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GOVERNMENT OF INDIA

CENTRAL GROUND WATER BOARD

MINISTRY OF WATER RESOURCES

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GROUND WATER CONDITIONS IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH AND DROUGHT MANAGEMENT STRATEGIES

By

K.C.B. RAJU,

D.S.S. MURTHY,

G. SUGREEVA REDDY,

AND

D.A. SURYA RAO,
CENTRAL GROUND WATER BOARD,
SOUTHERN REGION

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P R E F A C E

Drought has become a recurring phenomena. The semi-arid tract of Andhra Pradesh experiences this phenomena very frequently. In Andhra Pradesh the four districts of Rayalaseema Viz. Anantapur, Cuddapah, Kurnool and Chittoor, Mahabubnagar and Nalgonda districts of Telangana and the Prakasam district of the coastal tract have been identified as drought prone. The failure of the monsoon for the last three consequitive years has brought unprecedented misery and hardship on the population living in these districts. Crops have failed, due to the failure or late arrival of the monsoons. Water levels have declined and falling water levels in many parts of these districts have forced the people to deepen their wells, while many shallow dug wells have gone dry. Due to the lower input, the replenishable annual recharge to the ground water reservoir is also low indicating temporary overdeveloped conditions in some parts. This calls for a review of the situation and suitable measures for conservation and proper management of the resources especially the ground water resources of the area, as during the drought years it is the ground water which meets most of the water requirements of the urban and rural population. In this report, a brief review of the general features and the ground water conditions of each district have been discussed. Methods both short term and long term drought management strategies have been discussed to tide over the crisis and also as a permanent measure to solve the problems faced by the people of these districts.

It is hoped that this report will be useful to the district authorities and planners connected with the drought management, IRDP, DRDA and other agencies.

(K.C.B. RAJU)
DIRECTOR

A C K N O W L E D G E M E N T S

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GROUND WATER CONDITIONS IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH AND DROUGHT MANAGEMENT STRATEGIES

1.0. INTRODUCTION

Drought is a phenomenon which seems to occur regularly in some parts of the country, especially in the semi-arid and arid parts of the country. Sometimes the drought conditions may prolong for such a long time as to cause concern to the people who live in such areas and may be forced to migrate temporarily to the neighbouring areas to tide over the crisis.

Drought is a general term which implies deficiency of precipitation of sufficient magnitude so as to adversely affect the agriculture, economy and human society. Drought, though may mean lack of rainfall or absence of rainfall and prolonged dry spells often for more than three months at a stretch, needs to be defined from the meteorological as well as from the agro climatological point of view. From the meteorological point, a 'drought' can be defined as follows:

1. Absolute Drought- any period or spell of 15 consecutive days which does not receive rainfall of even a minimum of 0.25 mm/day.
2. Partial Drought- any period of atleast 29 consecutive days during which the daily rainfall received does not exceed 0.25 mm.
3. Dry Spell - any period of atleast 15 consecutive days where the daily rainfall received is not more than 1 mm.

The occurrence of the absolute and partial droughts will indicate the dry months which will not be useful for cultivation by use of rainfall for crop production. However, if we examine the occurrence of drought from the agroclimatological point of view, then

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the droughts are the dry periods which are characterised by deficits of rainfall which will hinder the crop cultivation and the occurrence of the so called 'effective rainfall' constitutes the deciding factor. The effective rainfall is defined as the rainfall which is sufficient to ocounteract the effects of evaporation and runoff and also maintain the soil moisture above the wilting point. As per I.M.D. definition a daily rainfall of 2.5 mm or monthly rainfall of 76.0 mm forms the effective rainfall for plant growth and crop growth. The India Meteorological Department also defined a drought year as a year where the annual rainfall received during that year is less than 75% of the normal. Similarly it also defined as a'moderate drought' year as a year where the annual rainfall received is less than 26 to 50 percent of the normal and a 'severe drought' year as one in which the rainfall received is less than 25% of the normal annual rainfall.

Similarly, the hydrological droughts are caused due to protracted meteorological droughts resulting in reservoirs, streams, tanks, wells drying up causing undue hardship to the people and livestock in various parts of the country. This hydrological drought also results in curtailment of power generation and irrigation and there by effecting industry and agriculture.

Areas which suffer regularly due to the vagaries of monsoons and, meteorological droughts are called as 'drought prone' areas. The second irrigation commission(1972) of Government of India defined drought as a situation arising in any area when the annual rainfall is less than 75 percent of the normal and in areas where drought as defined above, has occurred in 20 % of the years examined are considered as 'Drought prone' areas and where it has occurred in more than 40 percent of

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years as 'Chronically Drought prone' areas. Accordingly there are 557 community development blocks in 75 districts of 13 states of the country which have been identified as drought prone by Government of India.

1.1 VARIABILITY OF RAINFALL IN ANDHRA PRADESH AND ITS EFFECT ON IRRIGATION

Variability of Rainfall over Andhra Pradesh:

The rainfall over Andhra Pradesh is highly variable with respect to space and as well as time. In general, the annual rainfall increases from southwest (about 400 mm) to east and northeast (over 1200 mm). The coastal Andhra receives 972 mm in 52 days annually, the Telangana 911 mm in 52 days and the Rayalaseema 671 mm in 41 days.

The southwest monsoon contributes about 67 percent of the annual rainfall while the northeast monsoon contributes about 23 percent. Due to cyclonic storms over the Bay of Bengal, the coastal belt and in particular the southern coastal belt receives 500-700 mm during the northeast monsoon. The southwest monsoon is the main rainy season for the state and all the districts, except Nellore and parts of Prakasam and Chittoor districts, receive maximum rainfall during this season. During this season, the Telangana region receives over 75 percent of the annual rainfall, while in the interior Rayalaseema, i.e. Anantapur and western parts of Kurnool and Cuddapah districts and in the central to northern coastal Andhra, the contribution of the southwest monsoon is 50 percent to 75 percent and south of Krishna river, Nellore and eastern part of Chittoor district the contribution of this season is 25 percent to 50 percent. The rainfall normals of different regions are prosented in Table - 1.

September is the month of heaviest rainfall in the interior of Rayalaseema and the southern part of

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Table-1

Monthly Normal Rainfall of Andhra Pradesh (mm)

Name of the District	J	F	M	A	M	J	J	A	S	O	N	D	Annl
Srikakulam	8.0	18.4	15.9	37.3	66.0	122.4	156.9	184.2	202.2	186.1	79.1	11.6	1116.6
Vizianagaram	8.6	21.4	16.1	40.3	81.3	143.3	160.6	186.4	203.0	181.4	66.3	11.1	1119.8
Visakhapatnam	8.1	19.9	16.3	43.6	62.9	114.0	159.0	145.9	186.5	191.2	84.0	14.5	1024.9
East Godavari	5.8	13.0	12.8	25.4	52.1	133.6	203.0	174.8	186.6	214.0	108.1	55.5	1137.8
West Godavari	4.4	11.5	10.8	20.7	46.1	137.4	220 9	192.4	177.1	173.3	80.0	7.3	1081.7
Krishna	5.8	11.2	11.8	19.3	41.3	109.2	187.2	167.6	158.4	154.4	83.7	8.1	958.0
Guntur	5.3	11.2	10.0	18.2	43.4	90.0	133.2	130.9	145.2	137.4	79.1	11.8	815.7
Prakasam	8.2	8.8	9.2	14.8	44.3	49.2	84.4	84.1	127.0	167.6	135.5	24.1	75.71
Nellore	34.3	9.2	9.4	15.1	37.7	42.6	72.3	77.8	103.8	253.7	293.9	91.2	1041 .0
Kurnool	2.9	5.8	5.7	18.0	38.6	71.3	100.4	102.9	151.2	86.1	33.5	5.0	621.4
Anantapur	3.5	5.0	4.3	19.2	54.3	47.0	53.2	78.8	131.8	92.8	46.3	7.9	544.6
Cuddapah	10.7	3.7	6.2	15.2	44.5	58.9	84.0	96.3	135.0	117.2	99.7	25.4	685.4
Chittoor	20.3	7.3	10.5	24.0	62.4	56.4	79.1	102.2	126.8	149.3	143.2	46.0	827.4
Rangs Reddy	3.1	6.8	11.0	25.5	32.3	112.4	173.2	152.4	198.8	62.3	22.8	4.2	802.1
Hyderabad	8.1	11.7	12.9	25.9	28.7	107.4	161.3	134.9	170.7	73.1	31.7	5.8	772.2
Nizamabad	6.1	18.0	11.9	16.1	12.3	147.4	288.3	233.4	218.7	53.5	16.7	2.7	1025.1

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1	2	3	4	5	6	7	8	9	10	11	12	13	14
Medak	2.6	6.9	11.4	22.3	20.8	134.2	212.7	191.6	201.3	61.8	14.7	4.6	884.8
Mahabubnagar	1.2	4.2	4.1	14.7	27.0	92.0	160.6	153.6	163.2	64.4	14.8	5.0	704.8
Nalgunda	1.7	5.7	9.4	20.4	29.1	94.5	136.8	122.8	158.7	89.9	25.4	7.0	701.4
Warangal	5.9	12.3	9.7	22.5	30.1	150.7	263.5	204.8	187.4	71.5	22.5	6.5	987.3
Khammam	3.3	9.3	11.8	29.1	40.4	138.5	274.8	207.9	177.0	89.1	32.4	4.5	1018.1
Karimnagar	6.8	14.5	10.5	19.4	18.7	154.3	261.4	220.7	176.7	70.5	17.1	4.5	975.1
Adilabad	4.6	12.0	14.9	14.2	12.3	157.9	306.9	269.6	184.6	52.0	13.8	6.6	1049.4

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Telangana, while July is the month of heaviest rainfall in the northern part of Telangana and Godavari valley. October and November are the months of heaviest rainfall in the southern coastal tracts of Nellore and Prakasam districts and over a narrow coastal belt of Andhra, October is the rainiest month due to frequent cyclonic storms.

The annual coefficient of variation of rainfall in the northern parts of the state is 20 to 25 percent and in the southern parts 25 to 30 percent. During the southwest monsoon, the coefficient of variation is over 25 percent in Telangana and coastal belt whereas it is about 40 percent in Rayalaseema. During the northeast monsoon, the coefficient of variation of rainfall is 50 to 60 percent in coastal plains and Rayalaseema and about 80 percent in Telangana. Monthly rainfall is highly variable th the seasonal rainfall especially in Rayalaseema and adjoining areas.

1.2 DROUGHT CONDITIONS IN ANDHRA PRADESH:

Rainfall data for the period 1901-85 is analysed to study the drought conditions in Andhra Pradesh. Moderate to severe drought conditions prevailed in Telangana Region during the years 1911,1918,1920,1939, 1941, 1971, 1972 and 1979, while in coastal Andhra during the years 1935, 1942, 1945 and 1965 and in Rayalaseema in 1904, 1913, 1923, 1942, 1951, 1958, 1963, 1965 and 1980. In most of the cases the drought conditions prevailed dueto either delayed monsoon or weak monsoon.

The erratic droughts over the state have a profound influence on the ground water resources. A study of the well hydrographs reveals a close relationship between rainfall and the depth to water levels. In all the drought years, the water table has shown a definite declining tendency.

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The Government of India have launched a programme known as Drought Prone Area Programme(DPAP) which aims at long term development of areas frequently affected by drought through integrated development of local resources in agriculture and allied sector.

The drought prone areas have been identified on the basis of factors like high frequency of drought, low and erratic distribution of rainfall, less assured irrigation facilities etc. There are 557 community development blocks in 75 districts (including continguous districts) of 13 states.

In Andhra Pradesh there are seven drought prone districts (Fig. I). All the four districts of Rayalaseema namely, Anantapur, Chittoor, Cuddapah, and Kurnool, Nalgonda and Mahabubnagar districts of Telangana region and Prakasam district of Coastal Andhra. These districts cover an area of 1,08,443 sq.km with a population of 16,679,806, and fall in the shield area of the great Indian Peninsula consisting of the oldest rock types ranging in age from 100 to 4000 million years. These rocks during this long span of geological time have undergone deformation and disintegration due to the tectonic movements and unending weathering processes due to wind and water. The above factors and the absence of primary porosity in most of these rocks have rendered somewhat complex the occurrence, movement and distribution of water in these formations. As a result, the assessment of ground water potential and the location of well sites in the hard rock terrains has become a complex job.

Coupled with the uncertainity of finding reliable water sources, the vagaries of monsoon and the below normal rainfall received from the last two years

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in these districts the situation has become grim. In addition, the increasing demand for water for domestic, industrial, irrigation and drinking water uses in recent years has also contributed to the already depleting resources and declining water levels. Many dug wells have gone dry forcing people to go in for deep wells to meet the water requirements. In the context of this alarming situation it was decided to study the effect/relationship (with the data available with Central Ground EWater Board) of the rainfall, the longterm water level changes and the effect of drought and to examine whether the declining trend in water levels as observed in certain areas is a temporary phenomenon due to the receipt of below normal rainfall or deficit rainfall or due to the increase in draft with time or a combined effect, and then suggest a remedy or in otherwords a strategy for the management of the available resources without disturbing the ecological or the socioeconomic setup of the areas involved.

2.0. DISTRICTWISE DESCRIPTION OF GROUND WATER CONDITIONS AND DROUGHT MANAGEMENT STRATEGIES

The hydrometeorological, hydrogeological and hydrochemical setup of each drought prone districts of Andhra Pradesh is discussed in brief, including the work carried out tby Central Ground Water Board and suggesting a strategy for drought management on permanent basis

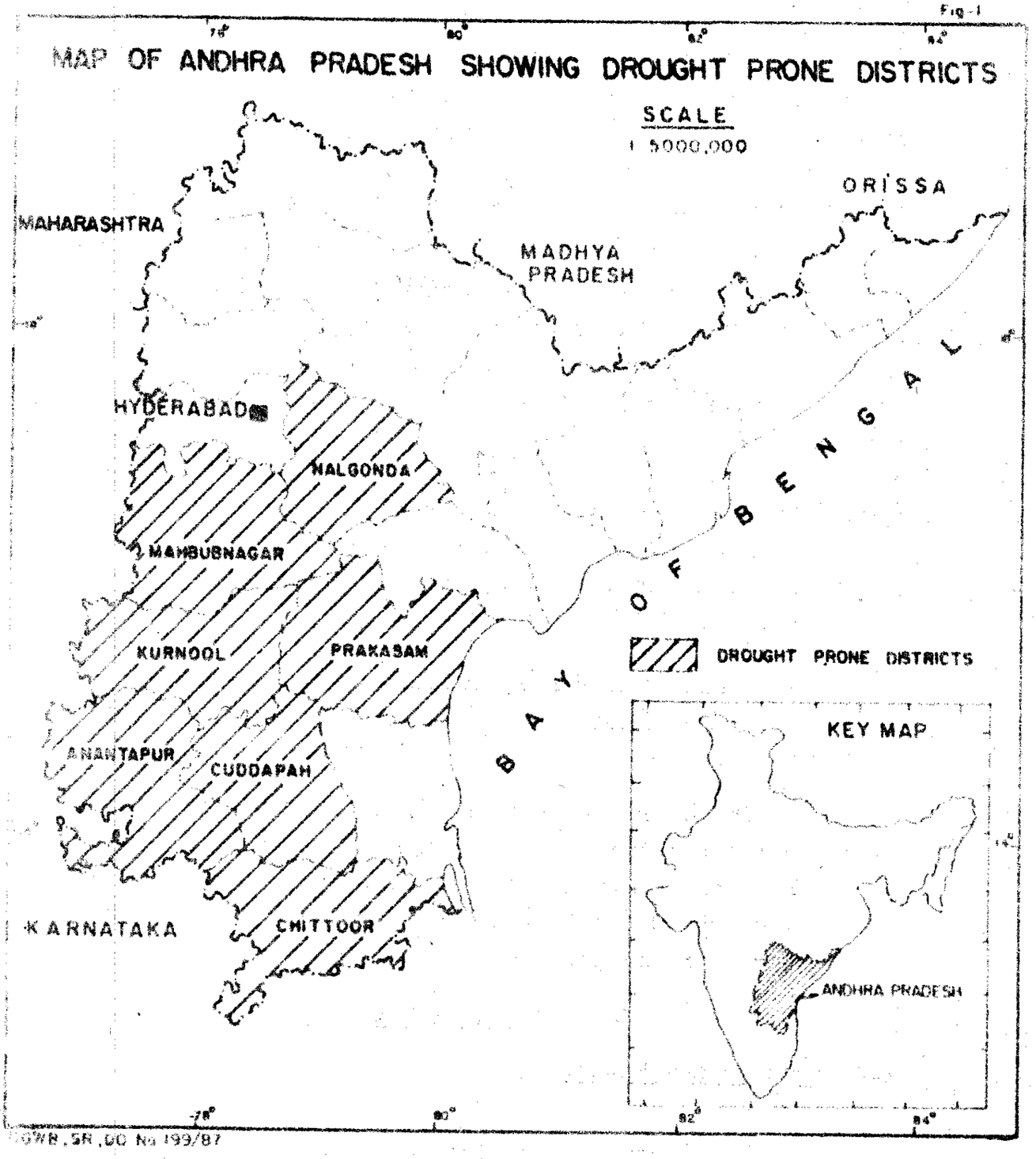
2.1 ANANTAPUR DISTRICT

2.2 Location and Extent:

Anantapur district occupies the southwestern part of the state falling between 13°14' and 15°14'N latitudes and between 76°47' and 78°26' E.Longitudes.It is bounded on the north by Bellary district of Karnataka

Fig-1

MAP OF ANDHRA PRADESH SHOWING DROUGHT PRONE DISTRICTS



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and Kurnool district of Andhra Pradesh and on the east by Cuddapah and Chittoor districts and to the south and west by the Karnataka state. The district is divided into 17 taluks and has a geographical area of 19,130 sq.km having a population of 2,548,012 (1981 census). There are 11 important towns and 958 villages in the district. The important towns are Anantapur, Hindupur, Kadiri, Kalyandurg, Guntaka, Rayadurg, Dharmavaram, Tadpatri, Gooty, Uravakonda and Penukonda, All the places are well coneected by all weather roads. The Bangalore-Hyderabad, Madras-Bombay and Hyderabad-Tirupati railway lines pass through the district. Anantapur is the only class I town in the district with a population of 119,531. Dharmavaram, Guntakal, Hindupur, Kadiri and Tadpatri are class II towns with a population of more than 50,000.

2.3 Physiography and Drainage:

The district forms the northern extension of the Mysore plateau and slopes from south to north. Thus many of the major streams take their origin in the Mysore plateau and flow north. Its elevation towards south is 600 m and gradually falls to 300 m near Gooty. The eastern side of the district towards Cuddapah is particularly hilly bordered by the cliff like quartzite hills. A good part of the district is occupied by black cotton soils. Red loamy soils occur in some parts.

The hill ranges in the district are rocky and bare with little or no vegetation. Sometimes even soil cover is absent. They run from north to south enclosing small valleys. The hill ranges run for 50 to 60 km at a stretch with varying widths reaching a height of 600 to 900 m above msl. The highest point is the Mallappakonda (909 m) near Bukkapatnam. The hill ranges have general N-S and NW-SE trends.

The district is drained by the rivers Pennar, Chitravati, Hagari or Vedavati, Papaghni and their tributaries, the Kushavati and Maddileru. Pennar river the most important of the drainage system of the district, is ephemeral like all other streams in the district and carries only monsoon runoff. In some parts of the district, the river carries the return flows from the Tungabhadra Command area. The district experiences hot weather, for most parts of the year with hot summers and mild winters. The highest maximum temperature recorded is 42.2°C and the mean daily maximum temperature during hottest month is 38.5°C where as the minimum temperature of 12.2°C has been recorded in January.

2.4 Hydrometeorology:

Anantapur is one of the districts of Andhra Pradesh which experiences low rainfall so often that sometimes a fear is expressed whether the district would be reduced to a state of an inland desert in course of time. The normal rainfall map of the district is depicted in Fig. 2. The rainfall decreases from east to west from about 620 mm to less than 400 mm. The district normal is 570 mm. The rainfall received at Anantapur which can be taken more or less as representative of the district has been studied for the period 1910-1985. The lowest rainfall of 233 mm has been received during the year 1934 and the maximum rainfall of 978 mm during the year 1919. To study the trend of rainfall and periods of below normal or above normal years, the 5 year and 10 year running means for the period are plotted. The plots Fig 3 indicate that periods between 1910-20 35-40, 1953-58, 1971-75 were good rainfall years whereas periods between 1920-25, 1931-35, 1941-53, 1958-71 and from 1975-83 are low rainfall periods. It also indicates that there is a declining trend in the rainfall over the

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HYDROMETEOROLOGY
DROUGHT PRONE DISTRICTS, A.P.

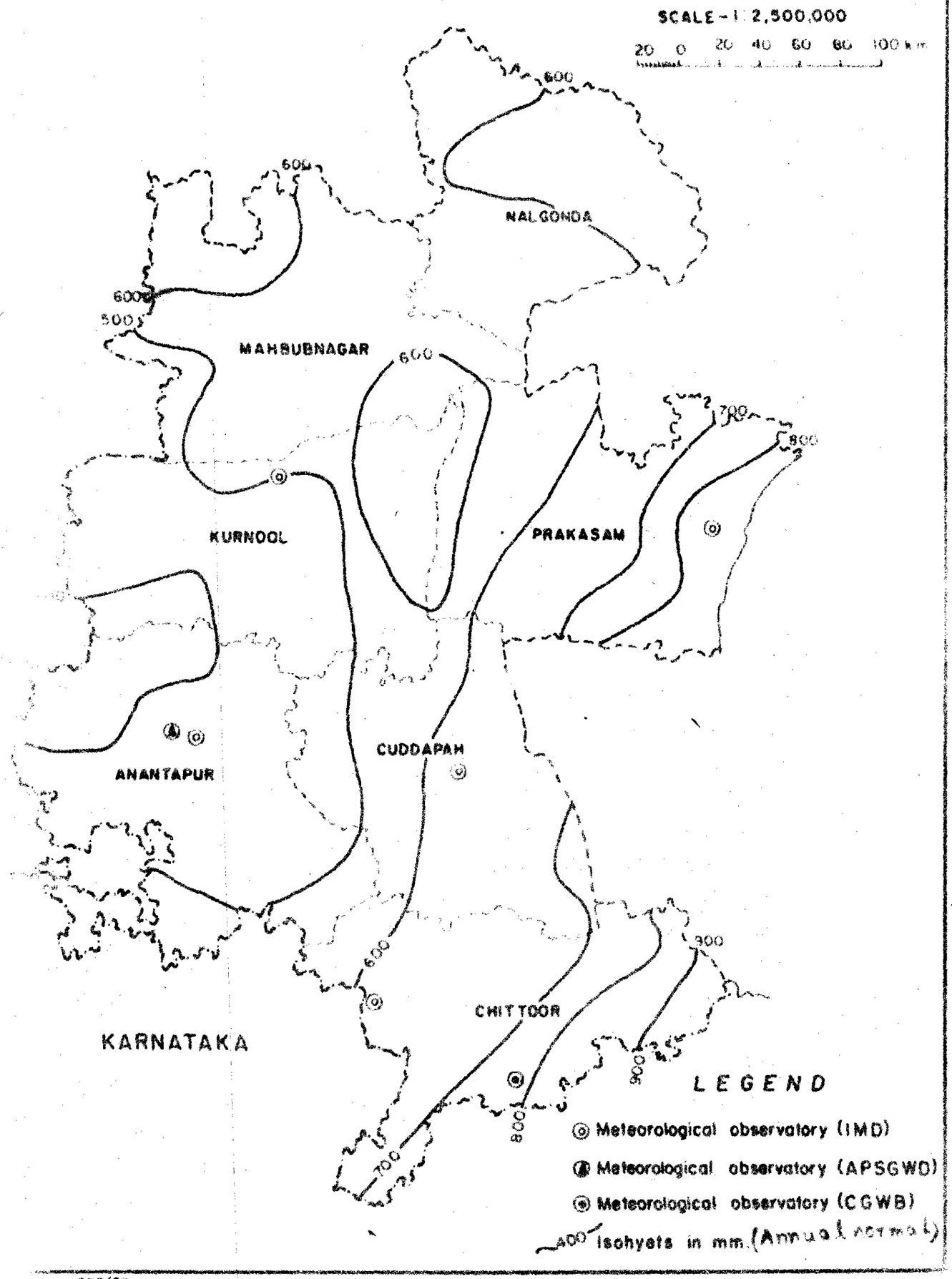
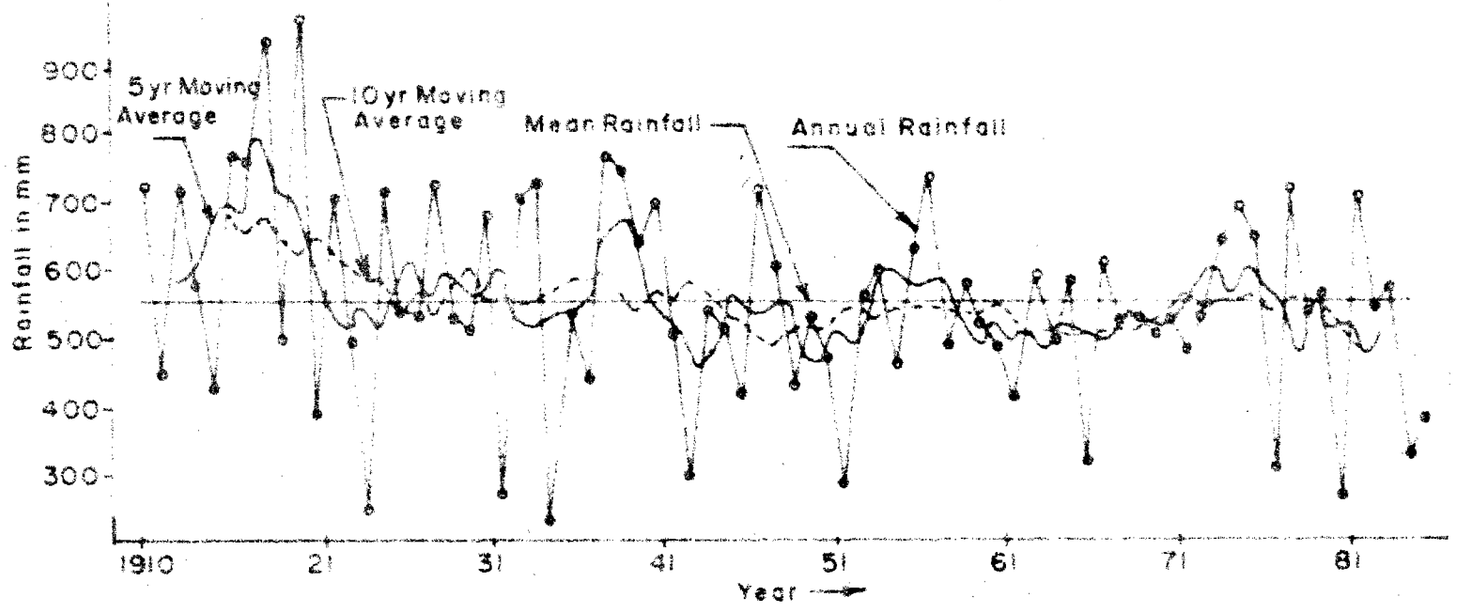


Fig. 3

RAINFALL TREND DURING 1901-85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE ANANTAPUR STATION, ANANTAPUR DISTRICT



years which is evident from the figures where the rainfall has not exceeded 750 mm at any time during the last 35 years. During the last decade normal rainfall was recorded in 4 years, excess rainfall in 2 years and deficit in 4 years. The graph indicates a declining trend in the forth coming years indicating the probability of receiving normal to below normal rainfall over the area.

The percentage frequency of occurrence of normal, excess and deficit rainfall in 5 continuous years during the period 1910-85 has been calculated for the weighted average annual rainfall. For this purpose rainfall of continuous 5 year periods from 1910-1914, 1911-15, 1912-16 etc upto 1980-84 and 1981-85 are taken in to consideration and in each 5 year data, the number of years of normal, excess and deficit rainfall are noted and then the percentage frequency of different combinations are noted. In the present case the percentage frequency of the different categories are given below:

No. of years with normal rainfall	3	4	1	2	2	4	1	5	3	3	2	1
No.of years with excess rainfall	1	0	2	2	1	1	3	0	0	2	3	4
No.of years with deficit rainfall	1	1	2	1	2	0	1	0	2	0	0	0
Percentage frequency of different combinations	17	17	13	10	9	9	8	6	1	1	1	

The above table indicates that there is a high probability of occurrence of normal rainfall in 3 years (17%) and excess and deficit rainfall in 1 year each in a period of 5 continuous years. The probability of occurrence of deficit rainfall is more than that of excess rainfall.

During the period 1981-85, normal rainfall occurred in 2 years, excess or above normal rainfall in one year and deficit rainfall in 2 years. In calculating

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the probability of normal, excess or deficit rainfall for example for 1986, the rainfall received upto the previous year that is upto 1985 from 1982-85(4 years) and its pattern (either normal, excess or deficit is considered and the prediction for 1986 with maximum probability(3 normal, 1 excess, 1 deficit) is given. In case of 1986 it is excess since in the 1982-85 period there were 3 normal and one deficit year. In the same way calculations for the other probability is given and also for the period from 1986 to 1990. The above statistical approach indicates that during the next 5 years, the probable frequency of occurrence of normal, excess and deficit rainfall may be one of the following:

	No.of years	
No.of years with normal rainfall	3	4
No.of years with excess rainfall	1	0
No. of years with deficit rainfall	1	1

Year	Anticipated Rainfall	
1986	E/N	N
1987	N/E	N
1988	N	N
1989	N	N
1990	D	D

From the above table it is possible to predict that the district may receive above normal rainfall in one year, normal rainfall in three years and deficit rainfall in one year.

Even from the study of the figures of rainfall for the last two years it is seen that the rainfall during the year 1984 was only 325 mm much below normal and during 1985 it was 380 mm also below normal.

2.5 Soils:

The soils of the district are predominently

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of the black and the red type. The district falls into three natural divisions according to the types of soils. Fertile black cotton soil predominates in the northern division consisting of Gooty, Uravakonda and Tadpatri taluks. The central division comprising the taluks of Anantapur, Dharmavaram, Kalyandurg and Rayadurg is covered by red soils with slight admixture of black soil in parts. The southern division comprising Madakasira, Penukonda, Hindupur and Kadiri taluks contain chiefly red soils.

2.6 Agriculture and Irrigation:

The district predominently depends on rainfall for agriculture coupled with well irrigation. However, the execution of the Tungabhadra High Level Canal and the Mid Pennar Project has helped being some area under assured surface water irrigation. Out of the total geographical area of 19,13492 hectares of the district, the extent of the total cropped area is 8,69027 hectares. An area of 1,96797 hectares is occupied by forests and the net area sown is 8,51,249 hectares which is 44.5 percent of the total geographical area. Out of this an area of 43883 hectares (gross) are irrigated by canals and 10,868 hectares (gross) are irrigated by tanks. Nearly 71,581 hectares are irrigated by wells, and the total area irrigated is 130,053 hectares. The area irrigated by wells in the district forms almost 55 percent of the total area irrigated. The canal irrigation with the waters of Tungabhadra High level canal is confined mostly to Anantapur, Gooty and Tadpatri taluks. The main crops grown are paddy, sugar cane, cotton, groundnuts, ragi, vegetables and chillies. Mulbery cultivation is gaining popularity of late especially in the areas irrigated by wells mainly because it is easy to grow, requires less water and returns are more.

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2.7 Industries and Mining:

There are several industrial estates located at Anantapur, Hindupur, Dharmavaram and Kadiri, Guntakal Spinning mills are located at Anantapur, Guntakal and Hindupur. Cotton pressing factories are located at Tadpatri. Other minor industries are located at Dharmavaram and Rayadurg. Dharmavaram is becoming a major centre for silk weaving industry which is in handloom sector. The district as such does not support any major industry. One sugar factory used to function at Hindupur but closed now for want of water.

The district is rich and is well known for some of the mineral deposits like gold, calcite, diamond, corundum, barytes. Granites, quartzite, dolerite, dolomite and limestone are excellent building materials and are mined at several places.

Diamond occurrences are reported from Vajra karur particularly after rains. Gold occurrences are known at Ramagiri where there are old workings. Recently Geological Survey of India has taken up further investigations in the district to locate areas economically viable for gold mining.

2.8 Geology:

Geologically the district is underlain by Archaean group of rocks, pre-Cambrian Cuddapah and Kurnool formations and the recent alluvium. The geological succession as seen in the district is as follows:

Recent	Alluvium	
	-------Unconformity --------	
Upper Pre-Cambrian to Lower palaeozoic	Kurnools	◊ Paniam quartzite ◊ Auk shales ◊ Narji limestone ◊ Banganapalle quartzite & ◊ conglomerates

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	------Unconformity-------		
Upper Pre-Cambrian	Cuddapah super group	Chitravati group	Tadpatri shales with basic intrusives
			Pulivendla quartzites
		Papaghni group	Vempalle shales and dolomites and limestone with basic intrusives
			Gulcheruvu quartzites and conglomerates
	----Unconformity----------		
Archaean to Lower Pre-Cambrian	Dharwar Super group	Dharwar	Dolerite dykes, pegmatites and quartz veins
			Schists, phyllites, Amphibolites
	Peninsular gneisses		Granitic gneisses Gneissic granites
	Eastern Ghat Group	Khondalites	Quartzites, charnokites

2.9 Hydrogeology:

The district is mostly underlain by Dharwar schists and phyllites, peninsular gneisses and granites, Cuddapah and Kurnool group of rocks consisting of shales, limestones and quartzites and river alluvium confined to the major stream courses. These rock types are traversed by quartz and pegmatite veins and also by dolerite dykes.

2.10 Ground Water in Archaeans and Dharwars:

The depth of weathering in the crystalline complex varies generally from less than a metre near the outcrops to more than 15.00 m in the valley bottoms and topographic lows. These crystalline rocks seem to be well fractured and jointed. Sometimes the fractures extend upto depths of 50.0 m and beyond as evidenced by the yields and lithologs of borewells drilled in the region.

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Ground water occurs under water table, semi confined to confined conditions and is developed by open dug wells, dug;-cum-borewells and borewells for irrigation and drinking water supply. The depth to water in wells located in the crystalline rocks, generally ranges from 1.30 m to more than 9 m bgl but sometimes the water table is found to be as deep as 20 m and more. In the last couple of years due to the failure of the monsoons and coupled with the excess withdrawals, the water table has been declining considerably in most parts of the district. The dug wells in the area, generally range in depth from 7 to 25 m bgl and yields vary from 20 to 220 m^3/d. The yields of borewells 35 m deep range from 9 to 45 m^3/h. Lately, however, the yields have been coming down due to the decreased saturated thickness of the formation available for pumping. A number of dolerite dykes intrude the granitic gneisses and seem to control the movement of ground water by acting as barriers to ground water flow. More or less similar conditions prevail in the wells tapping Dharwarian schists. However, due to the nature of the formations here, the yields are generally poor.

2.11 Ground Water Conditions in Cuddapah Formations:

The Cuddapah and Kurnool formations chiefly comprising of quartzites, shales, slates and limestones occur over a limited area confined mostly to the Tadpatri taluk of the district. The sedimentary rocks like the shales, sandstones and to some extent limestones have undergone compaction, metamorphism and are involved in the post Cuddapah tectonic movements undergoing faulting, folding and fracturing. Although the fracturing and faulting have created ideal condition in the rocks for holding water, the occurrence and movement of ground water in these rocks is however controlled by the degree of fracturing, faulting and the occurrence of solution channels and cavities especially in limestones. Shales which were

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once considered to be poor aquifers also yield substantial quantities in this area due to the presence of fractures. The depths of wells in these rocks generally range from 4.50 to 30 m bgl and the depth to water level varies from 2 to 29 m bgl. The yields of dug wells vary from 40 to 200 m^3/d. Borewells drilled down to a depth of 50 m bgl have given yields ranging from 0.5 to 2 m^3/h.

2.12 Ground Water Conditions in Alluvium:

Alluvium is found to occur locally and to a limited extent along Pennar and other streams like Chitravati, Kushavati, Tadakaleru and Maravanka. The thickness of alluvium varies from 1 to 10 m but exceeds 15 m as observed near Tadpatri town. Filter points, shallow tubewells and infiltration wells have been constructed to tap this formation in addition to the dug wells and there vary in depth from 3.5 m to more than 12 m bgl. and Yields varying from 8 to 135 m^3/h. are obtained from these wells. Presently, the alluvial aquifer has become practically dry as a result many of the wells now tap the fractures in the basement. The general depth to water as seen in the district based on water level data of networks stations of Central Ground Water Board for May, 1986 is given in Fig 4.

2.13 Status of the Studies:

Central Ground Water Board has been carrying out systematic hydrogeological and reappraisal surveys as part of the Boards' annual work programme in the district. By the end of March, 1987 the entire area of 19,130 sq.km of the district has been covered under systematic hydrogeological surveys and 13,421 sq.km under reappraisal surveys.

2.14 Ground Water Level Monitoring:

Monitoring of ground water levels through the establishment of a network of hydrograph stations

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commenced in the year 1969 with the establishment of 13 All India Network Stations. Presently there are 17 Hydrograph stations in the district being monitored 5 times a year (4 times a year since 1985). In addition, as part of the Pennar Basin studies in the district, 323 key observation wells are being monitored two times a year (pre-and post-monsoon) since 1981. The monitoring has indicated that fluctuations/ ground water levels occur /in in response to recharge and draft. Generally water levels start rising with the commencement of the monsoon and reaches a peak in November-December period. There after the levels start declining till May/June. The range of fluctuations varies from less than a metre near topographic lows to more than 9.7 m near upland areas. Lately, there has been a continuous decline in water levels in the southern parts of the district which may be due to the failure of monsoons during the last 2-3 years and increase in draft in these parts to meet the water requirements. This aspect will be discussed in detail at a later stage while discussing the resource aspects and the declining trends observed in some parts of the district.

22.15 Ground Water Exploration:

Ground water exploration in the district was initiated by Central Ground Water Board as part of the exploration programme in Vedavati and Chitravati River basins. About 43 exploratory wells have been drilled sofar in an area of 8391 sq.km in parts of Rayadurg, Kalyandurg, Madakasir, Dharmavaram, Kadiri and Uravakonda taluks. The depth of the wells drilled ranged between 38 and 88 m bgl in Vedavati River Basin and 50 to 300 m bgl. in Chitravati River Basin. The yields of borewells vary from 28 to 900 lpm (generally ranging from 50 to 300 lpm) for drawdowns ranging from 1.7 to 14.8 m. The ground water exploration programme in Chitravati and

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and Pennar basins is being continued during the year 1986-87 also.

2.16 Chemical Quality of Ground Water:

The chemical quality of ground water occurring in the district is being tested from time to time by analysing the samples collected from the open dug wells. The samples are collected from more than 300 observation wells in the Pennar basin and from the 17 All India Network Stations. The results of chemical analysis carried out sofar indicate, that the quality of water is suitable for domestic and irrigation and as well as for industrial purposes. Ground water in general is alkaline with pH values ranging from 7 to 9.1. In majority of the cases carbonate is absent, while the bicarbonate ranges from 49 to 1122 ppm. Total Hardness as $CaCO_3$ ranges from 60 to 1520 ppm and the waters can be classified as moderately hard to very hard. Chlorides range between 12 to 1219 ppm. The electrical conductivity varies from 390 micromhos/cm to 6065 micromhos/cm at 25°C but in majority of the cases it ranges from 750 to 2250 micromhos/cm at 25°C and thus presents salinity hazard (U.S. salinity Lab.classification). The fluoride concentration in ground waters of the district seems to be high in excess of permissible limits of 1.5 ppm and is reported from almost all parts of the district. The maximum values of 5 to 5.5 ppm of fluoride is reported from the Kadiri taluk. The general range of fluoride in the district is between 1 and 4.0 ppm.

2.17 Ground Water Resources and Development Prospects:

The district devoid of any perennial surface water sources except tanks, solely depends on ground water for meeting irrigational, industrial and drinking water needs. Nearly 55 percent of the irrigational requirements and 90 per - cent of the drinking water needs are met from ground waters.

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The earliest estimation of the ground water resources was carried out in the year 1977. This was revised subsequently on the basis of the Ground Water Estimation Committee's recommendations. The estimated tentative utilisable potential based on current data is given in Table 2. The total utilisable potential of the district is 925.0 MCM. As the district does not possess any notable surface water resources, the need to develop the ground water potential has been realised. As a result of this realisation, ground water is now being developed mostly by dug wells and dug-cum-borewells. Borewells and tubewells are not common for irrigational uses, but there are a good number of borewells fitted with hand pumps used for drinking water purposes.

With the increase in institutional financing, there has been a rapid increase in the development of ground water resource. The number of wells are on the increase. There were 63829 dugwells in 1976-77. But presently, there are 60,910 dug wells in the district out of which 47,212 wells are fitted with pumpsets. In keeping pace with the increase in ground water structures the ground water draft is also going up. It was 317.6 MCM in 1981-82, it went up to 320.3 MCM in 1983-84 and it has gone up to 332.3 MCM in 1984-85. The increase in the draft in 1983-84 and 1984-85 can be attributed to the drought situation which the district experienced in 1984 and 1985. Almost the entire district had received below normal rainfall in 1984 and 1985 and in some taluks like Hindupur, Kalyandurg, Uravakonda, Madakasira and Kadiri, the rainfall has been below normal right from 1982 onwards/ Almost continuous drought conditions have prevailed in most parts of the district. There has been a continuous decline in water levels also in several parts of the district except in Tadpatri, Mudigubba and Gooty. The decline in water levels varied from 0.7 m to 12 m (Fig 5). Maximum decline in the water level has been observed at Rayadurg where the /and as per the information available the rainfall for 1986 is also below normal.

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Table-2

Estimated Ground Water Potential and Ground Water Draft (Net) for Anantapur district (1984-85)

Sl. No.	Name of taluks	Estimated Utilisable G.W. Potential (MCM)	Estimated G.W. Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water Development Present %	Stage of Ground Water Development at year 5 %
1	2	3	4	5	6	7
1.	Tadipatri	89.5	30.8	58.7	34	38.0
2.	Anantapur	65.0	25.5	39.5	39	43
3.	Gooty	62.2	10.2	52.0	16	18
4.	Rayadurg	35.0	17.1	17.9	49	54
5.	Kanekal	53.8	5.5	48.3	10	11
6.	Uravakonda	44.3	5.0	39.3	11	12
7.	Madakasira	60.8	31.2	29.6	51	56
8.	Srisatyasai	42.5	21.6	20.9	51	56
9.	Siganamala	104.0	20.3	83.7	20	22
10.	Dharmavaram	35.0	35.6	-0.6	102	113
11.	Kadiri	101.2	46.7	54.5	46	51
12.	Kalyandurg	35.0	8.2	26.8	23	26
13.	Kambadurg	54.6	16.4	38.2	30	33
14.	Chennakotapally	40.3	15.0	25.3	37	41
15.	Hindupur	53.2	26.7	26.5	50	55
16.	Penukonda	48.6	16.5	32.1	34	37
		925.0	332.3	592.7	36	40

water level has been observed to be continuously declining right from 1971 onwards. The decline in the water level is also notable in Anantapur (6 m) from 1982 onwards, Hindupur (8 m) from 1983 onwards, Madakasira (8 m) from 1982 onwards and Penukonda(5 m) from 1982 onwards. An examination of data on draft from ground water for the last 4 years, indicates that there has been no appreciable increase in the withdrawals over the years and the draft is more or less same over the years (1981-82 to 1984-85). This indicates, that the decline in water levels has been solely due to the below normal rainfall received during the last 4 years. At this stage it is imperative to examine the hydrometeorological analysis discussed in the earlier chapters. The analysis has shown that there is a decreasing trend in rainfall observed over the years and drought conditions may prevail towards the end of the decade even if normal rainfall occurs in 1986 and perhaps in 1987.As such it may be necessary that certain restrictions are brought on water utilisation certain changes in cropping pattern are adopted and better water management techniques are adopted to reduce ground water draft.

2.18 Rural and Urban water supplies for drinking water and Industries:

Drinking water for urban and rural population is an important aspect. As per the statistics (1981) There are 20.88 lakh rural and 5.30 lakh urban population in the district. As per the information there are nearly 12,392 borewells and 382 pumping and mini pumping water schemes in the district which meet the drinking and domestic water requirements of the urban and rural population in addition to number of public and private dug - wells for the purpose. Taking the average consumption of 90 lpd for urban and 70 lpd for rural including the livestocks population. The total requirements works out to 70.73 MCM per year whereas a provision of 163 MCM has already been made for drinking water and industrial

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needs while calculating the utilisable ground water resources (925 MCM) from the gross recharge(1088 MCM). Hence there is ample scope for meeting the requirements from ground water. It is only during the drought years, the problem arises because of reduced recharge and declining water levels which can only be tackled by sinking deeper borewells or by deepening the existing dug wells.

