CHAPTER I

I N T R O D U C T I O N

GENERAL

The area under investigation covering approximately 1438 sq km (562 sq miles), is a part of the Saurashtra (Kathiawar) Peninsula of the State of Gujarat (Map I.1). It comprises of the western part of Surendranagar district and the eastern part of Rajkot district. It lies between latitudes 22° 30' and 22° 45' N and longitudes 71° 00' and 71° 30' E. It is represented by one inch to a mile Survey of India Toposheet No. $41\frac{N}{2 \& 6}$. Talukawise general information of this area regarding population, education, rest houses post and telegraph offices, hospitals, quarries and factories is given in Table I.1. The location and the international block number of villages are given in Table I.2.

COMMUNICATION

Than, which is centrally situated, is connected by meter guage railway to Surendranagar and Rajkot at a distance of 50 and 71 km respectively. The conversion of this meter guage railway line to broad guage railway line is in progress. Chotila, on the National Highway No.8, is located to the south of the area at a distance of 21 km from Than and is connected with it both by rail and road (Map I.2). Within

TABLE I.2

VILLAGE INVENTORY CHART

(Toposheet No. $41\frac{N}{2 \& 6}$)

Village	International Block Number	Taluka	District
1	2	3	4
1. Amarapar	C/2	Chotila	Surendranagar
2. Aya Dagdagia	D/3	Sayla	"
3. Aya Deriwala	E/3	"	"
4. Bhaduka	E/3	"	"
5. Bhasol	E/3	"	"
6. Bherda	A/1	Wankaner	Rajkot
7. Bhet	B/1	Muli	Surendranagar
8. Bokadthamba	A/2	Wankaner	Rajkot
9. Chandrelia	C/2	Muli	Surendranagar
10. Chitarkhada	B/1	Wankaner	Rajkot
11. Chorvira	D/2	Sayla	Surendranagar
12. Daldi	A/3	Wankaner	Rajkot
13. Devpura	B/2	Chotila	Surendranagar
14. Dharadungri	D/3	Sayla	"
15. Dholia	D/1	Muli	"
16. Dighalia	A/3	Wankaner	Rajkot
17. Digsar	F/1	Muli	Surendranagar
18. Dolia	E/3	Sayla	"
19. Dudhai	E/1	Muli	"
20. Gadhad	E/2	"	"

contd....

TABLE I.2 (contd.)

1	2	3	4
21. Gadhada	D/1	Muli	Surendranagar
22. Garia	A/3	Wankaner	Rajkot
23. Gosal	E/3	Sayla	Surendranagar
24. Gugaliana	C/3	Chotila	Surendranagar
25. Hadala	D/3	Sayla	"
26. Hirana	B/3	Chotila	Surendranagar
27. Jali	A/2	Wankaner	Rajkot
28. Jamvali	C/3	Chotila	Surendranagar
29. Jodhpur	A/3	Wankaner	Rajkot
30. Kashiagala	B/2	"	"
31. Khakhrathal	C/2	Muli	Surendranagar
32. Khakhravali	C/3	Chotila	"
33. Khampalia	D/1	Muli	"
34. Khatdi	E/1	"	"
35. Lakhamachi	B/3	Chotila	"
36. Lunsar	B/2	Wankaner	Rajkot
37. Mahika	A/3	"	"
38. Makhtanpur	A/1	Wankaner	Rajkot
39. Mandasar	B/2	Chotila	Surendranagar
40. Morthala	B/2	"	"
41. Muli	F/2	Muli	"
42. Naika	F/1	"	"
43. Navagam	C/2	Chotila	"

contd....

TABLE I.2 (contd.)

