) *One-inch Original Ground Survey.*—In sheets 46 N/9 and N/13 the existing density of control was supplemented by carrying out theodolite traversing in the flat area of sheet 46 N/9 and by carrying out triangulation in the undulating area of sheet 46 N/13. The triangulation and traverse were based

on the G.T. data given in the Triangulation Pamphlet for sheet 46 N ( 1916 Edition ).

The original ground survey on one-inch scale was carried out on zinc-mounted blank plane-table sections by the normal methods. Maps on the one-inch scale were available for some of the reserved forests in the area of survey, which proved helpful.

( b ) The methods adopted for the survey of Mahi Project and Sharāvati Project have been described in the Technical Report, 1952 ( page 45 ).

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## PART II.—MAP PUBLICATION AND OFFICE WORK

### TECHNICAL NOTES

#### VI. PRINTING

36. **Renovation of time-barred photographic material.**—At the end of World War II, the Survey of India found itself in possession of a large quantity of time-barred photographic plates and films. At the same time, the supply position of photographic material from abroad became very difficult and costs prohibitory. These factors made it imperative to find ways and means of making this time-barred photographic material usable. With this object in view experiments were started in P.Z.O. by Shri P. N. Kirpal, its Manager, for renovating these time-barred photographic plates and films, of which a brief reference had already been made in the Technical Report for 1952 ( page 47 ).

A brief account of the method employed and results obtained in the renovation of time-barred photographic material is given below :—

The time-barred plate or film is taken out of its container ( this can be done in diffused light, but strong sunlight or arc light must be avoided ) and examined in ruby light for cracks and chipping of the film. It is then washed in a water bath for about 3 to 4 minutes, the water in the bath being kept in motion. The film is then rinsed and dipped in the renovating solution which is kept in motion. The renovating solution is composed of :

Acid Chromic ( pure flakes )	..	440 grains
Potassium Bromide	.. ..	800 „
Pot. Alum	.. ..	1 ounce
Acid Acetic	.. ..	1 „
Water	.. ..	1 gallon

Care should be taken to see that the bath is free from dirt or impurity. After about 9 to 12 minutes in the renovating bath, the film is gently and thoroughly washed in water. No extra solution should remain on the surface of the film, as otherwise, marks will appear when the job is completed. The film is now active to light and dried in a dark room under an electric table fan or a slow current of air. The room should be free from dust and its temperature not more than 65°F. When dried, the film/plate is ready for immediate use or may be stored in the normal way for use later.

Samples tried were :—

Plates—Barnet (Sensichrome and special series), Kodak Wratten Process Pan, Ortho Ilford HT ;

Films—Kodalith (roll), Kodaline Slow, Special Process, Contrast Process, Commercial Ortho (thin and thick base) ;

and Ilford Photo-mechanical, B.G.1 and Kodak Bromide papers.

Good results were obtained after renovation in all cases except in the case of Commercial Ortho films (thick and thin base) where the renovated films were not contrasty.

The advantages of renovation are :

- ( i ) Salvaging of large stocks of time-barred films/plates satisfactorily and the saving resulting therefrom.
- ( ii ) No special equipment required : everything can be done in a dark room.
- ( iii ) Simplicity and cheapness of the process—only Re. -/13/- worth of material was used for renovating 4 films of size 20" × 26".

The disadvantages are :

- ( i ) Slowness of plates ( this actually is an advantage for contact work ).
- ( ii ) Loss of panchromatic qualities.
- ( iii ) Tendency for the backing of the material to dissolve and settle on the sensitive side in excessive heat of 70°F. and above. This can be avoided by maintaining a uniform cool temperature of 65°F. or less.

The renovation should not be carried out in a room where developing and fixing is being done, as hypo crystals flying about in the atmosphere are liable to get into the renovating solution, and spoil the work. The following developer is recommended for developing renovated films and plates :

Metol	..	9/16 ounces
Soda sulphate	..	10½ "
Hydro quinine	..	2½ "
Soda carbonate	..	14½ "
Pot. bromide	..	5/16 "
Water	..	3 gallons.