2.19 Ground Water Development with Reference to Rainfall and Water Levels:

As already discussed declining water levels has have been observed in most parts of the district in recent years. But if we examine the ground water draft for the last four years there is no appreciable increase in draft. This shows that this decline in water levels is not due to increase in draft but is attributable to only below normal rainfall received in the district especially during the period 1984 to 1985. and also during 1986. The post monsoon recoveries druing 1986 varied from 0.2 m to 6.10 m. The water levels are still lower than 1982 water levels. Hence this decline in water levels can be attributed to only below normal rainfall and not to over developed conditions. However the prolonged meteorological drought and below normal conditions seen in the district have created a situation where in there will be reduced recharge to ground water storage as compared to a normal or an excess rainfall year, so that successive below normal rainfall years with reduced recharge may create over developed conditions in course of time. This can be overcome if a good rainfall or above normal conditions occur in the coming years. In this context, a look at the hydrometeorological analysis carried out earlier shows that/chances are that by 1988 /the or 1989 drought conditions may recur, which means that there is a possibility of recurring drought and declining water levels towards the end of the decade even if normal rainfall occur between 1987 and 1988 resulting in the recovery of water levels and normal recharge conditions during this period. There is also a declining trend of/ observed

/rainfall

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over the district. This clearly shows that some management techniques have to be evolved and adopted in order to overcome the harmful effects of drought and find a suitable solutions to the problem.

2.20 Ground Water Management Practices and Drought Management Strategies:

As already mentioned the district of Anantapur is one of the chronically drought prone areas of the State. In most parts of the district the drought is a recurring feature. As a result of the failure of monsoon successively for the last 2 to 3 years, the district has been depleted of its water resources to such an extent that the agricultural operations were badly hit and income of the rural population is greately reduced. Much of the rural population who depend upon agricultural produce for their living and income have been reduced to destitution. Even the fodder for the cattle has become scarce. The kharif yield which is the main crop depending upon the rain has suffered drastically. To over-come the sufferings of the people and mitigate theirhardships certain longterm and short term measures have to be adopted which should yield results. Short term measures or drought management strategies can be considered as quick measures/ which are spread over the years are supposed to yield results which will improve the living conditions of the people in course of time and help them to meet their requirements in a phased manner./to tide over the crises and long term measures

2.21 Longterm drought management strategies: In the district, the total cropped area in 1982-83 was 3,50,885 ha which came down to 2,79,439 ha in 1984-85. Nearly 55 percent of the area is under well irrigation and most of the area cultivates paddy and to some extent groundnuts and sugar cane. Except for groundnuts the consumptive use of paddy and sugar cane is very high. Even in areas irrigated from

canals and tanks, the same trend is seen. However, groundnut is grown on a large scale but mostly rainfed. Whenever there is a failure of monsoon there is a drastic reduction in the yield of groundnut crop, which indirectly affects the market rate of the oil products. Hence, it is necessary that this crop is stabilised preferably in the areas irrigated by wells as a kharif crop and as a rabi crop under tank and canal irrigation. Since the district experiences a hot climate, with a very few rainy days and high evapo-transpirational losses, it is better to consider the idea of reducing the area of [illegible] cane cultivation/ take up cultivation/ dry /of /and crops on a large scale. Rice is being cultivated approximately over an area of 68,233 ha(1984-85) mostly under tank and canal irrigation. If instead, other crops which require less water like wheat, oilseeds (ground nuts, sun flower) pulses, cotton, mulberry are grown there is a vast saving of water for nearly 6 to 8 months. The water thus saved can be utilised for bringing additional areas under irrigation. This can stabilise ground water levels in many areas and ultimately surface and ground water can be put to conjunctive use in an affective manner. Of late farmers themselves are shifting to mulberry cultivation in areas under well irrigation. It is better this trend is encouraged even in tank and canal command areas, so that this gives a boost to sericulture and as well as farmers are assured of better income returns and purchasing power. The main food crop like rice can be imported into the district from the rice surplus areas like the coastal districts. In addition to the changing cropping pattern, the other drought management practices like the social forestry and DPAP programmes can be coupled to meet the fuel requirements of the rural population. The district has nearly 85,990 ha or 4.5 percent of the total geographical area as culturable waste . This should be put to use perhaps coupling with the DPAP and other dryland farming

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methods for growing fodder for the cattle.

The hills and hillocks looks almost barren and rocky in most parts of the district and are devoid of any vegetative cover. The forests as such are non-existent and what we see are only shrubs and small plants. There is need to build up a forest cover and take to afforestation on a large scale. This will not only check the soil erosion which is on the rise, but ensure better environmental conditions for living. The areal seeding of the hills may be carried out in the reserve forest areas during monsoon seasons and all attempts should be made to conserve and protect the forests from cutting for some years. A similar experiment was carried out in Maharashtra a year back which is reported to have yielded good results.

Another aspect which needs attention is controlling of grazing of the forests. Special grazing or grass lands may be developed for the cattle and sheep grazing so that the plants and the sapling do not wither away. All these, will stabilise indirectly ground water by adding and retaining moisture and reducing direct evaporation in case of down pours.Other rain water harvesting techniques like contour bunding, recharge ponds etc wherever feasible are to be adopted to conserve water and arrest flash floods. Check dams, recharge wiers are also useful. Other water use techniques like drip and sprinkler irrigation can be adopted for saving water.

2.22 Short term Management Strategies:

With the declining trends seen in several parts of the district, most of the drinking water wells (dug wells) which are shallow are going dry. This is an alarming situation and methods have to be devised to meet the drinking water needs which is the prime need of the population during drought years and more so in summer

months. Some of the methods discussed earlier will however take several years to yield results and they are long term strategies. To meet the immediate requirements and to mitigate the hardships of the people and the livestock population certain short term steps or strategies are to be adopted. One of the strategy is to drill boreholes tapping deeper aquifers and meeting the water requirements. Though borewells are being drilled on a large scale, many are dry and few are yielding very low discharges so that they cannot be put to use continuously. Many of these wells are drilled without proper scientific investigations.It is suggested that proper scientific investigative techniques be adopted to minimise the failures and as far as possible utilise the same for rural water supply and pumping water supply schemes. Wherever possible, these wells can also be utilised for growing fodder for the cattle to tide over the crisis and save the livestock population and also to avoid transportation of fodder from long distances. In this context, it might be mentioned here that some of the exploratory wells drilled by Central Ground Water Board in the district have given encouraging results and some of the wells have tapped fractured aquifers below 100 m giving substantial yields. These wells are to be utilised for rural water supply. While there can be possibilities of over exploitation temporarily. This cannot be avoided, keeping the situation in view and the need of the population as a whole.

The quality of water has not been a problem except that there is high fluoride in some parts of the district. The fluoride content in ground water goes upto 5 ppm in parts of Kadiri and Anantapur taluks. In case of Kadiri town where the fluoride content is reported to be around 3 ppm, there is a defluoridation plant in operation which brings down the fluoride content to the permissible limits. Defluoridation plants of small scale or even kits will be useful in tackling this fluoride pro-

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blem in the rural areas.

No major industry exists in the district and as such the demand on ground water is not much to meet the industrial requirements. If the trend of rainfall as seen from the analysis is true, then there is a possibility of grave water shortage especially in the southern and western taluks which are experiencing declining trends in water levels, decreasing rainfall and increasing drinking water shortgages. To meet the situation and solve the problem permanently the possibility of bringing surface water through canals from the neighbouring Karnataka state either from the Bhadra Reservoir or the extension of the Tungabhadra High Level canal through branch canals and distributaries may have to be examined. This will not only stabilise ground water but also will help the district permanently to solve its drought conditions and improve the socioeconomic conditions of the people living in the district.

3.0. KURNOOL DISTRICT

3.1 Location and Extent:

Kurnool district is situated between the N. Latitudes 14°54' and 16°18' and E.Longitudes 76°58' and 79°34' with a geographical area of 17,658 sq.km and population of 2,407,299. It is bordered by Tungabhadra and Krishna rivers as well as Mahabubnagar district on the north, Prakasam district on the east, Bellary district of Karnataka state on the west and Anantapur and Cuddapah districts on the south. It forms one of the drought districts of Rayalaseema Region and one among the seven drought prone districts of Andhra Pradesh. The district has 13 taluks with headquarters at Kurnool. There are 11 towns in the district and only Kurnool and Adoni have population fof more than 100,000.

3.2 Physiography and Drainage:

The district is characterised by scattered hill ranges with intermittent valleys and plains. The Veligondas, the Erramalais and the Nallamalai ranges form the main hill ranges. The average width of the hill ranges from west to east is nearly 40 km. They extend for about 113 km in the district reaching a maximum altitude of 909 m above msl. The upper reaches of the hill ranges has a thick forest cover of temperate type with rich fauna and flora. The Erramalais are low and cliff-scarped and plateau topped hills rising to a height of 606 m The Veligondas form the boundary and run parallel to Nallamalais. The ranges terminates at about 16 km east of Markapur town. The highest-point in the range is 815 m amsl.

The principal rivers which drain the district are the Krishna, the Tungabhadra and its tributaries, and the rivers/Kunderu and the Gundlakamma. Tungabhadra and/ the Krishna are the perennial rivers while other streams are ephemeral in nature.

3.3 Hydrometeorology:

The climate of the district is characterised by hot summers and mild winters. The period from December to February is dry and cool, summer season is from March to May and the period from June to September forms the south-west monsoon season. The mean daily maximum temperature during December is 30.3°C and minimum is 16.1°C. During the hottest period which is generally the month of May, the mean daily maximum temperature reaches 40.3°C. The highest temperature recorded is 45.6°C and the lowest temperature recorded is 6.79°C.

The average annual rain-fall of the district is 624.4 mm.(Fig. 2), depicts the normal annual rainfall of the district. The rainfall over the district decreases from east to west from more than 650 mm to less than 550 mm.

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To study the trend of the rainfall over a period of time and decipher any 'cycles' rainfall received at Kurnool for 85 years (1901-1985) has been studied and the 5 year and 10 year moving averages have been plotted and shown in figure-6. An examination of the figure indicates that a rough periodicity is apparent though not clear.It can be seen that the periods 1907-12, 1917-27, 1933-43, 1961-72 as below normal or deficit years whereas 1912-15, 1930-32, 1944-60 and 1973-80 as 'wet' years. An increasing trend in the rainfall is also apparent indicating the coming years to be good as far as rainfall is concerned. if we examine the record of 85 years, the lowest rainfall of 281 mm has been received in 1920 whereas the heaviest rainfall of 1070 mm has been received during the year 1970. The trend of rainfall for the last ten years during the last decade indicates that normal rainfall has been recorded in 5 years, excess rainfall in 3 years and deficit rainfall in 2 years. This indicates that there is a possibility of receiving normal rainfall in the coming years rather than deficit rainfall.

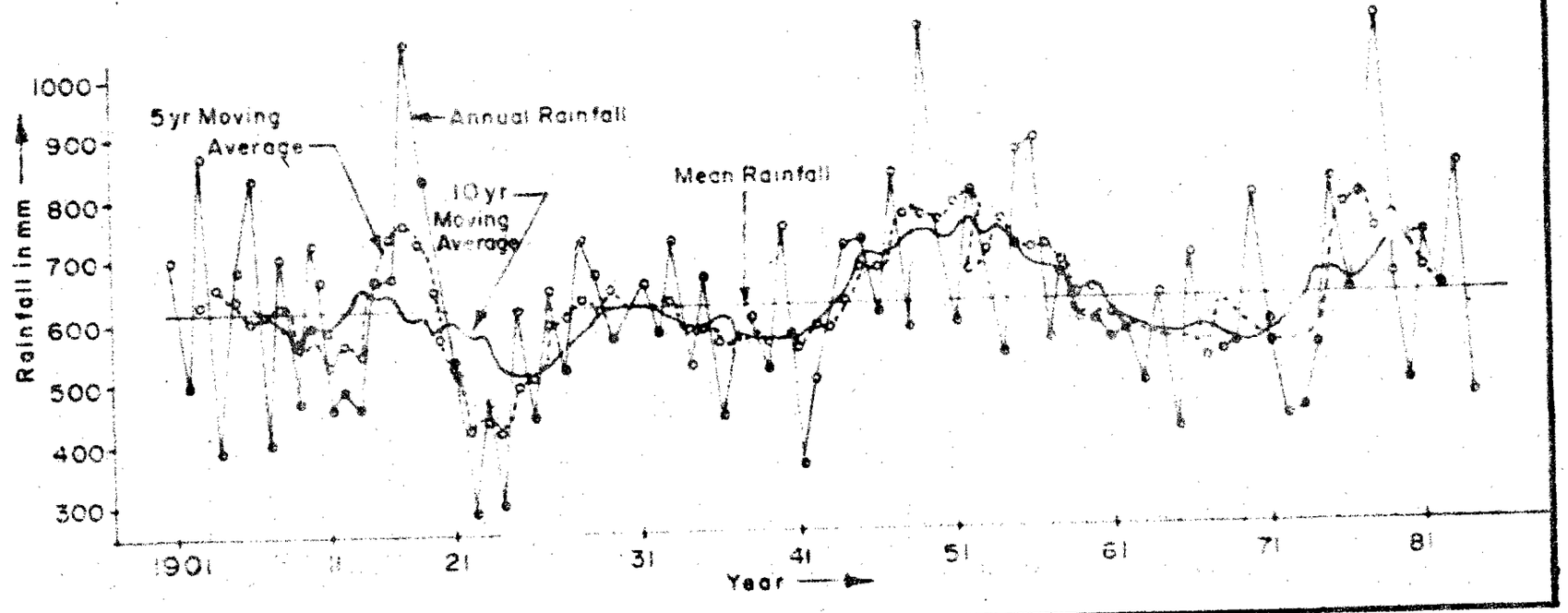
The percentage frequency of occurrence of normal, excess and deficit rainfall in 5 continuous years during the period 1901- 1985 is given below:

No. of years with normal rainfall	4	3	3	5	2	2	3	2	4	2	1
No. of years with excess rainfall	0	1	2	0	1	0	0	2	1	3	0
No. of years with deficit rainfall	1	1	0	0	2	3	2	1	0	0	4
Percentage frequency of occurrence	15	14	12	12	10	9	9	6	6	5	2

The table above indicates that in a 5 year continuous period, there is a high probability of occurrence of normal rainfall in 3 or 4 years and deficit rainfall

Fig. 6

RAINFALL TREND DURING 1901 – 85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE KURNOOL STATION KURNOOL DISTRICT



in 1 year. There may or may not be a year with excess rainfall. During 1981-85, normal rainfall has been received in 3 years, excess rainfall in 1 year and deficit rainfall in 1 year. From the above analysis it can be assumed that during the next 5 years (1986-90) the frequency of occurrence of normal, excess and deficit rainfall can be one of the following:

No.of years with normal rainfall	3	4
No. of years with excess rainfall	1	0
No. of years with deficit rainfall	1	1

Year	Anticipated rainfall	
1986	N	N
1987	N	N
1988	E	N
1989	D	D
1990	N	N

This indicates that in Kurnool district the situation of rainfall in the coming years is not ominous and there is a distinct possibility of getting normal and excess rainfall during the next five years with one of the years of low rainfall, probably during,1989.

3.4 Soils:

Kurnool district is mostly covered by regur and red ferruginous soils which constitute about 60 and 40 percent respectively. They have been further classified as clayey, loamy and sandy soils. The black cotton soils are predominent in the taluks of Pattikonda, Nandyal, Allagadda, Koilkuntla, Nandikotkur and Adoni. In the eastern part of the district red soil of poor quality largely predominent. These soils eventhough are poor in quality generally produce good crops with minimum of rainfall. The crops mainly raised are Rice, Jowar, Cotton and Pulses.

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Regur soil of good quality occurs in the central part of the district in Kurnool and Pattikonda taluks. The occurrence of alluvial soil is restricted and confined to smallarea near the confluence of Bhavanasi and the Krishna rivers.

3.5 Agriculture and Irrigation:

Nearly 51.0 percent of the district or 898336 hectares is the total cropped area sown out of the total area of 17,60,034 hectares. The gross area irrigated by different sources is 1,41, 426 hectares out of which the gross irrigated area under wells is 23273 hectares, which is about 16.4 percent of the gross irrigated area. The area under canal command is 98487 hectares. The Tungabhadra Canal Command irrigates an area of 63,545 hectares in parts of Adoni and Alur taluks while the K.C. Canal Command irrigates 74,727 hectares in Nandikotkur, Atmakur and Nandyal taluks. An area of 12,950 hectares is under Sanjeevaiah Sagar Project Canal Command in Hindri Basin. Nearly 13,307 hectares are under tank irrigation.Out of the area irrigated by different sources an area of nearly 1,03,788 hectares is under food crops. About 37930 hectares are under groundnut. The area under rice cultivation is 65,926 hectares and an area of 944 hectares is under sugarcane cultivation. Most of the rice, sugar cane and groundnut cultivated is in the canal command area. Under well irrigation mostly crops like groundnuts,onions, chillies and other vegetables are raised while under the few wells situated in areas served by canal or tank commands crops like sugar cane and rice are grown. It is proposed to bring an area of about 65,170 hectares in Nandyal, Banganapalli, Koilkuntla taluks under the Srisailam Right Bank canal and an area of 1.08 lakh hectares in parts of Nandyal, Allagadda, Atmakur and Nandikotkur taluks under the Telugu Ganga project. This brings the total area under canal irrigation

to 2,55,965 hectares which is about 14.4 percent of the total area of the district and 28.5 percent of the total cropped area of the district.

3.6 Industries and Mining:

Several industries exist in the district most of which are concentrated at Kurnool, Nandyal, and Adoni towns. Tungabhadra Industries located at Kurnool is the largest Groundnut oil and Vanaspati unit in the south. A few more industries like Spinning and Cotton Mills, Paper Mills are located at Kurnool and Adoni. The Panyam Cements and Mineral Industries is located at Bugganipalle near Banganapalle. Several small scale industries mostly agro based are located in the district. Handloom weaving an important cottage industry is located at Nandyal, Koilkuntla, Banganapalle, Allagadda, Alur, Yemmiganur and Nandikotkur. Minining is an important activity in the district. With several known occurrences of copper, diamonds, iron ore and limestone. There are several old workings of copper, diamond and iron ores. Limestones mining is a major industry in the district feeding the cement factory located at Bugganipalle. With nearly 19.6% of the area of the district under forests, forest based products like timber and bamboo also form important sources for several forest based industtries located at Nandyal and Kurnool.

3.7 Geology:

Geologically the district is underlain by the formations ranging from Archaean gneisses to the Recent alluvium. The broad geological succession as seen is given below:

Recent to Sub-Recent	Soils, Alluvium and Cavernous deposits

----Unconformity ----------

Upper Pre-Cambrian to Lower Palaeozoic	Kurnool Group	Nandyal shales	shales
		Koilkuntla limestones	Limestones
		Banaiam quartzites	Quartzites
		Auk shales	shales
		Narji limestones	Limestones
		Banganapalle quartzites	quartzites & Conglomerates
	------Unconformity -------		
		Srisailam Quartzites	Quartzites & Shales
	---- Unconformity --- ---		
CUDDAPAH SUPER GROUP	Nallamalai Group	Cumbum Shales	Cumbum shales & phyllites, slates, Pulampet shales with intrusives
		Bairankonda Quartzite	Bairenkonda quartzites and shales. Nagari quartzites, Ultra basic intrusives and alkaline intrusives
	---Angular Unconformity ----------		
Upper Pre-Cambrian	Chitravati Group	Tadpatri shales	Shales, quartzites with basic intrusives
	Pulivendla Quartzite		Conglomerates & quartzites
	.----Unconformity ------		
	Papagni Group	Vempalle dolomites & shales	Stromatolitic dolomites, cherts,

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			breccia, shales with basic intruives
	Papagni Group	Gulcheruvu Quartzites	Conglomerates, quartzites and shales
	------Unconformity ----------		
Archaean to Lower Pre-Cambrian	Dharwar Super Group	Dharwars	Dolerite dykes, pegmatites and quartz veins, schists, phyllites amphibolites
	Peninsular gneisses		Granitic gneisses, Gneissic granites

3.8 Hydrogeology:

A major part of the district in the west is occupied by granitic gneisses while the Cuddapah and Kurnool formations comprising of Gulcheruvu quartzites, Vempalle limestones and shales, Pulivendla quartzites and Tadpatri shales, Banganapalle quartzites Narji limestones, Auk shales, Koilkuntla limestones and Nandyal shales occur in the eastern part of the district. The Recent fromations represented by the river alluvium is confined to the major stream and river courses like Krishna, Tungabhadra, Gundlakamma and Kunderu. The ground water conditions as seen in different formations are discussed below:

3.9 Ground water conditions in crystalline rocks:

The granites and gneisses occupy the western half of the district. Ground water occurs in the weathered and fractured rocks under water table and semi-confined condirions. The depth of weathering varies from less than a metre near outcrops to about 18.0 m in

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topographical lows and valleys. The wells range in total depth from 4.00 to 26.00 m bgl. and depth to water in open wells varies from 1.0 m to 13.50 m bgl.Water table is shallow around 2.00 m in the area served by the Tungabhadra Low Level Canal Command area. falling in parts of Yemiganur, Adoni and Kurnool taluks. The yield of bore wells drilled down to a depths of 25 to 35 m vary from 1.84 to 9.2 m^3/h for drawdowns upto 20.0 m.

3.10 Ground water in Cuddapah formations:

The Cuddapah formations are represented by Gulcheruvu quartzites, Vempalli limestones and shales, Pulivendla quartzites and Tadpatri shales. Wells tapping all these formations vary in depth from 2.00 m to 34.0 m.The depth to water varies from less than a metre to 5 m in Gulcheruvu quartzites, from 0.2 m to 30 m in Vempalle limestones, from 2.8 to 20.5 m in Tadpatri shales and from 2 to 22 m in the traps sills intruding the Vempallis. Recent studies have shown that Tadpatri shales of Tammarajupalli area form potential aquifers down to a depth of nearly 60 m . Wells drilled by APSIDC down to depths 33 to 61.6 m have given discharges varying from 7.8 m to 59 m^3/h for drawdowns ranging from 2.2 to 6.6 m. The transmissivity of the aquifer ranged from 30 to 213 m^2/d. The depth to water in these wells varied from 2.4 to 8.5 m bgl.

3.11 Ground Water in Kurnool Formation:

The Kurnool formations are represented by Banganapalle quartzites and conglomerates, Narji limestones, Auk shales, plateau and pinnacle quartzites, Koilkuntla limestones and Nandyal shales. These formations occur in the eastern part of the district. These rocks have undergone compaction and metamorphism to a considerable degree obliterating the primary porosity. Hence, the occurrence and movement of ground water is confined to weathered,

fractured and jointed rock, solution channels and cavities. Ground water is developed by means of dug wells, dug-cum-borewells and borewells. Dug wells range in depth from 2 to 41 m.

Maximum depth to water in the wells tapping Banganapalle quartzites and conglomerates is 20.0 m while it is 13.5 m in Narji limestones, 18 m in Auk shales and 16 m in Nandyal shales. The yield of open wells vary from 2 5 to 100 m^3/d in Nandyal shales, around 36 m^3/d in Auk shales around 67 m^3/d in Narji limestones, 30 to 100 m^3/d in Paniam quartzites. The dug-cum-borewells in Koilkuntla limestones have given yields ranging from 100 to 1500 m^3/d with extension bores 25 m deep from the bottom of the wells. The borewells drilled in the above formations especially Koilkuntla limestones down to depths of 30 to 74 m have given yields varying from 8 to 70 m^3/h. The limestone forms a potential aquifer amongst the Kurnool formations.

The alluvium in general is limited in extent and not very important from the ground water point of view and are important only locally. The thickness of this formation varies from less than a metre to 8 m. Depth to water in wells tapping alluvium ranges between 1.2 and 5.3 m bgl. Fig. 7 depicts the general depth to water map of the district.

3.12 Status of Studies:

The entire /16,128 Km^2 of the district has been covered by systematic hydrogeological surveys till March, 1987. / area of

3.13 Ground Water Level Monitoring:

Ground water levels are being monitored from 1969 onwards with the establishment of 2 stations which have been increased subsequently to 15. The monitoring has indicated that the water level fluctuations occur in response to recharge and draft seasonally and also annually. The annual fluctuation ranges from less than a metre to

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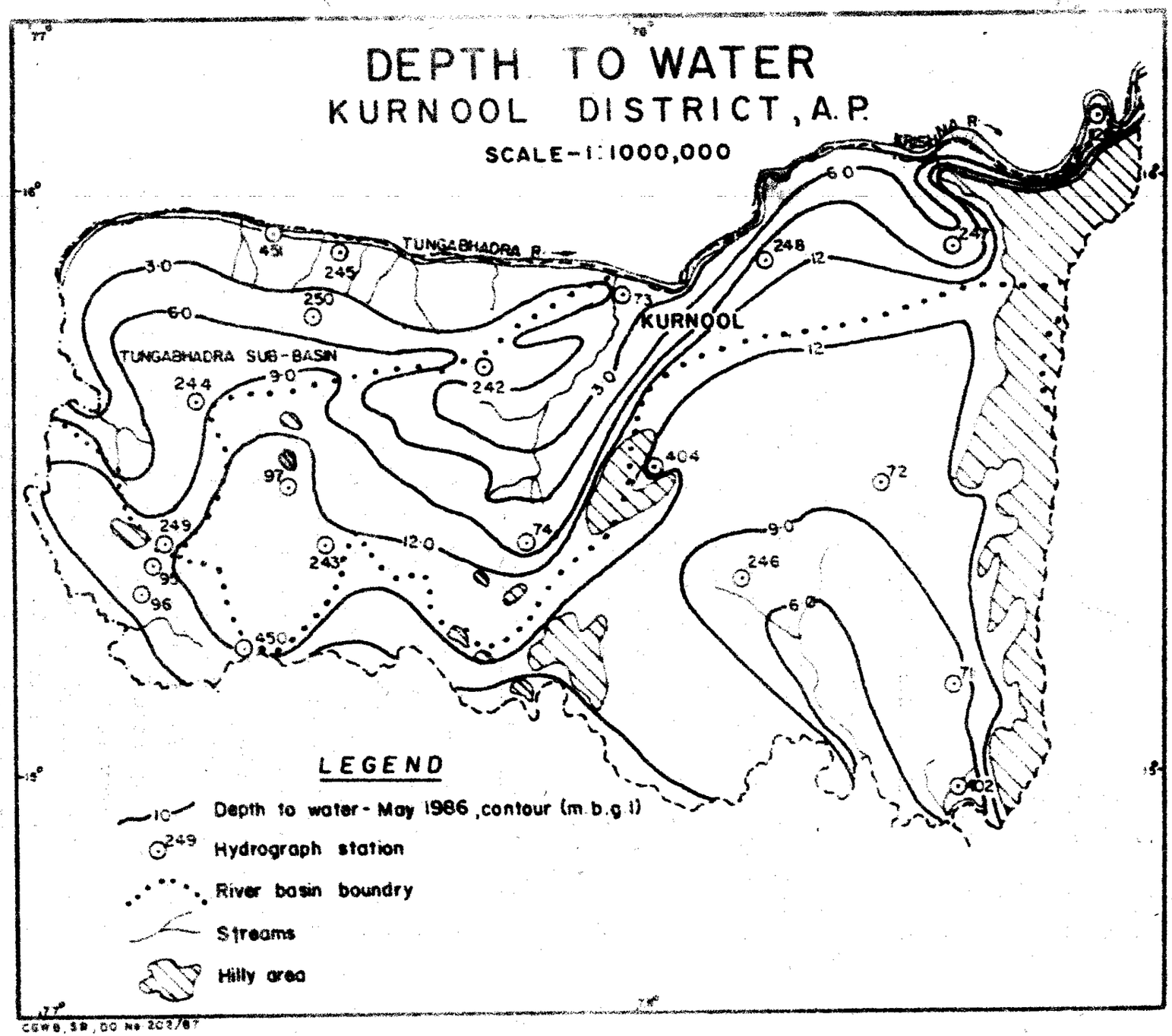
more than 4.50 m with the average fluctuation around 1 to 2.5 m. In recent years there has abeen declining trends in water levels observed in the south-western part of the district falling in parts of Adoni, Alur and Dhone taluks. This is mainly attributed to below normal rainfall received during the last 2 to 3 years and consequent increase in water demands being met from ground water sources.

3.14 Ground Water Exploration:

Central Ground Water Board carried out ground water exploration under the Vedavati River Basin Project studies falling in parts of Alur taluk. Three exploratory wells have been drilled down to depths of 40 to 52 m bgl covering an area of 929 sq.km and the yields from these wells varied from 75 to 900 lpm for drawdowns varying from 1.7 to 8.0 m. Pumping tests carried out on these wells have given transmissivity values varying from 585.55 m^2/d to 1370 m^2/d

3.15 Chemical Quality of Ground Water:

The quality of ground water from wells tapping the crystalline fromations is generally good and suitable both for irrigation and domestic purposes. The pH varies from 7.1 to 8.8. The Electrical Conductivity varies from 515 to 4412 micromhos/cm at 25°C. The total hardness as $CaCO_3$ in general varies from 120 to 1300 ppm and the chloride content varies from 67 to 790 ppm. There are pockets of high E.C. which can be attributed to local conditions. The quality of water in Cuddapah formations is generally good both for domestic and irrigation purposes. However, there are some saline pockets in Kurnool formations. The pH of ground water in Kurnool formations generally varies from 7.0 to 8.6. Higher pH is seen in areas with poor drainage and thick black cotton soils. The E.C.varies from 203 to 6780 micromhos/cm at 25°C. A high degree of mineralisation is seen in areas under-



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lain by Nandyal shales along the Kunderu river, while it is 500 to 1000 micromhos/cm at 25°C in areas underlain by Tadpatri shales, Paniam quartzites and Koiluntla limestones. The total hardness as $CaCO_3$ varies from 90 to 1440 ppm. Ground water in Nandyal shales is characterised by permanent hardness. The chloride content varies from 18 to 1144 ppm. The fluoride concentration in the ground waters of Kurnool district is slightly high ranging in concentration from 1.70 to 2.30 ppm which can be treated easily and used for human consumption.

3.16 Ground Water Resources and Development prospects:

Ground water forms an important resource in addition to the surface water. Ground water utilisation has been gaining momentum in recent years in view of the increase in institutional financing in addition to the major and medium irrigation projects and tanks. Consequent to increase in development, the estimation of ground water resources has assumed importances, and in order to keep up with the pace of development, estimation of ground water resources are being carried out from time to time. The first assessment was carried out in the year 1977. Subsequently the estimations have been revised and the latest tentative assessment for the year 1985 has been carried out as per the Ground Water Estimation Committee recommendations. The taluk-wise estimations are given in Table 3. As per the estimations, the total utilisable ground water resources of the district is 1356 MCM and the net draft is 118 MCM leaving a balance of 1236 MCM. The stage of ground water development is 9% which means there is a very good scope for further development.

The estimated Net draft in the district during the last four years are given below:

Year	Net draft	Stage of G.W. Development	Annual rise
1981-82	86.5 MCM	6.4	-
1982-83	96.3 "	7.1	0.7
1983-84	101.3 "	7.5	0.4
1984-85	118.0 "	9.0	1.5

Table-3

ESTIMATED GROUND WATER POTENTIAL AND GROUND WATER DRAFT (NET) FOR KURNOOL DISTRICT (1984-85)

Sl. No.	Name of taluk	Estimated utilisable Ground Water Potential (MCM)	Estimated Ground Water Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water development	
					Present %	at years 5 (%)
1	Alur	76.2	4.0	72.2	7	7.2
2	Yemignur	68.8	8.0	60.8	12	13
3	Nandyal	220.0	11.0	209.0	5	6
4	Atmakur	115.0	10.0	105.0	9	10
5	Koilakuntla	95.6	7.0	88.6	8	9
6	Allagadda	153.0	10.0	143.0	6	7
7	Adoni	72.0	8.0	64.0	11	12
8	Pattikonda	100.0	14.0	86.0	14	15
9	Nadikotkur	82.0	10.0	72.0	12	13
10	Kurnool	113.2	8.0	105.2	8	9
11	Banganpally	30.0	8.0	22.0	27	30
12	Dhone	115.0	11.0	104.0	10	11
13	Kodumuru	115.0	9.0	106.0	8	9
		1355.8	118.0	1237.8	9	10

(Data Based on Bureau of Economics and Statistics, Govt.A.P. for 1984-85)

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This shows that there is a steady increase in the draft. However, in spite of the increase in draft the stage of ground water development is only 9 percent and at the present rate of annual increase in the draft of less than 1 percent of the available resource, the stage of ground water development after 5 years (1990) can be anticipated to be less than 20 percent of the total available resource.

3.17 Rural and Urban water supplies for drinking water and for Industries:

As per 1981 Census there are 18.15 lakh rural and 5.89 lakh urban population living in the district. To meet the drinking water requirements of this population, the Panchayat Raj and the Public Health Engineer-Department have drilled 7552 bore wells and executed 320 pumping and mini pumping water schemes in the district. In addition to the above, there are No. of public and private shallow dug wells to meet the drinking and domestic needs of the people. As per the norms and taking the average consumption 90 lpd for urban and 70 lpd for Rural and livestock population the total requirements works to 65.74 MCM per year. This is for less than the provision of 239.3 MCM given for drinking water, industrial purposes and for unaccounted losses while calculating the utilisable potential of 1356 MCM from the gross recharge of 1595.3 MCM. There is enough scope for meeting the water requirements for rural and urban population. Part of the water requirement of some towns like Kurnool Mantralayam are met from the surface sources that is from the Tungabhadra River. However the problem is to meet the water requirements during drought years when the surface flows dwindle and the shallow wells go dry as the water levels go deeper. In such a situation, to meet the requirements, the existing wells have to be deepened and deeper borewells have to be drilled.

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3.18 Ground Water Development with reference/Rainfall and Water levels:

Ground water development in the district has been on the rise as evidenced from the increasing trend in the number of ground water extraction structures from 5,922 in 1976-77 to 19,301 in 1984-85. Presently there are 17,263 energised wells and 2048 dug wells with out pumps in the district. There has been increased energisation of wells in the district of late as is evident from the increase in the number of energised wells compared to the previous years. The ground water draft is also on the rise from year to year. However, if this rise in the ground water extraction is examined in relation to the tempo of development, rainfall and water levels, the rise in draft is recorded in all the taluks except in Kurnool taluk where there is actually decrease in draft from 14 MCM in 1983-84 to 11.3 MCM in 1984-85. If we examine the trend of water levels it will be seen that there is no fall in water levels at Kurnool which is almost steady from 1976 onwards (Fig 8).The stage of ground water development in Kurnool taluk is only 6 per cent. Kurnool area received below normal rainfall during 1984 and 1985, whereas it was above normal during 1983. Hence, the fall in draft can be atributed to low rainfall due to which there has not been any cultivation in areas which are partly irrigated and partly cultivated by rainfall.

There has been almost a failure of monsoon in the last three years i.e. 1984-85 and 1986 in most of the taluks of the district. Consequently demand for the ground water has gone up. Hence, the increase in ground water draft in most of the taluks. In some of the taluks like Kodumuru, Banganapalle and Alur the draft for 1985 was almost double compared to the previous year 1984. There has been a fall in ground water levels observed

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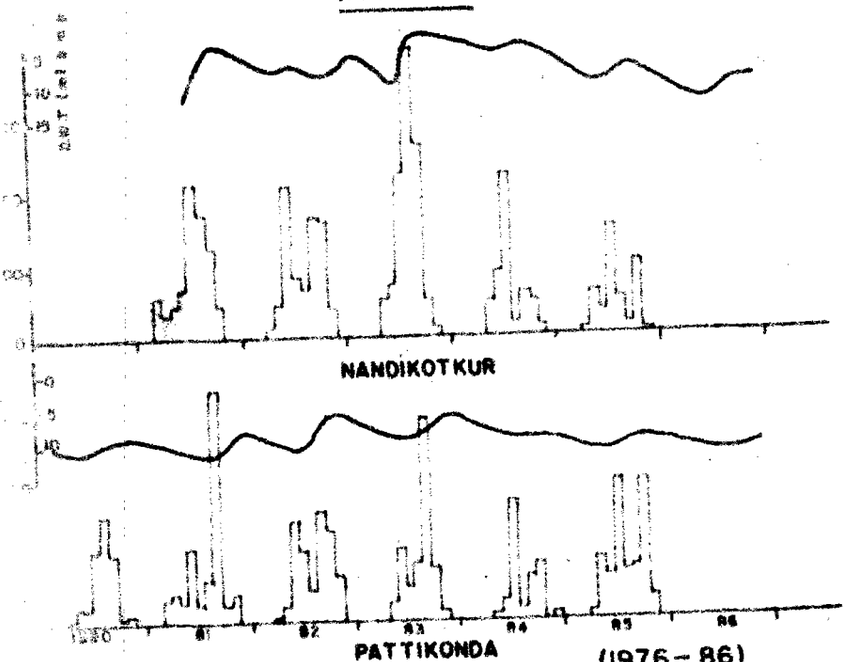
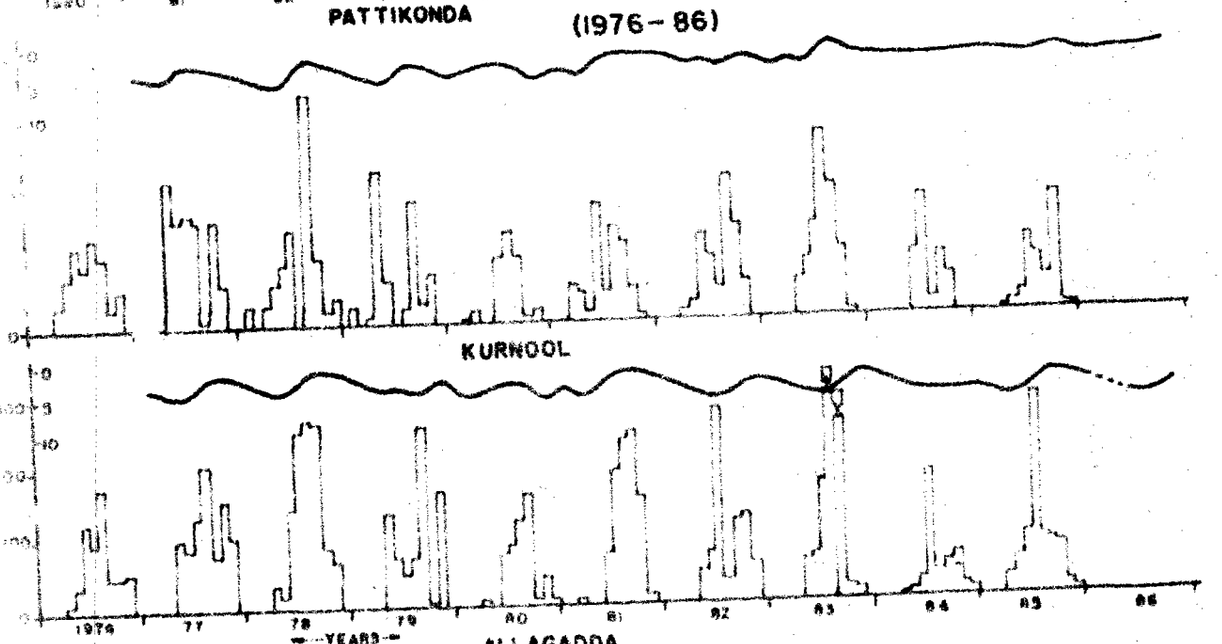
RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, KURNOOL DISTRICT, A.P.

(1980-86)



(1976-86)



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in almost all the network observation stations monitored by Central Ground Water Board in all the taluks except in Alur, Yemmiganur and Srisailam which show rise in levels varying from 0.13m to 1.18 m. However, the draft data indicate that the stage of ground water development has not exceeded more than 30 percent except only in the case of Banganapalle taluk. The fall in water levels vary from 6.30 m at Atmakur to 1.55 m at Nandyal between November 1983 and November 1986. This fall in levels can only be attributed to the below normal rainfall received during the last 3 years. As per the rainfall probability analysis carried out and discussed earlier, the rainfall during 1987 is likely to be normal which may help recover the water levels in these areas. The stage of ground water development as per estimations is also low.

3.19 Ground Water Management Practices and Drought Management Strategies:

As is evident from the estimations carried out, barring Banganapalle taluk, the stage of ground water development in most of the taluks is below 15 percent of the utilisable ground water resources. But the meteorological drought created by the below normal rainfall received in the district, has created problems with most of the tanks having gone dry and the recharge from rainfall being much below than in the periods of normal rainfall. As such there can be temporary lowering of the water table during the periods of drought. Coupled with this, due to the shortage of surface water sources,people will be forced to depend on ground water to meet their water nneeds. Hence increased draft from ground water sources can be anticipated and this is what has been observed during 1984 and 1985 in Kurnool district. However, as generally happens the proble is one of water management and efficient and optimal uti-lisation of water resources during the periods of water shortage which

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can help tide over the crisis.This calls for certain longterm and short term drought management strategies to overcome the crisis. The longterm strategies call for advance planning to solve the water needs on a permanent basis but essentially a slow one. The short-term strategies is to tide over the crisis for the time being to mitigate the hardships of the rural and urban population and calls for quicks decisions.

3.20 Long term drought management strategies:

The longterm measures or strategies like changes in cropping pattern and to raise crops which require less water like ground nuts, cotton vegetables, fruits, oil seeds and mulberry. Resorting to these measure will ensure the purchasing power of the farmers without reducing their income. Also practicing of the efficienct water use methods like drip and sprinkler irrigation techniques can save almost 30 percent of water on applied irrigation.

The problem in areas like the one served by the Tungabhadra Low Level Canal Commamd and the K.C.Canal is slightly different. Here the problem is one of plenty. The water table is shallow generally within 2 to 3 m bgl for nearly 8 months a year. Ground water is generally mineralised with EC values going upto 10 to 15,000 microsiemens/cm at 25°C. The ground water becomes mineralised due to water logging conditions, low leaching, low permeability of the soil and intense agricultural practices due to the availability of surface water at a lower cost for most part of the year, with minimum investment. Ground water is rarely used. The remedial measure is to adopt better water management practices like conjunctive use techniques, reduce the in take through canals, introduce water use efficiency techniques, encourage utilisation of ground water development by subsidies and drill borewells by the state agencies after adopting

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proper well siting techniques and mix the poor quality water with the canal waters. This will ensure lowering of water table in water logged areas and improve the quality of ground water in course of time due to creation of gradient and flushing which is otherwise stagnant This will also help bring additional area under irrigation and ensure that water will reach the tail ends. It may be worth mentioning here that an additional area of 1,73,170 hectares are proposed to be brought under irrigation under the Srisailam Right Bank Canal and the Telugu Ganga Project. Water management and conjunctive methods can be adopted at the time of execution itself, so that the quality problems, water logging problems etc can be avoided which may crop up at a later date.

In areas, where the water has fluoride of more than 1.5 ppm as in parts of Pattikonda, Alur and Dhone taluks people may be advised to use defluoridation kits or the water be supplied through pipes under rural water supply schemes, after defluoridation. In areas, where no surface source is available and ground water is brackish there is no other way except to use desalination plants and also resort to growing salt resistant crops. Perhaps use of solar energy which is quite abundant in these parts can be used successfully for desalination.

As far as the water requirements for the industries are concerned, no major industry exists in the district. Most of the industries are located at Kurnool and of their water requirements are met from the Tungabhadra River.

As one of the permanent measures for drought management, the DPAP Projects can be utilised for social forestry of barren and waste lands which is about 5.6 percent (98200 hectares) of the district. This can

retain the soil cover and also meet the fuel requirements and avoid further deforestation. Similarly the culturable waste which is about 4.9 percent of the district (85,800 hectares) can be used for cultivating fodder for the cattle in the areas. A much more viable proposition would be to harness the flash floods, and adopt rainfwater havesting techniques by construction of check dams/wiers construction of percolation ponds and ofcourse utilise the possibilities of storing this surface water 'underground' especially in the limestone terrain. The occurrance of thick Cuddapah and Kurnool limestone formations, the numerous caves and in particular the 'Belum Caves' offer a great scope for such an experiment. This can serve almost like a 'Ground water Sanctuary' and the water stored thus underground can be developed by dug cum bores or borewells in times of severe drought.

3.21 Short term Drought Management Strategies:

Some of the methods discussed above takes some time to yield results and they can be considered as longterm measures. But the people and the livestock have to withstand the hardship of the drought situation created by the failure of the monsoons and their urgent needs are to be met immediately and which cannot be postponed. The most important need is to meet the drinking water requirement of the people for survival. The urgent need will be to drill a number of boreholes to tap the ground water wherever feasible and meet the needs on war footing. The more efficient way is to look 'underground' to tap the potential aquifers in the favourable zones like the faults fractures, joints and other favourable location of ground water. Kurnool district holds good scope for development. The Cuddapah and Kurnool formations like the Tadpatri shales, Vempalle limestones and shales, Narji limestones and Koilkuntla limestones, Banganapalle, quartzites and conglomerates all hole good promise for

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development. They can be tapped extensively by utilising the latest techniques like remote sensing and geophysical surveys for accurate siting and pinpointing to minimise the well failures. Possibilities for tapping deeper aquifers below 100 metres should be examined also as they amay yield substantial quantities to tide over the crisis. The experience gained by deep drilling in the neighbouring Anantapur district will be helpful. In areas, served by canal command where there is quality problem storage ponds, tanks can be constructed near the villages and canal waters can be stored during the periods of canal operation and the water thus stored can be utilised during the periods when the canal is not in operation. This will help to tide over the summer months which are the periods during which canals are shutdown. This can be considered as a purely temporary measure or can also be used on a permanent basis during every summer months. Other measures can be utilise the IRDP, DPDA and NREP programmes of course to help the rural population to give employment and these programmes can also be utilised for construction of percolation ponds, check dams etc. which will help to conserve water even when there are summer showers. These methods will go a longway to help the rural and urban population during the crisis.