1	2	3	4
44. Paj	A/3	Wankaner	Rajkot
45. Palas	A/1	Wankaner	Rajkot
46. Palasan	E/2	Muli	Surendranagar
47. Palash(Palashdi)	A/2	Wankaner	Rajkot
48. Pandal	B/3	"	"
49. Phuleki	F/3	Sayla	Surendranagar
50. Raisangpar	D/1	"	"
51. Rajgad	B/1	Wankaner	Rajkot
52. Rampur	E/2	Muli	Surendranagar
53. Rampura	B/3	Wankaner	Rajkot
54. Ranipat	C/1	Muli	Surendranagar
55. Sadharka	A/2	Wankaner	Rajkot
56. Sagadhra	C/1	Muli	Surendranagar
57. Samatpara N	E/3	Sayla	Surendranagar
58. Sarla	E/1	Muli	"
59. Sarodi	B/3	Chotila	"
60. Sarsana	B/2	"	"
61. Sayla	F/3	Sayla	"
62. Shekhardi	A/3	Wankaner	Rajkot
63. Sidsar	F/2	Muli	Surendranagar
64. Somasar	F/2	"	"

contd...

TABLE I.2 (contd.)

1	2	3	4
65. Songadh	C/2	Chotila	Surendranagar
66. Sudamda N	F/3	Sayla	"
67. Tarnetar	C/2	Chotila	"
68. Than	C/3	"	"
69. Tidna	E/2	Muli	"
70. Tikar	F/1	"	"
71. Umarda	E/2	"	"
72. Vadusar	A/1	Wankaner	Rajkot
73. Vagadia	D/2	Muli	Surendranagar
74. Vanalia	E/3	Sayla	"
75. Velala	D/2	Muli	"
76. Waori	C/3	Sayla	"

the area all roads lead to Than which is an important industrial town. Other important towns of the area - Muli, Sayla, Lunsar, Vagadia and Ranipat are well connected by bus routes (Map I.3). The nearest airport is Rajkot at a distance of 71 km from Than and is connected by air services with Bombay via Ahmedabad and Jamnagar. The nearest seaports are Navlakhi and Kandla.

CLIMATE AND VEGETATION

The State of Gujarat receives rainfall from the south-west monsoon during the periods from June to September. The rainfall is decreasing from south to north. The average rainfall varies from 200 to 2000 mm. The temperature is increasing from south to north. The maximum and the minimum temperatures in Gujarat State are 45° and 10°C respectively. The climate of Gujarat in southern districts is moist while that in northern districts is dry. Natural vegetations are restricted to the agriculturally unproductive areas having adequate rainfall.

The study area receives the rainfall only during the monsoon from June to September. The occurrence of few showers in the remaining months is undesirable for agriculture. The average rainfall for the past fifteen years

from 1961 to 1975, for Rajkot district is 552.2 mm while the average rainfall for the years 1961 to 1971 (except 1968) and 1974 for Surendranagar district is 445.6 mm (Table I.3). Yearwise rainfall distribution for both the districts is shown in Graph I.1. The average of the highest and the lowest and the mean of both highest and lowest temperatures are shown in Tables I.4 & I.5. Yearwise temperature variations of both the districts are shown in Graph I.2. From the yearwise data, average values for average mean maximum, average mean minimum, highest, lowest and average of highest and lowest temperatures were calculated for the years 1961 to 1975. These are summarised as follows:

Temperatures	Rajkot Dist. (°C)	Surendranagar Dist. (°C)
Average mean maximum	34.02	34.71
Average mean minimum	19.58	21.16
Average highest	43.20	43.17
Average lowest	5.59	7.00
Average of highest and lowest	24.35	25.87

The temperature variations and the average rainfall in the study area are 43.20° to 5.59°C and 500 mm respectively. The variation in temperatures is great and the rainfall is

TABLE I.3

YEARWISE RAINY DAYS AND RAINFALL - RAJKOT & SURENDRANAGAR DISTRICTS (1961-1975)