It should be used at full strength, the time of development being from 1½ to 2 minutes.

*Life of renovated material.*—Further experiments have been conducted to gauge the life of the renovated films. So far the average life of this film is about 8 months. Perhaps this could be bettered by improving methods of storage. After 8 months, renovated film becomes fogged. It can be renovated again but the film becomes very slow.

Out of the same roll of 1945 film from which experiments were carried out in 1951 a piece was detached and renovated in April 1954. The results obtained were identical with those obtained three years ago. This shows that a time-barred film will respond to renovating treatment to the same degree whether it is 3 years old or 6 years old. In the present case the exposure time after renovating was  $1\frac{1}{2}$  minutes, the same as was obtained in 1951.

It is, therefore, recommended that time-barred film should be renovated on an as required basis and not for storage over three months.

Time-barred Panchromatic films lose their Pan qualities and speed but are fast enough for contact printing after renovation. In other words a renovated pan film is as good as a new ortho film, exposure time being in the region of 10 seconds to 15 seconds.

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## **I N D E X   M A P S**

**INDEX A.**—Modern Topographical Surveys and Compilation.

**INDEX C.**—Index showing Project Surveys in hand.

*N.B.*—The above two indexes are the same as Indexes A and C which appear in the General Report, 1953.



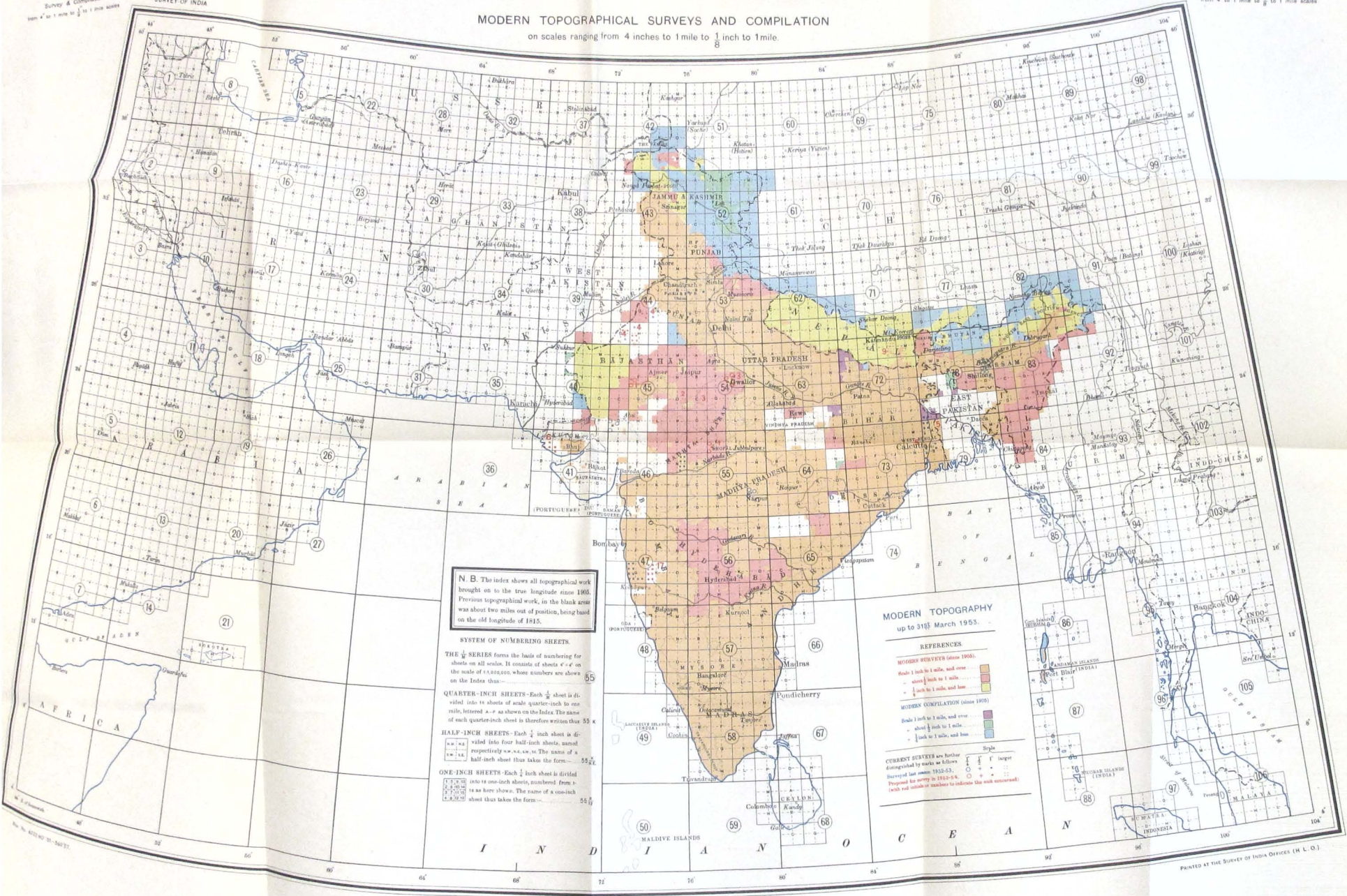
Survey & Compilation  
from 4" to 1 mile to 1/8" to 1 mile scales