4.0. CUDDAPAH DISTRICT

4.1 Location and Extent:

Cuddapah is one the four districts of Rayalaseema region of Andhra Pradesh with a total geographical area of 15,371 sq.km and lies between North Latitude, 13°43' and 15°14' and East Longitude 77°55' and 79°29' and bounded on the north by Kurnool district,

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on the east by Nellore on the south by Chittoor and on the west by Anantapur districts. The district is well connected by road and rail. The Madras-Bombay broad gauge line passes through the district. The district headquarters Cuddapah town, is about 480 km from the state capital by road and 558 km by train. There are 12 taluks, 15 towns and 1007 villages in the district of which only 7 are towns with more than 20,000 population. There are only two towns viz. Proddutur and Cuddapah with more than 50,000 population(1981 Census).

4.2 Physiography and Drainage:

The district is characterised by undulating topography with deep fronted hill ranges and intervening valleys and plains. The important hill ranges are Nallamalais'Velligondas, Palakondas, Lakkamalais and Yerramalais. The Nallamalais are covered by thick forest and abound in wild animals. Generally these hill ranges rise to a height of 735 m to 882 m.

Cuddapah district is drained by river Pennar and its tributaries. Pennar is the main river which enters the district near Tallaproddatur after passing through Anantapur district. Pennar flows through Jammalamadugu taluk and at the historic fort of Gandikota, it cuts through the Yerramalai hill ranges. The other important rivers of the district are the Chitravati Kunderu, Sagileru, Cheyyeru and Papaghni all of which are the tributaries of Pennar. However all these are ephemeral and even Pennar is dry for most part of the year and carry only monsoon discharge.

4.3 Hydrometeorology:

The district enjoys hot summers and mild winters. The period from December to February is comparatively cool and dry. The summer season starts from

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March and lasts till May. May is the hottest month of the year. This is followed by the southwest monsoon from June to September which brings down the temperature. October-November forms the retreating monsoon season. The mean maximum temperature is 40.8°C in May while the mean minimum temperature is 18.8°C recorded in December. The highest maximum temperature recorded is 46.1°C in May 1986 while the lowest temperature recorded is 11.7°C in January 1912 and December,1945 Cuddapah district generally experiences dry climate and the rainfall is erratic. Though it is under the influence of both the monsoons, the intensity and activity of the monsoons gets reduced by the time they reach the district. The average annual rainfall over the district is 730.00 mm. The rainfall generally increases from the north-west to south-east. Chitvel near the southeastern border receives 909.4 mm of rain while Pulivendla near the western border has an average annual rainfall of 563.9 mm. Fig-2 presents the normal annual rainfall of the district and fig 9 gives the 5 and 10 year running means for the rainfall station at Cuddapah for the period 1901 to 1985. From the study of the plot, it is clear that there is no decreasing or increasing trend in rainfall over the years. The heaviest rainfall of 1226 mm has been received during the year 1903 and the lowest rainfall of 386 mm has been received during the year 1923.

However, a rough periodicity or 'wet' and 'dry' periods can be deciphered. The periods from 1901 to 1920, 1935 to 1949, and from 1971 to 1981 can be said as above normal or 'wet' periods while the periods from 1921 to 1935, 1949 to 1971 (with a small above normal period from 1956 to 1957) can be said as below normal or 'dry' periods.

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If we examine the rainfall received during the last decade normal rainfall was recorded in 8 years, excess and deficit rainfall in 1 year each. The curve shows declining trend for the coming decade.

The percentage frequency of occurrence of normal, excess and deficit rainfall in 5 continuous years during the period 1901-85 is tabulated below:

No.of years with normal rainfall	4	3	4	2	2	3	3	1
No. " " excess "	0	1	1	1	2	0	2	3
" " deficit "	1	1	0	2	1	2	0	1
Percentage frequency of occurrence	20	17	16	11	9	7	7	4

The table indicates that there is a high probability of occurrence of normal rainfall in 3 or 4 years during any continuous 5 years period and excess and deficit rainfall in 1 year each. The probability of occurrence of deficit rainfall in an year is more than that of excess rainfall.

If the rainfall particulars for 1981-85, are examined it will be seen that normal rainfall occurred in 4 years and excess rainfall in 1 year. From this statistical approach it can be safely assumed that the probability of receiving normal, excess and deficit rainfall during the next 5 years can be any one of the following:

No.of years with normal rainfall	4	3
" " excess "	0	1
" " deficit "	1	1

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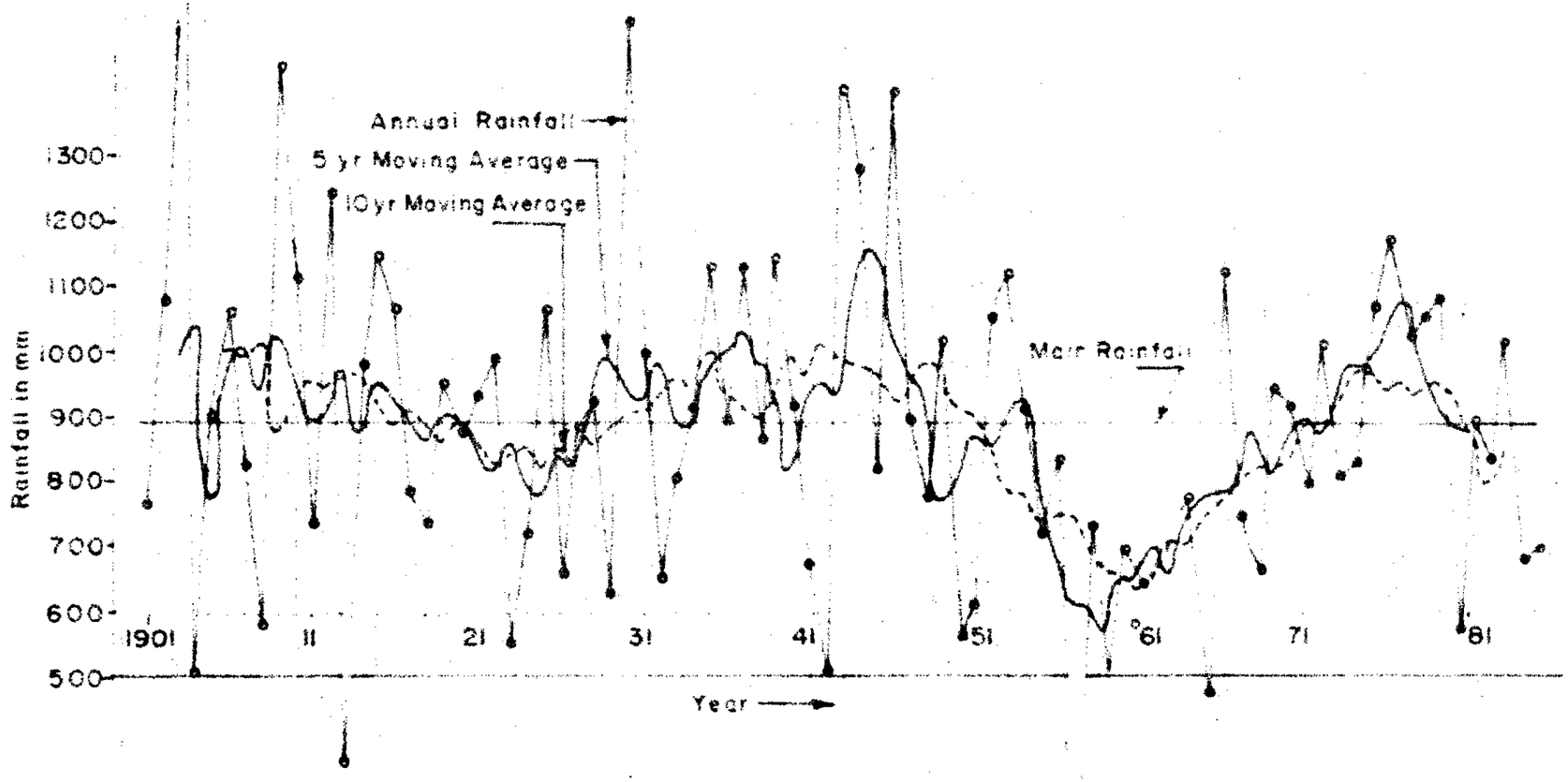
RAINFALL TREND DURING 1901-85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE CHITTOOR STATION CHITTOOR DISTRICT



Year	Anticipated	Rainfall
1986	D	D
87	N	N
88	N	E
89	N	N
90	N	N

From the above it is apparent that the coming periods may be below normal years.

This analysis indicates that there is a high probability of receiving normal rainfall in 4 years and deficit rainfall in 1 year during the next five years, But from the analysis of the plot of moving averages there is a possibility of below normal rainfall in one or two years within the next five years. From the study of annual rainfall also, it is clear that the rainfall was normal during the last 3 years, and as per the data collected for 1986 it is below normal (540 mm).

4.4 Soils:

Soils of the district have been classified into (1) Red ferruginous soil and (2) Black soil. These two classes are again subdivided into (a)clay (b) loam (c) sand with finer distinctions. The soil has also been further divided into six sub-divisions (1) black clay (2) black loam (3) black sand (4) red clay (5) red loam and (6) red sand.

Black clay or the black cotton soil is the most superior soil of the district and occupies 23.7% of the area of the district. Black loam is an alluvial soil and occurs throughout the district. It accounts for 18.2% of the area of the district. This soil is not deep

and hence sub-jected to erosion. Black sand is not very important and accounts for 3.9% of the area of the district. Red clay occurs over a small area in the district. Red loam occurs approximately over an area of 25% of the district. It is found mainly in Rajampet and Budvel taluks. This is of high agricultural value and all varieties of crops can be grown on this soil. It is suitable for wet cultivation. Red sand is of the lowest productive type. It occupies 27.5% of the area of the district and is not suitable for agriculture.

4.5 Agriculture and Irrigation:

The pattern of land utilisation is of interest. Of its total geographical area, forests constitute 32.8% barren and uncultivable land 16.4%. The culturable waste is 2.8%. Out of the total geographical area of 15,37,138 hectares, the net area sown is 3,52,388 hectares or 22.9 percent. The total cropped area is 3,64,679 hectares or 23.7%. The net area irrigated is 1,01,925 hectares which is 28.9 percent of the net area sown. The area under canals is 23,380 hectares. The area under tanks is 15,818 hectares and the area under wells is 57,655 hectares. That means the area under well irrigation is 56 percent. The gross area irrigated is 1,14,217 hectares (84-85) out of which the area under canals is 24,056 hectares, under tanks 17,508 hectares and under wells 76,701 hectares. The main crops grown in the district area Rice, Bajra, Jowar, Ragi, Turmeric, Sugarcane, Groundnuts, Sesamum and Cotton. Rice is cultivated over an area of 50,681 hectares, Bajra over an area of 8992 hectares cotton over an area of 2228 hectares, sugar cane over an area of 2317 hectares, Groundnut over an area of 14,824 hectares. It is proposed to bring an area of 66,000 hectares under irrigation through canals under the Telugu Ganga Project and Srisailam Right Bank canal in parts of Jammala-

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madugu, Proddutur, Badvel and Sidhout taluks.

4.6 Industries and Mining:

The district does not have any heavy industries or large scale industries except two cement factories run by Cement Corporation of India and M/s.Coromandal Fertilisers. It is also poor in small scale industries. Most of the small scale industries are agro based, like groundnut oil decorticication factories, oil and rice mills, ginning factories, saw mills and and barytes pulverising mills. Cottage industries like handloom weaving exist in Kamalapuram, Rayachoti and Rajampet taluks. Cuddapah district is the richest district inof Andhra Pradesh in mineral deposits and is known for the large variety and quantity of minerals. The exploitation of its mineral wealth from ancient days has continued through the mediaeval to the modern period. Occurrence of diamonds is known in addition to other mineral deposits. Lead, silver and copper seem to have been produced ain ancient times though there are no known workable deposits. Iron ore occurrences are limited and worked on a limited scale. The high grade asbestos of chrysotile variety is mined in Pulivendla taluk at Brahmanapalle and Lingala. Barytes is another important mineral in the district occurring in Pulivendla, Rajampet, Kamalapuram and Cuddapah taluks. The most important deposits are situated in the belt between Velupula and Vempalle in the Pulivendla taluk. The barytes deposits of Rajampet taluk are said to be the best. in the world. White clay is mined in Cuddapah taluk and used as filler in paper and textile industries. Limestone by far the most extensive deposit in the district is mined on a large scale and used for cement and also as building material granites, quartzites are also used as building material.

4.7 Geology:

Cuddapah district is underlain by a variety

geological formations belonging to the Archaeans Cuddapahs the Kurnools and the Recent alluvium. In fac it is the type area for the Cuddapah and Kurnool rocks which constitute the main Cuddapah Basin. The broad geological succession as seen in the district is given below:

	Recent Sub-Recent		Soils and Alluvium
	- - - - - - Unconformity - - - - - - - - -		
Upper Pre-Cambrian to Lower Palaeozeic	Kurnool Formations	Kundair group	Nandyal shales, Limestones Koilkuntla limestones
		--------Local disconformity-----	
		Jammalamadugu	Auk shales Narji limestones Banganapalle quartzites
	- - - - - - - - Unconformity - - - - - - - - -		
			Srisailam Quartzites-----
	Cuddapah Super Group	Nallamalai Group	--- Unconformity ----- Cumbum shales and phyllites (Pullampet) Bairenkonda quartzites Nagari quartzites
		-----Disconformity------	
		Chitravati Group	Gandikota quartzite Tadapatri shales Basic intrusives and sills Pulivendla quartzite

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		----Disconformity ----------	
		Papaghni Group	Vempalle dolomites and limestones, shales Basic intrusives Gulcheruvu quartzite
		----------Non-conformity ----------	
Archaeans to Lower Pre-Cambrian		Dharwar Super Group	Dolerite dykes, pegmatites Dharwarian Schists
		Unclassified Crystallines	Granites and Gneisses

The Archaean gneisses and granites are predominently exposed in the Rayachoti taluk with schistose pockets. Dolerite dykes, quartz and pegmatite veins occur as intrusions in these formations. Some of the dykes run for long distances. Dharwarian schists which are micaceous with phyllites occur in the north-eastern, northwestern and southern parts of the taluk.

Cuddapah formations represented by Gulcheruvu quartzites occur in the Palakonda ranges in the Rayachoti, Pulivendla and Cuddapah taluks. This formation consists of conglomerates, quartzites and sandstones with intercalation of shales. The Vempalle formations consisting of dolomites, limestones, cherts, breccia and mudstones overlie the Gulcheruvu quartzite in those taluks/ in Kamalapur taluk. This formation mostly consists /and also of fine grained, massive, flaggy, micaceous and dolomitic limestone with thin intercalations of sandstones and shales. They show intrusions of trap sills.

Pulivendla quartzites occur in Pulivendla, Kamalapur, Cuddapah and Rajampet taluks. Tadapatri formations represented by shales, dolomitic limestones, cherts and with volcanic tuffs, occur in Pulivendla, Muddanur,

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Kamalapura Cuddapah and Rajampet taluks. The basic intrusives like the trap sills occur in the western part of the district.

Gandikota quartzite occurs in Muddanur and Jammalamadugu taluks. The Nallamalai group represented by Bairenkonda quartzites and Nagari quartzites occur in the Nallamalai ranges in parts of Proddutur, Cuddapah Budvel, Siddhout and Rajampet taluks. The Cumbum formations.(shales, slates phyllites) with intercalations of quartzites, dolomites and limestones occur all along the eastern margin of the Cuddapah basin and are exposed in Proddutur, Budvel, Siddhout and Rajampet taluks. Pullampet shales are exposed in Rajampet taluk Srisailam quartzites occur as patches in Pulivendla taluk.

The Kurnool group of formations represented by the Jammalamadugu series (Banganapalle quartzites, Narji limestones and Auk shales) and the Kundair group(Koilkuntla limestones, Nandyal shales and limestones) occur in the north and northwestern part of the district covering parts of Muddanur, Kamalapur, Cuddapah, Jammalamadugu and Proddatur taluks.

Alluvium comprising of fine to coarse grained sands, gravel, clay and silt are seen as river deposits along the major rivers like Chitravati, Pennar, Papaghni, Cheyyar, Sagileru and Kundaru. However its occurrence is limited to the course of the river. The thickness varies from 3 to 20 m. However at some places they are found to extend upto 70 m depth as confirmed from geophysical surveys.

4.8 Hydrogeology:

From the hydrogeological point of view rock-types occurring in Cuddapah district can be broadly grouped in to six groups viz 1) crystallines 2)trap sills 3) quartzites 4) shales 5) limestones and 6) alluvium. The ground water conditions in these formations are discussed in brief below:

4.9 Ground Water in Crystallines:

Ground water in the Archaean crystalline gneisses and Dharwarian schists occur under water table and semiconfined conditions in the weathered, jointed and fractured portions of the rocks and is developed by dugwells, dug cum bores and borewells. The depth of weathering extends down to 15 m. Depth of wells range from 4 m to 14.5 m and depth to water ranges from 1.0 m to 10.70 m gbgl. The yield of dug wells ranges from 20 m^3/d to 220 m^3/d for drawdowns varying from 0.60 m to 3.80 m. for pumping periods of 4 to 6 hours.

4.10 Ground water in quartzites;

Quartzites are mostly confined to the hilly regions and forests. They are hard, compact and massive, jointed and occasionally fractured which make them permeable. Dugwells tapping quartzites (Pulivendla quartzites, Nagari quartzites, Banganapalle quartzites) range in depth from 5 m to 19 m and depth to water range from 1.70 m to 12.70 m bgl. with yields ranging from 45 m^3/d to 60 m^3/d. Borewells drilled ranging in depth from 31 m to 41 m yield upto 4.5 m^3/h.

4.11 Ground water in shales:

Major part of the district is underlain by shales (Nandyal shales, Aukshales, Cumbum shales and Tadapatri shales). These shales are compact and impervious except when jointed and fractured. Ground water occurs under water table and semiconfined conditions. Depth of weathering extends down to 20.0 m. Dugwells in shales range in depth from 5 m to 21 m and depth to water varies from 1 m to 15.50 m bgl. The yield of dugwells generally varies from 30 m^3/d to 150 m^3/d. Bore wells drilled for village water supply down to depths varying from 23.0 m to 49.0 m have given yields from 2.7 m^3/h to 18.1 m^3/h. In case of dug cum bore

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wells, bores are drilled from the bottom of the well varying in depth from 30 m to 100 m. The yields from Nandyal and Tadpatri shales are poor compared to other formations.

4.12 Ground water in limestones:

Limestones (Vempalli limestones, Koilkuntla limestones, Narji limestones and Nandyal limestones, Jarji limestones, and Nandyal limestones) occur approximately over an area of 10% of the district. The limestones are fine grained, massive, flaggy, dolomitic and cavernous at many places. Ground water occurs under water table and under confined conditions in the cavernous zones, fractures and bedding planes. The dug wells vary in depth from 4 m to 17 m while the depth to water varies from 1.20 m to 14.10 m bgl. The depth of weathering is found to extend down to 10.0 m. Dugwells have yields ranging from 30 m^3/d to 189 m^3/d for drawdowns varying from 0.80 m to 4.80 m. Bore wells drilled down to a depth ranging from 26 to 60 m have given yields varying from 5 m^3/h to 22.7 m^3/h. Limestones, especially the Koilkuntla limestones appear to be very potential aquifers in the area because of the presence of caverns.

4.13 Ground water in Trap sills:

Ground water occurs in the trap rocks in the weathered, jointed and fractured portions under water table and semiconfined conditions. Dug wells range in depth from 7 to 21 m and the depth to water in them ranges from 4.7 m to 12.8 m. The yields of wells vary from 45 m^3/d to 60 m^3/d for drawdowns varying from 2 to 3 m

4.14 Ground Water in Alluvium:

Alluvium occurs in limited patches along the major stream courses. Ground water occurs in this formation under water table conditions, and is developed

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mainly by dug wells and filter points. Dug wells range in depth from 3.0 m to 13 m while the depth to water in them varies from 1.0 m to 9.0 m bgl. The yield generally varies from 50 m^3/d to 300 m^3/d. The filter point wells which are of 10 to 15 cm diameter range in depth from 6 to 13.50 m and yield from 20 m^3/d to 50 m^3/d. Wells in alluvium sustain pumping for a longer period. The transmissivity values of the formations range from 270 m^2/d to 875 m^2/d. The exploration carried out by the State Ground Water Department has given promising results for the construction of shallow to medium duty tubewells in the Pennar alluvium. The yield of shallow tubewells range from 30 m^3/h to 100 m^3/h. Fig 10 depicts the general depth to water conditions in the district during May 1986.

4.15 Status of the studies:

An area of 11,577 km^2 has been covered under systematic hydrogeological surveys and an area of 50 km^2 has been covered under reappraisal surveys upto the end of March, 1987.

4.16 Ground Water Level Monitoring:

Ground water level monitoring has been introduced in the district with the establishment of network stations in 1969. Subsequently they have been increased to 7 stations and are being monitored 4 times a year. The long term observations indicated that fluctuations occur in response to the changes in the ground water regime. The average annual fluctuation ranges from 0.50 m to 6.40 m. In recent years there has been decline in water levels in parts of the district. The decline in levels varies from 5.0 m at Cuddapah to 1.5 m at Proddutur. This decline in water levels can be attributed to the below normal rainfall received during the last 2 to 3 years, and in case of Cuddapah the rainfall is below normal from the last 6

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to 7 years. This is bound to have an adverse effect on the water table.

4.17 Ground Water Exploration:

No ground water exploration has been carried out by Central Ground Water Board so far in this part of the state. It is proposed to carryout exploration in the Pennar basin in the near future. The potential of the limestone aquifers are also proposed to be explored.

4.18 Chemical Quality of Ground Water:

The quality of ground water in crystalline rocks is generally good with TDS values ranging from 295 to 1586 ppm pH values from 7.5 to 8.4 and chloride values from 10 to / The water is alkaline in /272 ppm nature suited for both irrigation and domestic purposes. The quality of ground water in Cuddapah formations is good to doubtful. Ground water is alkaline with pH ranging from 7.3 to 8.85 and E.C.varies from 115 micromhos/cm at 25°C to 5200 micro mhos/cm at 25°C. Chloride value ranges from 40 to 546 ppm. Ground water in Kurnool formation is sgenerally good for irrigation. It is mildly to storgly alkaline with pH ranging from 7.0 to 8.60,E.C. values range from 604 to 2250 micromhos/cm at 25°C. But sometimes EC values go beyond 2250 micromhos/cm at 25°C and then chloride exceeds 500 ppm. Ground water in alluvium is generally good both for irrigation and domestic needs. Flouride concentration is found to exceed 1.5 ppm at some places underlain by gneisses and alluvium.

4.19 Ground Water Resources and Development Prospects:

Cuddapah district devoid of surface water sources has been depending upon the ground water resources for agriculture and irrigation. Nearly 50% of

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the irrigation in the district is mainly from the wells.
been upward swing in ground water utilisation
ears due to the stress laid on institutional
nd also on increase in the agricultural pro-
nsequent on the increase in development it
at the ground water resources have to be
o plan the future development in a scienti-
Hence preliminary estimations were carried
which were revised later as more data be-
ble . The latest tentative assessment based
for 1985 are given in Table 4. This esti-
done based on the Ground Water Estimation
ecommendations. Presently the estimations have
ed out taluk-wise. As per the estimations,
utilisable ground water resource of the dis-
82.4 MCM and net draft is 277.3 MCM leaving
of 705.1 MCM for development. The stage of
er development is only 28% which means that
cope for further development.

ted Net draft for the last four years are
w:

	Net draft	Stage of G.W.Development
82	266.5 MCM	27.1%
83	272.1 "	27.6%
84	273.8 "	27.9%
85	277.3	28.2%

s that there is a steady rise in the draft
years. However inspite of the rise the stage
water development will be still less than 32%
fter 5 years, which means there is wide scope
lopment.

al and Urban water supplies for drinking water
Industries:

The district has (1981 Census) a population
lakhs out of which 15.53 lakhs live in the

Table-4

Estimated Ground Water Potential and Ground Water Draft (Net) for Cuddapah District (1984-85)

Sl. No.	Name of taluks	Estimated utilisable G.W. Potential (MCM)	Estimated C.W. Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water Development	
					Present %	at year 5 (%)
1.	Koduru	126.8	33.0	93.8	34	37
2.	Bodvel	108.3	21.7	86.6	25	27
3.	Muddanur	50.2	8.2	42.0	22	24
4.	Rajampet	82.2	35.0	47.2	55	61
5.	Pulivendla	140.1	26.9	113.2	30	33
6.	Proddatur	116.1	30.6	85.5	34	37
7.	Jammalamadugu	31.9	1.6	30.3	6	7
8.	Kamalapuram	40.0	19.9	20.1	63	69
9.	Sidhout	78.5	23.8	54.7	37	41
10.	Lakkireddipally	53.8	22.5	31.3	54	59
11.	Rayachoti	80.9	36.7	44.2	58	62
12.	Cuddapah	73.6	17.4	56.2	24	26
		982.4	277.3	705.1	28	32

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villages and 3.75 lakhs live in the towns or urban areas. Nearly 10,916 borewells have been drilled by the Panchayati Raj Department and 125 pumping and mini -pumping water schemes exist in the district. In addition, to these public bore wells and pumping schmes, there are number of private shallow dug wells existing which also partly meet the requirements. As per the norms existing for drinking water and domestic needs including the livestock population, the total water requirements of the district for drinking and domestic needs works out to 52.0 MCM per year with a per capita consumption of 90 litres per day for urban and 70 lpd for rural population. This figure is much below the projected demand of 173.4 MCM for drinking water and industrial purposes out of the gross recharge of 1155.8 MCM. However the problem may come only during drought years when the recharge to ground water body gets reduced and the shallow wells/borewells go dry due to declining water levels. This situation calls for sinking of additional deep borewells and also deepening of existing dugwells.

4.21 Ground Water Development with reference to Rainfall and water levels:

Ground water development has shown a rising trend as is evident from the increase in the number of wells in recent years. The number of wells used for irrigation were 44,406 in 1975-76 out of which 19,178 wells were energised. This figure has gone up to 49,466 wells in 1982-83 out of which 33,140 wells are energised. Presently (1984-85) there are 50,620 dug wells out of which 36,298 wells are energised. In keeping with this increase, the ground water draft is also on the rise from year to year. However if this rising trend is examined in relation to rainfall, and water levels, the rise in draft is recorded in all the taluks except in

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Muddanur which shows a marginal reduction in draft. However this increase in draft is very marginal and is not so serious as to affect the water levels. The decline in water levels seen in observation wells located at Cuddapah, Rayachoti, Badvel, Muddanur, Vempalle, Rajampeta/ and Proddatur can be attributed to below normal rainfall only. The fall in levels vary from 5.0 m at Cuddapah to 1.5 m at Proddatur. The other notable declines are at Badvel (4.00) Muddanur (3.62 m) (Fig-11) This declining trend in some parts is more or less due to below normal rainfall observed in the last 2 to 3 years. Should the conditions improve, then this declining trend may more or less get arrested.

4.22 Ground Water Management Practices and Drought Management Strategies:

It is seen from the estimations carried out earlier that barring Rajampet, Kamalapuram, Rayachoti and Lakkireddipalli taluks there is not much development. The stage of ground water development is below 30 percent of the utilisable ground water resources. But the below normal rainfall conditions experienced in the district during the last 2 to 3 years have created problems resulting in most of the tanks remaining dry and the recharge from rainfall being much below than in the periods of normal rainfall. This accounts for the temporary lowering of the water table in the last 2 to 3 years. With the restriction on the availability of surface waters, the requirement has to be met from the ground water resource. Hence, increased draft from ground water resources can be anticipated, though in the present case the increase in draft is marginal. The stage of ground water development in the district is less than 30%, so there is still scope for development. As it looks the problem is one of water management and efficient utilisation of available resources to tide over the crisis. However these drought management strategies have to/both longterm and short term measures. The long term be

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measures aim at solving the problem permanently. But some /short term measures are required to tide over the immediate problems.

4.23 Long term Drought Management Strategies:

The usual suggested longterm strategy is to change the cropping pattern and to raise the crops which require less water like Bajra, Ragi, Groundnuts or some other oil seeds which can ensure the purchasing power of the farmers without affecting their income and which also adds to the agricultural production of the district and the state.

Presently rice is irrigated over an area of 50,681 hectares(gross) out of which the area irrigated by tanks and wells is about 28,841 hectares. If instead of rice, other crops like groundnuts, Bajra or Ragi is cultivated much water can be saved. Use of drip and sprinkler irrigation will also help reduce use of water applied for irrigation. This should be tried. Farmers can be given advances on easy terms to purchase the drip and sprinkler irrigation equipments. This will be beneficial in the longrun.

Cuddapah district holds good promise for creation of ground water sanctuaries because of the existance of hills and narrow valleys. Recharge weirs, check dams will add to the water conservation methods which can be successfully employed to increase recharge to ground water reservoir. The limestone aquifers and to some extent the Cuddapah formations hold promise for future ground water develorment which can be explored successfully and development effected for drought management.

It is proposed to bring nearly 66,000 hectares of land under the Telugu Ganga Project and Srisailam Right Bank Canal Command covering parts of Jammalamadugu, Badvel, Sidhout and Proddatur taluks. It is better advance planning is done for conjunctive use of surface

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and ground water in the area so that in times of meteorological drought, water shortages are not felt in these taluks. The shallow ground water problems and water logging conditions which may come up at a later stage can be avoided.

The quality of ground water by and large is good and is bad only in areas where local pollution is there or where the shale aquifers occur. In such areas where it is not possible to get potable water from surface sources desalination methods can be employed. In areas, where high fluorides occur (Fluoride concentration of more than 1.5 ppm) defluoridation techniques may be adopted either through a centralised treatment and supply or through small treatment kit.

As a permanent drought management measure, the DPAP projects and afforestation and social forestry programmes can be utilised for growing fuel for the rural population in the barren and uncultivable land which is about 16.4% of the district. The district has nearly 2.9% of culturable waste (44,812 hectares) whcih can be used as a grazing land or for growing fodder which can meet the fodder requirements of the local cattle population.

4.24 Short term Drought Management Strategies:

The measures discussed above, however takes time and mean while it may be necessary to adopt certain short term measures to combat the drought situation so that people are not put to hardship for want of water for their needs until the monsoon sets in. The most immediate measure is to drill deep bore-wells to tap ground water on a large scale at favourable sites after carrying the site investigations, adopting latest investigation techniques to minimise failures. The water thus tapped may be used first to meet the drinking water and domestic needs and after meeting the above two requirements, can be used to grow fodder for cattle, and also for social forestry and other drought prone area programmes. The other measures like construction of percolation ponds, check dams will be useful to keep the rural population engaged, in gainful employment and also help in harvesting rain water for utility and help to induce infiltration and deep percolation which may help recharge ground water and thus arrest temporarily the declining water levels.

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5. CHITTOOR DISTRICT

5.1 Location and Extent:

Chittoor district has a total geographical area of 15,131 sq.km. It is one of the chronically drought affected areas of the state. It lies between N.Latitudes 13°13' and 14°05' and E.Longitudes 78°05' and 80°08' and bounded on the north by Anantapur district, on the west by Kolar district of Karnataka, on the south by Chingleput district of Tamil Nadu and on the east by Nellore district. Chittoor the district headquarters is well connected by road and rail. The Madras-Bombay broad-gauge and Hyderabad--Tirupati metre-gauge railway line passes through the district. Chittoor which is on Bangalore-Madras National Highway is the district headquarters. There are only two towns with a population of more than 50,000. The district has a population 2,737,316 (1981). 15 taluks and 13 towns in the district but there are

5.2 Physiography and Drainage:

The district is characterised by undulating topography formed by scattered hill ranges and narrow river valleys and plains. The general elevation of the ground varies from 150 m to 300 m above m.s.l. The highest peak reaches an elevation of 1313 m above m.s.l is in the Horsley hill range near Madanapalle. The Tirumala hills attain an altitude of 1093 m above m.s.l. Almost all the hills are thickly forested. Several ephemeral rivers and streams drain the district. The important ones are Swarnamukhi, Bahuda, Pincha, Ponnai, Kalangi, Nagari, Arani, Palar and their tributaries. The river Swarnamukhi originates in the valley between Pakala and Panapakam hill ranges and has a northeasterly course up to Kalahasti. Kalyani river is one of the important tributaries of Swarnamukhi river. Palar is another important river which originates in Kolar district of Karnataka and drains the district before joining the Bay of Bengal in Tamil Nadu. Almost all these rivers and streams are seasonal and flow only in response to monsoon rainfall. As such they do not have much of irrigational potential for development or utilisation.

5.3 Hydrometeorology:

The climate of the district in general is healthy. The mean maximum temperature is around 38°C and the minimum around 12°C. Madanapalle taluk is comparatively cooler than Kalahasti and Satyavedu taluks. The average annual rainfall of the district is 830 mm. Though the district enjoys rainfall from both the monsoons, the contribution of precipitation varies from place to place. In general, the contribution of northeast monsoon is much less than southwest monsoon in the taluks of Madanapalle and Vayalpad. Contribution from NE monsoon is maximum in Kalahasti, Satyavedu, Puttur, Chandragiri and Chittoor taluks. The contribution of both the monsoons are almost equal in the taluks of Palamaner, Punganur and Kuppam.

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Fig.2 depicts the normal annual rainfall isohyetal map of the district. A look at the map shows that the rainfall decreases from east to west from over 1000 mm to less than 650 mm. The peripheral influence of cyclonic storms that originate in the Bay of Bengal is responsible for more rainfall in the eastern parts. Fig.12 presents the 5 year and 10 year running means or moving averages using the data of 1901-1985 for the Chittoor station. From the Fig.12, it is evident that the curves are sinusoidal in nature and there is a negligeable change in the trend of the rainfall over the years. The heaviest rainfall of 1683 mm occurred during the year 1903 whereas the lowest rainfall of 259 mm was received during the year 1957. However, 'dry' and 'wet' spells can be broadly deciphered from the Figure-12, while the period from 1901 to 1920, 1928-50 and from 1972 to 1981 can be grouped as 'wet' or years of above normal rainfall, the periods from 1921 to 1928, 1951 to 1971 can be said as 'dry' or below normal rainfall years. During the last decade, normal rainfall was received in 5 years, excess rainfall in 2 years and deficit rainfall in 3 years. The trend indicates that the forthcoming years may be below normal. The 5 year moving average shows that during the next 5 years, the probability of receiving below normal and normal rainfall is more than receiving excess rainfall. The 10 year moving average also indicates that during the coming decade, normal and deficit rainfall may occur more frequently while excess rainfall may occur in about 2 years.

The percentage frequency of occurrence of normal, excess and deficit rainfall in 5 continuous years during the period 1901-85 is given below:

No.of years with normal rainfall	3	2	2	3	3	4	4	5	2	2	1	1	1
No.of years with excess rainfall	1	1	2	0	2	0	1	0	0	3	2	0	3
No.of years with deficit rainfall	1	2	1	2	0	1	0	0	3	0	2	4	1
Percentage frequency	18	13	13	9	9	8	6	5	4	4	4	4	3

The above analysis indicates that there is a high probability of occurrence of normal rainfall in 2 or 3 years, excess rainfall in 1 year and deficit rainfall in 1 or 2 year in a period of 5 continuous years.

If the rainfall received during the 1981-85 period is examined it is seen that normal rainfall occurred in 3 years and deficit rainfall in 2 years.

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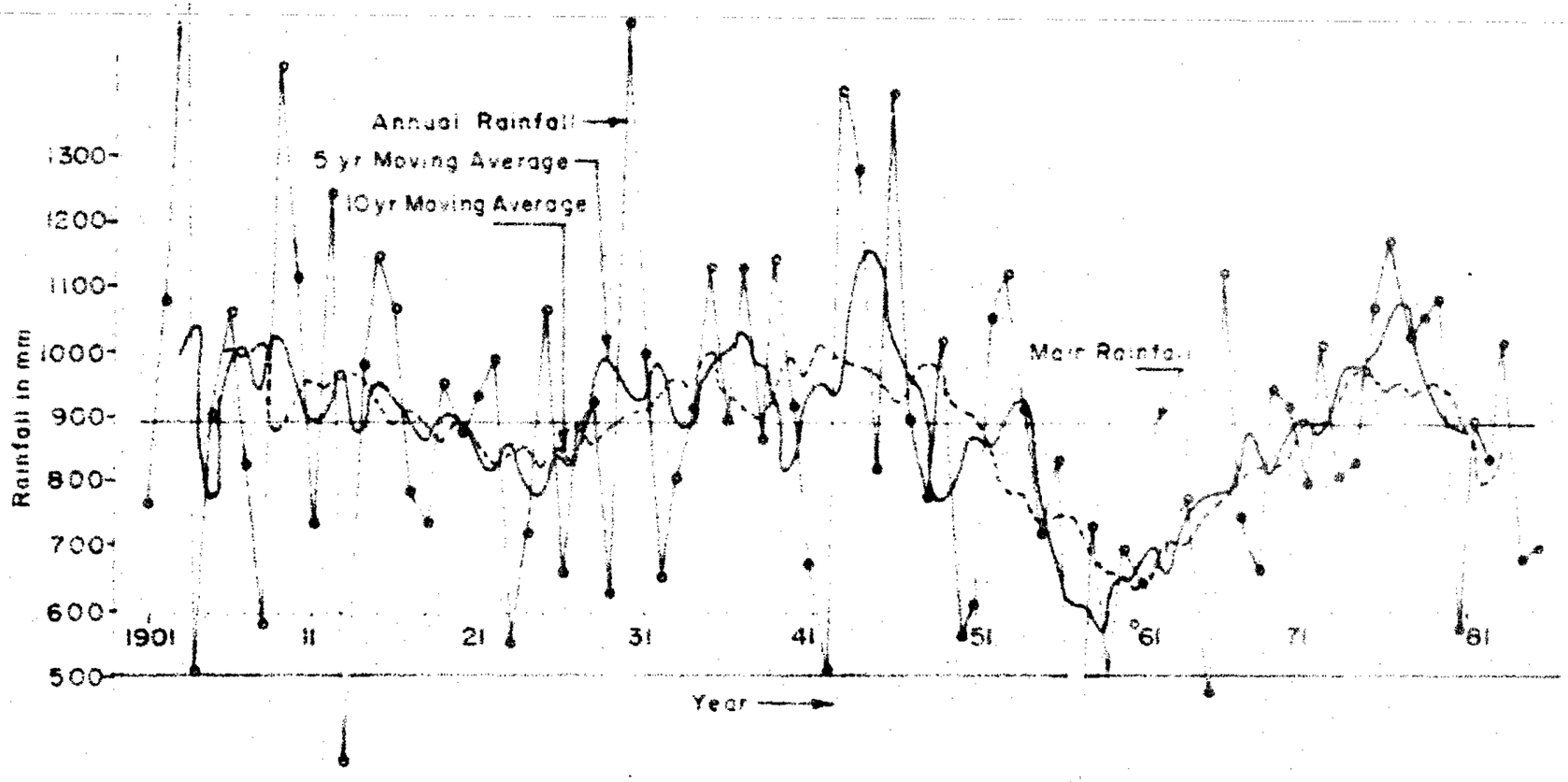
RAINFALL TREND DURING 1901-85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE CHITTOOR STATION CHITTOOR DISTRICT



From this analysis it can be inferred that during the next 5 year period (1986-90) the probable frequency of occurrence of normal, excess and deficit rainfall may be any one of the following:

No.of years with normal rainfall	3	2	2
No.of years with excess rainfall	1	2	1
No.of years with deficit rainfall	1	1	2

Years	Anticipated Rainfall		
1986	E/D	E/D	.E/D
1987	D/E	D/E	D/E
1988	N	D/E	E/D
1989	N	N	N
1990	N	N	N

From the above it is clear that there is a high probability of occurrence of normal rainfall in 2 years, excess or deficit rainfall in 1 year each and normal or excess in 1 year. In all probability normal rainfall may be received during 1989 and 1990.

5.4 Soils:

The major types of soils that are seen in the district are the red loamy sands, red sandy loams, red clayey loams and black soils. The red soils occupy about 95 percent of the cultivable land of the district and are found in almost all the taluks of the district. Red soils are seen mostly in the areas underlain by granites and gneisses. These soils are good for growing the rainfed crops like groundnuts and millets and for cultivation of irrigated crops if irrigational facilities are available. The black soils, also known as the black cotton soils are mostly clays and clayey loams. These soils are of very limited occurrence in the district. They occur in Kuppam, Chandragiri, Punganur and Madanapalle taluks. These soils are suitable for cotton and millets and wherever seen in valleys and tank ayacuts are good for paddy cultivation.

There are saline and alkaline patches seen at places in areas underlain by red soils especially in topographic lows and plain country near tanks and streams perhaps due to high evaporation and saline encrustations. However, such saline soils are very limited in extent.

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5.5 Agriculture and Irrigation:

Out of the total geographical area of 15,13,100 hectares of the district nearly 4,62,164 hectares or 30.5 percent of the total area is the net area sown and the total cropped area is 5,20,602 hectares (34.4 percent of the total geographical area). The net area under irrigation is 1,40,068 hectares and the gross area irrigated is 1,90,240 hectares. This is nearly 36.5 percent of the total cropped area of the district. There are not many irrigation projects in the district since no major perennial river drains the district. However, the scheme of optimum utilisation of surplus waters of Krishna and Pennar rivers under the Telugu Ganga Project is expected to bring maximum irrigation benefit to the district by irrigating 18,400 hectares of land. There are several minor irrigation projects on the rivers Swarnamukhi and Kalangi. The ones which can be mentioned are the Swarnamukhi project, the Mallimadugu project, Kalangi project, Bugga Anicut, Araniar project and Bahuda project. All put together, they irrigate an area of 4920 hectares (Gross). Hence, the only source of irrigation are the tanks and wells. There are 7536 tanks in the district altogether irrigating an area of 54,491 hectares. There are 1,10,418 dug wells in the district used for irrigation and out of this nearly 83,195 wells are energised, fitted with electric or diesel pump sets. The gross area irrigated by wells is 1,14,876 hectares (1984-85). Thus out of the area of 1,90,240 hectares, nearly 60 percent is irrigated by wells. The main crops, grown during kharif and rabi seasons both under canals, tanks and wells is rice, sugarcane and groundnuts. Out of this an area of 1,00,456 hectares is under rice and 21,528 hectares under sugarcane and 36,466 hectares under groundnuts. Rest of the area is under bajra, ragi, cotton and millets.

5.6 Industries and Mining:

Not many industries exist in the district. There are cotton spinning and weaving industries at Tirupati and Madanapalle. A cooperative sugar mill exist at Savatapalle in Chittoor taluk. Mppeds India Limited has a factory near Tirupati for the manufacture of mopeds known as 'Suvega'. Several small scale industries exist but most of them are agrobased. They are mainly located at Chittoor, Kalahasti, Madanapalle, Voyalpad, Putturu, and Kuppam. Private industrial estates exist at Chittoor and Tirupati, Cottage industries like handloom weaving exist at Putturu, Srikalahasti, Chittoor, Bangarupalem, Voyalpad and Punganur. Bricks kiln and related works is another cottage industry in the district. There is scope for future forest based industries and fruit based industries as there are several fruit gardens and orchards existing in the district.

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Mining is not an important activity in the district eventhough several known occurrences of gold, iron ore and steatite are there. Gold is known to occur at Bisanattam and Mallappa Konda areas which are considered to be extensions of the Kolar Gold Fields of Karnataka. Recently exploratory mining has been taken up by the Bharat Gold Mines Limited in the Chigaragunta area of Kuppam taluk. If it proves successful, then it will become another major source of employment. Steatite is mined locally near Chittoor and Iron Ore is reported to occur in Srikalahasti taluk. It is reported to be of poor grade and is not mined. The several outcrops of granites and gneisses, quartzites are mined locally for building material.

5.7 Geology:

Chittoor district is underlain by a variety of geological formations from the Archaeans to the Recent alluvium. The geological succession as seen in the district is given below:

Recent to Sub Recent		Soils, Alluvium,, talus, Laterite
----------Unconformity----------		
Upper Gondwanas	Kota Stage	Satyavedu sandstone and shales, Conglomerates
----------Unconformity----------		
Upper Precambrian to Lower Palaeozoic	Cuddapah Super Group / Nalla-malai Group	Nagari Quartzites
----------Unconformity----------		
Archaean to Lower Pre-Cambrian	Dharwar Super Group	Dolerite dykes, pegmatites and quartz veins
		Schists, Amphibolites
	Peninsular gneisses	Gneisses and Granites

5.8 Hydrogeology:

Chittoor district is mostly underlain by peninsular gneisses and granites with pockets of Dharwar schists, Nagari, quartzites, Upper Gondwana sandstones, talus and river alluvium. Dolerite dykes occur at places traversing the gneisses and granites. The hydrogeological conditions seen in each formation is discussed in brief in the following paragraphs:

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5.9 Ground Water in Crystalline Rocks:

More than 75 percent of the district is underlain by granites and gneisses with pockets of Dharwarian schists. Ground water occurs in the formation under water table and semi-confined conditions in the weathered, fractured and jointed rocks and is developed by dug wells and borewells. The thickness of weathered zone varies from less than a metre to 15 m.. The joints and fractures as evidenced from borewells drilled in the area are found to extend down to a depth of 50 m bgl. The depth of open wells generally vary between 3 and 28.5 m bgl and the depth to water in them varies from 1.60 to 27 m bgl. The yields of open wells vary from 24.5 m^3/d to 360 m^3/d. The yields of borewells varying in depth from 13 to 71.5 m range between 1.3 to 50 m^3/h for drawdowns varying from 2.82 to 12 m.