Year	Rajkot District			Surendranagar District		
	Rainy days	Rainfall (mm)	Deviation	Rainy days	Rainfall (mm)	Deviation
1961	42	774.4	+219.2	24	384.6	- 61.0
1962	27	404.7	-105.5	23	468.7	+ 23.1
1963	28	504.7	- 50.5	32	640.6	+195.0
1964	30	764.8	+209.6	26	413.9	- 31.7
1965	21	465.6	- 89.6	15	529.8	+ 84.2
1966	20	436.5	-118.7	17	415.5	- 30.1
1967	27	484.4	- 70.8	25	463.3	+ 17.7
1968	20	591.0	+ 35.8	——— NR ———		
1969	19	317.2	-238.0	12	175.9	-269.7
1970	36	1151.8	+596.6	32	641.5	+195.9
1971	49	544.4	- 10.8	-	508.2	+ 62.6
1972	38	364.7	-190.5	——— NA ———		
1973	87	325.1	-230.1	———NA ———		
1974	27	236.0	-319.2	28	261.1	-184.5
1975	69	963.5	+408.3	——— NA ———		
Average	36	555.2		23	445.6	

TABLE I.4

YEARWISE VARIATION IN TEMPERATURES - RAJKOT DISTRICT

(1961-1975)

Year	Highest Temp. (°C)	Lowest Temp. (°C)	Average of Highest and Lowest (°C)	Average Mean-Maximum (°C)	Average Mean-Minimum (°C)
1961	42.90	4.70	23.80	33.05	19.20
1962	42.50	3.80	23.15	33.90	19.50
1963	43.40	7.90	25.65	34.10	20.20
1964	43.70	3.50	23.60	33.70	19.00
1965	41.50	7.90	24.70	34.20	19.40
1966	44.00	6.20	25.10	34.60	19.50
1967	44.50	5.10	24.80	34.60	19.50
1968	42.30	5.90	24.10	33.90	19.40
1969	42.30	5.50	23.90	34.90	20.40
1970	43.90	7.00	25.45	33.50	19.70
1971	43.40	6.20	24.80	33.27	19.40
1972	44.80	5.10	24.45	34.23	19.06
1973	43.40	4.20	23.80	34.10	19.90
1974	42.70	4.80	23.70	34.90	20.00
1975	42.50	6.00	24.25	33.30	19.50
Average	43.20	5.59	24.35	34.02	19.58