Survey & Compilation  
from 4" to 1 mile to 1/8" to 1 mile scales

SURVEY OF INDIA

### MODERN TOPOGRAPHICAL SURVEYS AND COMPILATION

on scales ranging from 4 inches to 1 mile to 1/8 inch to 1 mile.



**N.B.** The index shows all topographical work brought on to the new longitude since 1903. Previous topographical work, in the blank area was about two miles out of position, being based on the old longitude of 1815.

#### SYSTEM OF NUMBERING SHEETS.

**THE 1/4" SERIES** forms the basis of numbering for sheets on all scales. It consists of sheets 4" x 4" on the scale of 1:250,000 whose numbers are shown on the Index thus—

**QUARTER-INCH SHEETS**—Each 1/4" sheet is divided into 4 sheets of scale quarter-inch to one mile, lettered a, b, c, d as shown on the Index. The name of each quarter-inch sheet is therefore written thus 53 a

**HALF-INCH SHEETS**—Each 1/2" sheet is divided into four half-inch sheets, named respectively w, x, y, z. The name of a half-inch sheet thus takes the form—

**ONE-INCH SHEETS**—Each 1" sheet is divided into 16 one-inch sheets, numbered from 1 to 16 as shown above. The name of a one-inch sheet thus takes the form—

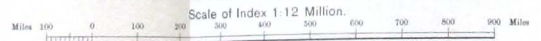
#### MODERN TOPOGRAPHY

up to 31st March 1953.

##### REFERENCES

- MODERN SURVEYS (since 1903):
  - Scale 1 inch to 1 mile, and over
  - Scale 1/2 inch to 1 mile
  - Scale 1 inch to 1 mile, and over
  - Scale 1/2 inch to 1 mile
  - Scale 1 inch to 1 mile, and over
  - Scale 1/2 inch to 1 mile

CURRENT SHEETS are further distinguished by marks as follows:  
Surveyed last season 1952-53.   
Proposed for survey in 1953-54.   
Link and number numbers to indicate the work continued.