5.10 Ground Water in Cuddapah Formations:

The Nagari quartzites of Cuddapah age with intercalations of shales occur in the northern parts of the district. These quartzites are hard and compact and not very important from the ground water point of view as they occur to a limited extent and occupy hill ranges. Water levels are fairly deep. The depth of wells generally range between 7 and 9 m bgl and depth to water level varies from 3.00 to 8.60 m bgl. The yields of the wells are fairly good whenever they tap joints and bedding planes and are reported to be around 40 m^3/d.

5.11 Ground Water in Upper Gondwanas:

The Satyavedu conglomerates and sandstones of Upper Gondwana formations are found in the east-north-eastern portion of the district in Satyavedu taluk. The depth of wells in these formations range between 3 and 10.9 m bgl and depth to water level in them normally varies from 2.9 to 9.8 m bgl. The yields of wells in these formations range between 9 and 90 m^3/d. Laterites are found capping the Satyavedu conglomerates and are generally limited in extent. The depth of the wells in laterite generally range between 5 and 10 m bgl and the depth to water in them varies from 3.25 to 5.50 m bgl. The yields of wells in these formations vary from 9 to 22 m^3/d.

5.12 Ground Water in Alluvium:

Alluvium occurs to a limited extent along the major stream courses. However, this formation is important locally and yields sufficient quantities whenever it is extensive and thick. The thickness of the alluvium ranges from 2 to 14 m. Ground water occurs in this formation under unconfined and semi-confined conditions. The wells tapping alluvium range in depth

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from 5.5 to 14.1 m bgl with depth to water in them generally varying from 4.6 to 8.1 m bgl. The yields from these wells range from 34.2 to 62.1 m^3/h. with drawdowns ranging from 1.0 to 3 m and are able to irrigate 2 to 8 hectares. Borewells drilled in the alluvium are reported to yield upto 1600 m^3/d. The average yield of the filter point is around 500 m^3/d. Figure 13 depicts the general depth to water in the district for May, 1986.

5.13 Status of the Studies:

An area of 12,000 sq.km has been covered by systematic hydrogeological surveys and 5500 sq.km by reappraisal hydrogeological surveys in the district. Thus almost 80 percent of the district has been covered by the hydrogeological surveys.

5.14 Ground Water Level Monitoring:

Monitoring of water levels in the district was introduced in 1969 through a network of two hydrograph network stations. As this was felt to inadequate in course of time the number was increased subsequently to have better control over space and time. Presently there are 29 hydrograph network stations in the district which are monitored 5 times a year (4 times a year from 1985). The monitoring has indicated that ground water level fluctuations occur in response to changes in the saturated zone which in effect is due to recharge from rainfall, irrigation and draft from wells, base flows, etc. Usually water levels start rising with the onset of monsoon and reach peak in December-January and thereafter start declining till May/June. The average annual fluctuations vary from 0.5 to 7.8 m but the general range is between 1.2 and 3.5 m. From the last 2 to 3 years a continuous decline in the water levels is seen in the southern part of the district. The decline varies from 7.18 m at Damalacheruvu to 0.1 m at Pileru/ This decline in water levels is attributable more to the failure of monsoon, than to increase in draft. /whereas some parts show rise in water leve_s varying from 1.14 m at Nagari to 0.10 m at Puttur.This rise / between Nov.83 and Nov.86. and fall have been seen --/

5.15 Ground Water Exploration:

Ground water exploration was carried out in the Poini River Basin, a tributary of Palar, during 1973-76 covering an area of 2500 sq.km falling in parts of Chittoor taluk. Exploratory drilling was carried out at 20 sites ranging in depth from 42.8 to 71.5 m bgl. The area explored is underlain by granites, gneisses and traversed by dolerite dykes. The exploration revealed the existence of productive fractures down to a depth of 60 m. The yields of these boreholes ranged between 188 and 857 lpm for drawdowns varying from 9.41 to 25.75 m. The transmissivity values of the hard rock aquifers varied from 1.39 to 820.2 m^2/d. and the storage coefficient varied from 1.5 x 10^{-1} to

4.8×10^{-3}. The exploration has revealed that production wells can be drilled after adopting proper well siting methods and the same can be used to bring additional areas under irrigation or to meet the drinking water requirements under rural water supply.

5.16 Chemical Quality of Ground Water:

Ground water in crystalline rocks is generally good except in local pockets where the quality of water has deteriorated because of local population. The pH varies from 7.9 to 8.6; Chlorides vary from 26 to 143 ppm with E.C. values varying from 210 to 7530 micromhos/cm at 25°C. Though the fluoride concentration is within the permissible limits of 1.5 ppm in most parts of the district, there are pockets in Kuppam taluk where the fluoride concentration in ground water exceeds 1.5 ppm and reaches maximum of 3.7 ppm. The quality of ground water in Satyavedu conglomerates is generally good with pH varying from 5.70 to 7.5 and slightly acidic to alkaline. The total hardness ranges from 10 to 343 ppm. The E.C. values vary from 70 to 1400 micromhos/cm at 25°C. Ground water in laterites is reported to be of good quality. The quality of water in alluvium is generally good. pH varies from 5.7 to 7.5 and the chloride varies from 20 to 200 ppm, total hardness as $CaCO_3$ varies from 140 to 360 ppm and specific conductance varies from 343 to 1910 micromhos/cm at 25°C.

5.17 Ground Water Resources and Development Prospects:

Ground water is an important source of irrigation and drinking water requirement of the district since no major perennial river or stream drains the district. All the streams are ephemeral and seasonal. Hence there is no scope for large scale irrigation facilities from surface water. However, under the Telugu Ganga Project, an area of 18,400 hectares is expected to be irrigated in Chittoor district. Nearly 60.0 per cent of the area in the district is irrigated from ground water sources. Rest of the area is irrigated by tanks and canals.

As the agricultural operations and the development of the district depend upon the availability of the ground water resource is necessary to have a reliable estimation of the ground water resource for proper planning and development. The earliest estimation of the ground water resource was attempted in 1977. Since this was a preliminary estimation based k on scanti data, it was felt to revise the estimations based on more reliable scientific data. The latest slightly acidic to alkaline. The total hardness ranges from 10.0 to 34.30 ppm. The E.C. values varies from 70 to 1400 m mhos/cm at 20°C. Ground water in laterite is reported to be of good quality. The quality of water in alkaline in generally good. pH varies from 6.7 to 8.6 and

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revised estimations of the ground water potential based on current data are given in Table-5. The total utilisable potential of the district is 1533.8 MCM and the present assessed ground water draft, is 614.1 MCM. This utilisable resource is developed mainly by dug wells, dug cum borewells and to some extent borewells and filter points.

As a consequence of greater steps on the ground water utilisation for crop production there has been increase in the number of wells in recent years. There were only 99,940 irrigation wells in 1976-77. This was gone upto 110418 in 1984-85. Of these Chittoor, Bangarupalem, Palmner, Punganur, Chandragiri, and Puttur have more number of wells compared to the other taluks. The ground water drafts are also high in these taluks. However as per estimations Chittoor taluk has the maximum draft while the minimum is in Srikalahasti taluk. The ground water draft in the district has also recorded a rise in recent years. But it is almost steady from the last 3 to 4 years. If we examine the rainfall data also, there has been below normal rainfall for the last two years which is also responsible for the declining trends seen in water levels in some of the taluks. If the development and the stage of ground water development aspects are examined, then as per estimations, the entire district has a 40% stage of development. If talukwise development aspects are examined, then Bangarupalem and Chittoor taluks have reached the 80% stage of ground water development. The development in Palmaner and Nagari taluks has crossed 60% of the utilisable resources. In the other taluks; the development is less than 50%. From this it is imperative, that the development has reached critical stage in Bangarupalem and Chittoor taluks and as a result of below normal recharge during the last two years, they will reach the over development stage which would mean that the development has to be severely curtailed in future in these two taluks. In case of Palmner and Nagari taluks, though there is more scope for development, critical stage will be reached soon. Hence the development in these two taluks has to be watched in the coming years. In case of other taluks, there is scope for development. However, if the rains fail successively, then the development has to be suspended temporarily and all advances suspended till the situation improves.

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Table-5

Estimated Ground Water Potential and Ground Water Draft (Net) for Chittoor district (1984-85)

Sl. No.	Name of taluks	Estimated Utilisable G.W. Potential (MCM)	Estimated G.W. Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water Development	
					Present %	at year 5 (%)
1.	Srikalahasti	128.9	12.0	116.9	9	10
2.	Palamneru	83.6	51.0	32.6	61	67
3.	Bangarupalem	80.5	64.0	16.5	80	87
4.	Punganur	186.5	59.0	127.5	32	35
5.	Kuppam	66.0	21.0	45.0	32	35
6.	Nagari	43.0	28.0	15.0	65	72
7.	Chittoor	106.4	92.0	14.4	86	95
8.	Puttoor	145.0	68.0	77.0	47	52
9.	Satyavedu	174.0	19.0	155.0	11	12
10.	Thotambedu	101.3	18.0	83.3	18	20
11.	Thambalapally	63.8	19.1	44.7	30	33
12.	Madanapally	86.1	32.0	54.1	37	41
13.	Voyalpadu	66.2	34.0	32.2	51	55
14.	Chinnagottugallu	88.8	34.0	54.8	38	42
15.	Chandragiri	113.7	63.0	50.7	55	61
		1533.8	614.1	919.7	40	44

5.18 Rural and Urban Water Supplies for drinking Water and for Industries:

The district has a total population of 27.47 lakhs, out of which 22.85 lakhs live in villages and the remaining 4.62 lakhs live in the urban areas (1981 Census). The Panchayat Raj Department and the Public Health Engineering Departments of Government of Andhra Pradesh have drilled 11103 borewells and executed 251 pumping and mini pumping water supply schemes to meet the requirements of the population. Over and above these public water supply facilities private dug wells also exist in most of the villages and towns which also meet the requirements partly. As per the norms in existence the average per capita requirements of water has been estimated as 90 litres per day for urban and 70 lpd for rural population including the livestock demand, the total water requirement is 73.60 MCM per year, where as the projected demand for drinking water and industrial needs is 270.7 MCM out of the estimated gross recharge of 1804.5 MCM. Hence there is available enough ground water to meet the demand. This picture may slightly change during the drought years when the recharge to ground water will be on the lowerside, much below the projection, as a result of which the shallow wells go dry. In such an event there is no other alternative except to go in for drilling additional wells which are deeper than the existing ones and deepen the shallow dugwells.

5.19 Ground Water Development with reference to rainfall and water levels:

The district has recorded good progress in developing the ground water resources. This is evident from the number of wells existing in the district. However in recent years declining trends have been seen in the water levels in some parts of the district notably in Chittoor, Bangarupalem, Punganur, Molakalacheruvu , Tirupathi and Chandragiri taluks. The decline in levels vary from 7.18at Domalacheruvu to 0.1 m at Pileru (Fig.14). The other notable declines are at Tirupathi(0.89), Chittoor (2.0 m), Bangarupalem (1.3 m), Putalapattu (3.2 m), Nendragunta (3m), Penumuru (2.6 m), Paradasami (5.5 m). This decline has been observed between Nov. 83 and Nov. 86. There has been some rises noted during this period also the notables being at Nagari (1.1 m), Palamner (0.60 m) and Madanapalle (0.33 m) Fig.14 a and B. If the water level decline with reference to ground water draft and rainfall is examined there does not seem to be any appreciable increase in ground water draft in all these taluks, over the years. If we examine the rainfall received during the last 2 to 3 years, there

has been below normal rainfall for the last three years (1984-85) and 1986 which is responsible for the decline in water levels seen over most parts of the district. This has been responsible for reduced recharge during the last couple of years resulting in scarce conditions which perhaps for the increase in draft by way of more withdrawals and lesser areas irrigated. This is evident from the reduction in the gross irrigated area from 202248 hectares in 81-82 to 190240 hectares in 1984-85. However, the position may improve, if normal rainfall occurs, but as per the hydrometeorological analysis carried out earlier, there is a possibility of below normal rainfall occurring towards the end of the decade, which means that the existing conditions will continue, more or less necessitating some drought management practices, and also changes in cropping pattern.

5.20 Ground Water Management Practices and Drought Management Strategies:

Chittoor district is a drought prone area though the problem is not that acute as compared to Anantapur or Kurnool district. It has a well developed ground water extraction system through wells and also surface water storage tanks which are more than 7500 in number with different ayacut areas. The surface water irrigation projects are almost nil and as such the irrigational potential of the district is solely dud to minor irrigation only. The present gross area irrigated is 1,90,240 hectares, out of which 1,14,876 hectares are irrigated through wells. Thus, nearby 60% of irrigated area in the district is under wells. The failure of the monsoon especially from the last three years has seriously affected the agricultural practices. This is evident from the fall in the total gross irrigated area from 2,02248 hectares (81-82) to 1,90,240 hectares in 1984-85. This calls for certain drought management measures both long term and short term.

5.21 Longterm Drought Management Strategies:

Generally some of the long term measures will be to change the existing cropping patterns, conjunctive use of surface and ground water resources wherever feasible even in tank ayacut areas and go in for afforestation and adopt certain water harvesting techniques. Out of the total gross area irrigated the area under rice cultivation is quite high both under khariff and rabi seasons, and both under well and tank irrigation. The total irrigated area is 1,90,240 hectares(1984-85) out of which the area under rice cultivation is

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1,00,456 hectares. The area under sugar cane is 21,528 hectares. The other crops like ragi, bajra, millets etc are cultivated in small areas. Groundnut is cultivated over an area of 36,466 hectares. Thus a major area, irrigated is under rice and sugarcane. These crops are water consuming and their consumptive use is high. As such their water requirement is also high. A major saving can be effected if this trend is changed. Even if the farmers are allowed to grow rice during khariff season, as they would like to grow paddy for their consumption, it is better they are advised to grow other crop like groundnut or some other oil seed during rabi season. Nearly 68,024 hectares is under paddy during Rabi season. This will itself save substantial quantity of water if paddy cultivation is given up at least for the second crop. Even additional areas can be brought under irrigation. With the receipt of below normal rainfall in the last 2 to 3 years, there has been lesser recharge and declining trend in water levels seen in some areas. Except in Bangarupalem and Chittoor taluks, the ground water development has not reached critical stage in any other taluk. Declining water levels seen can be considered as solely due to below normal rainfall received in the district and not due to increasing ground water draft except in Bangarupalem and Chittoor where the existing draft has almost reached 90% stage of development. As such, there has to be restriction in these two taluks on ground water development. In other taluks, there is scope for development, but this has to be watched in future so that the development may not reach a overdeveloped stage.

In a situation arising out of below normal rainfall, successively for more than two years, it is necessary that a cropping pattern as suggested above may be taken up so that substantial saving in water use can be effected. Efficient and effective utilisation of water for irrigation like the drip and sprinkler methods can be brought in to use to save water, so that failure of dug-wells (especially drinking water wells) can be reduced indirectly arresting declining trends. Other water harvesting techniques like, percolation tanks, recharge wiers etc may be constructed wherever feasible after spot investigations in areas where there is scope for development as per estimations and where potential is still available for utilisation, ground water development techniques and methods may be adopted for successful well siting, and in such areas, priority may be given for drinking water wells as in a drought situation the foremost problem will be to find a suitable drinking water source. As a supplementary measure, afforestation coupled with DPAP programmes may be taken up to develop forests and also meet the fuel requirements

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of the rural population, as the district does not support any major industry, meeting the water requirements for the industries does not pose a problem. The district has a cultivable waste of 52,978 hectares or 3.5 per cent of the total geographical area. This can be developed as a permanent grazing land or for growing fodder for the cattle, which can be utilised intime of need.

5.22 Short term drought management strategies:

However measures discussed above will take some time, perhaps years to yield results. Meanwhile it may be necessary to adopt certain immediate measures to meet the drought situation on warfooting. These measures can be termed as short term measures and include drilling of borewells wherever feasible based on proper site selection using sophisticated investigation techniques. Such borewells wherever feasible may be used not only for drinking purposes but also for growing fodder for the cattle. Recharge wiers, dams and percolation ponds can be constructed on a large scale so that, they can be used for collecting rain water o in case of summer showers. The water thus collected will not only be useful to meet the immediate needs, but also/as recharge /act ponds. Even construction of contour bunds in an undulating terrain will help retain moisture for a long time and help grow fodder in waste lands whenever sharp showers occur. This in turn will help meeting the immediate fodder requirements for cattle. These are some of the measures which can be thought of to meet the crisis.

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6. MAHABUBNAGAR DISTRICT

6.1 Location and Extent:

Mahabubnagar district is the fourth largest district of Andhra Pradesh with a total area of 18,472 km^2 and accounts for 6.75% of the total area of the State. The district has 1599 villages and 11 towns and liesbetween north latitudes 15°55' and 17°21' and east longitudes 77°15' and 79°15' and is bounded on the north by Ranga Reddy and Nalgonda district, on the east by Nalgonda and Guntur district-s and to the south byKrishna and Tungabhadra rivers and to the west by Raichur and Gulbarga districts of Karnataka state. The district is well served by roads and railways. The national highway No.7 and the Secunderabad-Guntakal metregauges section of the S.C. Railways passes through the district. Mahaboobnagar, the district headquarters is about 106 km from the state capital. The district is divided into 12 taluks for administrative purposes and as per the 1981 Census has a population of 1,590,686. Of the 11 towns and 1470 villages in the district, only Mahaboobnagar enhabited has a population of more than 50,000. Its population as per 1981 Census is 87,400.

6.2 Physiography and Drainage:

Mahabubnagar district is physiographically contiguous to the Mysore plateau and is characterised by erosional topography. The general slope is from north to south and the elevation varies from 610 m above MSL near Shadnagar to above 350 m above MSL towards Achampet, Gadwal and Wanaparthy. There are hill ranges extending from north to southin Achampet taluk consisting of flat topped hills. The northern part of Makhtal taluk is rugged and is occupied by prominent hills. There are several mountain peaks in the district with altitudes ranging from 600 m to 770 m above MSL.

The district is covered by eight major watersheds Magnur vaghu, Upper Krishna, Dindi, Musi,Tungabhadra, Okachettuvagu, Kagna and Lower Krishna. Of these only Krishna and Tungabhadra rivers are important which are perennial and which flow through the district.The Krishna, one of the biggest interstate rivers of the country, enters the district in Mukhtal taluk traverses through the taluks of Gadwal, Atmakur, Wanaparthy, Alampur and Achampet. The Tungabhadra river flows through the taluks of Gadwal and Alampur. River Dindi a tributary of Krishna, rises in Jadcherla taluk and joins Krishna about 29 km east of Chandragiri.

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6.3 Hydrometeorology:

Mahabubnagar district, though drained by one of the major rivers of the south viz the Krishna, experiences frequently drought conditions due to vagaries of the monsoons. The district also experiences hot summers and cold winters. The maximum temperature recorded is 45°C in summer and the lowest temperature recorded is 11.7°C in February. The normal annual rainfall of the district is 720 mm with 44 rainy days. The main rainfall season is the southwest monsoon season, July and August are the months with maximum rainfall. The isohyetal map of annual normals of the district is presented in Fig.2. It is evident from this figures that the rainfall decreases from north to south from 775 mm to 600 mm. To study the trend of rainfall over the district the rainfall received at Mahabubnagar station from 1901 to 1985 has been plotted along with the 5 year and 10 year running means and given in fig.15. It is clear from the figure that there is a rising trend in the trend of the rainfall over the years. During the last decade normal rainfall was recorded in 6 years, excess rainfall in 3 years and deficit rainfall in 1 year. From the fig.10 the 'wet' and 'dry' periods can be distinguished and when the rainfall was above normal or below normal. While periods from 1914 to 17, 1932 to 38, 1945 to 1965 and from 1975 to 83 can be said as wet periods or years of above normal rainfall the periods from 1904 to 1914, 1917 to 1932, 1938 to 1948 and from 1965 to 75 can be termed as below normal or dry periods. From the examination of the rainfall data of the last 75 years, it is seen that the highest rainfall of 1397 mm has been received during the year 1916 whereas the lowest rainfall of 400 mm has been received in the year 1918.

Although, the long term trend of rainfall shows a rising trend, when the data is analysed for the period 1901-85, there is a decline in the trend over the last decade (1975-85) and shows declining trend in the coming years.

The percentage frequency of occurrence of normal, excess and deficit rainfall in 5 continuous years during the period 1901-85 has been worked/and /out is given below:

No.of years with normal rainfall	4	3	3	5	4	3	22	1	2	2	1	2	1
No.of years with excess rainfall	0	1	2	0	1	0	23	0	1	3	2	1	3
No.of years with deficit rainfall	1	1	0	0	1	2	10	4	1	0	2	2	1
Percentage frequency of occurrence	15	14	12	12	12	9	76	4	3	3	1	1	1

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From the above it is clear that there is a high probability of occurrence of normal rainfall in 3 years and excess and deficit rainfall in 1 year each. During 1981-85 normal rainfall occurred in 3 years and excess and deficit rainfall in 1 year each. By extending the same analysis for the coming 5 years (1986-90) the probable frequency of occurrence of normal, excess and deficit rainfall are as follows:

No. of years with normal rainfall	4	3
No. of years with excess rainfall	0	1
No. of years with deficit rainfall	1	1

Year	Anticipated Rainfall	
1986 ..	N	N
1987 ..	N	N
1988 ..	N	E
1989 ..	N	N
1990 ..	D	D

From the above it can be inferred that in the next 5 years there is a high probability of occurrence of normal rainfall in 3 years and excess and deficit rainfall in 1 year each. Chances are that deficit or below normal rainfall conditions may occur by the end of the decade and it may prolong well to the next decade as is evident from the moving average plots. This may call for advance planning for the utilisa-tion of water resources in the coming decade.

6.4 Soils:

The district has four types of soils. The major group is red earth, comprising of loamy sands, sandy loams and sandy clay loams. Black soils, mostly clayey loams and deep clays occur as narrow strips alongside the banks of Krishna and Tungabhadra and other streams and nallas. The loamy sands are brown to red in colour and of poor fertility. The sandy loams occur on sloping terrains with good surface drainage. These soils, in general are non-saline and non-alkaline. Clayey loams and clays are found in appreciable extent in Alampur and Gadwal taluks and also in patches in Kodangalm Makhtalm, Kolhapur and Atmakur taluks. They are dark grey, brown to dark grey in color and are less permeable and poorly drained.

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6.5 Agriculture and Irrigation:

Out of the total area of 18,47,241 hectares nearly 761263 hectares or 41.2 per cent of the district is the net area sown. The total cropped area is 8,23,293 hectares or 44.6 per cent of the total geographical area of the district. Nearly 80,921 hectares or nearly 11 per cent of the net area sown is irrigated, and if we take the gross area irrigated it is 1,30,952 hectares or 15.9 per cent of the total cropped area. Out of this nearly 26.3 per cent or 34,498 hectares (gross 84-85) is irrigated from wells and 21,730 hectares is irrigated from canals and the rest of the area irrigated from tanks (32,740 hectares) and other sources. It is evident that tanks and wells form the main source of irrigation in the district. As per the statistics, there are 6235 tanks, 263 tube wells and 78,265 dug wells in the district. The main crops grown are Rice, Millets and Groundnuts. Other crops are Wheat, Ragi and Seasmum. Rice is cultivated over major part of the district. It is cultivated over an area of 85,661 hectares, followed by groundnuts over an area of 35,482 hectares. Out of this the area cultivated by wells growing rice is 43,887 hectares. Thus a major area is under rice cultivation. The area irrigated by canals comes under Rajolibanda Diversion Scheme, the Koilsagar Project and the Sholasagar Project.

6.6 Industries and Mining:

Mahabubnagar is industrially backward. Generally cottage and village industries exist in the district. There are no large scale industries also. Only one cotton mill exists near Mahabubnagar town. A few small scale industries and agro-based industries exist at Makthal, Wanaparthy, Mahabubnagar, Nagar-Kurnool and Shadnagar. Gadwal is famous for handlooms weaving industry. The other notable weaving centres are Narayanpet, Nagarkurnool, Kalvakurthy, Atmakur and Kolhapur. Other industries like dyeing and printing, leather industry, pottery exist locally.

Several known occurrences of minerals on a small scale like asbestos, copper, clay, diamonds, iron ore, limestones, quartz and steatite are reported from several parts of the district. Only the Koilkuntla and Narji limestones are mined, where they are flaggy and are used as a building and flooring material. The clay deposits are utilised for bricks and pottery. Quartz is mined for glass industry. Soapstones which occur in the Kolhapur block is mined locally for use in the talcum powder. The Cuddapah slabs are mined at Alampur, Pebbair and Venkatapur.

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6.7 Geology:

Mahabubnagar district forms part of the Indian Peninsular shield and is underlain by the rocks belonging from Archaean to Recent. The succession of geological formations as encountered in the district is given below:

Recent Sub Recent			Alluvium, gravels, soils & laterites
----------Unconformity----------			
Upper Mesozoic to Lower Tertiary		Cretaceous to Eocene	Deccan Traps
----------Unconformity----------			
Upper Precambrian to Lower Palaeozoic	KURNOOLS	Kundair Series	Nandyal shales
		Panaim Series	Koilkuntla limestones and quartzites
		Jammalamadugu series	Auk shales Narji limestones
		Banganapalle Series	Banganapalle sandstones, quartzite and conglomerates
----------Unconformity----------			
Srisailam quartzites			Quartzites
----------Unconformity----------			
Upper Precambrian	CUDDAPAH SUPER GROUP	CUDDAPAHS	Vempalle Series: Limestones and Cherts with trap-sills Gulcheruvu Quartzites: Quartzites and Conglomerates
----------Unconformity----------			
Archaeans to Lower Precambrians	Dharwar Super Group		Basic dykes, pegmatites, Aplites, Quartz veins Schists & Metavolcanics
	Unclassified Crystallines		Granites and Gneisses

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6.8 Hydrogeology:

Mahabubnagar is mainly occupied by Archaean crystalline rocks. The precambrian sedimentaries represented by Cuddapah and Kurnool formations occur as a narrow belt along the northern bank of Krishna river bordering the southern part of the district. Deccan Traps occur as detached patches in parts of Kodangal and Shadnagar taluks in the western part of the district.

The degree and depth of weathering in the peninsular gneissic rocks vary widely even within short distances. The thickness of the weathered mantle varies from less than a metre near outcrops to as much as 23.0 m in valley bottoms and low lying areas. Ground water occurs in the weathered and fractured rock under water table and semiconfined conditions. The depth to water varies from 0.5 m to 19.80 m bgl in open wells and the yields of these wells vary from 18 to 375 m^3/d. Depth to water in borewells range between 0.45 m and 6.6 m bgl and the yield from the borewells vary from 100 and 4500 lph for drawdowns varying from 1 m and 12 m. The open wells situated in Cuddapah and Kurnool formations range in depth from 2 to 30 m bgl and the depth to water level in them varies from 0.4 m to 29 m. bgl. These wells yield limited supplies of water varying from 15 to 100 m^3/d. Alluvium occurs along the courses of Dindi river and its tributaries. The wells in alluvium range in depth from 2 to 8.9 m bgl and depth to water level in them range between 0.8 m and 6.6 m bgl. The yields of open wells in alluvium vary from 105 to 200 m^3/d and sustains 2 to 6 hours of pumping. Wells in Kalvakurthy taluk are reported to sustain pumping for a longer time. Figure 16 depicts the general depth to water in the district for May 1986.

6.9 Status of S the Studies:

Central Ground Water Board has been carrying out systematic hydrogeological and reappraisal surveys in the district. Till the end of March 1987 an area of 9520 km^2 has been covered under the systematic hydrogeological surveys and an area of 760 km^2 under the reappraisal surveys.

6.10 Ground Water Level Monitoring:

Ground water level monitoring by CGWB has been introduced in the district by the establishment of 2 network hydrograph stations in the year 1969. The number

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has been subsequently increased progressively and presently there are 33 All India Network Stations in the district. The long term studies and analysis of the data indicate that fluctuations occur in the ground water regime in response to recharge and draft. The range of annual fluctuation varies from less than 0.5 m to 16.3 m but in general it varies from 1 to 4.3 m. Declining trends in water levels have been observed in some parts of the district notably in Shadnagar, Gadwal, Nagarkurnool, Kalwakurthy, Jadcherla, Atmakur and Kothakota areas which may be due to below normal rainfall received in the district for the last 2 years.

6.11 Ground Water Exploration:

Ground water exploration was carried out by CGWB during the year 1971-75 in an area of 1280 km^2 covering parts of Shadnagar and Kodangal taluks of the district under the Indo-Canadian Collaboration Project. Twenty exploratory wells were drilled down to depths ranging between 27 and 75 m bgl. The yields of these wells ranged between 60 and 700 lpm. Out of the total area of 1280 km^2 covered under the exploration, an area of 774 km^2 was proved ground water worthy for further ground water exploration.

6.12 Chemical Quality of Ground Water:

The ground water occurring in the district is good and fit for both irrigation and domestic purposes except locally where local pollution has rendered it unfit. In the granitic terrain the pH varies from 7 to 8.5, EC from 450 to 3310 micromhos/cm at 25°C and the Chloride content from 28 to 638 ppm and total hardness as $CaCO_3$ from 125 to 495 ppm. In the Archaean gneisses, high concentration of fluoride upto 5 ppm is reported at few places. The ground water from shales, sandstones, conglomerates and limestones is usually alkaline with pH value varying between 7.4 to 7.8. The bicarbonate content ranges between 248 and 446 ppm. The chloride content is in the range of 10 to 395 ppm. The total hardness as $CaCO_3$ varies from 200 to 470 ppm.

6.13 Ground Water Resources and Development Prospects:

As is evident from the agriculture and irrigation particulars discussed earlier, nearly 50 percent of the area is irrigated by wells. The district is endowed with two perennial rivers the Tungabhadra and the Krishna both form the southern boundary of the district they are having surface irrigation facilities through canals. Thus nearly 50 per cent of the district has to depend upon ground water sources. Of late ground water development has been only the southern part of the district

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gaining momentum due to the availability of institutional financing and other facilities, thus there is a marked increase in the number of structures every year. In 1976-77 there were no tubewells and filter points. There were 49,665 dug wells out of which 17,944 wells are with oilengines and 13,440 wells are with electric motor pumpsets, irrigating an area of 51,840 hectares(gross), whereas presently(1984-85) there are 263 tubewells and filter points, 78,265 dug wells, out of which 30,147 wells are with oil engines and 29,169 are with electric motors pump sets, an increase of 28,600 wells over a period of 8 years. With the stress on minor irrigation particularly under wells, it was also felt that assessment of the ground water potential became a necessity so that development can take place on scientific lines. So the first assessment of ground water potential was carried out in 1977. Subsequently the assessment was revised and the latest assessment for the year 1985 was made as per Ground Water Estimation Committee recommendations. The taluk-wise estimations are given in Table-6. As per the estimations the total utilisable ground water resource of the district has been estimated as 1294.4 MCM and and the net draft 450.1 MCM leaving a balance of 844.3 MCM. The stage of ground water development is 35 per cent which means there is scope for further development especially in some of the backward taluks where the tempo of development is slow. The stage of ground water development is more than 50 per cent in Nagar-Kurnool, Mahabubnagar and Wanaparthy taluks/so that they may not reach the stage of over development. However, it may be seen from the talukwise draft for the last 3 to 4 years that the ground water draft shows a rise in almost all the taluks for 1984-85 and total net draft for the district has shown a rise from 427.1MCM in / 450.1 MCM during 1984-85. This rise in draft can be/1983-84 in attributed to below normal rainfall during the last two years which probably has brought down the area sown from 9,31,291 in 1982-83 to 761263 hectares in 1984-85. However this can be considered as a temporary phase as the rainfall becomes normal the conditions may improve. /and further development has to be watched in these taluks

6.14 <u>Rural and Urban Water Supplies for Drinking Water and for Industries:</u>

The district has a population of 24.47 lakhs of which 21.79 lakhs live in the rural areas and 2.68 lakhs live in the urban areas. Presently there are 6988 borewells and 289 pumping and mini-pumping water schemes exist in the district which meet the drinking water and domestic needs of the population. In addition

Table-6

Estimated Ground Water Potential and Ground Water Draft (Net) for Mahbubnagar district (1984-85)

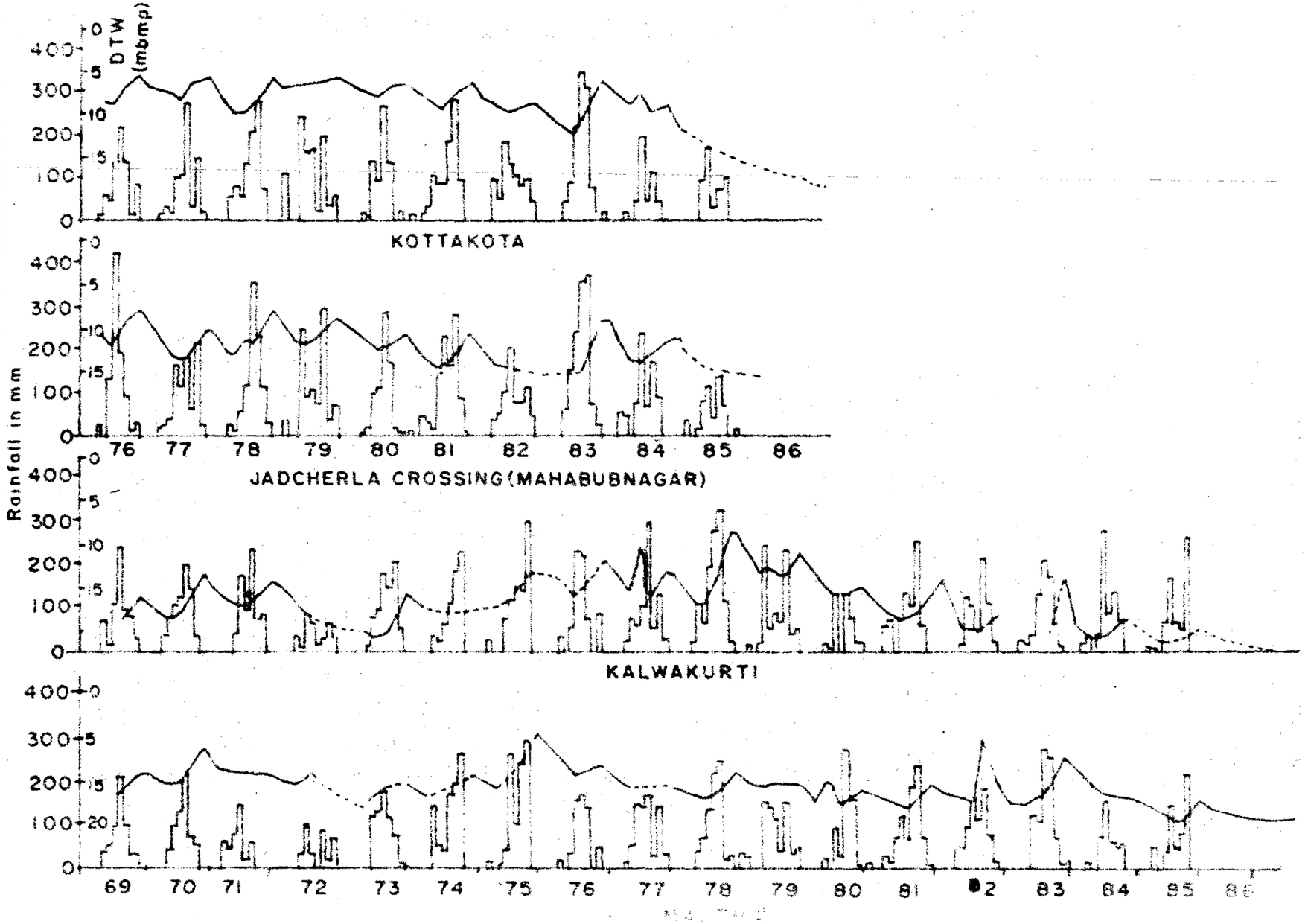
Sl. No.	Name of taluks	Estimated Utilisable G.W. Potential (MCM)	Estimated G.W. Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water Development	
					Present %	at years 5 (%)
1.	Alampur	68.7	9.4	59.3	14	15
2.	Nagarkurnool	110.5	56.2	54.3	51	56
3.	Achampet	115.0	11.5	103.5	10	11
4.	Shadnagar	83.8	32.7	51.1	40	43
5.	Kodangal	159.6	26.8	132.8	17	19
6.	Makthal	99.5	33.6	65.9	34	37
7.	Jadcherla	61.0	29.9	31.1	49	54
8.	Gadwal	81.5	31.2	50.3	38	42
9.	Kolhapur	109.0	38.0	71.0	35	38
10.	Mahabubnagar	52.6	28.2	24.4	54	59
11.	Vanaparthy	114.3	56.9	57.4	50	55
12.	Atmakur	76.3	29.3	47.0	38	42
13.	Kalvakurthy	162.6	66.4	96.2	41	45
		1294.4	450.1	844.3	35	38

there are number of private dugwells being used to supplement the demands. As per the norms/90 lpd for /of urban population and 70 lpd for rural and livestock consumption the total requirements worksout to 64.5 MCM. A provision of 228.4 MCM has been made from the gross recharge of 1522.8 MCM while calculating the utilisable ground water recharge of 1294.4 MCM for meeting the drinking water and industrial requirements of the district. This will take care of the future requirements also. However, this may fall short of the requirements during the years of drought when the annual recharge will be less than the normal years and water levels go down and wells going dry. This has to be met by sinking deeper borewells and by deepening existing dugwells to tide over the crisis.

6.15 Ground Water Development in relation to water levels and Rainfall:

Ground water development in the district has been on the rise as is evident from the discussions in the previous pages and the increasing structures seen year after year. Presently there are 78,265 ground water extraction structures in the district irrigating an area of 44,498 hectares accounting for about 35 per cent (Net) of the utilisable resources. As can be seen, from the annexure-II barring only 3 taluks, the development stage has not exceeded 50 per cent in any of the other taluks. So it is clear that there is scope for further development. However, when the trend of development or the ground water draft is examined in relation to rainfall and water levels it is seen that though there is a rising trend in the draft the total cropped area has come down compared to the previous years. This reduction in the total cropped area can be attributed to the below normal rainfall received in the last two years and in some taluks like Kalwakurti the rainfall was below normal for the last 4 years. Hence, the fall in cropped area. The water levels have also shown declines notably from the last five years (fig.17 a, b, c & d). The decline varies from 11.70 m at Musapet to 0.4 m at Mahabubnagar. The other notable declines are at Nagarkurnool (10.5 m), Kalwakurti (11.50 m), Maddur (9.40 m), Gadwal (5.0 m), Makhtal (10.0 m), Kothakota (10.0), Jadcherla (6.87 m), Shadnagar (9.60 m), Welijorla (7.50 m), Atmakur(6.0 m), Kodangal (9.66 m), Gundimal (8.39 m) and Koilkonda (7.13 m). This fall or decline in levels can be partly attributed to the rise in ground water draft seen in most of the taluks for the last 2 to 3 years and also partly due to below normal /received in the /rainfall district during 1985 and 1986. It is possible, that due to below normal rainfall, the recharge has come

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS MAHABUBNAGAR DISTRICT A.P.



RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, MAHABUBNAGAR DISTRICT, A.P. 1981–86

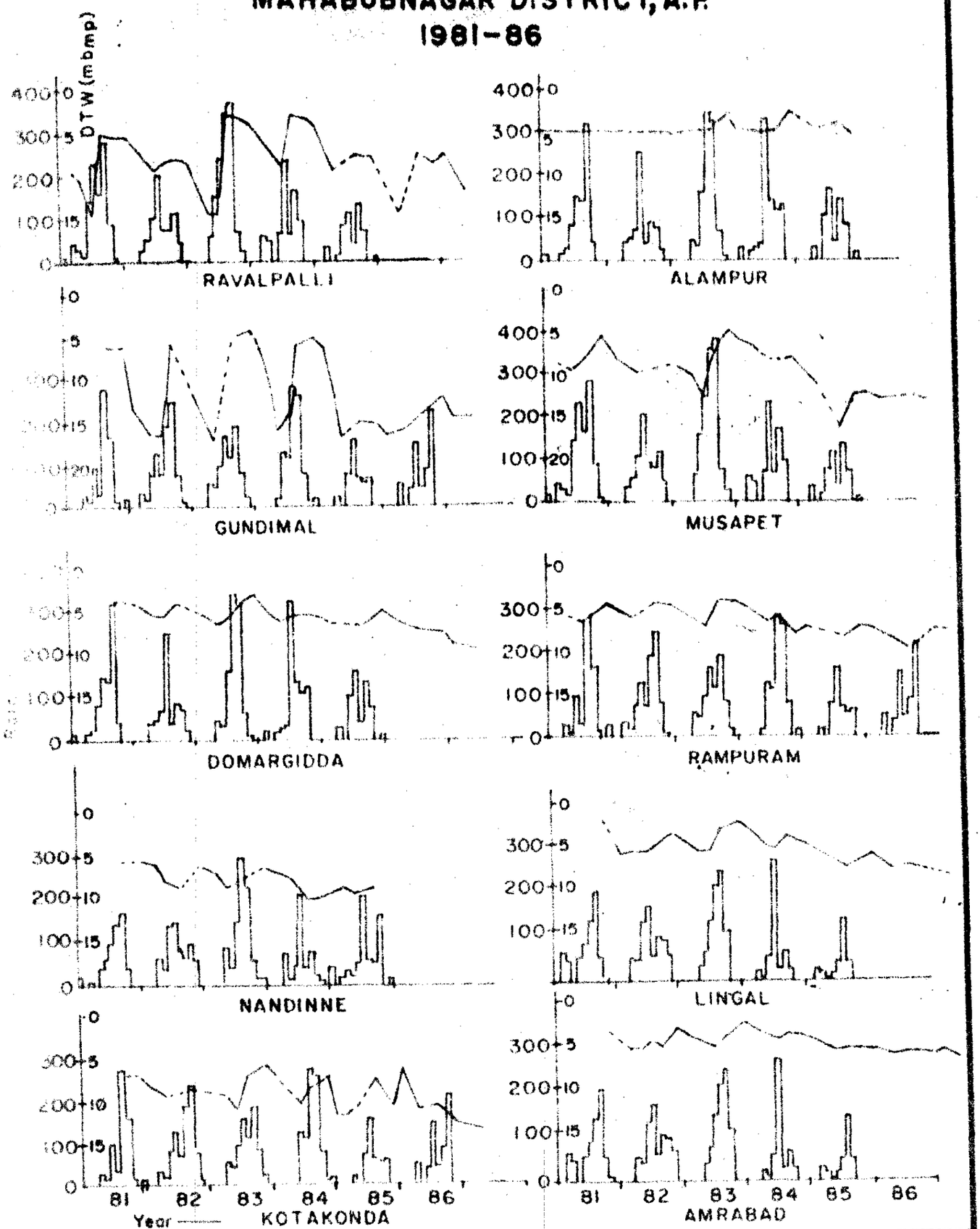
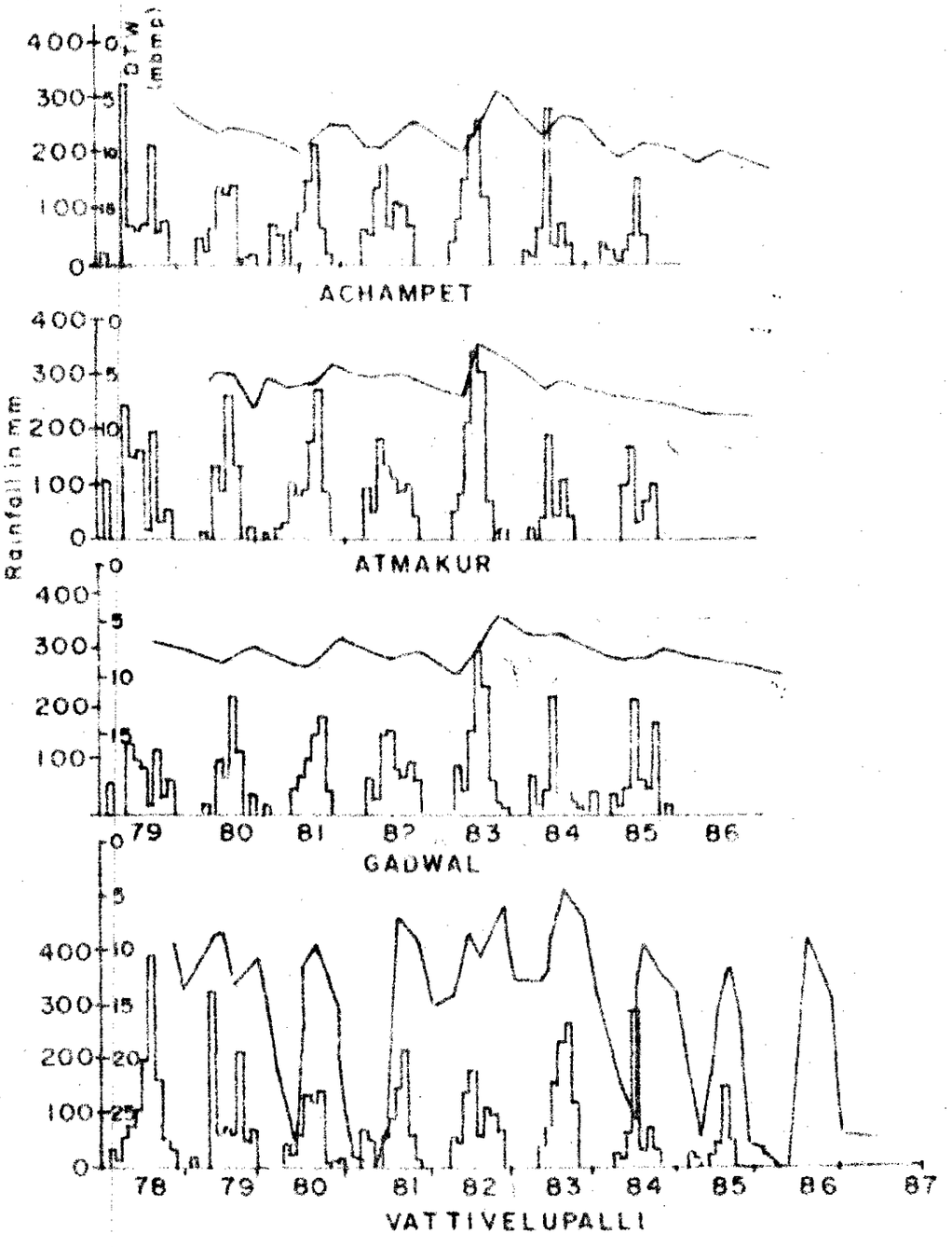


Fig 17(d)

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS MAHABUBNAGAR DISTRICT A.P.



cultivation. Rice is a crop which requires lot of water and its consumptive use is very high. With higher ground temperatures as is the case in the district, the evapotranspiration is bound to be high. Moreover rice is cultivated even in rabi season as a second crop over an area of 30,098 hectares. If this pattern is changed, it can save lot of water. The second crop can be any oil seed or millet or maize or someother irrigated dry crop which requires less water. Barring the canal irrigated area where water supply is assured, the well and tank irrigated areas can switch over to some other dry crop. Groundnut is one crop which holds good promise. With the edible oil prices going high, it is economically paying for the farmers to go in for the groundnut crop, which is also a short duration crop. Vast areas can be brought under groundnut cultivation. With the black soil occupying large areas, it can also hold the moisture required for the growth of the crop. Cotton is another crop which is not grown on a large scale. It should also be popularised. The growth of such irrigated drycrops will reduce the demand on the water requirement and stabilise ground water levels over the years to come.