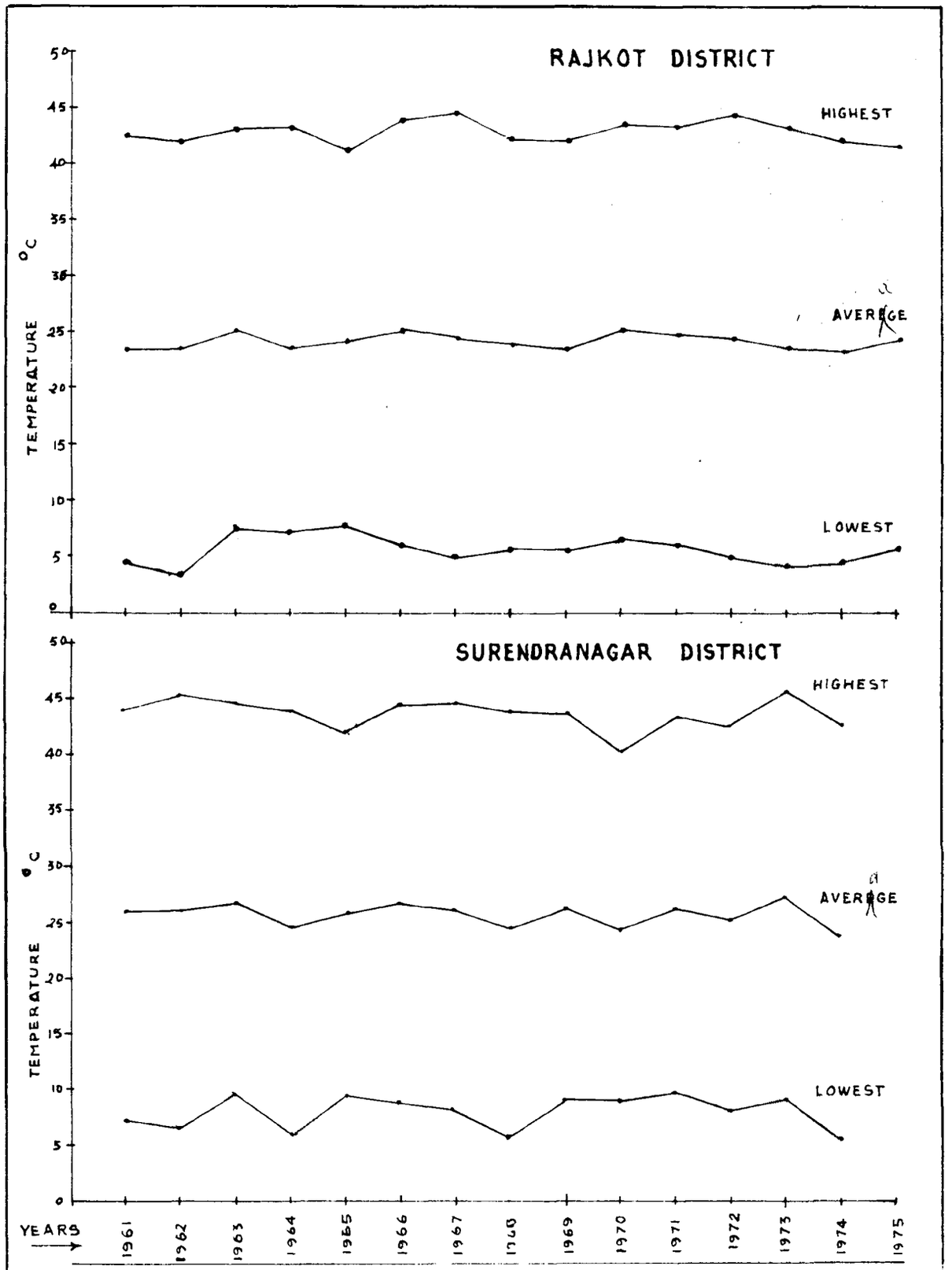
TABLE I.5

YEARWISE VARIATION IN TEMPERATURES - SURENDRANAGAR DISTRICT

(1961-1975)

Year	Highest Temp. (°C)	Lowest Temp. (°C)	Average of Highest and Lowest (°C)	Average Mean-Maximum (°C)	Average Mean-Minimum (°C)
1961	44.20	7.60	25.90	33.90	21.20
1962	45.20	6.70	25.95	34.60	21.40
1963	44.60	9.50	27.05	34.60	22.00
1964	44.10	5.70	24.90	34.50	21.10
1965	42.40	9.50	25.95	35.00	21.50
1966	44.70	9.00	26.85	35.30	21.40
1967	44.70	8.20	26.45	24.20	21.30
1968	43.90	5.60	24.55	34.80	21.20
1969	43.80	9.10	26.45	35.60	22.40
1970	40.20	9.00	24.60	33.00	21.00
1971	43.60	9.70	26.65	33.90	21.10
1972	42.80	8.00	25.40	34.60	21.00
1973	45.80	9.10	27.45	36.70	19.70
1974	42.80	5.20	24.00	35.20	20.00
1975	NR	NR	NR	NR	NR
Average	43.77	8.00	25.87	34.71	21.16

GRAPH I.2



YEARWISE TEMPERATURES:- RAJKOT AND SURENDRANAGAR DISTRICTS
(1961-1975)

(REF:- CENSUS - 1961 FOR THE YEAR, 1961-1970
METEOROLOGY LABORATORY, 1971-1975)

low. The climate is semi-arid type. The natural vegetation of the area is mostly thorny type (Plate I.1). Acacia leucophyla, Prosopis specigeria and Salvedora oleoids are common trees. Euphorbia neriifolia and Caparis aphylla are common shrubs. Cassia auriculata is a common herb. The above mentioned natural vegetations of this area have stunted growth and are characteristic of semi-arid climate and sandy to loamy soils. The natural vegetations are more on the plain ground where the rocks are covered by soil. Minor forest is observed west of Ranipat.