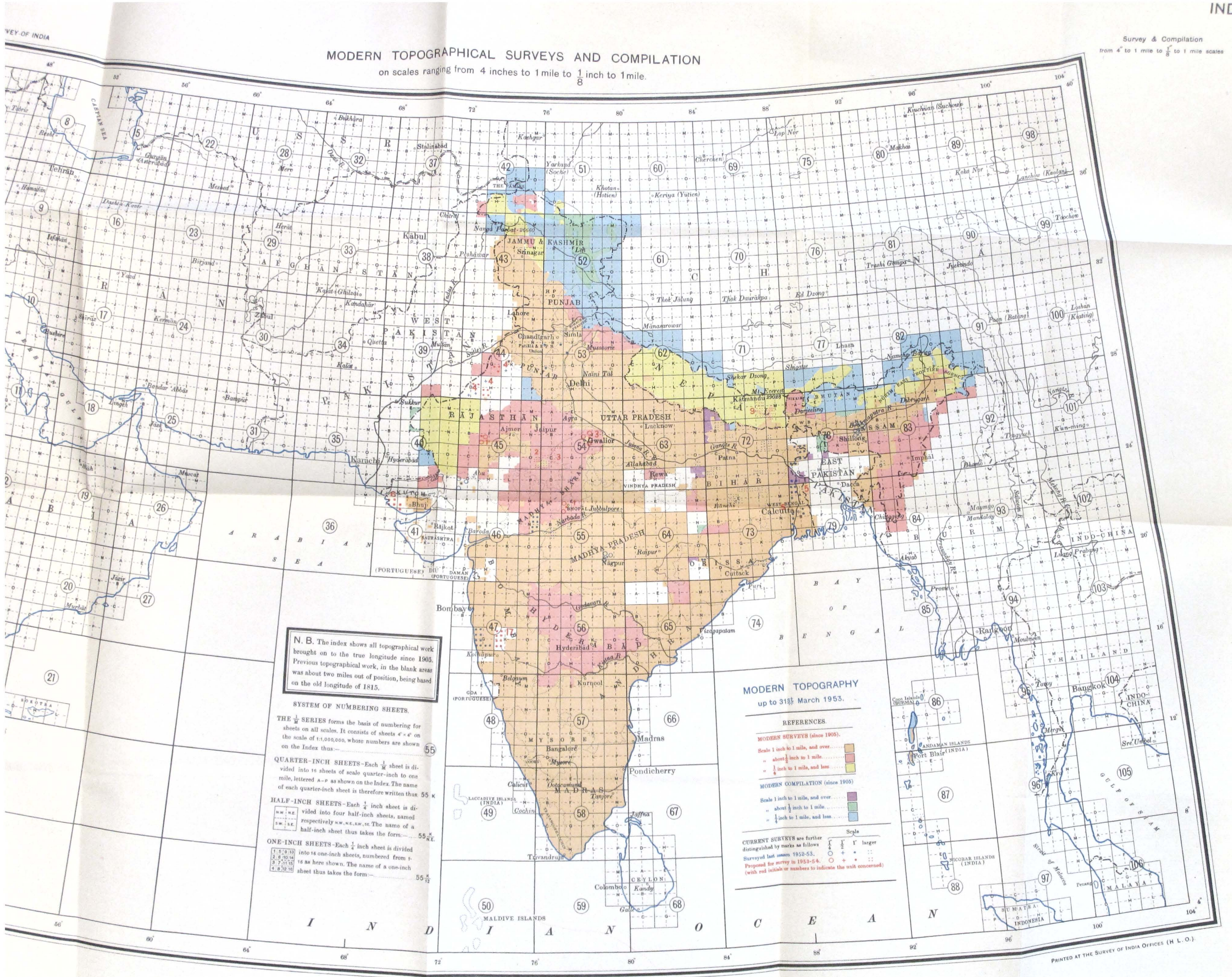
Published under the direction of Brigadier I. H. R. Wilson, F.R.I.C.S., M.S.I.(col), Survey-General of India, 1953.

Sikkim and Bhutan are attached to India by special treaty.  
Madras state was divided into Andhra & Madras on 2nd October 1953.

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MODERN TOPOGRAPHICAL SURVEYS AND COMPILATION  
on scales ranging from 4 inches to 1 mile to 1/8 inch to 1 mile.

Survey & Compilation  
from 4" to 1 mile to 1/8" to 1 mile scales



N. B. The index shows all topographical work brought on to the true longitude since 1905. Previous topographical work, in the blank areas was about two miles out of position, being based on the old longitude of 1815.