The district has nearly 16.4 percent of the area as forests and 6.4 percent as barren land. Many of the hills look bare with little forest and soil cover. It is better aerial seeding of these hills is taken up as discussed earlier and afforestation methods taken up on a large scale, so that soil erosion is reduced and prevent runoff to some extent. The DPAP methods can be coupled with this, so that it will also meet the fuel requirements of the local rural population. There is nearly 1,16,451 hectares of land not put to agriculture use and about 10,780 hectares as a cultivable waste. These can be developed into permanent grazing lands and also for growing fodder for the cattle. They can be of use in times of need. This will also reduce the load for grazing on form lands and watershed catchments.

The other water harvesting or water use techniques like contour bunding, construction of recharge wiers, subsurface dams, use of drip and sprinkler irrigation methods will not only induce recharge but also reduce water consumption. Percolation ponds wherever viable (only sandy soils) should be constructed to reduce runoff and also as a temporary storage as percolation to ground water will increase the recharge. Conjunctive use of Surface and Grround Water in the Canal Command Areas is also

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down in recent years which also affect the trends. In this context if we examine the hydrometeorological analysis carried out earlier, there is a possibility of normal rainfall upto 1989 and after that drought conditions may set in. That means theere is a possibility of recovery of water levels and normal recharge in the next 2 years, but conditions may become bad by the end of the decade which might call for some measures for water management etc to meet the situation that may arise later.

6.16 Ground Water Management Practices and Drought Management Stratagies:

From the foregoing it is clear, that there is still scope for ground water development in most of the taluks except three taluks where the stage of development is more than 50 per cent. It is possible that during years of drought, there can be less recharge to ground water/over draft conditions may prevail /and temporarily. This has to be considered as a temporary phase as these are indidations of normal rainfall likely to be received in the next couple of years which may arrest the declining trend of water levels. The recharge will also go up and the development can continue especially in the other taluks where it is below 50 per cent. However, caution has to be exercised in the other three taluks where there is a possibility of overdevelopment in the coming years. Another significant factor which has emerged from the hydrometeorological analysis is that dry conditions may be encountered again by the end of the decade. That means eventhough there is a respite from the drought conditions now seen in the district the situation may become bad again possibly by 1990 or earlier. This calls for some permanent or long term measures or drought management strategies to alleviate the sufferings of the population on a permanent basis.

6.17 Longterm Drought Management Strategies:

Nearly 85,661 hectares of the gross area irrigated is under rice cultivation out of the total gross irrigated area of 1,30,952 hectares. Out of this the gross area irrigated by wells is 34,498 hectares. That means nearly 65 per cent of the area irrigated is under rice cultivation. No other crop is grown on such a large area. Similarly, nearly 31,792 hectares is under the ayacut of tanks cultivating rice. That means if we put togehher, nearly 90 per cent of the area irrigated is under rice

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another important aspect which will help better utilisation of water resources in the long run. These are some of the long term, or permanent measures suggested which will yield results in course of time. However there has to be some short term measures to meet the immediate requirements and tide over the crisis. These are discussed below under the short term drought management strategies.

6.18 Short Term Drought Management Strategies:

While many of the measures suggested above might take some period or years to yield results it may be necessary to adopt certain crash programmes or short term measures to meet the scarcity conditions which will help tackle the problem on an emergency basis.

Ground water development should be effected fully for optimum utilisation and results. In developing ground water to meet the irrigation and water requirements, proper investigation techniques be adopted to avoid well failures. These wells wherever feasible be drilled preferably to meet the drinking water requirements of the rural and urban population and supplement the irrigation requirements. Subsurface dams can be constructed after carrying out due site investigations to stabilise the irrigational water requirements where quality is not a problem. The quality of water is generally reported to be good except in high fluoride areas of the Archaean gneisses. Here proper defluoridation methods are to be adopted before supplying water for drinking. Where the quality of water is bad locally, desalination of water can be thought of to make it potable or alternate surface sources from the canals/reservoirs can be made available. This will meet to some extent the requirements of the people temporarily and the permanent solutions as suggested earlier will ensure that the water requirements will be met on a permanent basis.

7.0. NALGONDA DISTRICT

7.1 Location and Extent:

Nalgonda district, one of the chronically drought prone districts of Telengana is bounded on the north by Medak and Warangal districts on the west by Mahbubnagar and Rangareddy districts on the south by Guntur district and Krishna river and on the east by Khammam and Krishna districts. The total geographical area of the district is 14,223 km^2 and lies between

N.Latitudes 16°25' and 17°50' and E.longitudes 78°40 and 80°05'.

The district is divided into seven taluks. The total population of the district as per 1981 census is 2,279,685. There are seven towns namely, Nalgonda, Miryalguda, Kodad, Huzurnagar, Bhongir, Suryapet, Choutuppal and Devarakonda, of which only Nalgonda Bhongir, Kodad and Suryapet are bigger towns with a population of more than 20,000. Only Nalgonda town, the district headquarters has a population of more than 50,000. Nalgonda town is well connected by road and the Hyderabad-Kazipet broadgauge railway line passes through the district. The newly laid Bibinagar and Nalgonda metre gauge line also passes through the district.

7.2 Physiography and Draingage:

The district is traversed by four ranges of hills. One range of hills runs through the taluks of Nalgonda and Devarakonda. The second range of low hills runs in NE direction inthe south western part of the district. The third range of hills known as Nallapahad bifurcates the second range of hills after reaching the Dindi and Peddavagu. A fourth range occurs in the North-Western part of the district and runs west of Pasnur in a north-westerly direction as far as Sirikonda before taking a sudden turn towards east and extending over a distance of /. The general slope of the /19 Km land is towards southeast and elevation varies from 480.0 m above msl to 80 m above msl towards south and south-east. In general it presents a rolling topography typical of gneissic country. The hills comprising of quartzites stand out in the south.

The district is drained by the rivers Krishna, Musi, Aler, Peddavagu, Dindi, Halal and Kongal. However, the most important river is the Krishna which

is perennial and forms the southern boundary of the district. Almost the entire district is in Krishna Basin. Musi river, a tributary of Krishna, is the next important river draining the district. Aler is a tributary of Musi. Peddavagu and Dindi are the other two important rivers which drain Devarkonda taluk and join the Krishna river. Kongal and Halal rivers flow southeast of Nalgonda town and join Krishna river. The water spread area of the Nagarjunasagar project extending into the district is one of the most beautiful and picturesque spots.

7.3 Hydrometeorology:

The district is characterised by hot summer and general dryness except during southwest monsoon season. The maximum temperature is about 40°C but sometimes may go upto as high as 45°C, generally recorded in May whereas the minimum temperature during winter is around 16°C. The lowest recorded temperature during winter is 10°C generally recorded in January. The normal annual rainfall pattern over the district is given in Fig. 2. The district normal is 770.0 mm .As is evident from the fig.2 the rainfall decreases from north to south from 900 mm to less than 700 mm. Fig 18 gives the trend of rainfall for 1901-1985 for the station at Nalgonda along with the moving averages for 5 years and 10 years period. From the study of the plots it is clear that the curves are somewhat inusoidal in nature with a slight rising trend. If the rainfall data of last 85 years is examined it is seen that the highest rainfall of 1715 mm has been received during the year 1978 and the lowest rainfall of 422 mm has been received in the year 1926.

From the Fig 18 we can pick up 'wet' and 'dry' periods for the period 1901-1985. While periods 1903 to 1913, 1918 to 1933, 1933 to 1945, 1949 to 1953 1964 to 1975 and from 1980 onwards can be said as below normal years, periods from 1913to 1918, 1933

to 1938, 1945 to 1949, 1953 to 1964 and from 1975 to 1980 can be said above normal or wet periods.

During the last decade, normal rainfall has been received in 4 years, excess rainfall in 2 years and deficit or below normal rainfall in 4 years. The curve shows a declining trend indicating drier period a head. The percentage frequency of occurrence of normal excess and deficit rainfall in 5 continuous years during the period 1901-85 is calculated below:

No. of years with normal rainfall	3	4	1	2	2	4	1	5	3	3	2	1	
-do- excess "	1	0	2	2	1	1	3	0	0	2	3	4	
-do- deficit "	1	1	2	1	2	0	1	0	2	0	0	0	
Percentage frequency of occurrence	17	17	13	10	9	9	8	8	6	1	1	1	

The above statistical method indicated that there is a high probability of occurrence of normal rainfall in 3 years and excess and deficit rainfall in 1 year each. Comparatively there is more possibility of receiving deficit rainfall to occur than excess rainfall.

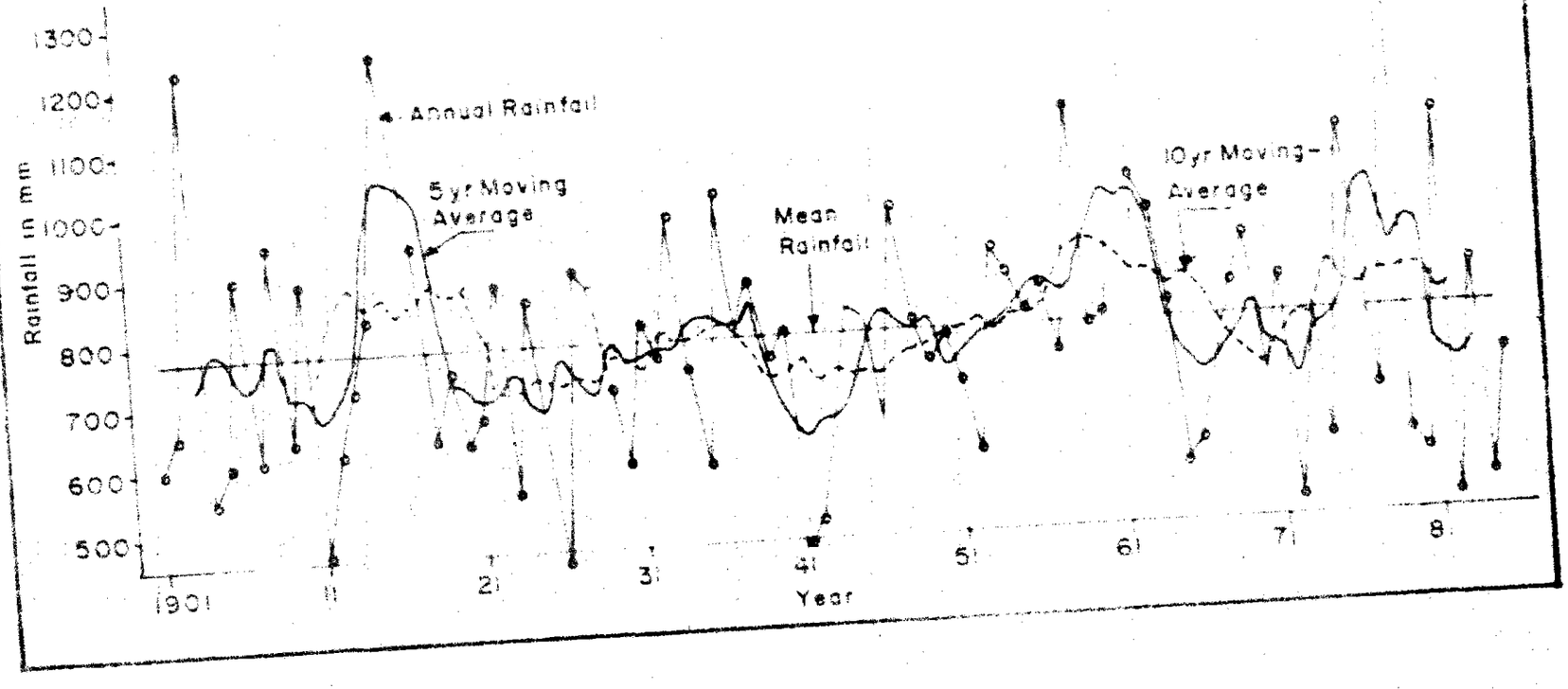
During the period 1981-85, normal rainfall occurred in 3 years, excess rainfall in 1 year and deficit rainfall in 1 year. From this analysis it can be inferred that in the coming 5 years (1986-90) the probable frequency of occurrence of normal, excess and deficit rainfall may be one of the following:

No. of years with normal rainfall	3	4	1
" excess "	1	0	2
" deficit "	1	1	2

Year	Anticipated rainfall		
1986	E	N	D/E
1987	N	N	E
1988	N	N	E
1989	D	D	D
1990	N	N	N

Fig 18

RAINFALL TREND DURING 1901-85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE NALGONDA STATION NALGONDA DISTRICT



It can be safely assumed from the above analysis that there is a high probability of occurrence of normal rainfall in 3 years excess rainfall in one year and deficit rainfall in 1 year probably in 1989 indicating dry period towards the end of the decade.

7.4 Soils:

The important soil types occurring in the district are the red loamy soils, grey loamy soils, black cotton soils and alluvial soils of which the most common type of soil seen in the district is the red loamy soils mostly derived from the granitic gneisses. The grey loamy soils occur in patches in the district. These soils are supposed to have been derived from the calcareous shales. The black cotton soils are found as patches along the Musi river in Miryalaguda taluk, west of Wasirabad. These blacksoils are suitable for cultivation of cotton, groundnuts etc. The alluvial soils occur to a very limited extent along the Krishna river.

7.5 Agriculture and Irrigation:

In respect of the area under cultivation Nalgonda district is more fortunate than many of the other districts in the state especially in Telengana or Rayalaseema region. Nearly 11.6% of the district is under cannal irrigation. This has become possible because of the Nagarjunasagar project. What was once a barren-land has been transferred into a rice bowl. The other irrigation projects in the district are the much smaller Musi, Dindi, Asifnagar, Pendlipakala and the Shaligowravaram projects. Besides a good number of tanks and wells add to the area under irrigation. Out of the total geographical area of 14,22324 hectares of the district the net area sown is 629,682 hectares which is 44.3 percent of the area of the district. The total cropped area is 7,41,070 hectares which is 52 percent of the total area of the district. The net area under irrigation is 1,66,310 hectares which is 22.4 percent of the total

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cropped area and the gross area irrigated is 249734 hectares. Out of this the gross area under paddy is 229913 hectares. Of this, the total area irrigated by canals is 97051 hectares. There are 5508 tanks irrigating an area of 35262 hectares. There are 15 tubewells, 74,441 dugwells irrigating an area of 74436 hectares (84-85) . The main crops grown are paddy, jowar, ragi, groundnut, castor and pulses are also grown. Tobacco, cotton are also cultivated.

7.6 Industries and Mining:

The district being predominantly an agriculture one, not many industries exist. The important crafts are the time honoured pbronze ware, jewellery, spinning and weaving. Of late some industries are being set up under the district development plans. Four mini-cement factories have been tset up. They are M/s Rasi Cement Limited, Deccan Cements Limited, Nagarjuna Cements Limited and Sagar Cements Limited. There are several small scale industries in the district mainly agro based mostly located at Bhongir, Miryalguda, Nalgonda, Suryapet, Huzurnagar and Devarkonda. Handloom weaving is an important cottage industry. The important centres are Nalgonda, Suryapet, Devarakonda and Aler,

The district is poor in mineral wealth. There are known occurrences of galena, soapstone, corundum, clay and limestone. Clay is mined for use in ceramics. Corundum is mined locally for use in abrasive industry. Soapstone is used for making stoneware and slate pencils. However, vast deposits of cement grade limestone occur in the district. They extend as a belt along the northern banks of the Krishna river occupying parts of Devarakonda, Miryalaguda and Huzurnagar taluks. Limestone is mined for use in the cement industry. A part from this the granites and limestones are also used as excellent building stones.

7.7 Geology:

The district is mostly underlain by the Archaean gneisses and Dharwarian schists. However, other formations of the Cuddapah and Kurnool age also occur in the southern corner of the district. The broad geological succession as seen in the district is given below;

Recent to sub Recent			Soil, Alluvium
	---------Unconformity ---------		
Upper Precambrian to Lower Palaeozoic	Kurnool Group		Jammalamadugu limestone and shales
	---------Unconformity --------		
Upper PreCambrian			Srisailam Quartzites shales
	-------Unconformity ---------		
	Dharwar Super Group	Dharwars	Dolerite dykes Pegmatite and Quartz veins Schists, Phyllites, Amphibolites
Archaean to Lower Pre-Cambrian	Penisular gneisses		Granitic gneisses Gneissic granites

7.8 Hydrogeology:

Nalgonda is one of the chronically drought affected districts of Telengana region of the state. Major part of the district is underlain by Archaean gneisses and granites, The Dharwar schists occur as minor patches in the granitic complex. The Cuddapah and

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Kurnool formations represented by the sandstones, shales and Palnad limestones respectively occur along the bank of Krishna river forming the southern boundary of the district. The recent alluvium occur only to a limited extent along the major river courses like Krishna, Dindi and Munneru. Ground water occurs in all these formations in the weathered and fractured rock and in alluvium under unconfined to confined and semi-confined conditions The ground water conditions as seen in deferent formations are described in brief below:

7.9 Ground Water in Crystalline rocks:

Ground water occurs in the weathered and fractured gneisses and Dharwarian schistose rocks both under un-confined and semiconfined conditions and is developed by dug wells, dug-cum-borewells and to some extent by bore wells. The depth of weathering in these rocks varies from less than a metre to 15 m.bgl. The depth of open wells situated in Dharwars range between 3.6 m and 9.6 m. bgl and the depth to water varies from 1.9 m bgl to 8.4 m. bgl. The wells tapping the granites and gneisses range in depth from 4 m to 16 m bgl and the depth to water in these wells range from 0.3 to 4 m bgl in the canal command area and it varies from 5 to 13.7 m bgl outside the canal command. The general range of depth to water is between 2m and 7 m bgl. Open wells tapping the granites and gneisses sustain a pumping of 3 to 6 hours daily yielding approximately around 50 to 160 m^3/d. Borewells drilled in these formations to depths of 80 m have given yields ranging from 1.4 m^3/h to 2.6 m^3/h for drawdowns ranging from 2 m to 30 m.

7.10 Ground Water in Cuddapah and Kurnool Formations:

Ground water development in Cuddapah formations is very much limited since these rocks occupy hills and hillocks in the district. A few wells exist in the area which are mostly used for meeting drinking water requirements. The depth of these wells vary between 5.0 m and

19.40 m and depth to water in them vary from 1.95 m to 16.0 m bgl. A minor patch of Kurnool formations (Jammalamadugu series) is seen where ground water development is not extensive. The total depth of the wells tapping the Jammalamadugu limestone varies between 4.20 m and 22.0 m and depth to water between 4.0 m and 8.0 m bgl. Nearer to Krishna river, the depth to water becomes deeper. There are not many irrigation wells in the area. A few irrigation wells yield around 80 m^3/d for pumping period of 4 hours for drawdown around 2.5 m.

7.11 Ground Water in Alluvium:

Dug wells tapping alluvium range in depth from 3 m to 8 m bgl and depth to water ranges from 2.0 to 5.8 m bgl. Most of the wells in alluvium sustain pumping for a longer period yielding upto 400 m^3/d. Most of the wells sustain a pumping period of 10 to 12hours. The general depth to water map of the district for May,1986 is presented in Fig-19.

7.12 Status of the Studies:

An area of 6695 Km^2 has been covered under the systematic hydrogeological surveys in the district upto the end of March,1987.

7.13 Ground Water Level Monitoring:

Under the All India Ground Water Monitoring programme two hydrograph network stations were established in 1969 which were later found to be inadequate for monitoring purposes for the entire district.Presently there are 16 hydrograph network stations in the district. These wells are being monitored 5 times a year that is in January,April, June, August and November/4 times a/and year from 1985 in January, May, August and November). The observations have indicated that fluctuations occur in response to changes in the staturated zone. The average annual fluctuations range from 1.1 m to 5.35 m. Of late, the water levels have been showing declining

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trends in some parts of the district ranging from 0.30 m to 4.78 m. This has been attributed to the below normal rainfall received in the district during the last two years.

7.14 Ground Water Exploration:

To locate suitable ground water resourcess and meet the irrigation demands in this drought prone area, ground water exploration was initiated by Central Ground Water Board in Nalgonda district, in Peddavagu Sudipalli basins of Deverakonda taluks during 1982-84. A total number of 10 exploratory wells were drilled down to depths varying frim 58 m to 90 m. All these wells are located in the granites gneisses and their discharge vary from 1.2 m to 29.8 m. The transmissivity values obtained from the long duration tests carried out on these wells varied from 0.5 m^2/d to 900 m^2/d. The bore wells constructed under the drought relief operations in Ramannapet and Chintapalli blocks during 1968-69 recorded yields ranging from 2.33 m^3/h to 4.1 m^3/h for drawdowns from 0.62 m to 5.15 m in Ramannapet blocks and from 60 to 650 lph for drawdowns from 0.25 m to 18 m in Chintapalli block. 1.4 m^3/hr to 20.6 m^3/hr for drawdown varying from

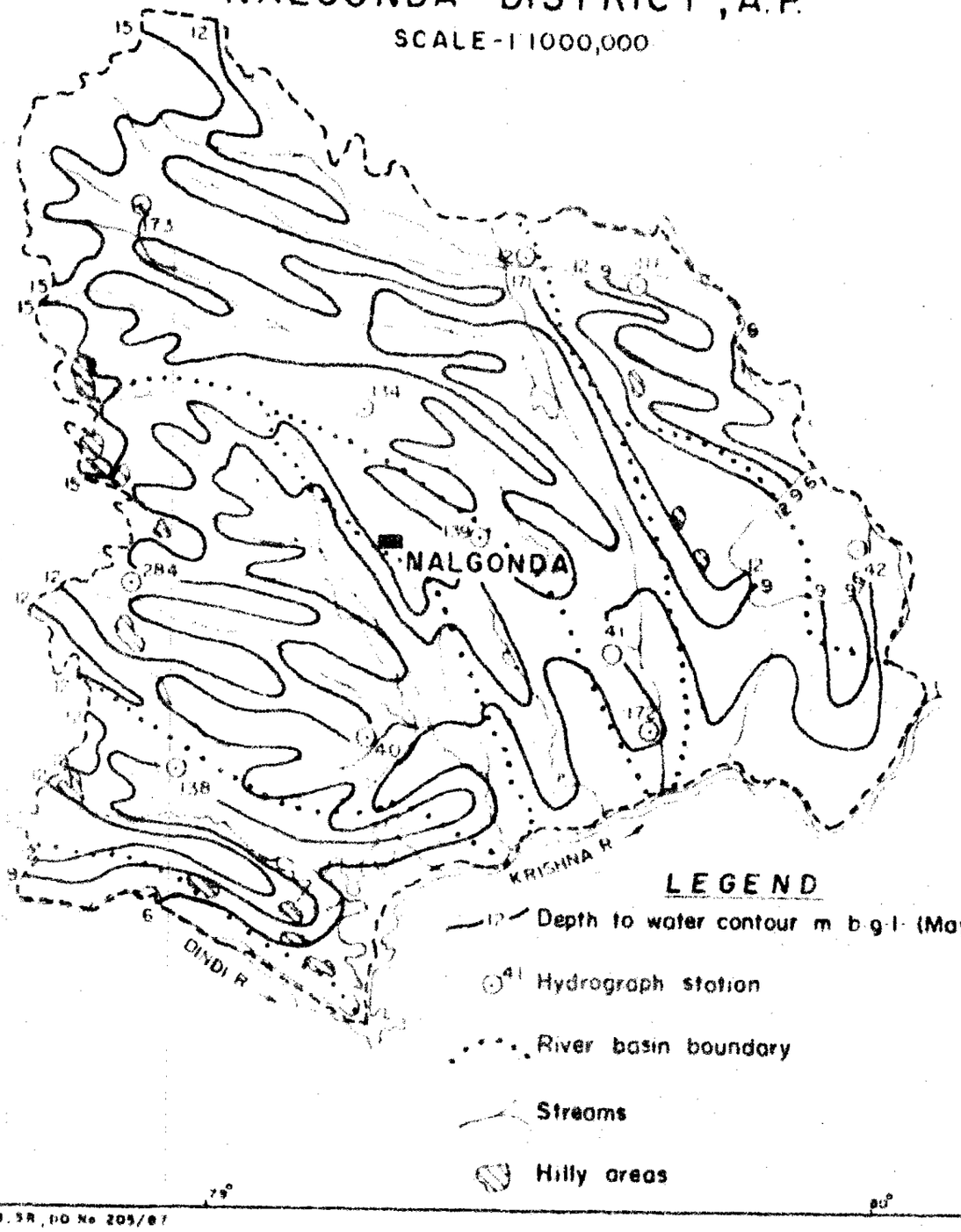
7.15 Chemical Quality of Ground Water:

The water from the granitic and gneissic area is generally alkaline with pH values ranging from 7.5 to 8.7m. The specific conductance varies from 462 to 2580 mi mhos/cm at 25°C. The other radicals like chloride vary from 6.4 to 194 ppm. However, the waters from wells located in black clayey soils are highly mineralised with specific conductance values ranging between 1365 and 3600 micro mhos/cm at 25°C and the chloride content going up to 487 ppm. The suitability of some of these waters even for irrigation is doubtful unless some salt resistant crops are grown. The waters from wells located in alluvium are lightly alkaline with pH varying from 7 to 8.3 . The E.C. value range from 482 to 1092 micromhos/cm at 25°C and the

Fig 15

DEPTH TO WATER
NALGONDA DISTRICT, A.P.

SCALE - 1:1000,000



SWR, SR, DO No 205/87

chloride content varies from 22 to 78 ppm Another important aspect which has come to light as a result of the surveys carried out by Central Ground Water Board is the presence of fluoride in ground waters in certain parts of the district where the concentration exceeds the permissible limit of 1.5 ppm for human consumption. The fluoride content is generally around 2 to 3 ppm and occassionally goes upto 8 ppm. The geochemical studies carried out around Nalgonda town and its neighbourhood showed that the fluoride concentration in surface waters varies from 2 to 4 ppm and the subsoil is also rich in fluoride and perhaps gets leached in course of time to enrich ground water.

7.16 Ground Water Resources and Development Prospects:

Ground water development was on low key till 1976-77 but picked up slowly after '77 with the stress on minor irrigation and extension of loaning facility and institutional financing. There were 50,665 ground water extraction structures in 1976-77 while the number has gone upto 74,441 in 1984-85. With the increasing trend in ground water development the need for resource evaluation has became very important. The first attempt at resource evaluation was made in 1977. This was revised subsequently with the availability of more data.The present estimated utilisable ground water potential is 1314.8 MCM. The talukwise potential is given in Table-7. The calculated net draft is 418.1 MCM leaving a balance of 896.7 MCM for development. From the trend of draft for the last 3 to 4 years it is seen that 1981-82 to 1982-83 there was increase in net draft from 373.1 MCM to 383.0 MCM. A slight decline is observed subsequently from 383.0 MCM in 1982-83 to 378.2 MCM 1983-84 and then an increase to 418.1 MCM during 1984-85. However, the stage of ground water development is only 32% indicating that there is still scope for development in some taluks. The stage of ground water development has exceeded 50% in 8 taluks and 70% in 4 taluks viz. Nakrekal, Chendur,

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Table-7

Estimated Ground Water Potential and Ground Water Draft (Net) for Nalgonda district (1984-85)

Sl. No.	Name of taluks	Estimated Utilisable G.W. Potential (MCM)	Estimated G.W. Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water Development	
					Percent %	at year 5 (%)
1.	Miryalaguda	194.2	9.7	184.5	5	6
2.	Huzurnagar	117.4	9.2	108.2	8	9
3.	Suryapet	85.7	29.3	56.4	34	38
4.	Nalgonda	77.5	43.0	34.5	55	61
5.	Ramannapeta	65.5	36.5	29.0	56	61
6.	Bhongir	66.3	31.1	35.2	47	52
7.	Mothkur	57.0	39.9	17.1	70	77
8.	Thungathurthy	64.2	32.2	32.0	50	55
9.	Nakrekal	53.0	39.9	13.1	75	83
10.	Chendur	37.0	28.4	8.6	77	84
11.	Nampally	50.0	25.5	24.5	51	56
12.	Nidamanur	135.0	15.9	119.1	12	13
13.	Kodad	118.0	11.7	106.3	10	11
14.	Devarkonda	141.3	18.8	122.5	13	15
15.	Yadagirigutta	52.7	47.0	5.7	89	98
		1314.8	418.1	896.7	32	35

Mothukur and Yadgirigutta. Some restrictions in development should be introduced in these taluks. In the other 4 taluks (Nalgonda, Ramannapet, Thagguparthi, Nampalli) the development exceeds 50% and may reach critical stage. Hence future development needs to be monitored in these taliks. As regards the increase in the draft and the area under irrigation in the last two years the increase in draft can be explained as due to less area irrigated by canals in the last two years, due to drought conditions prevailing and below normal rainfall received in the district for the last two years and also due to a reduction in the total cropped area and hence reduction in the area irrigated by wells and partly by rainfall.

7.17 Rural and Urban water supplies for drinking water and for Industries:

Nalgonda district has a population of 22.75 lakhs out of which 20.16 lakhs live in the villages and the remaining 2.59 lakhs live in towns. The district has 7926 borewells which are in use with handpumps and 232 pumping and mini-pumping water schemes to meet the water requirements. A number of private dugwells are also in use both in urban andrural areas which also supplement the requirements. As per the norms of 90 lpd for urban population and 70 lpd for Rural and livestocks population the total requirements worksout to 60.00 MCM.while this being the rural and urban requirement, for drinking and domestic purposes, provision has been given for the drinking water and industrial needs to the tune of 232.0MCM while calculating the utilisable ground water potential of 1314.8 MCM from the gross recharge of 1546.8 MCM. This will also meet the future demands that may arise due to increase in population or industrialisation.Only there may be difficulty in meeting these quantities during drought years when the recharge will be less than the estimated figures and there may be declining water levels in some parts of the district. This even tuality has to be met by sinking deeper borewellsoor by deepening of the

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existing shallow dug wells.

7.18 Ground Water Development in relation to Rainfall and Water Levels:

Though the tempo of ground water edevelopment is gaining momentum in the district, there has been no appreciable decline in the water levels for the last two years in almost all the taluks except in Taggupar-thi and Mothukur taluks where the development has just crossed 50%. But when the net area irrigated and the total cropped area/ they show a decline during 1984-85/are examined over the previous years. There has been below normal rainfall in most parts of the district for the last two years. This is reflected in the/declines vary from 8.50 m at Narketpalli to 0.30 m at Kodad and Suryapet(Fig 20 a & b). The other notable declines are at Choutuppal 9.85 m Peddavoora(4.5), Devarakonda (2.6 m), Tipparthi(5.60 m), and Bongir (4.3 m) and Nalgonda (4.38 m). These declines have been observed between November,1983 and November, 1986. In case of Narketpalli and Choutuppal the declines are continuous from 1978 onwards. However except in the case of Choutuppal and Narketpalli, the declines seen in the other areas can be attributed to the below normal rainfall received in the last two years. If the situation does not improve and below normal rainfall is received in the coming couple of years it becomes necessary to restrict the development in most of the taluks, except in Miryalguda, Huzur Nagar, Nidamanur, Kodad and Devarakonda taluks where the development is less than 15%. In face enough impetus should be given for rising the tempo of development in these taluks. The two wells mentioned above viz Narketpalli and Choutuppal are located in Nakrekal taluk which has already reached 75% of development. Hence the development should be restricted. Further the continuous declining trends indicate that there may be need for some water management to change the cropping pathern and to stabilise ground water levels in the area./ declining trend in water levels seen in the district. The

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7.19 Ground water Management practices and Drought Management Strategies:

Nalgonda district, a chronically drought stricken district in Telengana, presents certain peculiarities with the introduction of canal irrigation in the district through the Nagarjuna Sagar, Dindi and Musi projects. Part of the district has come under assured irrigation. However inspite of the introduction of canal irrigation in the district as early as 1960, the northern part of the district still experiences drought conditions causing undue hardships to the people. To mitigate the hardships experienced by the population living in the area, certain longterm and short term measures are required to be implemented which will help them overcome the problem.

7.20 Long term Drought Management Strategies:

Presently, nearly 741,070 hectares come under the total cropped areaconstitutes about 52.1% of the district and the net area irrigated is 1,66,310 hectares which forms 22.4 percent of the total cropped area. Out of this the net area under canals is 97,051 hectares, under tanks 23,031 hectares and under wells 40,485 hectares, which means that nearly 25% of the net area irrigated is under wells. Similarly the gross area irrigated is 2,49,734 hectares. The gross area irrigated under canals is 1,30,980 hectares, under tanks 35,262 hectares and under wells 74,436 hectares which mean that an area of 83,424 hectares is irrigated twice in the rabi period. Nearly 2,29,913 hectares (gross) is under paddy and only 22,076 hectares is under groundnut . Sugarcane is not cultivated on large scale. Most of the area under paddy is irrigated in the Kharif period and to some extent in the Rabi over an area of 72,532 hectares. Instead of paddy, if groundnuts, cotton or any other oilseeds are grown as/ will save a lot of water and perhaps the area under Rabi can be doubled.

/ second crop it

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Similarly other crops like Mulberry can be grown which require less water and is a short duration crop. This crop will be ideal under well irrigation. It will ensure the purchasing power of the farmer without affecting his income in any way. It will also improve the socioeconomic conditions of the farmers living in these areas. Hence it is suggested that the cultivation of groundnuts sunflower, mulberry, cotton and other oilseeds under canal and tank irrigation as a rabi crop and as both kharif and rabi crop under well irrigation be taken up. This will reduce the intensity of well irrigation and stablise ground water levels in the region. Presently the ground water development in Huzurnagar, Miryalguda and Kodad taluks is very low, less than 10% the reason being they fall in the command area of the Nagarjuna Sagar Project.(Right Bank canal command) The water table here is shallow within 3.0 m bgl. and there is water logging conditions seen for almost six months in a year. There are also brackish water pockets seen due to which the EC values have gone up to 7000 micromhos/cm 25°C. Here there is wide scope for development and also for conjunctive use of surface and ground water which can reduce water logging conditions. It is suggested if possible also to reduce the in take through the canals, encourage ground waters development through subsidies. State agencies/construction and development of borewells in the area and encourage farmers to use ground water. The bad quality water can be mixed with the surface waters of the canal and used for irrigating paddy crop which can withstand a higher concentration of total dissolved solids than other crops. This can be tried with success. /can also taken up

The hills in the district, especially in the northern parts do not have much of vegetative cover.

Aerial seeding of these hills may be carried out during monsoon months so that the afforestation methods yield good results. This will also meet the fuel requirements of the rural population. Other afforestation and social forestry methods can be taken up in association with DPAP and ARDA programmes to yield better results. The district has a culturable waste of 28,925 hectares which is about 2% of the district. This can be developed into grazing lands or for cultivating fodder for the cattle so that in times of need the cattle will not suffer for want of fodder. 'Ground Water sanctuaries' is a new concept and thought can be given for creating such sanctuaries in Devarakonda, Ramannapet, Nalgonda and Bhongir taluks to meet the water needs in times of drought or to augment the existing supplies.

High fluoride bearing waters is a problem in large parts of the district especially in Suryapet, Nalgonda, Miryalguda and Devarakonda taluks where the fluoride in ground waters often exceeds 8.0 ppm. The only possibility is to meet the rural water supply needs after defluoridation of the high fluoride water or alternately go in for surface water through canals wherever it is feasible. These are some of the longterm measures suggested to overcome the drought conditions occurring frequently in different parts of the district, on a permanent basis. This may ensure a bother living condition for the people living in the area. But, these measures are bound to take a longtime for implementation and it will be difficult for the people to withstand the hardships for longer periods. Hence, some

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short term strategies have to be adopted to solve the problems temporarily.

7.21 Short term Drought Management Strategies:

To overcome the difficulty and to meet the crisis and the water shortage encountered by the human and livestock population the immediate task will be to find the source of water, more so when all the surface sources have dried up and the shallow wells are dry. In such areas, and also in areas where there is still scope for development, the ground water may be developed by drilling bore wells upto 90.0 m depth after adopting proper well siting techniques in hard rock areas using remote sensing, geophysical and other methods to avoid or atleast minimise well failures. Priority may be given for drilling such wells for drinking water first and then for supplementing the irrigational requirements.

The other water harvesting and water use techniques like construction of recharge weirs, check dams and percolation ponds to arrest flash floods due to summer showers. Cultivation of fruits and orchards instead of any water requiring crops will help to supplement the income of the rural population. Such cultivations can be takenup in the problematic areas like Nalgonda, Choutuppal, Nalgonda and Ramanapet areas. Where the quality turnsout to be bad, then such areas can be served by canal waters or atleast through temporary mobile units till the situation improves. However if permanent measures as suggested earlier can help to improve the situation in course of time.

8.0 PRAKASAM DISTRICT

8.1 Location & Extent :

Prakasam district has been carved out of Guntur, Kurnool and Nellore districts on 2.2.1970. The district has a geographical area of 17,626 km^2 lying between north latitudes 14°55' and 16°20' and East Longitudes 78°45' and 80°28'. It is bounded by Guntur district on the north Kurnool district on the west Cuddapah district on the South west, Nellore district on the south and Bay of Bengal on the east. It is one of the drought affected and backward districts of Andhra Pradesh. As per the 1981 census the district has a population of 24,56,543. There are 10 towns and 1007 villages in the district out of which the towns with population of more than 50,000 are only two. The district headquarters is Ongole and has a population of 85,300. The district is well connected by road and rail. The Madras-Culcutta and Madras-Hyderabad National Highway passes through the district. The Madras-Culcutta-New Delhi broadguage railway line and Bombay-Madras broadgauge lines passes through the district.

There are 17 taluks in the district.

8.2 Physiography & Drainage :

Three district physiographic regions can be recognised in the district viz: the western most hilly terrain characterised by the Nallamalai Hill ranges, the rolling plains lying between the hills on the west and the easternghats in the east adjacent to the coast and the coastal plains which extend from the eastern ghats and the coast line. The hilly terrain constituting the Nallamalais form the eastern part of the Cuddapah basin, rise more than 900m above MSL. The hil ranges trend in NE-SW, NNE-SSW direction

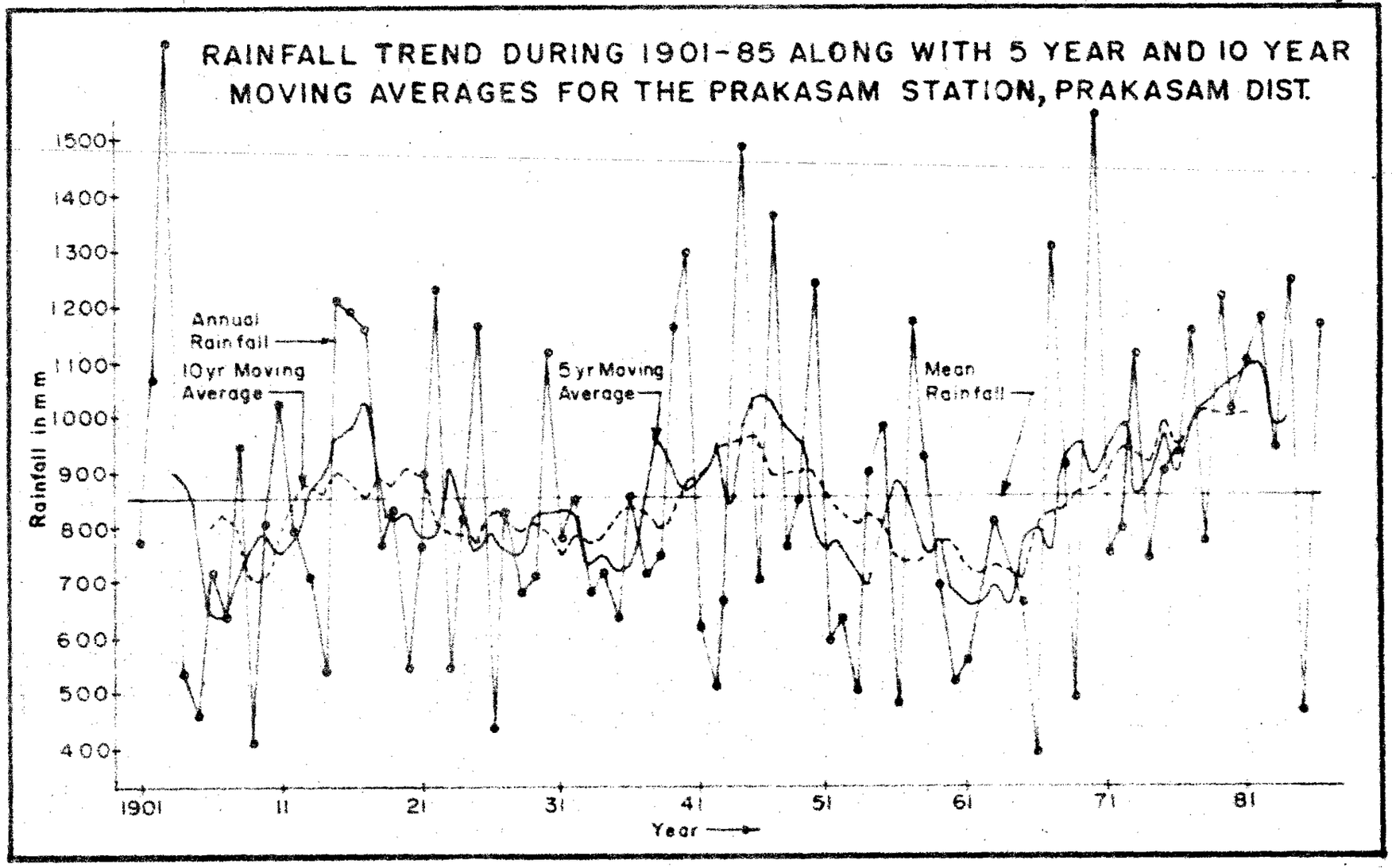
with elevations ranging from 330m to 917 m above MSL. The rolling plains to the east has a general elevation from 103m to 118 m above MSL. The coastal plains fringe the east coast with the general elevation ranging from 18m to 56m above MSL. The general slope of the land in the district is from west to east.

Gundlakamma is the only major river which drains the northern part of the district, while the Musi, Paleru, Manneru are the minor rivers draining the central and southern parts. The Gundlakamma river rises in the Nallamalai Hills in Kurnool district and enters the plains through the Cumbum gorge feeding the Cumbum tank. The Musi river rising in Veligondas in Podili taluk traverses the central part of the district. Similarly Paleru and Manneru originate in Veligonda hills and flow across Kanigiri and Kandukuru taluks and join Bay of Bengal. All these rivers are seasonal.

8.3 Hydrometeorology :

The climate of the district is characteried by mild winters and severe summers. Generally May records the highest temperatures and January the lowest temperatures. The minimum temperature of 15°C is recorded in January and maximum temperature of 46°C is recorded in May. The normal annual rainfall over the district is 850 mm. Both southwest and northeast monsoons contribute equal amount of rainfall. The annual normal isoheyetal map of the district is given in fig. 2. The rainfall decreases from more than 1 [illegible] in the east along the coast to less than 700 mm in the west. Fig.21 gives the plot of 5 year and 10 year moving averages and also the annual course of rainfall from 1901 to 1985. The curve is somewhat sinusoidal in nature with a slight rising trend. A rough periodicity is evident. We can recognise the periods of 'lows' and 'highs' or 'dry' and 'wet' periods. While periods from 1903 to 1913, 1919 to 1937, 1949 to 1966 can be recognised as years of below normal or dry periods, periods from 1913 to 1919, 1937 to 1949

Fig. 21


RAINFALL TREND DURING 1901-85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE PRAKASAM STATION, PRAKASAM DIST.
Rainfall in mm
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
Annual Rainfall
10yr Moving Average
5 yr Moving Average
Mean Rainfall
1901
11
21
31
41
51
61
71
81
Year

and from 1966 to 1985 can be recognised as periods of above normal rainfall or 'wet' periods. During the last decade normal rainfall was recorded in 3 years, excess rainfall in 6 years and deficit rainfall in 1 year. If the annual rainfall figures are examined it is seen that the highest rainfall of 1672 mm was received in the year 1903 and the lowest rainfall of 385 mm was received in the year 1965.