PHYSIOGRAPHY

There are three physiographic units of Gujarat which are further divided into subdivisions (Map I.4). Saurashtra consists of low hills with an average altitude between 75 to 150 m (Map I.5). The entire region is dotted with hills which are more prominent in the south, west and north while in the east they are low. The central part of Saurashtra has a radial drainage.

Physiographically, the study area is a part of the inland plain of Saurashtra which can be broadly divided into Western region and Eastern region.

PLATE NO.I.1

Euphorbia neriifolia (Thor), W of Songadh hill (E of Than Sara Road).

(a) WESTERN REGION :

This region lies between latitudes 22° 30' and 22° 45' N and longitudes 71° 00' and 71° 30' E. The western part of this region is in Rajkot district while the eastern part is in Surendranagar district. The nature of the ground is hilly and undulating. The northern and the southern parts of this region consist of hills and hillocks which are generally elongated with flat tops and rugged outlines. The ground elevations in this region vary from 85 to 186 m. The general slope of the ground is towards northwest and north. The maximum elevation of the ground is 186 m near the village Khakhravali east of Than and the minimum elevation of the ground is 85 m near the village Vadusar NNW of Than. Most of the rivers of this region have their origin in Chotila taluka. The Machhu and the Maha rivers originate from the hills of Chotila and flow northwesterly to westerly. The Maha river joins the Machhu river near Wankaner which ultimately dies out in the Rann of Kutch. The tributaries, viz. Kharodio, Lavario, and Machhurio meet the river Machhu, south of Bokadthamba village. The other river Balal, originating from the hills near Gugaliana and Khakhravali, flows towards north finally ending in the Rann of Kutch.

(b) EASTERN REGION :

This region lies between latitudes 22° 30' and 22° 45' N and longitudes 71° 15' and 71° 30' E. It is mainly a part of Surendranagar district. The nature of the ground is mostly plain with some isolated hillocks. The ground elevations vary from 91 to 185 m. The general slope of the ground is in the north-east direction. The maximum elevation of the ground is 185 m near the village Gugaliana and the minimum elevation of the ground is 91 m near the village Digsar, north-east of Muli. The Wadhwan-Bhogavo river originating from the hills of Chotila taluka, flows through Aya, Dolia, Umarda, Bhaduka, Muli and Naika villages of this region and finally merges in the Gulf of Cambay towards the east. The general course of this zigzag river is north-east. The other river Bambhan originating near the village Nalkhamba of Muli taluka flows towards north and finally merges into the Rann of Kutch.

GEOLOGY

The geological formations of Gujarat range from Archaean to Recent and those of Saurashtra Peninsula range from uppermost Jurassic to Recent (Appendix I.1 p.243). The oldest rocks exposed in Saurashtra Peninsula belong

to Dhrangadhra Group equivalent to Umia beds of Upper Gondwana system. These rocks are overlain by Wadhwan Group of rocks equivalent to Bagh beds of the Mainland of Gujarat. Both are overlain by Deccan trap lavaflows. There are numerous dykes connected with Deccan trap activity. The Deccan trap is overlain by Tertiary and Recent deposits.

In the study area, Dhrangadhra Group of rocks are the oldest and are well exposed, covering greater part of this region. It consists of sandstone and shale. Wadhwan Group of rocks conformably overlie the rocks of Dhrangadhra Group. Deccan trap lavaflows are the youngest rocks in this area and occur as outliers near Daldi and South of Nava Sudamda. Dolerite dykes connected with Deccan trap activity, cut across all the older rocks and form prominent surface features.

SOILS

The soils of Gujarat, are broadly classified into seven groups based on the type of parent rocks and climatic conditions. The soils of the mainland of Gujarat are deep black, alluvial sandy loam and alluvial sandy soils. The soils of Saurashtra and Kutch are medium black, alluvial

sandy, coastal alluvium and desert sandy soils. Desert soils are mostly saline. Black soils are productive and fertile while sandy soils are unproductive.

In the study area, the soils are medium black and alluvial sandy loam. Medium black soils are shallow and occur on basaltic rocks. The alluvial sandy loam is moderately deep and occurs generally on sandstones. There are four types of irrigable soils covering nearly 75% of the study area.