SYSTEM OF NUMBERING SHEETS.  
THE 1/4" SERIES forms the basis of numbering for sheets on all scales. It consists of sheets 4" x 4" on the scale of 1:1,000,000, whose numbers are shown on the Index thus: 55

QUARTER-INCH SHEETS - Each 1/4" sheet is divided into 16 sheets of scale quarter-inch to one mile, lettered A-F as shown on the Index. The name of each quarter-inch sheet is therefore written thus: 55 K

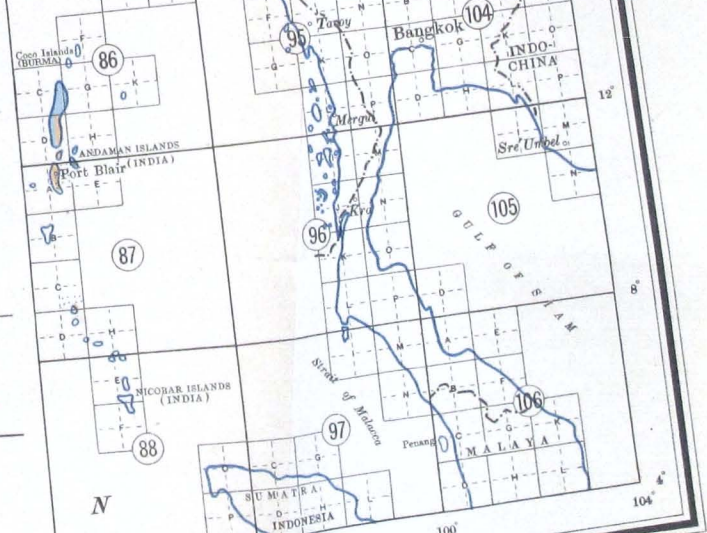
HALF-INCH SHEETS - Each 1/4" sheet is divided into four half-inch sheets, named respectively N.W., N.E., S.W., S.E. The name of a half-inch sheet thus takes the form: 55 K N.E.

ONE-INCH SHEETS - Each 1/4" sheet is divided into 16 one-inch sheets, numbered from 1-16 as here shown. The name of a one-inch sheet thus takes the form: 55 K 12

MODERN TOPOGRAPHY  
up to 31st March 1953.