The percentage frequency of occurrence of normal, excess and deficit rainfall in 5 continuous years for the period 1901-85 is given below.

No. of years with normal Rainfall	3	2	2	3	4	1	3	2	1	4	5
No. of years with excess Rainfall	1	1	2	2	1	2	0	3	3	0	0
No. of years with deficit Rainfall	1	2	1	0	0	2	2	0	1	1	0
Percentage frequency of Occurence	20	12	11	10	10	9	9	6	5	4	4

From the above satistical analysis it is clear that during period of 5 continuous years, there is a probability of occurrence of normal rainfall in 2 or 3 years, excess rainfall in 1 year and deficit rainfall in 1 or 2 years.

For the 1981-85 period, excess rainfall occurred in 3 years and normal and deficit rainfall in one year each. From this analysis we can in fer that for the next 5 year period, the probable frequency of occurrence of normal excess and deficit rainfall can be any one of the following.

No. of years with normal rainfall	3	2
No. of years with excess rainfall	1	1
No. of years with deficit rainfall	1	2

Year	Anticipated Rainfall	
1986	N	D
1987	N	N
1988	N	N
1989	D	D
1990	E	E

The above projection shows that for the next 5 years period (1986-90) there is a high probability of occurrence of normal rainfall in 2 years, excess rainfall in 1 year and deficit rainfall in 2 years and hence the possibility of a dry year by the end of the decade. This indicates that we may have to adopt some water conservation methods to face the impending dry years at a later stage.

8.4 Soils :

The predominent soils in the district are the red loams, black cotton soils and sandy loams. Nearly 60% of the district is covered by the red loamy soils and about 30% of the district by the black cotton soils while the remaining area is covered by sandy loam. The black cotton soils predominantly occur in the blocks of Bestavaripet, Maddipadu, Ongole and Korisapadu Santhanagalur and Parachur. The red loamy soils occur mainly in the blocks of Kanigiri, Venigondla, Markapur, Tarlapadu, Giddalur, Yerragondapalem and Podili. The sandy loams are restricted to the blocks of Vetapalem and Tallur. Saline soils occur as isolated patches near the coast and in some topographic lows, valleys and near the tanks.

8.5 Agriculture and Irrigation :

Out of the total geographical area of 17,14062 hectares forests occuppy nearly 12.3% of the area of the district. The net area sown is 6,22,484 hectares or 36.3% of the total area. The total cropped area is 6,68,596 hectares or 39.0% of the area of the district. The net area irrigated is 1,73,837 hectares or 27.9% of the net area sown and the gross area irrigated is 2,00,611 hectares which is about 30.0% of the total cropped area. Canal irrigation has been introduced through the Nagarjuna Sagar project/on Manneru river. The total area irrigated by canals is 87063 (net) hectares. Tanks form an important source of irrigation in the district. There are 784 tanks in the district irrigating an area of 28,737 hectares (net).

/ right bank canal and other projects like the mopad project

Cumbum tank is the biggest tank in these parts with an ayacut of 2762 hectares. Well irrigation is also quite popular. There are 32023 dug wells in the district (1984-85) out of which nearly 17,770 wells are energised. The area under dug well irrigation and tube well (223) is 43,904 hectares (1984-85) (net). The gross area irrigated is 62,891 hectares. This is nearly 31% of the area irrigated in the district. The main crops grown in the district are Rice, Jowar, Bajra and Ragi. The other crops grown are sugarcane, groundnut, cotton and tobacco. Rice is cultivated over an area of 82,660 hectares (net) and Bajra over an area of 22,247 hectares. Ragi is cultivated over an area of 21,828 hectares and groundnut over an area of 10,920 hectares. However, if we examine the different sources of irrigation for rice and other crops grown, it will be seen that rice is cultivated over an area of 68,941 hectares by canals, 28,154 hectares by tanks and only 1190 hectares by wells. But bajra is cultivated over an area of 22,247 hectares and ragi over an area of 21,828 hectares, groundnut over an area of 10,920 hectares and cotton over an area of 6505 hectares are cultivated by wells. This means that mostly irrigated dry crops are grown under well irrigation.

8.6 Industries & Mining :

Not many industries exist in the district eventhough there are good natural resources for industrial development. Bulk of the factories relate to tobacco industry, like the tobacco redrying units. The Indian leaf tobacco development company for tobacco redrying is situated in the district. There is a Co-operative spinning mill at Chirala. The other important industries are the Coromandel Agro products, Chirala and the Poorna Agro Products and Oils Ltd., at Renina-gavaram. There are a few rice oil and saw mills.

There are minor occurrence of iron ore, clay and manganese. Flaggy limestone occuring in the district is an important source of mining. Nearly 80% of the country's slate is mined near Markapur and the well known Cuddapah slate of

Markapur as a roofing and flooring slab is quite famous. Clay is mined locally for kaolin based products. Salt is an important marine product produced along the coast.

8.7 Geology :

The general geological succession as seen in the district is given below:

SubRecent to Recent		Wind blown sands, Alluvium, Laterite
- - - - - - - - - - - - - - unconformity - - - - - - - - - - - -		
Middle Triassic to Lower Cretaceous	Upper Gondwanas	Pavalur sandstone Vemavaram shales Budavada sandstones
- Unconformity - - - - - -		
Upper Precambrian to Lower Palaeozoic		Srisailam Quartzites
- Unconformity - - -		
	Nallamalai Series	Cumbum shales, slates Bairenkonda quartzites with shales & slates.
- - - - - - - - - - - - - - unconformity - - - - - - - - - - - -		
Archaeans to Lower precambrian		Dolerite dykes, pegmatites and quartz veins
	Dharwar Super Group	Dharwarian schists.
	Unclassified Crystallines	Granites and gneisses, Khondalites, Charnockites.

8.8 Hydrogeology :

The granites and gneisses represented by garnetiferous biotite gneisses together with migmatites occupy the central part of the district. The charnockites are seen as isolated patches in parts of Darsi taluk and are found as inclusives in granite-gneisses. Khondalite group of rocks and associated magnetite quartzites, garnetiferous biotite-cordierite gneisses occur in the northeastern part of the district. The Dharwarian schists occur as elongated bands in the central part of the district all along the eastern margin of the Cuddapah basin and in the area between Kanigiri and Kandukur taluks. The Cuddapah rocks represented by the Nallamalai and Krishna series occupy the western part of the

district. The Upper Gondwana formations occur as isolated patches in the eastern part of the district. Laterites occur as cappings over the lower Gondwana formations and the crystallines mostly in the east. The wind blown sands occur towards east forming a narrow zone of 3 to 5 km in width fringing the coast line. Alluvium is present in the area along Gundlakamma and Musi rivers. However, the thickness is limited to around 18 to 40m, as evidenced from boreholes.

Ground water occurs in all these formations under water table to semiconfined and confined conditions in the weathered and fractured rock and is being developed by dug wells, filterpoints and to some extent by bore wells and tube wells. A brief description of the ground water conditions as observed in different formations are described below:

8.9 Ground Water Conditions in the Archaeans and Dharwars :

The depth of weathering is found to vary from 3m to 14m as evidenced from the dug wells in the district. Ground water occurs under water table conditions in the weathered zone and under semi-confined to confined conditions in joints, fractures and other weak planes. The depth of open wells in the crystalline formations varies from 3 m to 27.0 m.b.g.l. and the depth to water ranges from 1.5m to 14.5 m.b.g.l. The yields vary from 10 to 110m%/d. Borewells drilled by State agencies down to depths of 50m have given yields ranging from 3.2m3/hrto 27m 3/hrfor drawdowns ranging from 3.2 m to 14.35 m.

8.10 Ground Water Conditions in Cuddapah Formations :

Cuddapah formations represented by the Bairenkonda quartzites, Cumbum shales and Srisailam quartzites occur in the western part of the district in Markapur and Giddalur taluks. Ground water occurs in these formations in the weathered and fractured portions under water table and confined conditions and is being developed both by open wells and bore wells. The depths of open wells vary from 2.75 to 17.5mbgl.

and the depth to water levels in them range between 1.5 m and 12.5 mbgl. Extension bores have been put at some places from the bottom of the wells up to 33m. These wells yield from 45 to 135m3/d. Tube wells constructed by State agencies tapping the fractures and other openings in these formations vary in depth from 1 to 14 m.b.gl. These have given yields varying from 1.4m3/h to 51m3/h for drawdowns ranging from 2.1m to 12m. Depth to water in these boreholes vary from 2.8m to 15.40 m.b.gl. The results of these boreholes have given indication that boreholes sited properly in these formations can give good supplies of water which can meet the needs of the people in times of drought.

8.11 Ground Water In Gondwana Formations :

The Upper Gondwana formations occur in the district as isolated patches in Kandukur, Ongole, Addanki and Chirala taluks in the eastern margin. Ground water occurs under water table and confined conditions. The depth of open wells in the formations vary from 2 m to 14 m.b.g.l. and the depth to water generally varies from 1.00m to 6.20 m.b.g.l. From the data avilable from the boreholes drilled in the area, the thickness of the gondwana formation appears to vary. Two bore wells drilled by G.S.I. at Kandukuru gave poor yields and poor quality water. One bore well yielded 540 lph for a drawdown of 36.4m. This has indicated that the Upper Gondwanas are not very productive in this area for a large scale development of ground water. At best they can meet only local requirements.

8.12 Ground Water in Sub Recent & Recent Formations :

Laterite occurs as discontinuous patches in Ongole and Kandukur taluks of the district bordering the Archaeans. Since laterite is highly permeable, it yields copious supplies of water. However, its water retaining capacity is poor and the yield will be local and also seasonal. Further exploration is needed to prove the yield characteristics of the laterites. Ground water occurs under water table and confined conditions

in the alluvium and is developed mostly by dug wells, shallow tube wells and filter points. Open dug wells vary in depth from 2.5 to 13 mbgl and the depth to water generally varies from 0.2m to 7.6mbgl. The yields vary from 0.7 to 1.0m3/h for draw downs varying from 1.27 to 2.07m. The tube wells are reported to yield from 10.0m3/h to 60.0m3/h, for draw downs varying from 1.7 m to 4.8m. Wind blown sands are very productive and dug wells and filter point wells will be ideal to tap the ground water.

Fig.22 depicts the general depth to water map of the district for May,1986.

8.13 Status of the studies :

Systematic hydrogeological surveys have been carried out in the district and an area of 11,598 km2 has been covered upto the end of March,1987.

8.14 Ground water level monitoring :

Ground water level monitoring is being done since 1969 with the establishment of 2 net work stations. Presently there are 12 All India Net work Hydrograph stations in the district. Water level fluctuations have been observed in response to recharge and draft. The long term studies and analysis of the data indicate that the range of annual fluctuations vary from less than a meter to 4.8m. with general fluctuations around 2.5m. Compared to other drought prone districts of the state Prakasam district is better placed. However, the western taluks of the district borde ing Cuddapah, Kurnool and Anantapur districts do experience drought conditions frequently. Declining trends in the water levels have been observed in wells located at Muddanur, Giddalur and Markapur. This can possibly be atributed to below nor-mal rainfall in the last 3 years.

8.15 Ground Water Exploration :

Two exploratory bore wells have been drilled by the earstwhile Ground Water Wing of Geological Survey of India in 1969, down to a depth of 130 m at Kandukuru. This did not yield sufficient quantity of water whose quality was also poor.

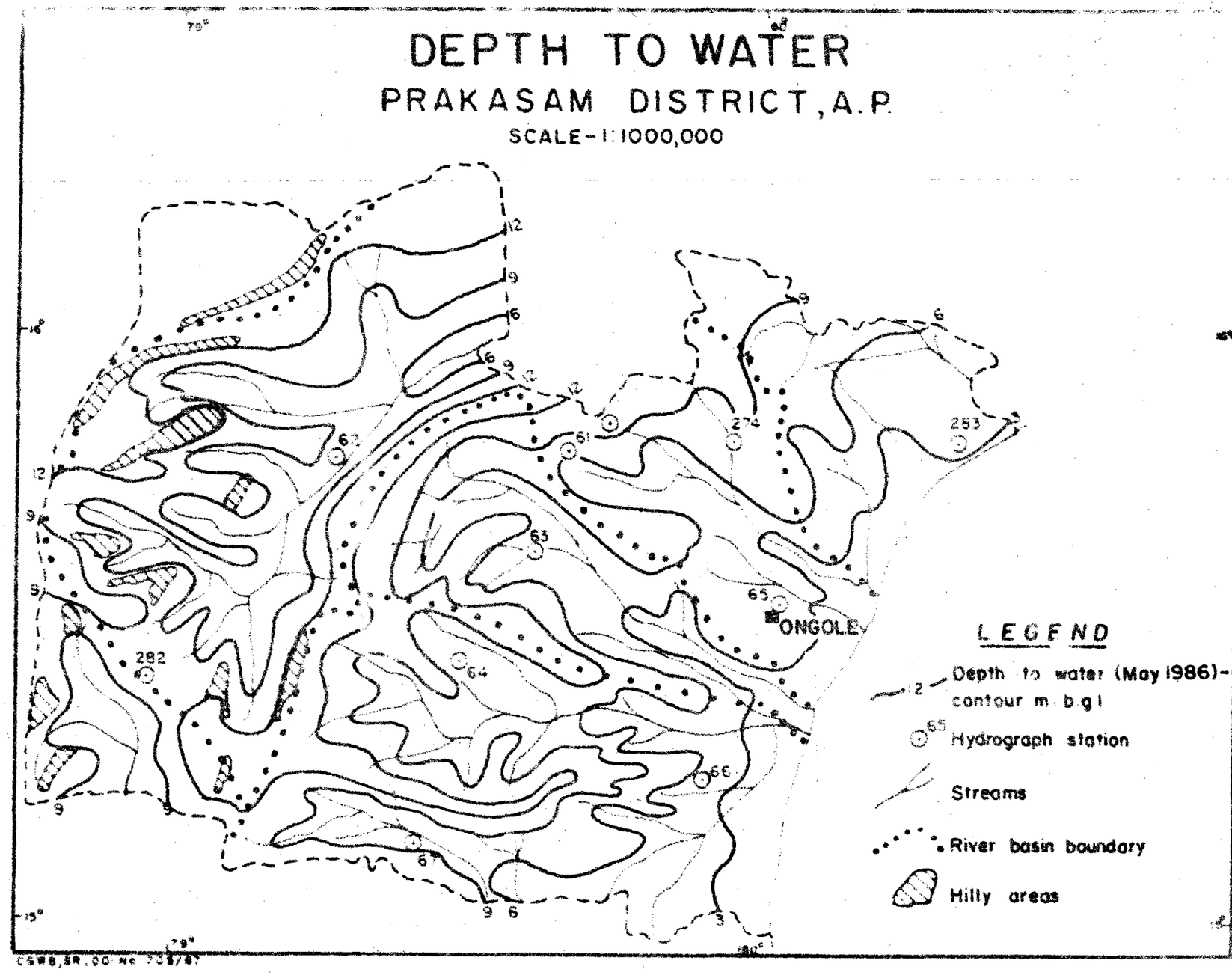
Data also indicated the non existence of any productive granular zones. The yield of one of the borewells was 540 lph for a draw down of 36.4m. However in recent years, successful wells have been drilled by the State agencies notably the State Ground Water Department and the State Irrigation Development Corporation by piercing the fractures and other openings in the basement and the Cuddapah formations and to some extent in the valley fills upto 60m depth. Those borewells have given yields varying from 2.8 m3/h to 60m3/h for draw downs ranging from 1.7m to 21.5m. This has shown that if wells properly sited, good quanties of water can be tapped from these aquifers.

8.16 Chemical Quality of Ground Water :

The chemical quality of ground water tapping the crystalline aquifers have yielded potable water in the district. However, occurrence of brackish water has also been reported where the E.C. & chlorides are high. Ground water is alkaline with the PH values varying from 7.5 to 9.2. The E.C. generally varies fror 260 to 12,600 micromhos/Cm at 25°C. The chloride varies from 50 to 4580 ppm with the general value around 200 ppm only. Fluoride content exceeds the permissible limit of 1.5 ppm which makes the ground water unfit for drinking. Ground water in major parts of Kanigiri, [illegible]li, Darsi and parts of Giddalur taluks has fluoride concentration of more than 1.5 ppm and reaches a maximum of 8.5 ppm in Darsi taluk. Ground water in the Gondwana formation is potable to Brackish. The water is alkaline with PH value ranging from 7.8 to 8.5. The E.C. ranges from 3250 to 7850 micromhos/Cm at 25°C. The high E.C. can be attributed to the nearness to the coast and shallow water table conditions. The total hardness as CaCO3 varies from 80 to 1380 ppm. The fluoride concentration varies from 1 to 2 ppm but often goes upto 5.0 ppm.

Quality of water in laterites is generally good. Water is alkaline with E.C. of 4770 micromhos/cm at 25°C from one of the samples collected from the area. The constituents like bicarbonate, carbonate and chlorides are 390ppm, 30 ppm and 1160 ppm respectively.

The alluvial area, ground water is potable and brackish. Ground water is alkaline with PH values ranging from 7.3 and 9.1. Chloride concentration varies from 48 to 7845 ppm, however the


DEPTH TO WATER
PRAKASAM DISTRICT, A.P.
SCALE-1:1000,000
79°
16°
15°
ONGOLE
282
283
274
LEGEND
Depth to water (May 1986)-contour m.b.g.l
Hydrograph station
Streams
River basin boundary
Hilly areas
CGWB,SR.00 No 703/87

general value is around 1000 ppm. The sulphates vary from 180 to 875 ppm. The ground water nearer to the coast is almost saline with E.C. exceeding 15000 micromhos/Cm at 25°C.

8.17 Ground Water Resources and Development Prospects :

Prakasam district is comparatively a smaller coastal district with good scope for development of ground water. However, there are quality problems, as seen along the coast, and also there are fluoride rich areas which hinder development on a large scale.

The earliest estimations of ground water potential were carried out in 1977 which were later revised as in the case of other districts. The latest utilisable estimates of the ground water potential is given in Table-8. The estimated potential is 1293.9 MCM and the estimated present net draft is only 138.1 MCM (1984-85) leaving a balance of 1155.8 MCM for development. The stage of ground water development is also only 11%. Except Cumbum, Kanigiri, Podili and Darsi taluks there is no significant development in any other taluk. Here also the stage of development is less than 15% except for Cumbum where it is 33% at the present stage of development. However, if we examine the course of development in the taluks for the last 4 years (1981-82 to 1984-85), there has not been any significant rise in the ground water draft except in the case of Darsi, Kanigiri and Kandukur taluks where some draft has been recorded. This is ofcourse no likely to affect the water levels. But when we examine the water levels there has been some decline in the levels varying from 3m at Addanki to 1 m at Kanigiri over a period 5 years. But this fall seems to be due to the below normal rainfall received in the district during the last 2 years which has seriously affected the recharge and hence the fall in levels. This fall in levels can be considered as solely due to rainfall and might record a rise should be monsoon conditions in the coming years improve. Presently there are 32,023 dug wells in the district out of which nearly 7770 wells are energised fitted with electric motors and diesel pumpsets. As it looks, there is wide scope for development. Added to this, there is nearly 80,062 hectares, under Nagarjuna Sagar Right Bank Canal Command. Hence, there is no problem as such, and in fact there may be problems of

Table-8

Estimated Ground Water Potential and Ground Water Draft (Net) for Prakasam district (1984-85)

Sl. No.	Name of taluks	Estimated utilisable G.W. Potential (MCM)	Estimated Ground Water Draft (Net) (MCM)	Balance available for development (MCM)	Stage of Ground Water Development	
					Percent %	at year 5 (%)
1.	Cumbum	36.6	12.1	24.5	33	36
2.	Podili	84.2	13.0	71.2	15	17
3.	Ongole	47.7	2.6	45.1	5	6
4.	Giddalur	123.2	15.3	107.9	13	14
5.	Kanigiri	196.2	27.6	168.6	14	15
6.	Chimakurthy	66.1	0.4	65.7	0.1	0.1
7.	Dhonakonda	50.4	5.7	44.7	11	12
8.	Kandukur	233 .3	20.3	213.0	9	10
9.	Markapur	115. 8	7.7	108.1	7	7.3
10.	Chirala	27.8	0.31	27.5	1	1.1
11.	Darsi	75.5	11.5	64.0	15	17
12.	Parchur	56.8	1.0	55.8	1.8	2
13.	Addanki	106.7	12.6	94.1	12	13
14.	Yerragondapalem	73.6	8.0	65.6	11	12
		1293.9	138.1	1155.8	11	12

shallow water table conditions encountered in the Darsi, Podili, Kandukuru, Addanki taluks due to which water logging and quality problems may crop up necessitating conjunctive use of ground and surface waters. The problem is therefore one of water management.

8.18 Rural and Urban Water Supplies for drinking Water and Industries :

Prakasam district has a population of 24.37 lakhs out of which 21.08 lakhs live in the villages and 3.29 lakhs live in the towns. The district has 7817 bore wells which are in use and 107 pumping and mini pumping water schemes have been executed to date to meet the water requirements of both urban and Rural Population. In addition to the above public bore wells and pumping water schemes, several dug wells both public and private exist in the district which also meet the water needs of the population. As per the existing norms for drinking water and domestic needs including the live stocks population in the rural areas, the total water requirements of the district both for drinking and domestic purposes works out to 64.7 MCM with a percapita consumption of 90 lpd for the urban and 70 lpd for the Rural population including the live stocks consumption. The projected demand for the drinking water and industrial needs of the district is 228.3 MCM out of the gross recharge of 1522.2 MCM. Hence sufficient provision is made for the additional requirements in the future except in the years of drought when the actual recharge will be less than the normal years and this is manifested by drying up of wells or lowering of water table especially in the western part of the district which is drought prone. Only in such conditions, to meet the eventuality and to mitigate the hardships of

the population these will be a need to sinds additional [illegible] bore wells which are deeper than the existing one and deepening of the existing dug wells taken up on priority basis.

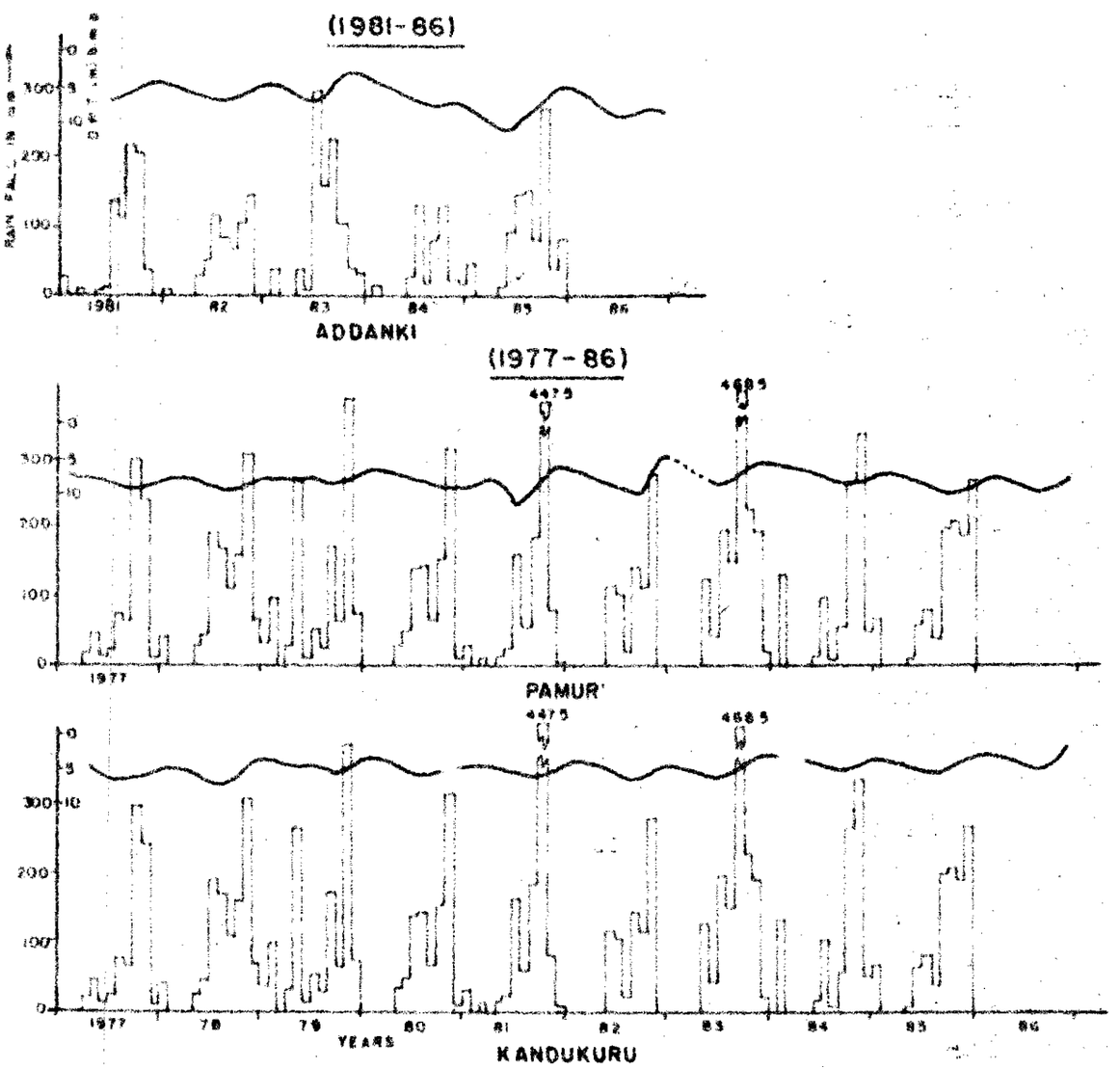
8.19 Ground Water Development with Reference to Rainfall and Water Levels :

Though the district is having sufficient utilisable resources, the development has not been much. The number of wells used for irrigation in 1975-76 was 24,333 and there were 748 tanks used for irrigation in 1975-76. The number of wells in 1982-83 was 25,384 which in 1984-85 has gone up to 32,023. Hence, the development of ground water resources has not picked up perhaps because of canal irrigation introduced into the district under the Nagarjuna Sagar Project, Out of the gross area of 2,00,611 (1984-85) hectares irrigated in the district nearly 03,723 hectares are irrigated by canals and another 29,725 hectares are irrigated by tanks, the remainihg area of 62,891 hectares is irrigated by wells which is roughly 31% of the total area irrigated. The area irrigated by Nagarjuna Sagar Project is in Podili, Markapur and Darsi taluks. If the water level data of the stations in the district are examined the declining trends have been seen only at Kanigiri (1.3m), Markapur (4.4m), Giddalur (3.0m) pamuru (2.60m and Addanki (3m). Fig 23) However, if this trend is compared with the rainfall received in these areas, there has been below normal rainfall in these areas for the last two years which perhpas affected the water levels due to reduced recharge to ground water reservoir. Hence, the fall in water levels/not to any over development. In fact, there is wide scope for development in the district and as per estimations, the stage of ground water development is only 11% at present, and the tempo of development should be geared up to meet the drought situation by increased ground water development.

/ can be atributed to below normal rainfall only and

Fig-23(a)

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, PRAKASAM DISTRICT, A.P.



CGWB, SR, EO No 212/87

8.20 Ground Water Management Practices and Drought Management Strategies :

As discussed above, the tempo of ground water development is low in the district and there is wide scope for development. But the vagaries of monsoon has created scares conditions in certain parts of the district where as the parts covered by Canal Command has problems of plenty. This needs certain management practices and change of strategies both long term and short term to over come the drought conditions as well as ensure equitable distribution of the available water resouces.

8.21 Long term Drought Management Strategies :

Nearly 93,723 hectares are under the canal irrigation in the district and Rice is cultivated over an area of 82,660 hectares which includes both Kharif and Rabi periods. Rice is a crop which requires lot of water and there is wide scope for saving if the crop is not cultivated as a second crop. If rain water is harvested during the first crop period which overlaps the south-west monsoon period, then also there is scope for saving water. Also in the command area there is widescope for ground water development and also for conjunctive use of surface and ground water by sinking or drilling additional bore wells in the canal command. There are pockets of bad quality ground water where E.C. values go up to 12,000 micromhos/Cm at 25°C. In such areas, there is scope for mixing ground and surface waters and use it for irrigation for salt resistant crops like paddy, sugarcane etc. In areas, where the fluoride concentration is a problem from the drinking water point of view, defluoridation may be taken up to meet the drinking water needs. In areas, where there is no scope for surface water sources and ground water is saline, only the possibility is to go in for desalination to meet the water requirements especially for drinking.

While developing the untapped resources where the development is low the scientific investigation techniques and well siting methods may be adopted, so that well failures

in the command area

are minimised. The latest remote sensing techniques/will be of help in mapping the promising areas for development. The Cuddapah limestones are very promising from the ground water point of view and it is better that they are explored systematically and developed properly to boost the agricultural production as well as meet the drinking water requirements in times of need. The district has 1,02,512 hectares or 6.0% of the total geographical area as culturable waste which can be utilised for growing fodder for the cattle and can also be used as a grazing land. The other water harvesting techniques like sprinkler and drip irrigation can be adopted wherever feasible for optimal utilisation of the resources. Other district developmental programmes like afforestation schemes, social forestry and DPAP and DRDA programmes can be coupled to yield better results in the long run. / including in geophysical surveys

8.22 Short term Drought Management Strategies :

The long term measures discussed above with however take long periods to yield results. Some short term or immediate measures have to be taken up to solve the problem and the hardship faced by the people and the livestock population, so that their water requirements are met. Where the shallow wells have gone dry, borewells are to be drilled at favourable sites pinpointed after adopting the latest well siting techniques, to meet the drinking and domestic water requirements. Extension bores can also be drilled from the bottom of the shallow dug wells, in addition to the borewells to meet or to supplement the irrigation requirements. Where the resultant ground water turnsout to be bad, quality wise, either defluoridation (if fluoride concentration is higher than (1.5ppm) or desalination can be done before supplying the water for use. Alternately canal or tanks water wherever it is feasible can be used to meet the drinking water needs. Other water harvesting techniques like, construction of recharge wiers, percolation ponds can be taken up on a largescale, wherever viable (sandy soil areas or more suited than black soils) to arres the flash floords/thunderstorm water, so that the water thus stored can recharge ground water / or can be used to meet the emergency requirements.

ANNEXURE -I

YEAR WISE NUMBER OF GROUND WATER EXTRACTION STRUCTURES IN THE DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH

Sl. No.	District	1981 - 82				1982 - 83				1983 - 84				1984 - 85		
		D.W	O.E	E.M	Total	D.W	O.E	E.M	Total	D.W	O.E	E.M	Total	D.W	O.E	E.M
1.	Kurnool	1622	3597	6169	11388	1571	4199	6460	12230	1387	4862	6681	12930	2048	4130	13123
2.	Anantapur	11753	17716	27037	56506	11533	17639	27660	56832	8864	14299	33669	56832	13698	13165	34047
3.	Cuddapah	16111	10722	22337	49170	16326	10340	22800	49466	13950	10163	25567	49680	14322	10250	26048
4.	Chittoor	33392	30897	45127	109416	34670	29305	46003	109978	31276	28220	50812	110308	27223	26035	57160
5.	Prakasam	12072	8241	6891	27204	10339	7948	7097	25384	8937	9744	7875	26556	14253	9710	8060
6.	Mahaboobnagar	17925	32858	18551	69334	16378	35249	20165	71792	17784	30147	29169	77100	14853	30792	32620
7.	Nalgonda	25769	12231	31156	69156	71682	19302	40529	71682	20787	10064	41108	71959	15322	10954	48165

D.W : Dug wells with out pump sets
O.E : Oil Engines
E.M : Electric Motors

(Source: Bureau of Economics and Statistics, Govt. of A.P)

LAND USE PATTERN IN THE DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH
(1984 - 85, in hectares)

Sl. No.	District	Total Geographical area	Forests	Net area sown	Percentage to the total area	Total Cropped area	Cultivable waste	GROSS AREA IRRIGATED			Total gross area irrigated *	NET AREA IRRIGATED			Total net area irrigated *
								Tanks	Wells	Canals		Tanks	Wells	Canals	
1.	Anantapur	1913492	196797	851249	44.50	869027	85990	10868	71581	43883	130053	9513	62871	37517	113085
2.	Kurnool	1760034	318250	823995	46.80	898336	94429	13307	23273	98487	141426	12172	17100	82795	116684
3.	Cuddapah	1537838	505403	352388	22.90	364679	44812	17508	66781	24056	114217	15818	57655	23380	101925
4.	Chittoor	1513100	453355	462164	30.50	520602	50249	68832	114876	3799	190240	54491	80540	2678	140068
5.	Mahaboobnagar	1847241	303189	761263	41.30	823293	10780	32740	34498	21730	130952	27107	40362	12175	80921
6.	Nalgonda	1422324	85839	629682	44.30	741070	28925	35262	74436	130980	249734	23031	40485	97051	166310
7.	Prakasam	1714062	212066	622484	36.30	668596	102512	29725	62891	93723	200611	28737	43884	87063	173837

* Total irrigated area includes the area irrigated by other sources.

(Source: Bureau of Economics & Statistics, Govt. of Andhra Pradesh)

ANNEXURE - III

SOURCE WISE IRRIGATIONAL PARTICULARS IN THE DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH 1984-85
(Area in Hectares)

Districts	RICE			BAJRA			SUGAR CANE			COTTON			GROUND NUT		
	Tanks	Canals	Wells	Tanks	Canals	Wells	Tanks	Canals	Wells	Tanks	Canals	Wells	Tanks	Canals	Wells
Prakasam	28154	68941	1090	-	-	2677	-	-	382	-	5544	961	410	3807	6703
Kurnool	9959	43789	3552	-	-	-	2	611	295	1277	12025	3607	914	29418	6550
Anantapur	6858	17544	16406	-	-	1007	6	6	2062	355	8762	1236	110	14956	10777
Cuddapah	16743	18614	12098	-	-	8992	195	1216	906	15	289	1924	420	1717	10939
Chittore	56210	2824	39625	-	-	3158	3792	20	17640	-	-	-	5444	865	29649
Mahaboobnagar	31792	8719	43877	-	-	83	-	-	53	-	3142	319	841	9063	24888
Nalgonda	35262	110657	66840	-	-	-	-	679	55	-	2627	27	Nil	15266	5919

(Source: Bureau of Economics & Statistics, Govt. of Andhra Pradesh)

ANNEXURE - IV

WATER LEVEL DATA OF HYDROGRAPH NET WORK STATIONS IN DROUGHT PRONE DISTRICTS.

ANDHRA PRADESH

(From 1969 to 1986)

Sl.No.	Well No.	Name of the Station	Year	Depth to water (m.bmp) Jan.	Apr./ May	June	Aug	Nov.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ANANTAPUR DISTRICT :								
1.	75	Gooty	1977	8.31	11.33	9.75	7.94	5.47
			1978	6.08	8.45	10.32	11.12	9.10
			1979	10.00	12.70	12.46	11.72	9.74
			1980	8.64	10.64	11.85	12.61	10.56
			1981	11.08	12.40	-	Dry	6.61
			1982	5.85	6.11	7.95	7.42	2.19
			1983	3.44	4.14	4.73	4.96	3.85
			1984	4.61	5.91	7.39	5.30	5.28
			1985	6.22	9.27	-	7.03	5.14
			1986	5.30	7.47	-	8.72	6.60
2.	76(A)	Anantapur(Old)	1969	-	-	-	6.65	4.77
			1970	7.75	6.75	7.15	6.50	7.65
			1971	3.20	5.85	6.65	7.36	6.95
			1972	7.45	7.30	7.55	-	-
			1973	7.20	6.90	7.90	-	-
			1975	-	-	7.54	-	6.49
			1976	-	7.12	7.91	-	8.66
			1977	Dry	Dry	-	-	-
			1978	-	-	-	-	-
			1979	-	-	-	-	-
					(Abondoned)			
3.	76	Anantapur(New)	1977	-	8.80	-	7.64	6.65
			1978	6.33	7.20	8.26	8.79	8.55
			1979	7.85	8.86	8.38	8.90	7.80
			1980	3.50	6.74	7.69	7.97	8.50
			1981	Dry	Dry	-	Dry	6.35
			1982	5.16	5.44	6.40	7.10	7.30
			1983	6.58	6.41	7.25	Dry	10.87
			1984	10.32	10.88	Dry	Dry	Dry
			1985	Dry	Dry	-	Dry	Dry
			1986	(Abondoned)				
	477	New Well	1986	-	-	-	-	6.80
4.	79	Kadiri	1977	8.51	9.51	9.55	10.09	8.81
			1978	9.30	11.01	11.81	11.91	10.91
			1979	10.58	11.87	11.72	11.98	9.59
			1980	9.35	11.40	11.90	12.41	12.82
			1981	12.72	Dry	13.10	13.22	7.56
			1982	5.85	6.11	7.95	7.42	2.19
			1983	8.90	10.62	11.01	10.64	9.25
			1984	9.74	9.70	-	11.00	9.44
			1985	9.93	11.41	-	11.47	10.90
			1986	11.76	13.70	-	11.03	8.90

Contd..... 2/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	80	Penukonda	1978	-	15.20	16.36	16.82	16.22
			1979	15.95	17.88	18.80	19.18	18.50
			1980	10.15	19.72	-	Dry	Dry
			1981	9.50	Dry	Dry	Dry	3.90
			1982	15.24	15.84	16.05	15.74	14.55
			1983	13.30	14.54	15.27	15.62	13.40
			1984	13.40	13.95	15.15	15.19	14.05
			1985	14.70	16.89	-	17.62	17.80
			1986	18.06	19.05	-	Dry	15.92
6.	110(A)	Rayadurg(Old)	1971	9.96	10.85	10.30	-	9.96
			1972	7.82	7.51	Dry	-	Dry
			1973	-	12.05	11.10	Dry	9.91
			1974	-	Dry	-	-	-
			1976	-	-	- (Abondoned)		
7.	110	Rayadurg(New)	1970	-	-	11.05	10.83	10.87
			1971	11.77	13.35	13.30	-	9.49
			1972	9.50	12.20	13.12	-	13.01
			1973	-	15.10	14.87	14.52	11.42
			1974	-	13.00	-	-	13.37
			1975	-	14.88	-	-	14.55
			1977	-	20.95	-	-	-
			1978	-	18.25	18.95	19.76	20.31
			1979	19.20	20.05	20.44	20.78	18.01
			1980	16.58	16.90	13.71	18.78	18.67
			1981	18.90	19.32	-	20.20	19.09
			1982	10.35	19.66	20.03	20.095	20.10
			1983	19.87	20.30	21.22	Dry	Dry
			1984	20.40	Dry	Dry	Dry	Dry
			1985	Dry	Dry	-	Dry	Dry
			1986	Dry	Dry	-	Dry	Dry
8.	127	Tadpathri	1978	-	-	-	8.30	7.67
			1979	7.61	7.97	8.30	8.44	
			1980	7.47	7.88	8.37	8.08	8.06
			1981	8.05	8.36	8.97	8.41	7.
			1982	7.75	7.86	7.91	8.11	7.56
			1983	-	7.91	7.98	7.82	7.59
			1984	7.63	7.89	8.23	7.95	7.84
			1985	7.985	8.65	-	9.64	8.46
			1986	8.15	8.73	-	8.97	8.42

Contd..... 3/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.	128	Kalayandurg	1978	-	-	-	9.36	9.39
			1979	8.68	10.10	10.56	10.63	3.83
			1980	3.91	5.01	5.18	6.50	6.77
			1981	7.30	8.69	-	8.09	3.70
			1982	5.35	5.13	-	7.615	7.11
			1983	7.13	8.94	8.17	8.63	8.15
			1984	8.47	Dry	Dry	Dry	Dry
			1985	Dry	Dry	-	Dry	Dry
			1986	Dry	17.58	-	Dry	13.05
10.	236	Uravakonda	1980	10.12	-	10.35	10.41	10.11
			1981	10.30	9.66	-	10.38	7.20
			1982	7.42	7.66	8.24	12.91	10.10
			1983	-	12.55	11.02	9.03	8.08
			1984	8.84	10.36	12.30	11.36	8.69
			1985	9.58	13.54	-	12.76	13.40
			1986	Dry	13.58	-	Dry	13.52
11.	237	Thagguparthi	1981	-	-	10.91	13.13	10.13
			1982	-	11.03	10.80	12.91	10.70
			1983	-	10.76	10.84	11.87	10.07
			1984	10.17	10.45	10.83	10.86	10.97
			1985	11.13	11.58	-	11.81	11.80
			1986	12.06	12.41	-	12.46	12.22
12.	238	Mudigubba	1981	-	-	14.02	10.79	5.30
			1982	6.145	10.66	14.19	14.49	11.16
			1983	10.32	13.74	11.37	8.52	5.52
			1984	7.32	8.65	9.80	11.17	9.94
			1985	11.00	14.58	-	-	4.98
			1986	7.18	10.94	-	9.20	5.00
13.	239	Dharmavaram	1981	-	-	-	8.35	2.67
			1982	3.09	4.06	4.48	4.99	3.015
			1983	3.64	4.88	5.60	5.30	2.105
			1984	2.77	3.62	4.58	5.10	4.67
			1985	5.16	7.40	-	7.52	7.41
			1986	8.06	10.60	-	10.80	7.14
14.	240	Hindupur	1981	-	-	20.00	Dry	12.40
			1982	-	12.75	14.64	15.91	16.93
			1983	17.47	19.78	Dry	Dry	20.14
			1984	Dry	Dry	Dry	Dry	Dry
			1985	Dry	Dry	-	Dry	Dry
			1986	Abondoned				
15.	241	Madakasira	1981	-	-	-	10.27	4.19
			1982	-	10.66	4.11	4.94	5.07
			1983	3.65	6.25	6.52	7.885	6.61
			1984	7.41	8.08	8.78	9.32	9.53
			1985	14.35	10.70	-	11.30	11.70
			1986	12.06	18.90	-	13.65	12.73

Contd..... 4/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
KURNOOL DISTRICT :								
1.	71	Allagadda	1977	3.76	5.78	5.31	2.20	2.35
			1978	3.09	4.80	3.95	1.31	1.49
			1979	2.71	4.47	3.98	4.93	2.54
			1980	4.91	3.90	3.38	3.40	6.23
			1981	4.02	5.67	2.68	2.69	-
			1982	3.50	5.375	5.84	5.13	N.C
			1983	3.99	5.80	6.05	6.70	2.32
			1984	3.48	5.47	-	5.59	5.54
			1985	5.59	Dry	-	3.55	3.85
			1986	4.80	Dry	-	Dry	4.97
2.	72	Nandyal	1969	-	-	-	5.45	4.97
			1970	4.94	5.64	5.74	2.74	5.00
			1971	4.81	5.16	5.36	5.23	5.45
			1972	5.65	6.05	6.10	-	4.42
			1973	-	-	6.46	5.29	-
			1974	-	-	6.42	-	-
			1975	-	5.68	-	-	3.85
			1976	-	5.08	-	-	5.16
			1977	5.55	6.27	6.03	4.40	4.51
			1978	5.33	5.69	5.72	4.13	3.98
			1979	4.81	5.38	5.54	5.32	5.16
			1980	5.48	5.86	6.61	5.33	5.71
			1981	6.16	6.62	7.40	5.00	5.03
			1982	5.40	6.725	7.40	6.76	Nil
			1983	5.40	7.05	7.70	4.29	4.96
			1984	5.40	6.28	-	5.59	4.90
			1985	-	7.67	-	5.30	5.40
			1986	6.26	7.76	-	7.34	6.51
3.	73	Kurnool	1977	4.21	5.29	2.78	2.90	3.56
			1978	4.06	6.10	6.30	1.94	3.21
			1979	4.01	5.40	5.47	3.68	4.02
			1980	4.91	3.90	3.38	3.40	6.23
			1981	4.02	5.67	2.68	2.69	-
			1982	2.57	4.01	3.67	4.15	2.37
			1983	4.42	3.74	4.40	1.48	2.68
			1984	2.80	3.30	-	3.57	3.25
			1985	-	3.61	-	3.45	3.06
			1986	3.96	3.28	-	3.12	4.72
4.	74	Dhone	1969	-	-	-	6.20	6.59
			1970	4.40	5.40	4.80	4.00	4.05
			1971	6.57	6.69	9.49	4.95	4.70
			1972	4.95	6.19	5.95	-	-
			1973	-	5.50	5.48	5.75	-
			1974	-	-	5.95	-	-
			1975	-	-	5.05	-	5.08
			1976	-	4.41	4.70	-	5.48
			1977	5.38	5.75	4.38	4.32	4.31
			1978	4.65	6.05	5.87	4.74	4.52
			1979	4.63	5.90	6.23	7.05	4.04
			1980	4.39	6.03	6.63	5.45	6.08
			1981	6.69	7.48	7.36	Dry	5.38
			1982	5.94	6.73	7.24	7.44	5.00
			1983	4.66	6.45	6.34	5.26	3.57
			1984	4.50	4.71	-	4.51	3.76
			1985	5.07	7.20	-	5.05	4.90
			1986	-	7.68	-	7.47	6.56