ENGINEERING AND INDUSTRIAL RESOURCES

The State of Gujarat is rich in rocks and mineral deposits. Minerals are used as raw materials in various industries while the rocks are used as building stones, ornamental stones and aggregates. The loose materials viz. river sand, coastal sand and soil are also used as fine aggregates in construction. In Saurashtra the engineering resources, viz. Sandstone, limestones, crushed aggregates (Trap, sandstone, limestone), fine aggregates (river sand, coastal sand and soil) and industrial resources, viz. Silicasand, industrial clays, gypsum, bauxite and salt are available.

In the study area, the soils, riversands and rocks are available as engineering resources. Soils are used as construction material for making roads and earthfills and also as base for foundation of structures. Sands from river beds are used as fine aggregates in construction work. The natural coarse aggregates are in short supply in this area, hence crushed aggregates of trap and sandstone prepared by crushing or hand breaking, are used as coarse aggregates in the construction of roads, as railway ballast and in concrete works. Sandstone and basalt are locally used as building stones in the construction of buildings and temples.

The silicasand, industrial clays (fireclays and white clays), and coalseams are available as industrial resources. Silicasand obtained from friable white sandstone is used in glass and ceramic industries and in foundaries. Fireclays are used as raw materials in ceramic industries. White clays are used in making white cement. Coalseams are of sub-bituminous type and are not of any economic importance.

HYDROGEOLOGY

All the main rivers of Gujarat flow towards Gulf of Cambay except some rivers which die out in the Rann of

Kutch. Most of the rivers are seasonal. The rivers of Saurashtra exhibit radial drainage. The river waters are stored by making dams across the rivers at many places in Gujarat. Hydrogeologically Gujarat can be broadly divided into six Groundwater Provinces.

In the study area surface water is available from natural and artificial reservoirs. Groundwater from many openwells is suitable for drinking and irrigation purposes. The depth of water level in openwells, is between 3 to 15 m from the surface in dry season. Mostly the openwells are in sandstone near the contact of dykes. The recharge of groundwater to the openwells is through joints, pores, bedding planes and weathered rocks. Water from openwells in weathered Deccan trap and from shallow aquifers in rocks of Dhrangadhra and Wadhwan Groups, is mostly brackish.

SCOPE OF THE PRESENT WORK

The main purpose in undertaking the present investigations of the study area, is to classify the soils into soil/land irrigability classes, land capability classes and to assess the engineering and industrial resources of this area.

The augerbore soil samples were tested for their physical and engineering properties in the field and in the laboratory to classify the soil/land for the purpose of irrigation and for land capability. Field tests were made on these soil samples for their colour, texture, moisture and lime content. Laboratory tests were carried out on these soil samples for their properties viz. grain size analysis, available water holding capacity, permeability, soil reaction and salinity. The observations of surface features viz. ground slope, erosion, drainage, and depth of water level near augerbore sites were also recorded in the field.

The samples of soils taken from openpits, sands from river beds, crushed aggregates and rocks from quarries, were tested for their engineering properties to find out their suitability as construction materials. The openpit soil samples were tested for their index and engineering properties viz. specific gravity, Atterberg limits, grain size analysis, relationship between dry density and moisture content (compaction test), penetration resistance, permeability and shear strength. These samples were also studied for the presence of constituents, heavy minerals and clay minerals. The sand samples from

river beds were tested to determine their fineness modulii and deleterious materials.

The crushed aggregate samples were tested for their engineering properties viz. impact value, crushing value, abrasion value, specific gravity and water absorption.

The rock samples from quarries were tested for their physical properties, viz. specific gravity, water absorption and dry crushing strength.

Information on availability and usefulness of industrial resources viz. industrial clays, silicasand, coal, and raw materials for lime was collected and compiled.

A contour map was prepared from the data on the static ground-water levels in openwells from the ground surface to assess the ground-water potentialities for irrigation and drinking purposes.