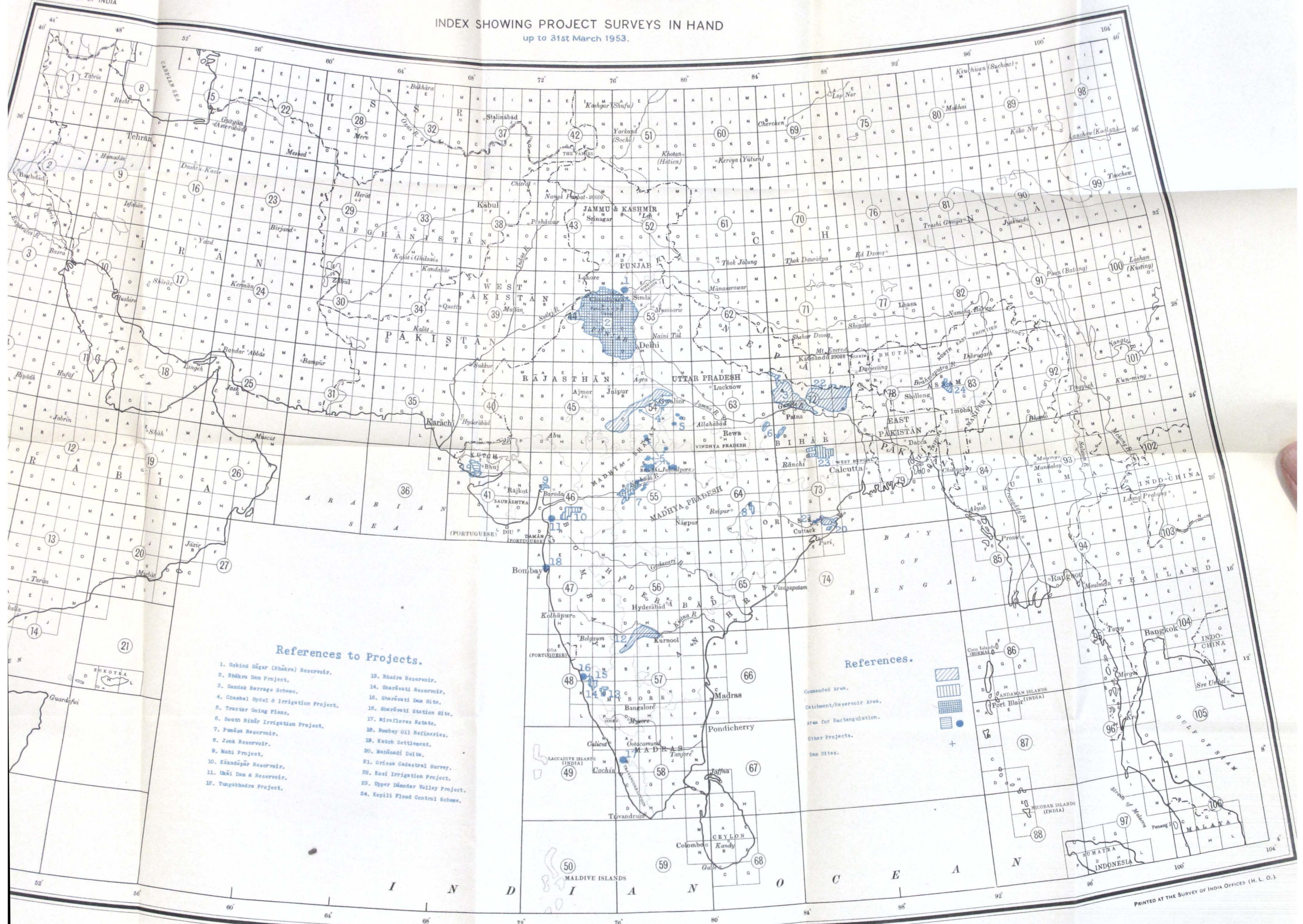
- REFERENCES
- MODERN SURVEYS (since 1905):
    - Scale 1 inch to 1 mile, and over: [Orange box]
    - " about 1/2 inch to 1 mile: [Red box]
    - " 1/4 inch to 1 mile, and less: [Yellow box]
  - MODERN COMPILATION (since 1905):
    - Scale 1 inch to 1 mile, and over: [Purple box]
    - " about 1/2 inch to 1 mile: [Green box]
    - " 1/4 inch to 1 mile, and less: [Blue box]

CURRENT SURVEYS are further distinguished by marks as follows:  
Surveyed last season 1952-53: [Red circle]  
Proposed for survey in 1953-54: [Blue circle]  
(with red initials or numbers to indicate the unit concerned)



SURVEY OF INDIA

INDEX SHOWING PROJECT SURVEYS IN HAND  
up to 31st March 1953.



References to Projects.

- 1. Gobind Sagar (Bhakra) Reservoir.
- 2. Bhakra Dam Project.
- 3. Gandak Barrage Scheme.
- 4. Chashal Hydel & Irrigation Project.
- 5. Tractor Gearing Plans.
- 6. South Bihar Irrigation Project.
- 7. Punjab Reservoir.
- 8. Jonk Reservoir.
- 9. Nahi Project.
- 10. Kakadpār Reservoir.
- 11. Ukai Dam & Reservoir.
- 12. Tungbhadra Project.
- 13. Bhadra Reservoir.
- 14. Sharavati Reservoir.
- 15. Sharavati Dam Site.
- 16. Sharavati Station Site.
- 17. Miraflores Estate.
- 18. Bombay Oil Refineries.
- 19. Kutch Settlement.
- 20. Mahisudi Delta.
- 21. Orissa Cadastral Survey.
- 22. Kosi Irrigation Project.
- 23. Upper Damodar Valley Project.
- 24. Kapiili Flood Control Scheme.

References.

- Commanded Area.
- Catchment/Reservoir Area.
- Area for Rectangulation.
- Other Projects.
- Dam Sites.