Cont..... 5/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	126	Srisailam	1978	-	-	-	-	8.67
			1979	11.54	13.00	10.00	8.56	13.70
			1980	11.90	12.83	-	-	-
			1981	12.83	11.24	13.24	8.58	-
			1982	13.29	9.08	7.60	6.50	5.00
			1983	10.00	13.56	11.58	4.19	8.24
			1984	9.80	13.45	-	8.87	10.67
			1985	10.03	12.70	-	9.80	10.92
			1986	12.06	13.45	-	8.90	8.76
6.	242	Kodumuru	1980	3.43	5.08	4.96	3.70	3.92
			1981	4.36	5.35	5.37	4.16	3.05
			1982	3.63	4.335	4.72	4.06	2.85
			1983	3.52	4.32	4.70	3.64	2.51
			1984	3.21	3.98	-	3.12	3.28
			1985	-	4.67	-	3.87	3.60
			1986	-	5.36	-	5.51	6.45
7.	243	Pattikonda	1980	9.75	10.74	11.42	9.54	8.91
			1981	9.50	11.02	11.30	11.81	8.17
			1982	-	10.69	10.25	9.26	5.35
			1983	6.92	8.08	9.01	9.27	5.90
			1984	7.10	8.52	-	9.04	9.29
			1985	9.87	11.24	-	10.20	9.34
			1986	10.00	11.70	-	11.85	10.35
8.	244	Adoni	1980	2.25	2.75	2.68	2.02	2.38
			1981	3.43	3.81	7.23	6.76	5.22
			1982	5.64	6.82	7.46	5.92	5.71
			1983	5.42	6.56	6.99	6.89	2.75
			1984	3.73	4.86	-	4.26	5.97
			1985	6.28	7.62	-	7.22	6.30
			1986	2.54	6.63	-	8.40	8.52
9.	245	Mantralayam	1980	-	-	7.55	6.76	5.22
			1981	6.89	7.10	6.92	6.44	5.72
			1982	5.83	6.38	5.95	5.79	5.82
			1983	5.96	6.34	6.50	5.12	4.39
			1984	5.17	5.84	-	5.64	5.69
			1985	-	6.70	-	-	5.10
		(New Well)	1986	5.80	Dry	-	13.47	13.68
0.	246	Banaganapalle	1981	-	-	8.06	7.85	5.12
			1982	4.9	6.07	-	5.92	N.C
			1983	4.59	5.03	4.61	4.44	4.16
			1984	3.84	4.71	-	4.635	4.90
			1985	5.26	6.11	-	6.60	5.82
			1986	6.22	6.92	-	7.84	8.14
1.	247	Atmakur	1981	-	-	8.06	3.72	3.37
			1982	4.19	8.22	7.76	5.68	N.C
			1983	5.80	Dry	6.07	1.46	2.96
			1984	4.12	7.74	-	4.96	3.20
			1985	-	Dry	-	3.60	4.09
			1986	5.60	Dry	-	Dry	9.26
2.	248	Nandikotkur	1981	-	-	11.90	4.94	5.17
			1982	5.41	8.638	6.90	8.23	N.C
			1983	5.40	8.06	10.38	2.94	3.20
			1984	3.85	5.24	-	4.31	5.04
			1985	-	10.33	-	7.35	8.53
			1986	10.35	12.55	-	9.99	8.80

Cont..... 6/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
KURNOOL DISTRICT :								
1.	71	Allagadda	1977	3.76	5.78	5.31	2.20	2.35
			1978	3.09	4.80	3.95	1.31	1.49
			1979	2.71	4.47	3.98	4.93	2.54
			1980	4.91	3.90	3.38	3.40	6.23
			1981	4.02	5.67	2.68	2.69	-
			1982	3.50	5.375	5.84	5.13	N.C
			1983	3.99	5.80	6.05	6.70	2.32
			1984	3.48	5.47	-	5.59	5.54
			1985	5.59	Dry	-	3.55	3.85
			1986	4.80	Dry	-	Dry	4.97
2.	72	Nandyal	1969	-	-	-	5.45	4.97
			1970	4.94	5.64	5.74	2.74	5.00
			1971	4.81	5.16	5.36	5.23	5.45
			1972	5.65	6.05	6.10	-	4.42
			1973	-	-	6.46	5.29	-
			1974	-	-	6.42	-	-
			1975	-	5.68	-	-	3.85
			1976	-	5.08	-	-	5.16
			1977	5.55	6.27	6.03	4.40	4.51
			1978	5.33	5.69	5.72	4.13	3.98
			1979	4.81	5.38	5.54	5.32	5.16
			1980	5.48	5.86	6.61	5.33	5.71
			1981	6.16	6.62	7.40	5.00	5.03
			1982	5.40	6.725	7.40	6.76	Nil
			1983	5.40	7.05	7.70	4.29	4.96
			1984	5.40	6.28	-	5.59	4.90
			1985	-	7.67	-	5.30	5.40
			1986	6.26	7.76	-	7.34	6.51
3.	73	Kurnool	1977	4.21	5.29	2.78	2.90	3.56
			1978	4.06	6.10	6.30	1.94	3.21
			1979	4.01	5.40	5.47	3.68	4.02
			1980	4.91	3.90	3.38	3.40	6.23
			1981	4.02	5.67	2.68	2.69	-
			1982	2.57	4.01	3.67	4.15	2.37
			1983	4.42	3.74	4.40	1.48	2.68
			1984	2.80	3.30	-	3.57	3.25
			1985	-	3.61	-	3.45	3.06
			1986	3.96	3.28	-	3.12	4.72
4.	74	Dhone	1969	-	-	-	6.20	6.59
			1970	4.40	5.40	4.80	4.00	4.05
			1971	6.57	6.69	9.49	4.95	4.70
			1972	4.95	6.19	5.95	-	-
			1973	-	5.50	5.48	5.75	-
			1974	-	-	5.95	-	-
			1975	-	-	5.05	-	5.08
			1976	-	4.41	4.70	-	5.48
			1977	5.38	5.75	4.38	4.32	4.31
			1978	4.65	6.05	5.87	4.74	4.52
			1979	4.63	5.90	6.23	7.05	4.04
			1980	4.39	6.03	6.63	5.45	6.08
			1981	6.69	7.48	7.36	Dry	5.32
			1982	5.94	6.73	7.24	7.44	5.00
			1983	4.66	6.45	6.34	5.26	3.57
			1984	4.50	4.71	-	4.51	3.76
			1985	5.07	7.20	-	5.05	4.90
			1986	-	7.68	-	7.47	6.56

Cont..... 5/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	126	Srisailam	1978	-	-	-	-	8.67
			1979	11.54	13.00	10.00	8.56	13.70
			1980	11.90	12.83	-	-	-
			1981	12.83	11.24	13.24	8.58	-
			1982	13.29	9.08	7.60	6.50	5.00
			1983	10.00	13.56	11.58	4.19	8.24
			1984	9.80	13.45	-	8.87	10.67
			1985	10.03	12.70	-	9.80	10.92
			1986	12.06	13.45	-	8.90	8.76
6.	242	Kodumuru	1980	3.43	5.08	4.96	3.70	3.92
			1981	4.36	5.35	5.37	4.16	3.05
			1982	3.63	4.335	4.72	4.06	2.85
			1983	3.52	4.32	4.70	3.64	2.51
			1984	3.21	3.98	-	3.12	3.28
			1985	-	4.67	-	3.87	3.60
			1986	-	5.36	-	5.51	6.45
7.	243	Pattikonda	1980	9.75	10.74	11.42	9.54	8.91
			1981	9.50	11.02	11.30	11.81	8.17
			1982	-	10.69	10.25	9.26	5.35
			1983	6.92	8.08	9.01	9.27	5.90
			1984	7.10	8.52	-	9.04	9.29
			1985	9.87	11.24	-	10.20	9.34
			1986	10.00	11.70	-	11.85	10.35
8.	244	Adoni	1980	2.25	2.75	2.68	2.02	2.38
			1981	3.43	3.81	7.23	6.76	5.22
			1982	5.64	6.82	7.46	5.92	5.71
			1983	5.42	6.56	6.99	6.89	2.75
			1984	3.73	4.86	-	4.26	5.97
			1985	6.28	7.62	-	7.22	6.30
			1986	2.54	6.63	-	8.40	8.52
9.	245	Mantralayam	1980	-	-	7.55	6.76	5.22
			1981	6.89	7.10	6.92	6.44	5.72
			1982	5.83	6.38	5.95	5.79	5.82
			1983	5.96	6.34	6.50	5.12	4.39
			1984	5.17	5.84	-	5.64	5.69
			1985	-	6.70	-	-	5.10
		(New Well)	1986	5.80	Dry	-	13.47	13.68
10.	246	Banaganapalle	1981	-	-	8.06	7.85	5.12
			1982	4.9	6.07	-	5.92	N.C
			1983	4.59	5.03	4.61	4.44	4.16
			1984	3.84	4.71	-	4.635	4.90
			1985	5.26	6.11	-	6.60	5.82
			1986	6.22	6.92	-	7.84	8.14
11.	247	Atmakur	1981	-	-	8.06	3.72	3.37
			1982	4.19	8.22	7.76	5.68	N.C
			1983	5.80	Dry	6.07	1.46	2.96
			1984	4.12	7.74	-	4.96	3.20
			1985	-	Dry	-	3.60	4.09
			1986	5.60	Dry	-	Dry	9.26
12.	248	Nandikotkur	1981	-	-	11.90	4.94	5.17
			1982	5.41	8.638	6.90	8.23	N.C
			1983	5.40	8.06	10.38	2.94	3.20
			1984	3.85	5.24	-	4.31	5.04
			1985	-	10.33	-	7.35	8.53
			1986	10.35	12.55	-	9.99	8.80

..... 6/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.	249	Alur	1981	-	-	8.12	8.21	4.10
			1982	-	6.77	8.75	9.09	6.32
			1983	-	8.75	9.00	8.45	7.58
			1984	8.45	8.97	-	6.62	6.45
			1985	7.44	9.37	-	7.77	6.92
			1986	7.46	9.43	-	8.25	6.40
14.	250	Yemmiganur	1981	-	-	2.90	2.44	2.07
			1982	2.24	2.805	2.53	2.46	2.0
			1983	2.50	3.06	3.48	1.58	2.33
			1984	2.73	3.02	-	2.36	2.72
			1985	-	3.45	-	1.81	2.30
			1986	2.54	3.50	-	3.34	3.0
CUDDAPAH DISTRICT :								
1.	70	Badvel	1977	-	4.27	4.78	5.55	3.95
			1978	-	-	-	-	-
			1979	3.08	5.70	5.55	7.12	5.41
			1980	2.89	4.45	5.86	5.36	6.71
			1981	6.35	7.78	9.22	9.32	4.37
			1982	4.15	5.98	7.20	8.26	4.79
			1983	3.72	5.49	7.31	5.42	2.72
			1984	2.915	4.99	6.74	7.24	5.17
			1985	6.2	8.60	-	9.58	7.03
			1986	6.71	Dry	-	Dry	6.71
2.	77	Cuddapah	1977	6.80	7.26	6.90	5.07	5.95
			1978	5.69	6.89	7.04	6.44	3.12
			1979	5.25	6.25	6.48	7.32	6.85
			1980	-	7.01	8.08	7.97	7.90
			1981	7.78	8.50	9.52	9.20	6.53
			1982	7.72	7.68	8.49	9.10	7.65
			1983	8.81	9.62	10.09	5.24	4.92
			1984	5.595	7.01	9.4	7.30	7.32
			1985	7.72	9.19	-	9.65	8.41
			1986	9.10	Dry	-	Dry	Dry
3.	78	Vempalle	1969	-	-	-	10.00	8.06
			1970	8.07	8.87	8.77	8.57	8.25
			1971	8.45	9.36	9.26	8.98	8.75
			1972	9.05	10.48	9.38	-	-
			1973	-	9.60	-	8.75	-
			1976	-	7.27	8.90	-	8.20
			1977	-	-	-	8.65	8.54
			1978	8.60	9.94	10.21	9.35	8.14
			1979	8.41	9.80	9.39	10.15	8.75
			1980	8.53	9.98	10.60	10.79	10.61
			1981	9.78	10.95	10.02	10.09	8.27
			1982	9.24	10.60	10.20	10.80	9.94
			1983	9.93	11.13	9.92	10.20	8.43
			1984	8.62	9.74	10.68	9.80	9.12
			1985	12.35	11.29	-	11.52	10.72
			1986	11.12	12.35	-	Dry	10.28

Cont..... 7/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4.	82	Rayachoti	1977	6.03	9.65	7.83	7.42	7.24
			1978	6.66	10.29	11.63	9.96	7.55
			1979	7.14	10.88	10.60	13.17	9.10
			1980	6.20	10.56	13.43	14.59	16.30
			1981	11.00	13.28	11.59	11.18	9.50
			1982	10.77	12.22	12.89	14.90	8.52
			1983	10.51	13.28	17.86	13.80	6.08
			1984	6.37	8.18	7.73	10.13	7.41
			1985	11.15	9.92	-	10.12	10.20
			1986	10.44	13.88	-	12.00	10.35
5.	83	Rajampet	1977	2.51	3.84	6.98	4.95	4.22
			1978	3.79	4.66	5.78	6.34	5.03
			1979	4.31	5.45	5.66	7.16	6.37
			1980	-	4.89	6.65	7.01	8.02
			1981	4.32	4.87	7.22	8.60	5.69
			1982	5.61	7.97	9.37	9.45	6.60
			1983	7.20	9.11	9.385	8.23	3.01
			1984	3.39	3.86	4.98	5.51	4.78
			1985	1.88	4.55	-	5.32	-
			1986	4.90	6.80	-	8.26	5.42
6.	234	Muddanur (Old)	1981	-	-	13.78	13.72	11.78
			1982	12.87	13.88	14.00	14.15	12.33
			1983		Abandoned.			
7.	235	Proddatur	1981	-	-	7.97	8.12	7.77
			1982	7.79	7.76	7.97	7.94	7.92
			1983	7.19	7.26	7.35	7.35	6.63
			1984	6.53	6.60	6.78	6.80	6.86
			1985		7.87	-		7.88
			1986	7.85	8.11	-	8.[illegible]	8.08
8.	301	Muddanur (New)	1983	14.16	14.73	14.31	4.51	11.38
			1984	11.36	11.96	12.40	12.14	12.22
			1985	12.763	13.99	-	13.58	13.61
			1986	14.18	Dry	-	Dry	Dry
CHITTOOR DISTRICT :								
1.	81	Molakalacheruvu	1978	-	5.50	7.40	7.50	7.18
			1979	5.75	6.94	7.90	8.19	7.85
			1980	7.44	8.48	8.28	9.13	8.41
			1981	8.37	9.56	Dry	Dry	5.52
			1982	4.83	6.63	6.15	7.38	7.00
			1983	-	8.48	8.88	Dry	5.23
			1984	5.42	6.33	-	6.30	4.82
			1985	5.38	-	-	8.86	8.14
			1986	8.92	16.50	-	Dry	8.50

Cont..... 8/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
6.	95 (303)	Karvetinagar	1977	-	-	-	12.72	12.38
			1978	-	-	-	-	-
			1979	11.66	14.15	Dry	14.36	Dry
			1980	12.57	13.90	13.70	Dry	Dry
			1981	13.70	Dry	-	Dry	10.42
			1982	-	11.27	14.55	13.61	Dry
			1983	Dry	10.56	10.76	11.03	9.13
			1984	7.81	8.05	-	10.03	8.28
			1985	6.24	10.26	-	9.16	10.20
			1986	6.71	9.82	-	10.80	9.83
7.	96	Pallipattu	1977	-	9.87	6.64	7.24	5.27
			1978	3.93	4.80	7.00	7.76	6.12
			1979	5.28	7.69	8.84	9.48	9.05
			1980	5.06	8.16	9.01	9.33	9.26
			1981	8.73	9.70	9.68	9.60	2.16
			1982	5.28	5.20	7.30	8.60	7.27
			1983	7.40	8.81	9.56	9.61	7.56
			1984	7.11	8.05	-	7.37	6.65
			1985	4.85	6.75	-	6.76	6.50
			1986	4.48	6.36	-	7.80	7.18
8.	97	Nagari	1977	-	-	-	6.00	4.95
			1978	2.89	4.43	6.02	6.32	6.71
			1979	3.93	4.78	5.80	6.48	5.92
			1980	3.34	5.09	5.75	-	-
			1981	6.30	7.83	7.32	7.33	4.29
			1982	-	4.74	8.90	7.23	-
			1983	7.15	7.05	8.68	Dry	8.46
			1984	7.86	6.42	-	7.46	-
			1985	5.75	5.79	6.29	-	6.42
			1986	3.76	5.65	-	7.12	7.38
9.	98	Chittoor	1977	2.14	3.24	4.51	4.80	2.93
			1978	2.05	3.26	4.93	5.72	3.90
			1979	2.15	3.13	5.21	5.62	0.53
			1980	2.21	3.83	5.61	6.39	6.87
			1981	6.91	8.80	9.20	9.71	3.17
			1982	3.98	5.44	6.20	6.72	4.62
			1983	-	6.09	8.17	9.00	4.39
			1984	4.47	2.42	-	5.26	4.48
			1985	4.16	6.63	-	7.30	6.88
			1986	5.10	9.10	-	7.77	6.50
10.	99	Perumuru	1977	-	8.08	-	10.43	-
			1978	5.33	8.47	11.61	6.61	6.82
			1979	-	8.06	11.33	12.23	11.13
			1980	9.24	12.22	14.78	14.30	13.90
			1981	13.17	15.60	15.80	15.15	8.52
			1982	8.31	10.88	13.05	13.40	8.60
			1983	4.38	16.38	7.14	6.59	12.14
			1984	11.97	9.95	-	11.65	7.97
			1985	6.60	11.50	-	10.70	9.74
			1986	10.45	12.86	-	16.50	14.80

Contd..... 10/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2.	91	Kalahasthi	1977	3.58	5.00	6.31	4.95	4.95
			1978	4.26	8.21	8.94	9.82	3.47
			1979	3.61	4.88	5.51	6.77	5.86
			1980	4.27	5.54	7.07	7.42	8.56
			1981	4.53	5.02	6.97	7.45	4.57
			1982	4.04	5.98	7.35	7.95	5.87
			1983	5.52	6.68	8.28	7.93	4.70
			1984	3.74	3.99	-	5.69	4.73
			1985	3.45	3.43	-	6.30	5.64
			1986	4.21	5.50	-	6.60	4.88
3.	92	Tirupathi	1977	4.52	8.55	7.54	6.20	3.96
			1978	4.26	8.21	8.94	9.82	3.47
			1979	-	7.72	9.20	9.65	8.50
			1980	4.91	8.20	10.35	9.86	10.96
			1981	7.61	9.32	10.82	10.27	7.00
			1982	7.46	9.63	10.88	10.73	5.36
			1983	9.60	11.35	11.86	11.20	6.59
			1984	5.28	7.21	-	9.58	7.50
			1985	4.25	10.10	-	10.50	9.75
			1986	5.56	10.38	-	11.14	7.45
4.	93	Chandragiri (Old)	1977	-	-	-	7.87	5.30
			1978	2.82	5.06	7.37	9.43	10.51
			1979	8.57	8.96	10.65	Dry	Dry
			1980	7.81	8.48	Dry	Dry	Dry
			1981	9.12	Dry	Dry	Dry	Dry
			1982	9.17	10.88	Dry	Dry	Dry
			1983		Dry	(Abondoned)		
5.	94	Puttur	1969	-	-	-	8.42	2.77
			1970	2.07	2.52	3.82	7.53	4.10
			1971	5.09	6.80	6.97	5.62	5.50
			1972	5.82	6.34	7.20	-	-
			1973	-	-	-	6.30	5.33
			1974	-	-	-	-	7.03
			1976	-	4.81	6.18	-	2.73
			1977	2.90	4.51	5.72	5.77	4.07
			1978	3.32	4.58	5.53	5.19	4.37
			1979	3.70	5.31	6.58	7.01	6.26
			1980	4.05	5.76	6.72	6.86	7.15
			1981	4.38	5.73	6.50	6.27	3.45
			1982	3.52	5.24	6.70	6.50	4.21
			1983	5.02	6.58	7.92	8.33	4.20
			1984	3.43	4.15	-	5.97	4.53
			1985	3.07	5.57	-	4.86	5.00
			1986	3.31	5.68	-	6.92	4.10

Contd.....9/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
11.	100	Puthalapattu	1977	-	9.15	-	9.52	7.42
			1978	6.05	9.48	11.21	10.50	5.02
			1979	5.92	8.13	9.63	11.49	10.16
			1980	6.12	9.96	10.75	10.10	12.10
			1981	10.50	12.30	9.91	11.92	4.52
			1982	6.89	9.54	12.15	12.51	8.42
			1983	9.13	13.32	14.54	13.36	6.44
			1984	6.23	6.23	-	14.69	8.19
			1985	7.62	13.52	-	11.74	10.61
			1986	7.95	12.90	-	12.87	9.63
12.	101	Nendragunta	1977	-	5.03	-	5.87	5.71
			1978	-	-	-	-	-
			1979	4.95	6.18	7.32	8.05	6.77
			1980	6.21	7.66	9.86	9.29	12.35
			1981	9.97	10.05	9.80	9.60	3.71
			1982	3.88	6.12	7.90	8.79	6.79
			1983	7.22	8.82	10.72	8.48	4.7
			1984	4.29	4.30	-	7.15	5.31
			1985	4.36	6.80	-	6.22	6.36
			1986	5.15	6.90	-	7.53	7.66
13.	102	Danalcheruvu	1977	-	3.86	-	5.42	2.54
			1978	2.22	3.61	5.33	7.26	3.58
			1979	2.35	3.21	4.88	7.27	5.44
			1980	2.52	3.40	6.98	7.07	10.20
			1981	7.77	11.00	12.03	11.3	4.25
			1982	3.22	5.15	9.55	10.735	5.82
			1983	3.15	7.26	9.88	7.80	2.80
			1984	2.85	2.40	-	4.08	2.73
			1985	2.70	6.38	-	5.16	4.45
			1986	3.18	5.26	-	10.78	9.98
14.	103	Kalluru	1977	-	15.64	-	16.40	11.31
			1978	9.85	15.38	17.60	16.75	8.25
			1979	11.98	16.38	19.08	21.25	18.22
			1980	12.86	9.13	19.38	16.27	18.20
			1981	18.65	18.70	18.10	18.34	12.38
			1982	13.31	15.55	17.05	18.14	12.38
			1983	15.07	17.08	18.34	12.50	7.42
			1984	7.45	8.93	-	12.44	10.98
			1985	10.88	15.00	-	10.64	9.28
			1986	7.30	12.96	-	13.60	8.74
15.	104	Bhakrapet	1977	-	8.86	-	9.17	-
			1978	5.84	8.05	8.82	9.30	6.86
			1979	5.58	7.79	9.22	10.47	10.44
			1980	7.71	10.48	10.53	10.00	9.76
			1981	9.13	11.58	13.03	13.49	9.54
			1982	11.59	15.12	14.75	14.90	14.37
			1983	13.67	15.82	Dry	15.00	6.72
			1984	6.33	7.45	-	11.09	10.34
			1985	8.27	11.76	-	11.14	11.46
			1986	8.56	Abondoned			

Cont.... 11/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
16.	105	Pileru	1977	-	4.87	-	4.35	4.0
			1978	4.31	4.94	6.08	6.00	3.60
			1979	4.39	4.47	5.42	4.20	4.40
			1980	4.36	5.02	5.74	5.36	6.26
			1981	6.15	8.23	10.10	6.89	4.14
			1982	4.32	5.70	12.35	9.74	5.38
			1983	4.64	6.15	6.84	5.27	4.21
			1984	4.35	4.50	-	10.42	4.60
			1985	4.53	5.53	-	4.86	4.30
			1986	3.28	10.80	-	6.80	4.31
17.	106	Somala	1977	-	4.73	-	5.21	-
			1978	3.54	5.63	6.44	6.83	2.46
			1979	2.79	5.55	6.25	6.04	3.63
			1980	2.15	5.12	6.21	7.15	6.90
			1981	7.07	8.84	5.30	7.26	2.80
			1982	3.92	6.60	6.15	8.75	4.94
			1983	6.04	8.04	6.56	8.17	4.84
			1984	4.45	3.52	-	6.35	2.90
			1985	3.38	6.18	-	4.90	4.76
			1986	4.20	7.56	-	7.50	5.94
18.	107	Palamner	1977	4.51	5.85	6.48	6.88	5.84
			1978	3.64	5.20	5.95	6.34	3.87
			1979	3.38	4.83	-	5.27	3.75
			1980	2.64	4.37	5.50	5.90	6.26
			1981	6.40	7.47	6.59	7.07	2.83
			1982	3.51	4.70	5.30	6.60	3.96
			1983	4.36	5.85	6.27	5.98	4.13
			1984	3.92	4.40	-	5.76	4.70
			1985	5.00	7.09	-	5.50	3.90
			1986	3.72	5.32	-	6.40	3.55
19.	108	Punganoor	1977	-	9.26	-	8.92	7.87
			1978	6.54	9.09	10.18	9.38	6.21
			1979	4.74	5.52	6.28	6.83	4.61
			1980	4.19	4.47	4.98	6.55	9.45
			1981	8.69	10.23	10.82	9.99	6.47
			1982	7.11	9.75	11.35	12.00	9.05
			1983	7.27	8.08	9.63	10.56	7.33
			1984	6.95	8.20	-	10.97	7.60
			1985	5.45	10.53	-	10.40	8.49
			1986	5.47	10.73	-	12.10	10.04
20.	109	Madanapalle	1969	-	-	-	14.40	14.25
			1970	11.55	11.55	12.25	12.35	14.35
			1971	13.30	12.15	13.85	12.69	12.65
			1972	11.10	12.45	12.60	-	-
			1973	-	8.30	9.00	10.05	9.15
			1974	-	9.05	-	-	6.91
			1975	-	-	10.25	-	9.68
			1976	-	8.82	10.12	-	10.60
			1977	10.24	10.93	11.48	11.25	10.86
			1978	10.99	10.41	10.70	11.54	11.06
			1979	10.11	9.69	10.66	10.01	10.40
			1980	8.34	7.54	9.65	10.50	11.36
			1981	11.69	12.16	13.90	13.31	12.80
			1982	11.85	13.08	13.80	13.79	14.22
			1983	15.10	15.04	Dry	Dry	15.33
			1984	14.70	13.55	-	15.26	15.75
			1985	11.90	12.11	-	12.43	12.20
			1986	11.61	11.77	-	13.70	15.00

Cont.....12/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
21.	129	Bangarupalem	1977	-	13.09	-	13.99	-
			1978	7.97	8.99	10.90	12.97	11.01
			1979	6.26	8.03	9.78	11.50	12.09
			1980	4.47	9.44	10.40	12.56	12.58
			1981	12.77	14.10	14.52	Dry	8.64
			1982	7.64	9.82	10.90	13.01	6.22
			1983	6.64	10.08	Dry	12.28	8.09
			1984	5.50	4.85	-	9.48	7.66
			1985	4.76	10.47	-	12.56	12.45
			1986	11.15	13.20	-	14.10	9.40
22.	130	Anantapuram (Jangalapalle)	1977	-	6.61	-	7.33	2.48
			1978	3.86	4.94	8.43	7.75	2.39
			1979	3.21	6.19	9.53	10.21	2.03
			1980	-	-	-	3.54	3.55
			1981	4.05	5.01	5.11	4.73	-
			1982	7.17	10.80	Dry	Dry	8.20
			1983	Dry	Dry	Dry	Dry	4.35
			1984	3.89	4.60	-	7.87	4.06
			1985	4.11	10.18	-	Dry	Dry
			1986	-	10.20	-	Dry	6.32
23.	131	Satyavedu	1977	-	8.07	8.07	8.04	7.79
			1978	7.84	7.97	7.86	8.03	7.78
			1979	7.84	7.85	7.76	7.76	7.87
			1980	12.82	7.86	-	-	-
			1981	7.86	7.84	7.85	7.92	7.78
			1982	-	7.82	7.99	7 84	-
			1983	7.68	7.80	7.90	7.78	8.00
			1984	7.81	7.77	-	7.80	-
			1985	7.55	8.00	7.93	-	7.82
			1986	7.96	7.83	-	8.13	7.75
24.	132	Panatoor	1977	-	8.66	-	8.05	5.57
			1978	4.41	7.90	8.70	8.38	5.42
			1979	4.75	8.38	9.52	9.16	3.36
			1980	5.28	8.99	9.28	8.58	9.51
			1981	9.70	10.80	11.80	12.70	7.01
			1982	9.30	10.80	11.80	12.80	12.46
			1983	13.29	14.58	15.40	14.73	8.39
			1984	6.95	5.73	-	9.05	6.81
			1985	7.63	10.59	-	9.43	9.10
			1986	9.17	11.80	-	13.60	8.10
25.	133	Paradarami	1977	-	9.23	-	8.57	5.73
			1978	-	-	-	-	-
			1979	2.61	-	7.60	8.55	4.99
			1980	2.63	6.04	8.65	9.52	10.55
			1981	10.15	11.50	12.00	12.00	5.60
			1982	4.97	7.60	7.75	10.54	5.65
			1983	7.22	9.85	10.16	10.20	5.58
			1984	4.44	4.47	-	8.75	8.62
			1985	7.90	10.43	-	9.96	9.62
			1986	7.95	11.40	-	12.80	11.10

Contd..... 13/-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
26.	153	Nagalapuram	1977	-	3.10	3.03	3.32	2.10
			1978	2.83	2.91	3.01	3.14	1.78
			1979	2.16	2.98	3.36	3.22	2.60
			1980	3.07	3.25	-	-	-
			1981	3.83	3.04	3.49	2.55	1.88
			1982	-	2.90	3.37	3.40	-
			1983	3.00	3.60	4.33	4.18	2.60
			1984	2.17	2.98	-	3.25	-
			1985	2.24	4.40	-	4.35	3.52
			1986	2.75	3.20	-	3.55	2.67
27.	251	Gangadharanellore	1980	-	-	-	3.54	3.55
			1981	4.05	5.01	5.11	4.73	-
			1982	1.05	2.56	9.10	4.37	N.C
			1983	2.265	4.08	4.335	2.70	1.51
			1984	1.11	1.43	-	1.00	1.00
			1985	0.945	-	-	3.96	3.22
			1986	7.05	-	-	-	-
28.	252	Peramalgudipalle	1980	-	-	-	3.45	4.50
			1981	4.56	5.64	6.05	6.44	3.10
			1982	1.69	1.78	3.95	4.42	N.C
			1983	1.855	1.57	3.24	2.89	1.66
			1984	1.12	0.92	-	1.71	1.60
			1985	1.515	2.50	-	2.54	2.345
			1986	-	-	-	-	-
29.	267	Tirumala	1981	-	-	-	6.05	1.31
			1982	1.77	3.22	5.93	4.00	2.45
			1983	6.05	4.16	3.60	1.38	1.27
			1984	1.515	1.05	-	2.30	0.96
			1985	1.86	5.23	-	2.24	4.50
			1986	2.02	3.28	-	2.55	1.47
30.	302	Chandragiri(New)	1984	5.55	4.45	-	7.05	4.55
			1985	3.42	7.03	-	9.03	8.30
			1986	4.03	8.00	-	8.43	9.03
MAHABOOBNAGAR DISTRICT :								
1.	36	Jadcherla Crossing	1976	-	10.51	12.05	9.35	8.00
			1977	9.17	12.28	13.67	13.18	10.04
			1978	10.44	13.05	11.11	11.93	8.13
			1979	8.70	11.95	11.70	10.66	9.08
			1980	9.38	11.33	12.45	12.30	10.68
			1981	11.61	14.09	14.88	14.54	10.67
			1982	12.11	14.42	14.68	14.95	N.C
			1983	Dry	Dry	Dry	15.00	9.45
			1984	9.50	13.70	14.26	13.05	11.39
			1985	11.67	Dry	-	Dry	Dry
			1986	Abondoned				

Cont..... 14/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2.	37	Makhthal	1969	-	-	-	11.30	8.73
			1970	9.1	10.07	10.28	9.06	6.33
			1971	8.62	8.96	9.33	9.29	9.26
			1972	10.11	10.50	9.00	-	-
			1973	-	12.96	11.65	10.80	10.12
			1974	-	11.80	-	-	9.65
			1975	-	10.65	-	-	4.50
			1976	-	7.86	9.30	-	8.22
			1977	9.42	10.41	10.57	10.60	10.50
			1978	10.95	11.62	12.11	11.62	8.98
			1979	9.65	10.70	10.37	10.38	10.62
			1980	12.46	10.10	12.76	12.12	11.11
			1981	11.74	12.65	13.06	12.51	10.29
			1982	11.48	11.86	12.63	5.05	11.30
			1983	11.87	12.76	-	11.14	7.6
			1984	8.45	10.20	11.18	11.46	12.13
			1985	12.60	13.70	-	14.90	12.60
			1986	12.90	14.10	-	14.54	14.56
3.	38	Kottakota	1976	-	8.54	8.77	7.32	5.67
			1977	6.89	7.50	8.53	6.70	6.02
			1978	7.19	10.00	10.31	8.95	6.32
			1979	7.30	-	7.23	6.87	6.05
			1980	6.68	7.65	8.02	7.02	6.94
			1981	7.54	8.80	9.93	7.98	6.77
			1982	8.18	9.17	10.00	9.37	N.C
			1983	10.08	12.00	Dry	10.19	6.64
			1984	7.37	9.10	7.87	10.02	9.36
			1985	12.20	Dry	-	Dry	Dry
			1986	16.33		-	Dry	Dry
4.	39.	Kalvakurthi	1969	-	-	-	19.00	16.38
			1970	16.92	18.36	18.83	16.52	13.57
			1971	16.18	17.08	17.43	16.26	14.63
			1972	14.94	17.35	18.60	-	-
			1973	-	20.30	20.85	20.40	15.80
			1974	-	17.70	-	-	17.85
			1975	-	17.50	-	-	13.20
			1976	-	14.63	16.20	-	12.04
			1977	13.23	15.36	10.47	16.27	12.98
			1978	14.32	16.23	16.86	13.28	8.81
			1979	11.23	13.65	13.02	14.19	11.17
			1980	13.09	15.60	16.45	16.11	15.96
			1981	17.15	18.66	19.16	18.61	16.02
			1982	13.77	19.72	20.05	20.40	18.35
			1983	19.40	-	Dry	Dry	14.25
			1984	19.14	Dry	-	19.90	19.00
			1985	19.9	Dry	-	Dry	20.05
			1986	20.28	-	-	Dry	Dry
5.	125	Vattivelipalli	1978	-	-	-	-	9.72
			1979	14.22	9.00	8.53	13.38	10.73
			1980	14.05	28.58	11.83	9.45	15.87
			1981	28.70	29.86	27.25	6.98	9.63
			1982	15.08	14.02	8.55	10.90	5.9
			1983	12.78	12.90	12.08	4.83	7.48
			1984	13.58	-	25.85	9.36	12.90
			1985	13.33	27.60	-	11.54	27.90
			1986	27.96	31.40	-	9.11	14.45

Contd.... 15/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
6.	144	Maddur	1979	-	-	-	-	8.23
			1980	9.74	13.52	12.73	12.55	12.33
			1981	12.87	13.48	-	9.84	7.50
			1982	9.14	7.96	11.55	10.90	N.C
			1983	11.87	13.06	9.71	3.85	4.71
			1984	8.25	10.70	11.80	9.64	7.13
			1985	-	13.15	-	11.70	11.16
			1986	11.61	13.80	-	12.48	14.11
7.	145	Gadwal	1979	-	-	-	7.09	-
			1980	7.51	8.23	8.82	8.04	7.58
			1981	8.02	8.95	9.16	8.57	6.68
			1982	7.27	7.96	8.32	7.90	8.05
			1983	8.55	9.87	9.46	7.16	4.60
			1984	5.50	6.30	-	6.59	7.30
			1985	7.77	8.74	-	8.53	7.75
			1986	8.02	9.05	-	9.40	9.65
8.	146	Nagarkurnool	1979	-	-	-	-	4.27
			1980	4.80	6.10	7.23	5.96	6.25
			1981	6.99	8.42	8.84	7.73	4.5[illegible]
			1982	15.48	7.18	8.10	7.75	6.5[illegible]
			1983	7.64	8.95	9.88	9.08	4.27
			1984	4.90	6.75	-	7.29	7.86
			1985	8.47	11.00	-	11.40	12.06
			1986	12.28	Dry	-	Dry	14.[illegible]
9.	147	Achampet	1979	-	-	-	-	5.27
			1980	6.20	7.37	8.12	7.76	7.92
			1981	8.32	9.25	9.88	8.77	7.44
			1982	7.31	9.48	9.65	8.33	7.20
			1983	8.13	9.51	10.20	7.64	4.48
			1984	5.68	7.60	8.45	6.65	7.10
			1985	8.10	10.33	-	9.19	9.10
			1986	9.84	Dry	-	10.00	10.70
10.	148	Shadnagar	1979	-	-	-	15.86	15.06
			1980	15.88	17.55	19.10	19.27	18.70
			1981	19.37	-	21.08	9.67	13.94
			1982	15.08	17.56	18.68	19.85	N.C
			1983	9.52	20.61	21.57	20.14	14.40
			1984	15.30	18.20	19.33	19.10	18.94
			1985	19.60	21.60	-	Dry	20.78
			1986	23.43	Dry	-	Dry	Dry
11.	174	Devarkhadra	1980	7.64	8.10	8.22	6.20	6.51
			1981	6.79	7.68	7.96	6.47	6.19
			1982	6.62	7.48	7.60	5.68	4.45
			1983	6.81	6.68	8.22	5.45	5.42
			1984	6.28	8.21	8.04	6.90	5.70
			1985	6.74	8.96	-	7.79	7.96
			1986	8.20	9.23	-	8.86	9.60
12.	175	Narayanpet	1980	4.34	4.78	5.53	5.10	4.22
			1981	4.57	5.16	5.74	5.17	2.89
			1982	3.41	3.29	4.80	4.45	4.52
			1983	3.94	5.65	6.15	5.05	2.29
			1984	2.65	3.78	4.16	3.98	3.68
			1985	4.28	5.31	-	5.66	6.10
			1986	5.02	9.45	-	9.62	9.20

Contd..... 16/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.	176	Weljorla	1981	9.76	-	11.67	10.72	5.50
			1982	7.35	10.12	10.625	11.07	10.32
			1983	11.49	13.08	13.40	10.61	5.81
			1984	6.90	8.73	10.81	11.00	10.01
			1985	11.75	13.40	-	12.65	11.89
			1986	-	14.15	-	14.11	14.33
14.	177	Krishna	1980	-	-	7.62	7.20	7.49
			1981	7.34	7.61	7.56	7.60	6.70
			1982	7.08	7.28	7.42	7.25	6.98
			1983	7.20	7.54	-	-	6.23
			1984	6.72	7.55	7.50	7.20	7.37
			1985	7.69	8.36	-	6.90	7.61
			1986	7.62	8.00	-	7.90	4.70
15.	178	Atmakur	1980	-	5.96	4.96	5.06	8.30
			1981	5.26	6.29	6.22	6.14	3.95
			1982	5.04	5.40	5.04	5.02	N.C
			1983	5.97	6.86	7.23	2.50	3.23
			1984	4.20	-	6.29	5.70	6.49
			1985	6.86	7.93	-	7.40	7.96
			1986	8.00	8.95	-	8.95	9.26
16.	179	Kodangal	1981	-	-	-	-	5.24
			1982	13.06	11.50	12.30	10.05	11.20
			1983	12.41	14.15	15.45	6.45	3.37
			1984	5.64	9.69	11.12	5.00	5.00
			1985	7.33	10.47	-	12 17	12.96
			1986	13.46	14.25	-	11.32	13.03
17.	180	Kosgi	1981	-	-	7.02	4.72	2.80
			1982	4.24	2.72	3.75	3.50	3.98
			1983	4.76	7.72	6.77	2.95	2.67
			1984	2.65	2.80	4.51	3.03	3.60
			1985	4.69	7.67	-	6.25	7.78
			1986	7.02	8.65	-	7.93	8.50
18.	181	Koilkonda	1981	-	-	8.84	5.56	4.89
			1982	3.64	4.75	6.90	3.95	3.60
			1983	6.26	7.58	8.45	4.10	4.70
			1984	3.45	5.40	7.10	3.60	3.17
			1985	9.85	7.47	-	7.86	8.30
			1986	6.41	11.41	-	9.55	10.30
19.	182	Suraram	1981	-	-	-	-	4.12
			1982	4.91	7.03	-	7.57	N.C
			1983	7.00	8.44	8.67	-	3.34
			1984	4.21	7.50	8.18	4.90	7.43
			1985	5.52	12.90	-	9.10	13.75
			1986	13.40	-	-	9.80	-
20.	183	Mahaboobnagar	1981	-	-	9.61	9.29	6.63
			1982	6.95	8.09	8.92	8.58	10.21
			1983	Dry	Dry	Dry	7.85	5.84
			1984	6.20	9.77	7.84	-	8.65
			1985	9.25	Dry	-	Dry	Dry
			1986	7.27	8.00	-	6.24	6.24

Contd..... 17/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
21.	184	Koduru	1981	-	-	-	-	4.22
			1982	4.85	5.67	5.45	3.93	N.C
			1983	4.72	5.96	5.85	2.40	3.23
			1984	4.30	5.34	5.93	4.25	3.80
			1985	4.68	6.27	-	5.36	5.52
			1986	5.76	6.80	-	6.57	7.10
22.	185	Kurumurthy	1981	-	-	-	-	12.29
			1982	14.06	14.10	-	13.87	N.C
			1983	15.23	15.74	5.42	13.75	8.95
			1984	-	13.07	13.58	14.75	14.82
			1985	6.70	Dry	-	Dry	Dry
			1986	Abondoned				
23.	186	Kistapur	1981	-	-	-	-	2.69
			1982	2.95	3.80	-	2.95	N.C
			1983	2.79	3.65	4.80	3.26	2.26
			1984	2.55	4.23	4.12	2.93	2.50
			1985	4.40	-	-	4.76	-
			1986	7.50	5.15	-	4.75	-
24.	187	Kotakonda	1981	-	-	-	-	6.87
			1982	8.29	9.50	-	8.94	N.C
			1983	9.11	9.53.	11.10	7.10	6.00
			1984	7.23	-	10.46	8.48	7.49
			1985	12.20	11.28	-	7.86	10.98
			1986	6.41	11.40	-	10.70	12.76
25.	188	Damargidda	1981	-	-	-	-	4.20
			1982	4.60	5.80	5.98	4.10	N.C
			1983	5.03	6.69	6.05	4.32	3.04
			1984	4.38	6.10	5.85	5.32	5.50
			1985	6.09	6.54	-	6.49	5.00
			1986	5.48	6.60	-	7.16	7.42
26.	189	Gundinal	1981	-	-	-	-	6.21
			1982	13.09	16.45	16.93	5.67	N.C
			1983	12.22	17.02	-	5.10	4.25
			1984	6.28	16.37	14.06	6.28	5.31
			1985	6.25	16.86	-	15.23	15.47
			1986	16.92	16.40	-	14.20	12.64
27.	190	Ravalpalle	1981	-	10.63	14.74	5.15	5.93
			1982	5.90	8.31	9.47	8.45	7.89
			1983	9.34	14.99	14.90	2.70	3.19
			1984	4.40	7.38	9.23	3.05	3.39
			1985	4.42	9.79	-	7.63	7.95
			1986	-	14.60	-	7.30	8.90
28.	191	Amarabad	1981	-	-	-	-	4.35
			1982	5.07	5.67	4.95	5.25	3.20
			1983	4.30	5.00	5.55	4.41	2.90
			1984	3.45	4.43	4.91	4.10	4.42
			1985	4.71	5.97	-	5.64	5.82
			1986	5.77	6.60	-	6.04	6.30

Contd..... 18/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
29.	192	Lingal	1981	–	–	–	–	3.90
			1982	6.33	5.89	5.95	4.80	3.95
			1983	4.54	5.92	5.84	3.35	2.62
			1984	2.95	5.00	5.50	4.02	4.65
			1985	5.40	6.40	–	7.80	6.83
			1986	6.60	8.00	–	7.52	8.10
30.	193	Nandinne (Old)	1981	–	–	–	–	6.67
			1982	7.77	8.90	9.24	6.70	N.C
			1983	7.45	8.86	9.72	Abondoned	
31.	306	Nandinne (New)	1983	–	–	–	5.63	6.34
			1984	7.92	8.90	–	6.42	7.77
			1985	8.96	–	–	6.90	7.60
			1986	7.93	Dry	–	10.01	9.14
32.	194	Rampuram	1981	–	–	6.73	5.83	4.52
			1982	5.18	6.06	–	4.50	4.65
			1983	5.37	6.53	7.25	4.25	4.11
			1984	4.90	6.15	6.86	6.05	8.35
			1985	7.40	–	–	8.60	7.10
			1986	7.26	8.20	–	Dry	Dry
33.	195	Musapet	1981	–	–	9.38	8.03	5.23
			1982	7.00	8.79	9.80	–	N.C
			1983	8.70	9.93	12.92	8.33	4.96
			1984	5.97	6.96	–	8.48	8.35
			1985	9.40	11.52	–	16.70	12.15
			1986	12.16	13.10	–	12.63	Dry
34.	278	Alampur	1982	5.31	5.21	5.34	5.25	N.C
			1983	5.11	5.20	–	–	5.21
			1984	5.90	5.21	–	5.28	3.56
			1985	5.11	5.26	–	5.17	3.64
			1986	–	5.16	–	4.70	–
NALGONDA DISTRICT :								
1.	33	Choutuppal	1977	–	–	–	–	5.68
			1978	6.16	7.18	7.03	3.12	3.36
			1979	3.98	4.77	6.30	6.65	6.52
			1980	6.92	7.88	8.83	9.59	10.35
			1981	10.81	11.78	10.68	10.00	9.77
			1982	9.80	11.30	9.50	11.20	10.65
			1983	11.17	Dry	Dry	11.49	9.56
			1984	10.40	11.64	Dry	Dry	Dry
			1985	–	Dry	–	–	Dry
			1986	12.20	12.70	–	11.90	12.04
2.	34	Narketpalle	1976	–	–	–	–	1.19
			1977	1.52	2.20	4.90	5.25	5.1
			1978	6.26	7.63	7.22	2.18	1.67
			1979	3.54	4.47	5.88	7.57	7.22
			1980	9.20	10.82	10.54	9.49	9.54
			1981	10.22	11.44	11.34	11.28	9.72
			1982	9.82	–	10.50	11.50	11.30
			1983	11.35	Dry	Dry	Dry	8.06
			1984	9.50	10.97	11.20	9.34	8.43
			1985	9.31	11.06	–	Dry	Dry
			1986	–	Dry	–	Dry	Dry

Contd..... 19/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
3.	40	Peddavoora	1976	-	6.53	-	-	6.54
			1977	6.92	7.48	8.52	6.25	7.80
			1978	7.47	8.28	8.62	7.36	6.45
			1979	6.94	7.83	8.40	8.73	-
			1980	7.47	8.37	6.80	7.33	7.71
			1981	8.35	9.45	9.65	8.92	7.18
			1982	7.34	8.30	9.10	8.90	7.25
			1983	8.02	8.80	9.06	6.54	5.19
			1984	6.80	8.10	8.50	7.40	7.58
			1985	8.06	9.02	-	7.82	5.63
			1986	-	9.36	-	8.93	-
4.	41	Miryalaguda	1978	8.30	3.14	3.64	2.14	3.49
			1979	3.67	3.09	3.63	3.87	2.96
			1980	3.20	3.85	3.80	2.97	3.14
			1981	4.03	4.00	4.44	3.10	3.65
			1982	3.37	4.50	4.70	4.96	3.74
			1983	3.22	4.50	4.93	3.82	3.58
			1984	3.80	3.90	4.30	3.85	3.75
			1985	3.87	4.44	-	3.45	3.60
			1986	3.90	4.20	-	3.41	4.00
5.	42(A)	Kodad(Old)	1977	3.26	4.00	Dry	3.12	2.85
			1978	2.98	3.15	N.A	N.A	N.A
6.	42	Kodad(New)	1976	-	-	-	-	2.47
			1977	-	-	-	3.48	3.21
			1978	3.24	3.35	3.00	2.42	2.83
			1979	3.30	3.63	4.27	3.15	3.25
			1980	3.32	3.38	3.30	-	3.27
			1981	3.53	4.45	5.87	2.47	3.07
			1982	3.40	4.50	6.15	3.90	3.37
			1983	2.93	4.22	5.86	3.51	2.92
			1984	3.25	4.15	5.46	4.20	3.27
			1985	3.42	4.31	-	2.82	3.10
			1986	3.30	5.20	-	3.15	-
7.	111	Suryapet	1969	-	-	-	3.70	3.20
			1970	3.02	3.40	4.13	2.38	2.93
			1971	3.42	4.23	4.75	4.75	3.84
			1972	4.05	4.05	5.71	2.10	5.40
			1973	-	-	7.45	5.94	9.09
			1974	-	10.85	-	-	8.50
			1975	-	4.46	-	-	2.31
			1976	-	3.18	4.15	-	4.42
			1977	4.70	6.04	4.10	3.52	3.84
			1978	3.74	6.78	6.18	1.75	2.38
			1979	3.74	3.45	4.50	6.02	3.23
			1980	4.05	4.84	5.53	4.44	5.87
			1981	6.57	-	6.42	4.37	4.70
			1982	3.94	8.40	8.20	6.10	5.22
			1983	3.00	4.40	5.71	3.49	3.18
			1984	3.78	4.40	5.07	4.00	3.94
			1985	4.25	4.56	-	3.35	4.02
			1986	4.86	5.20	-	6.53	3.52

Contd..... 20/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
8.	138	Devarakonda	1979	-	-	-	-	4.94
			1980	5.60	6.86	6.65	5.16	6.26
			1981	6.87	7.36	7.64	6.92	4.77
			1982	5.18	6.60	5.55	6.22	4.80
			1983	5.43	-	6.16	3.86	3.51
			1984	4.54	5.75	6.36	6.00	4.90
			1985	5.84	7.44	-	6.93	7.00
			1986	7.30	9.09	-	6.74	6.10
9.	139	Tipparthi	1979	-	-	-	-	9.70
			1980	9.75	11.05	10.63	9.78	11.35
			1981	12.25	12.95	Dry	11.65	8.88
			1982	8.77	10.70	11.10	12.25	11.10
			1983	11.54	Dry	Dry	Dry	5.99
			1984	8.03	10.70	11.80	10.52	9.65
			1985	10.2	11.56	-	11.25	-
			1986	Abondoned				
10.	171	Tirumalgiri	1980	12.00	13.20	13.64	12.48	11.45
			1981	13.18	13.94	Dry	13.13	11.20
			1982	9.15	12.80	13.43	12.42	11.94
			1983	12.00	13.20	Dry	12.26	7.84
			1984	8.58	10.90	11.70	11.04	11.45
			1985	12.08	Dry	-	Dry	Abondoned
			1986	-	-	-	-	-
11.	172	Damarcherla	1980	3.75	3.97	4.52	3.37	3.55
			1981	4.57	4.90	Dry	3.79	3.27
			1982	4.02	6.60	6.10	-	4.70
			1983	3.64	5.40	Dry	4.94	2.80
			1984	3.50	4.12	5.30	4.86	3.60
			1985	3.91	4.76	-	2.42	3.28
			1986	-	7.00	-	3.62	Abondoned
12.	173	Bhongiri	1980	11.26	13.72	14.70	17.06	15.68
			1981	15.93	15.81	16.12	13.31	11.55
			1982	10.71	11.97	11.50	11.07	9.05
			1983	10.60	11.20	12.21	8.67	7.25
			1984	9.28	10.10	10.52	10.10	9.80
			1985	10.65	12.91	-	11.15	11.56
			1986	13.05	-	-	11.55	-
13.	254	Dindi	1982	12.46	13.70	Dry	13.75	13.85
			1983	12.55	-	Dry	Dry	12.02
			1984	11.09	12.10	13.20	11.45	10.70
			1985	10.88	13.26	-	-	-
			1986	Dry	Dry	-	-	10.07
14.	284	Kurumedugate	1982	-	-	-	-	11.30
			1983	11.51	12.25	12.16	10.91	9.32
			1984	9.78	9.90	10.50	10.00	8.32
			1985	9.11	10.04	-	10.26	10.27
			1986	10.08	11.52	-	11.66	13.10
15.	338	Nalgonda	1984	-	-	-	-	11.17
			1985	14.43	16.60	-	11.25	12.16
			1986	13.60	15.50	-	14.13	15.55

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PRAKASHAM DISTRICT :								
1.	61	Darsi	1977	8.76	8.46	9.33	3.68	8.58
			1978	7.90	8.54	9.13	3.18	8.01
			1979	7.63	8.02	8.18	8.49	8.28
			1980	7.88	8.28	9.09	9.26	9.17
			1981	-	9.37	10.05	10.01	-
			1982	3.26	8.62	8.90	9.22	N.C
			1983	N.C	7.60	7.91	7.18	5.82
			1984	5.67	5.80	-	6.46	6.05
			1985	6.02	6.40	-	8.24	5.
			1986	5.40	5.77	-	5.67	4.90
2.	62	Markapur	1977	6.36	7.74	6.93	7.20	6.88
			1978	6.46	7.15	7.17	7.05	3.93
			1979	5.42	5.55	3.96	5.59	4.46
			1980	3.80	4.45	5.92	5.56	6.11
			1981	-	6.57	8.60	7.52	-
			1982	4.52	4.81	5.33	5.34	N.C
			1983	5.27	6.50	6.94	7.38	6.48
			1984	7.70	5.53	-	6.26	5.37
			1985	5.54	7.80	-	9.47	8.15
			1986	8.58	Dry	-	9.97	9.80
3.	63	Podili	1969	-	-	-	4.00	4.30
			1970	3.38	3.80	3.90	4.50	3.28
			1971	4.02	4.09	4.01	4.66	2.18
			1972	5.65	5.05	6.10	-	4.42
			1973	-	-	6.42	-	-
			1975	-	5.68	-	-	3.85
			1976	-	3.14	4.98	-	3.85
			1977	3.21	3.80	4.88	5.30	3.40
			1978	3.34	4.24	5.02	4.10	2.89
			1979	3.30	4.10	3.62	4.59	3.24
			1980	3.18	3.48	4.24	4.52	4.42
			1981	-	4.30	4.82	3.41	-
			1982	8.10	4.19	4.36	5.01	N.C
			1983	N.C	3.90	4.03	3.10	3.05
			1984	3.25	3.77	-	4.16	3.26
			1985	3.33	4.84	-	5.17	3.80
			1986	3.08	5.47	-	3.47	3.10
4.	64	Kanigiri	1973	-	6.75	-	8.22	-
			1975	-	8.75	-	-	5.50
			1976	-	-	7.95	-	5.48
			1977	4.86	6.16	7.45	7.73	6.00
			1978	6.25	7.34	7.74	6.87	-
			1979	5.08	6.95	3.77	5.61	4.44
			1980	-	5.74	7.23	6.29	6.71
			1981	-	6.71	7.62	6.91	-
			1982	4.10	6.29	7.07	7.89	N.C
			1983	N.C	6.90	7.42	5.75	3.20
			1984	4.84	6.06	-	7.83	7.45
			1985	7.10	8.60	-	9.40	8.20
			1986	6.15	7.97	-	8.35	4.50

Contd..... 22/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	65	Ongole	1977	2.94	3.83	4.63	4.73	3.15
			1978	3.59	4.53	5.15	3.38	1.93
			1979	3.04	3.90	3.82	4.67	2.47
			1980	2.88	4.45	5.08	4.17	3.14
			1981	3.77	4.97	3.88	-	-
			1982	3.20	4.37	5.27	5.30	N.C
			1983	N.C	5.00	5.88	3.57	2.30
			1984	3.36	4.32	-	5.59	5.48
			1985	4.70	6.18	-	5.42	3.25
			1986	2.73	4.78	-	4.98	2.27
6.	66	Kandukuru	1977	-	5.06	6.63	7.24	5.69
			1978	4.97	6.09	7.02	7.16	3.43
			1979	3.89	4.74	4.06	5.41	4.20
			1980	2.81	4.62	5.72	5.30	4.64
			1981	-	4.59	6.00	6.05	-
			1982	3.18	-	5.64	6.52	N.C
			1983	N.C	5.45	6.42	5.14	1.72
			1984	2.80	3.56	-	5.42	3.44
			1985	3.32	5.35	-	5.78	3.16
			1986	1.83	4.27	-	5.45	1.60
7.	67	Pamuru	1977	6.96	7.45	8.63	9.34	8.41
			1978	7.54	8.25	9.32	10.01	7.70
			1979	7.27	7.75	7.59	8.32	7.85
			1980	6.33	7.12	8.63	8.73	8.89
			1981	-	6.72	11.43	9.24	-
			1982	6.31	7.75	8.72	9.55	N.C
			1983	N.C	7.40	8.22	7.69	5.46
			1984	5.93	6.45	-	8.40	8.20
			1985	7.25	9.00	-	10.07	9.60
			1986	7.56	9.00	-	9.68	8.05
8.	274	Addanki	1981	-	-	6.41	6.04	-
			1982	3.87	5.42	6.25	6.38	N.C
			1983	N.C	5.83	7.15	3.84	2.66
			1984	3.82	5.37	-	7.30	6.56
			1985	9.32	Dry	-	8.18	4.54
			1986	4.76	7.85	-	7.56	7.50
9.	230	Chirala(Old)	1981	-	-	5.27	5.10	-
			1982	4.00	4.34	4.10	Abondoned	
10.	282	Giddalur	1982	-	-	-	9.22	N.C
			1983	7.29	2.85	8.66	6.27	6.68
			1984	7.06	7.26	-	7.00	-
			1985	8.43	9.40	-	9.20	8.68
			1986	9.30	10.65	-	9.55	9.65
11.	283	Chirala(New)	1982	-	-	-	4.20	N.C
			1983	N.C	3.70	3.76	3.44	2.44
			1984	2.72	3.12	-	3.40	3.625
			1985	3.95	4.00	-	4.20	3.60
			1986	3.95	4.05	-	4.13	3.50

HYDROCHEMICAL DATA OF HYDROGRAPH NET WORK STATIONS OF DROUGHT PRONE DISTRICTS (ANDHRA PRADESH) (1969 - 85)

ANNEXURE - V

Sl. No.	Location	Month/ Year	pH	E.C in micro mhos/Cm. at 25°C	Total Hardness as $CaCO_3$ in mg/l.	Total alkalinity as $CaCO_3$ in mg/l.	Non Carbonate hardness as $CaCO_3$ in mg/l.	Ca^{++} (in ppn)	Mg^{++} (in ppn)	Na^{+} (in ppn)	K^{+} (in ppn)	CO_3^{--} (in ppn)	HCO_3^{-} (in ppn)	Cl^{-} (in ppn)	F^{-} (in ppn)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
ANANTAPUR DISTRICT :																
1.	Anantapur (Old)	4/70	7.70	2216	230	-	-	44	29	408	2	-	660	294	2.25	S
		4/71	8.30	2240	190	-	-	32	22	400	2	10	536	313	2.0	S
		4/72	7.50	1638	420	-	-	104	38	195	3	-	530	310	2.0	S
		1/77	-	-	-	-	-	-	-	-	-	-	-	-	2.22	
		4/77	8.50	1450	152	448	-	25	23	276	-	-	497	172	-	
		4/78	8.30	1930	280	440	Nil	40	44	-	-	Trace	537	312	-	
		4/79	9.25	1880	255	415	Nil	18	51	304	8.0	30	445	25	1.60	
2.	Anantapur (New)	1980	7.65	2700	490	-	-	76	73	389	12	Nil	656	482	1.70	
		1981	-	-	-	-	-	-	-	-	-	-	-	-	-	
		1982	7.80	4770	840	-	-	138	120	874	63	0	720	993	-	
		1983	7.81	2480	305	-	-	50	44	446	8	-	732	319	-	
3.	Penukonda	4/78	8.00	2000	400	380	20	56	39	1209	20	Nil	464	298	2.30	
		4/79	7.95	2190	491	330	161	80	71	1130	30	Nil	403	355	1.85	
		1980	7.70	3220	1200	-	-	208	165	278	39	Nil	592	674	1.82	
		1982	7.80	1860	500	-	-	76	75	161	70	0	366	284	-	
		1983	7.54	3200	730	-	-	96	119	405	2	-	439	532	-	
		1984	7.70	1992	425	-	-	42.1	77.8	-	-	Nil	561.2	319.10	-	
		1985	8.45	2870	620	-	-	60	114	345	2.0	18	177	546	2.15	
4.	Tadipatri	4/79	7.90	5150	571	310	261	84	88	893	8.5	Nil	378	1110	-	
		1980	7.76	4820	560	-	-	116	66	846	8.6	Nil	571	1040	0.77	
		1981	8.20	4950	510	-	-	74	79	874	7.8	Nil	513	971	1.10	
		1982	8.60	4750	310	-	-	32	56	920	14.00	48	189	973	-	
		1983	7.78	5450	440	-	-	60	70	1023	9.0	-	476	1079	-	
		1984	7.55	6000	515	-	-	106.2	60.8	1127	10.9	Nil	664.9	1176.9	-	
		1985	7.50	5950	580	-	-	-	-	-	-	-	-	-	0.70	

Cont.....

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
5.	Rayadurga(Old)	4/70	7.80	651	250	-	-	52	29	45	3	-	300	30	0.5
		1/1971	7.50	2003	740	-	-	52	24	30	2	-	505	346	1.0
		4/71	7.60	2304	750	-	-	92	126	90	2	-	420	330	0.5
6.	Rayadurga(New)	4/78	7.62	4126	751	380	371	164	83	360	390	Nil	464	773	0.55
		4/79	7.62	3650	601	370	231	152	54	332	367	Nil	452	616	0.60
		1980	7.55	4300	740	-	-	144	92	402	422	Nil	595	816	0.38
		1981	7.75	4500	771	-	-	168	85	368	469	Nil	958	777	0.60
		1982	8.00	4000	961			274	67	437	47	-	67	791	-
		1983	7.17	4080	971			274	69	425	30	-	287	738	
7.	Kadiri	1/77	-	-	-	-	-	-	-	-	-	-	-	-	2.18
		4/77	8.27	780	285	245	40	42	44	621	-	-	299	69	-
		4/78	8.25	940	309	240	69	47	46	829	1.60	Trace	293	94	2.04
		4/79	8.00	10750	420	290	130	72	58	622	0.80	Nil	354	50	1.50
		1980	7.60	1310	495	-	-	93	67	73	0.80	Nil	403	151	1.75
		1981													
		1982	7.80	1680	680	-	-	140	80	71	2.70	0	378	234	-
		1983	7.90	1279	470	-	-	72	71	76	2.00	-	293	170	-
		1984	7.40	1573	580	-	-	90.2	86.3	943	1.90	Nil	451.4	212.70	-
		1985	8.20	1805	945	-	-	100	96	90	1.1	Nil	287	287	0.80
8.	Gooty	1/71	-	-	-	-	-	-	-	-	-	-	-	-	0.74
		4/77	8.75	5100	935	250	685	104	118	529	-	-	150	1080	-
		4/78	7.95	4816	1151	430	721	241	131	410	300	Nil	535	1030	0.80
		1980	8.20	3910	790	-	-	160	95	326	242	Nil	668	739	0.45
		1981	7.80	6600	1190	-	-	196	170	74	390	Nil	768	1460	0.41
		1982	7.80	4120	620	-	-	104	94	380	438	0	421	826	-
		1983	7.96	5860	755	-	-	148	94	276	351	-	500	646	-
		1984	7.70	5920	865	-	-	1102	1433	-	-	Nil	4453	1247.8	-
		1985	7.50	5650	1122	-	-	200	151	518	391	Nil	860	1050	0.60
9.	Kalyandurg	1980	7.90	3280	630	-	-	138	69	308	266	Nil	872	567	1.25
		1981	8.85	1420	440			54	74	127	0.8	18	256	234	1.00
		1982	8.00	1650	565			90	83	115	2.30	0	305	255	-
		1983													
		1984	8.14	2110	615	-	-	982	89.9	-	-	Nil	195.2	361.6	-

Contd 3/-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
10.	Uravakonda	1980	7.55	2519	860	-	-	208	83	179	3.90	Nil	299	345	1.30
		1981													
		1982	8.00	2620	820			198	79	221	7.00	0	165	376	-
		1983	7.53	2550	710			168	70	271	4.00	0	317	319	-
		1984	7.80	2400	615	-	-	138	65.6	-	-	Nil	335.5	280.1	-
		1985	7.40	2600	660	-	-	136	78	262	3.10	Nil	354	298	-
11.	Thagguparthi	1982	7.90	4270	765	-	-	130	107	598	13.00	-	531	376	-
		1983	7.95	4240	285	-	-	72	25	805	8.00	-	634	412	-
		1984	7.66	4300	750	-	-	74.1	137.3	-	-	Nil	664.9	379.3	-
		1985	8.50	7990	1000	-	-	40	219	1587	8.2	72	781	709	1.70
12.	Mudigubba	1982	8.20	1870	405	-	-	60	62	235	7.00	-	238	309	-
		1983	7.96	1265	435	-	-	62	68	216	7.00	-	348	266	-
		1984	8.00	2970	535	-	-	48.1	100.90	386.4	9.4	Nil	427.0	4998	-
		1985													
13.	Hindupur	1982	7.80	1450	450	-	-	84	58	115	15.00	-	378	220	-
		1983	8.02	1163	350	-	-	48	56	120	2.00	-	305	146	-
		1984	8.35	1089	255	-	-	40.1	44.9	-	-	Tr.	2867	141.8	-
14.	Dharmavaram	1982	7.80	885	355	-	-	98	27	38	2.00	0	214	107	-
		1983	7.95	1022	335			86	28	8	2.00	0	360	103	-
		1984	7.25	1108	345	-	-	98.2	243	87.4	1.90	Nil	427	134.70	-
		1985	7.70	1317	415	-	-	124	26	90	1.1	Nil	427	170	0.70
15.	Madakasira	1982	8.20	1420	385	-	-	50	63	143	14.00	-	299	216	-
		1983	7.80	1809	565	-	-	110	71	150	9.00	-	524	266	-
		1984	7.45	1473	380	-	-	78.10	44.9	-	-	Nil	549	202	-
		1985	8.55	1250	365	-	-	46	61	108	7.00	24	214	216	0.70

Contd..... 4/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
KURNOOL DISTRICT:																
1. Kurnool		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-
		4/1977	7.72	1300	228	228	-	66	15	184	-	351	168	-	-	-
		4/1978	8.55	1200	250	275	Nil	68	20	150	12	287	167	-	0.40	-
		1980	7.70	1760	365	-	-	104	26	161	15	Nil	400	266	0.36	-
		1981	8.15	1220	130	-	-	26	16	189	3.1	Nil	226	202	0.54	-
		1983	-	1293	-	-	-	-	-	-	-	-	-	261	-	-
		1984	7.15	1622	375	-	-	118.20	19.4	220.8	14.1	Nil	542.9	216.2	-	-
		1985	8.35	1540	170	-	-	36	19	253	20	18	226	252	-	-
2. Nandyal		4/1970	7.70	2522	390	-	-	56	60	408	4	-	490	300	1.75	
		4/1971	8.00	2887	-	-	-	72	70	400	5	-	455	380	2;00	
		4/1972	8.60	2400	380	-	-	44	65	370	3	-	340	330	2.00	
		5/1975	8.70	2936	410	205	-	32	80	-	-	-	250	433	-	
		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	1.94	-
		4/1977	7.96	3910	750	400	350	116	112	610	-	-	488	610	-	-
		7/1978	8.00	3204	500	320	180	88	68	-	-	-	391	524	1.78	-
		1980	8.20	3170	570	-	-	84	88	495	4.70	Tr.	513	504	1.55	-
		1981	7.95	2940	496	-		70	78	437	6.70	Nil	531	447	1.70	-
		1982	8.1	3740	595			154	51	584	6.70	0	336	667	-	
		1983	-	3010	-	-	-	-	-	-	-	-	-	482	-	-
		1984	7.70	5110	950	-	-	130	182	56.4	14.9	-	494.1	935.9	-	-
		1985	8.70	4960	760	-	-	52	153	863	5.1	18	177	936	-	-
3. Srisailam		11/1978	9.25	508	110	90	20	16	17	37	2,8	24	61	82	-	-
		4/1979	7.55	845	240	158	82	68	17	65	2.4	Nil	192	10.6	0.29	-
		1980	7.55	654	178	-	-	46	15	40	18	Nil	195	112	0.52	-
		1981	7.20	886	235	-	-	64	18	62	51	Nil	165	128	0.34	-
		1982														
		1983	-	734	-	-	-	-	-	-	-	-	-	103	-	-
		1984	8.60	962	240	-	-	62	20.70	101.20	30.5	30.00	976	145.3	-	-
		1985	7.45	850	225	-	-	64	16	67	28	Nil	287	110	0.32	-

Contd..... 5/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
4.	Allagadda	4/1977	7.79	880	230	180	3	80	7.3	109	-	-	220	307	-	
		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	0.54	
		4/1978	7.92	280	250	195	55	86	8.5	104	2.40	Nil	238	128	0.30	
		4/1979	7.90	920	205	100	105	64	-	109	2.00	Nil	122	160	0.52	
		1980	7.70	1000	250	-	-	84	9.7	108	2.7	Nil	269	67	0.44	
		1981	7.75	800	178	-	-	56	9.1	92	2.0	Nil	195	112	0.52	
		1982														
		1983	-	736	-	-	-	-	-	-	-	-	-	113.	-	
		1984	7.25	1054	255	-	-	88.2	8.5	126.5	2.3	Nil	274.5	138.3	-	
		1985														
5.	Dhone	4/1970	8.10	1349	420	-	-	40	77	115	15	-	590	118	1.50	SO_4:
		4/1971	7.80	1767	600	-	-	72	102	90	3	-	364	298	1.00	SO_4:
		4/1972	7.90	1831	550	-	-	52	98	200	11	-	540	360	2.00	SO_4:
		4/1974	8.00	2103	593	473	-	45	117	-	-	-	611	498	-	
		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	1.68	
		4/1977	8.86	1840	330	370	-	24	66	276	-	-	360	323	-	
		4/1979	8.25	2800	801	440	361	80	146	382	22	Nil	537	574	1.85	
		1980	7.95	2850	970	-	-	76	146	286	16	Nil	531	645	1.35	
		1981	7.65	2820	755	-	-	70	141	92	20	Nil	195	112	0.52	
		1982	7.30	2640	1140	-	-	82	227	27	15	0	433	603	-	
		1984	7.30	3940	1000	-	-	1082	177.4	414	16.00	Nil	512.4	790.5	-	
		1985	7.60	3650	820	-	-	80	175	276	9.8	Nil	610	674	0.70	
6.	Kodumuru	1980	8.40	800	145	-	-	16	26	111	9.80	6.0	391	50	1.32	
		1981	8.60	812	145	-	-	16	26	115	5.0	36	244	46	1.50	
		1982	8.30	876	155	-	-	18	27	124	9.1	0	415	43	-	
		1983	-	865	-	-	-	-	-	-	-	-	-	60	-	
		1984	7.30	793	120	-	-	30.10	10.90	140.30	2.7	-	359.9	67.4	-	
		1985	7.45	884	140	-	-	26	18	129	11	Nil	482	50	-	
7.	Pattikonda	1980	8.25	880	290	-	-	42	45	82	2.0	Nil	424	55	1.15	
		1981	8.88	897	283	-	-	46	41	78	2.0	Nil	429	48	1.45	
		1982	8.5	914	270	-	-	52	34	87	Tr.	54	342	60	-	
		1984	8.85	991	90	-	-	12	14.6	220.8	1.40	-	335.5	63.8	-	
		1985	8.00	1000	300	-	-	44	46	92	Tr.	Nil	458	71	0.60	

Contd..... 6/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
8.	Adoni	1980	8.95	2060	140	-	-	10	28	378	13	45	330	305	1.15	-
		1981	8.05	2270	245	-	-	58	24	368	31	Nil	74	294	1.00	-
		1982	7.70	1640	625	-	-	108	86	66	10	0	384	326	-	-
		1983	-	1235	-	-	-	-	-	-	-	-	-	253	-	-
		1984	8.25	1222	440	-	-	48.1	77.7	80.5	9.4	Nil	256.2	216.2	-	-
		1985	7.50	2600	972	-	-	174	130	83	11	Nil	427	482	0.20	-
9.	Atmakur	1980	7.90	465	165	-	-	36	18	32	1.00	Nil	226	32	0.70	
		1981	7.70	695	230	-	-	62	18	60	2.00	Nil	336	34	1.70	
		1982	7.30	973	195	-	-	72	3.7	133	2.00	-	293	121	-	
		1984	7.50	3060	825	-	-	116.20	27.9	138.0	7.40	Nil	481.9	177.3	-	
		1985														
10.	Banaganipalle	1981	7.85	1200	200	-	-	47	20	179	1.20	Nil	476	177	1.25	
		1982	7.80	1360	185	-	-	32	26	229	Tr.	0	439	188	-	
		1984	7.50	1544	260	-	-	64.4	24.30	234.6	0.80	Nil	500.2	216.20	-	
		1985	7.60	1630	305	-	-	86	22	207	Tr.	Nil	537	252	0.65	-
11.	Nandikottur	1981	7.45	1570	463	-	-	141	26	133	2.0	Nil	256	223	0.73	
		1982	7.50	1560	365	-	-	104	26	165	1.6	0	238	309	-	
		1983														
		1984	7.85	3060	-	-	-	254.50	46.2	299	2.7	Nil	140.3	5140	-	
		1985	7.85	2070	510	-	-	138	40	207	23	Nil	140	337	-	
12.	Aluru	1981	7.65	900	260	-	-	56	29	187	7.8	Nil	369	75	2.00	
		1982	7.35	500	120	-	-	30	11	58	0.78	0	201	37	-	
		1983														
		1984	8.50	1086	285	-	-	52	37.70	128.8	4.30	Nil	3294	131.20	-	
		1985	7.40	1005	290	-	-	62	33	83	7.4	Nil	452	85	0.70	
13.	Emiganur	1981	7.85	1980	240	-	-	48	29	322	31	Nil	568	305	2.30	
		1982	7.50	1850	230	-	-	52	24	98	30	0	488	312	-	
		1983	-	2200	-	-	-	-	-	-	-	-	-	383	-	
		1984	7.85	2740	275	-	-	58.1	31.6	437	83.6	Nil	603.9	368.7	-	
		1985	8.00	1084	110	-	-	22	13	191	16	Nil	452	110	0.95	

Contd..... 7/-.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
14. Mantralayam		1981	8.15	11160	961	-	-	104	170	2140	39	Nil	1040	2400	1.40	
		1982	8.70	12250	835	-	-	28	186	2520	20	90	488	2950	-	
		1983														
		1984														
		1985	8.45	1145	205	-	-	34	29	184	1.6	24	336	103	0.95	-
CUDDAPHA DISTRICT :																
1. Cuddapah		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		4/1977	8.10	2520	283	608	-	32	49	280	-	-	-	-	0.46	-
		4/1978	8.37	2635	279	746	Nil	28	51	503	25	22	740	471	-	-
		1980	8.20	4550	630	-	-	140	88	770	24	Tr.	904	355	-	-
		1981	8.00	3690	435	-	-	75	60	495	39	Nil	1370	943	0.40	-
		1982	7.65	6410	640	-	-	100	91	1260	28	Tr.	854	730	0.47	-
		1984	8.35	1568	360	-	-	48.1	34	112.7	14.5	24	1280	1440	-	-
		1985	8.15	6820	700	-	-	52	139	1400	22	Nil	597.8	148.9	-	-
2. Vempalle		4/1970	7.5	1156	400	-	-	48	67	75	2	-	1458	1546	0.53	-
		4/1971	8.4	1034	370	-	-	40	150	120	2	28	550	40	1.75	
		4/1972	8.3	1236	380	-	-	56	58	60	1	-	481	46	1	
		4/1976	8.00	1150	420	-	-	45	75	-	-	-	520	50	2	
		1/1977	-	-	-	-	-	-	-	-	-	-	515.4	110	-	-
		4/1977	8.30	1000	333	370	-	31	62	87	-	7.40	-	-	2.12	-
		4/1978	8.02	1030	330	379	Nil	32	61	91	1.6	Nil	461	60	2.00	-
		4/1979	8.20	1095	425	405	20	54	63	79	1.6	Nil	494	78	1.50	-
		1980	8.10	1060	473	-	-	63	77	18	2.0	Nil	537	67	1.95	-
		1981	7.85	1080	400	-	-	49	67	75	0.8	Nil	528	62	2.40	-
		1982	8.32	1050	390	-	-	36	73	62	2.0	3.9	406	92	-	-
		1984	8.25	1400	480	-	-	28.1	99.6	230	2.7	Nil	500.2	202.1	-	-
		1985	7.80	1511	450	-	-	40	85	154	5.9	Nil	665	131	0.93	-

Contd..... 8/-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(1
3.	Rayachoti	1/1977	-	-	-	-	-	-	-	-	-	-	-	-	0.64	
		4/1977	7.75	2750	1080	105	975	228	124	124	-	-	128	588	-	
		4/1978	7.85	655	235	231	4	51	26	36	6.0	Nil	281	30	1.22	
		4/1979	8.22	574	218	193	25	40	29	32	35	Nil	235	27	1.00	
		1/1980	7.7	795	350	-	-	80	37	32	4.3	Nil	330	46	1.15	
		1981	8.05	680	258	-	-	56	29	37	2.7	Nil	299	32	1.50	
		1982	8.56	627	250	-	-	43	35	29	Tr.	Nil	250	43	-	
		1984	8.00	457	455	-	-	66.1	70.5	66.7	7.0	Nil	372.1	187.9	-	
		1985	8.00	1208	490	-	-	102	57	64	4.7	Nil	390	128	0.65	
4.	Rajampeta	1/1977	-	-	-	-	-	-	-	-	-	-	-	-	1.70	
		4/1977	8.0	2520	528	230	298	61	91	332	-	-	281	506	-	
		4/1978	8.48	2750	526	229	297	64	89	345	29	27	223	497	1.58	
		4/1979	7.90	2980	761	420	341	128	107	310	28	Nil	513	496	10.05	
		1980	7.95	3020	823	-	-	140	115	312	3.7	Nil	534	553	1.25	
		1981	7.55	3120	845	-	-	120	133	321	31	Nil	537	567	1.30	
		1982	8.18	3500	800	-	-	30	176	391	27	6.0	262	837	-	
		1984	7.50	4040	990	-	-	148.3	150.7	425.5	43	Nil	427	833.1	-	
		1985	8.45	3350	600	-	-	44	143	414	30	18	98	780	0.66	
5.	Badvel	4/1977	8.00	4400	780	285	495	86	136	667	-	-	348	112	-	
		4/1978	7.80	3385	639	227	412	81	107	466	4.4	Nil	272	794	1.18	
		4/1979	7.75	2705	641	340	301	96	97	320	2.4	Nil	415	582	0.92	
		1980	7.90	3960	890	-	-	126	140	575	3.5	Nil	543	1000	1.25	
		1981	7.82	2520	610	-	-	94	91	290	2.0	Nil	455	525	1.25	
		1982	8.66	2740	460	-	-	104	49	345	125	42	305	468	-	
		1984	8.35	6240	985	-	-	46.1	211.4	943	6.3	24	322.1	1871.8	-	
		1985	8.25	3261	600	-	-	148	73	920	6.6	Nil	329	1206	0.10	
6.	Muddanur	1982	8.90	1080	205	-	-	12	43	152	3.1	78	256	119	-	
		1984	8.75	1728	235	-	-	10	51	312.8	4.3	72	445.3	241.1	-	
7.	Proddatur	1982	8.87	1480	140	-	-	28	17	189	153	66	397	152	-	
		1984	7.5	5680	800	-	-	182.4	83.8	920	8.6	Nil	366	1531.4	-	
		1985	7.75	5120	670	-	-	148	73	920	6.6	Nil	329	1206	0.15	

Contd..... 9/-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
CHITTOOR DISTRICT:																
1. Chittoor		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	0.30	-
		4/1977	8.25	850	135	288	-	24	18	129	-	-	351	64	-	-
		7/1978	7.80	1161	230	430	Nil	48	27	-	-	-	525	114	-	-
		4/1979	7.65	1030	240	380	Nil	52	27	130	0.04	Nil	464	85	1.00	-
		1980	7.40	1170	285	-	-	62	32	92	0.8	Nil	534	117	1.50	-
		1981	7.56	1160	305	-	-	72	30	120	4.3	Nil	464	121	1.20	-
		1982	7.60	1420	338	-	-	87	29	184	2.7	0	567	142	-	-
		1983	7.93	906	325	-	-	390	85	-	86	27	66	6	-	-
		1984	8.20	926	160	-	-	28.1	21.9	149.5	3.90	Nil	298.9	113.4	-	-
		1985	7.90	2150	470	-	-	20	102	276	3.9	Nil	470	351	0.65	-
2. Puttur		4/1970	7.5	341	140	-	-	24	19	19	Tr.	-	185	29	0.5	SO4 -
		4/1971	7.6	401	170	-	-	28	24	40	15	-	218	26	Nil	" -
		4/1972	8.0	450	180	-	-	44	16	35	1	-	240	40	0.5	" -
		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	1.46	-
		4/1977	7.75	5200	1480	115	1365	230	220	529	-	-	140	1320	-	-
		4/1979	7.70	3100	911	270	641	140	136	310	2.0	Nil	330	694	1.20	-
		1980	7.85	3950	1080	-	-	150	171	396	3.9	Nil	159	1000	0.60	-
		1981	7.80	3680	1040	-	-	158	158	336	2.0	Nil	427	812	0.75	-
		1982	8.4	3870	1120	-	-	196	153	409	2.7	0	601	858	-	-
		1983	7.45	4490	1390	-	-	500	1070	-	244	190	380	4	-	-
		1984	7.60	6890	1680	-	-	266.5	246.7	759	2.3	Nil	567.3	1602.3	-	-
		1985	8.15	5500	1472	-	-	200	236	633	2.7	Nil	122	1404	0.50	-
3. Tirupathi		1/1977	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-
		4/1977	7.60	370	123	165	-	40	5.5	242	-	-	201	14	-	-
		4/1978	9.56	98	18	77	Nil	5	1.2	41	2.0	30	31	15	0.46	-
		4/1979	8.15	220	40	80	Nil	15	0.6	26	0.4	Nil	97	21	0.50	-
		1980	7.85	310	88	-	-	26	55	28	2.4	Nil	107	48	0.39	-
		1981	8.15	243	50	-	-	11	55	31	0.8	Nil	857	27	0.4	-
		1982	7.90	324	95	-	-	30	4.9	31	2.0	0	79	50	-	-
		1983	8.8	1732	173	-	-	366	316	48	154	33	290	6	-	-
		1984	7.65	286	90	-	-	301	3.6	23	Nil	Nil	103.7	28.4	-	-
		1985	8.10	1980	435	-	-	28	89	230	70	Nil	634	355	0.50	-

Contd..... 10/-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(1
4. Kalahasthi		1/1977	-	-	-	-	-	-	-	-	-	-			0.54	-
		4/1977	8.25	1150	235	193	42	40	33	138	-	-	229	193	-	-
		4/1978	8.68	1085	212	169	43	27	35	155	3.2	27	149	204	0.66	-
		4/1979	8.[illegible]	1140	250	110	140	32	41	130	2.0	18	98	195	0.53	-
		1980	8.10	1270	400	-	-	88	44	113	2.4	Nil	427	156	0.45	-
		1981	7.72	1130	308	-	-	49	45	106	2.4	Nil	259	184	0.47	-
		1982	7.90	2760	400	-	-	99	37	296	86	Nil	293	482	-	-
		1983	7.54	1045	300	-	-	308	156	-	59	37	95	18	-	-
		1984	7.55	1276	290	-	-	38.1	47.4	156.4	3.5	Nil	457.5	170.2	-	-
		1985	8.05	1357	300	-	-	20	61	152	1.6	Nil	366	138	0.50	-
5. Somala		4/1977	7.90	820	230	213	17	43	30	110	-	-	259	89	-	-
		4/1978	8.32	862	175	164	11	21	30	97	1.6	25	148	114	1.92	-
		4/1979	7.70	1000	350	270	80	66	46	79	0.8	-	330	121	1.20	-
		1980	7.75	1220	285	-	-	98	97	149	0.4	Nil	433	147	1.25	-
		1981	7.60	870	285	-	-	50	39	67	Tr.	Nil	360	67	1.20	-
		1982	7.20	2500	531	-	-	163	30	212	121	Nil	421	417	-	-
		1983	8.45	781	220	-	-	189	103	18	24	39	78	1	-	-
		1984	-	-	-	-	-	-	-	-	-	-	-	-	0.50	-
		1985	8.40	974	275	-	-	32	47	94	1.2	12	171	145	-	-
6. Pileru		4/1977	8.35	1600	225	470	-	19	43	83	-	-	561	227	-	-
		4/1978	8.60	1420	191	513	Nil	18	36	280	2.4	10	586	162	2.34	-
		4/1979	8.15	1600	200	491	180	40	24	270	2.0	Nil	598	227	2.00	-
		1980	7.80	1390	230	-	-	26	40	230	2.0	Nil	601	144	2.20	-
		1981	7.80	1050	170	-	-	32	22	76	Tr.	Nil	256	67	1.20	-
		1982	7.4	1880	395	-	-	72	52	262	2.0	0	732	252	-	-
		1983	8	1246	305	-	-	415	192	-	44	47	150	3	-	-
		1984	7.85	1685	240	-	-	26.1	42.5	326.6	1.6	Nil	707.6	212.7	-	-
		1985	7.90	3240	780	-	-	92	134	460	2.7	Nil	622	730	0.90	-

Contd..... 11/-.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
7.	Bhakrapet	4/77	7.90	1340	480	148	332	89	63	81	-	-	180	250	-	-
		4/78	8.20	1320	413	113	300	64	62	104	1.6	Trace	137	250	0.76	-
		4/79	7.50	1875	631	240	391	132	73	110	1.2	Nil	293	347	0.70	-
		/80	7.35	1550	655	-	-	135	77	54	1.6	Nil	384	269	0.72	-
		/81	7.50	1820	810	-	-	174	91	51	Trace	-do-	500	298	0.56	-
		/82	7.05	2100	828	-	-	180	92	95	2.0	0	488	328	-	-
		/83	7.60	1280	265	-	-	-	-	-	158	114	85	3	-	-
		/84	7.20	3120	1255	-	-	244.5	156.8	218.5	1.9	Nil	402.6	751.5	-	-
		/85	8.05	3100	997	-	-	148	152	184	3.1	-do-	116	613	2.15	-
8.	Kalluru	4/77	8.32	1555	368	275	93	47	61	184	-	-	311	316	1.00	-
		4/78	7.45	2420	722	125	597	180	66	170	8.0	Nil	153	479	0.70	-
		4/79	8.15	2236	791	170	621	200	471	141	2.4	-do-	208	440	0.36	-
		/80	7.85	2140	695	-	-	160	72	166	5.1	Nil	137	454	0.35	-
		/83	7.9	6520	1520	-	-	1159	1633	-	440	102	690	215	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
9	Damalcheruvu (Damarcherla)	4/78	8.25	1535	196	446	Nil	18	37	262	0.8	Trace	543	142	1.80	-
		4/79	8.20	1125	245	476	-do-	48	30	176	-do-	Nil	580	71	2.10	-
		4/80	7.95	956	350	-	-	68	44	64	2.4	-do-	366	103	1.80	-
		/81	7.80	968	380	-	-	42	67	55	Trace	-do-	470	78	1.20	-
		/82	7.60	1090	250	-	-	35	41	133	0.8	0	574	71	-	-
		/83	8.13	1013	270	-	-	506	71	-	22	40	150	Trace	-	-
		/84	7.75	1393	260	-	-	301	44.9	230	Nil	Nil	677.1	127.6	-	-
		/85	8.60	857	160	-	-	12	32	138	1.2	36	415	46	1.15	1.15
10	Penumuru	4/78	8.00	3040	1144	273	871	336	73	136	6.4	Nil	333	656	0.84	-
		4/79	8.60	1504	601	250	351	160	49	82	3.9	24	256	273	0.52	-
		/80	7.25	1400	538	-	-	146	42	69	-do-	Nil	323	245	0.60	-
		/81	7.30	923	355	-	-	82	37	46	2.7	-do-	299	106	0.56	-
		/82	7.65	1210	440	-	-	107	42	76	3.9	0	574	71	-	-
		/83	7.66	663	263	-	-	314	67	-	72	20	35	2	-	-
		/84	8.10	1865	665	-	-	782.3	51	124.2	7.8	Nil	475.8	343.9	-	-
		/85	7.95	2650	972	-	-	272	71	129	3.9	-do-	34.2	507	0.80	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
11	Puthalpattu	4/78	7.80	2260	483	307	173	122	41	230	125	-	375	425	0.80	-
		4/79	8.10	2520	591	340	251	64	103	225	117		-415	440	0.40	-
		4/80	7.9	1500	380	-	-	85	41	152	45	0	616	158	-	-
		/83	7.93	2250	525	-	-	427	373	-	134	46	207	94	-	-
		4/84	8.25	2340	490	-	-	122.2	44.9	257.6	125.1	Nil	597.8	368	-	-
		/85	8.10	2900	760	-	-	192	68	267	70	-do-	452	489	0.50	0.50
12	Nandragaon	4/78	8.65	1030	127	330	Nil	14	23	149	40	36	330	84	1.56	-
		4/79	8.10	2520	591	340	251	64	103	225	117	-	415	440	0.40	-
		4/80	7.95	1110	278	-	-	61	30	107	36	Nil	598	64	1.70	-
		4/81	7.80	989	250	-	-	54	28	113	12	-do-	513	43	-do-	-
		4/82	7.20	1530	375	-	-	86	39	148	46	0	619	156	-	-
		4/83	7.55	1152	252	-	-	518	101	-	45	27	143	31	-	-
		4/84	8.45	1512	255	-	-	26.1	46.2	211.6	78.2	1.2	402.6	202.1	-	-
		4/85	8.10	366	115	-	-	32	8.5	28	Traces	Nil	134	43	0.95	0.95
13	Anantapuram (Jangalapalle)	4/78	8.90	1340	227	462	Nil	28	38	207	414	Trace	564	118	1.58	-
		4/79	7.90	1405	320	430	-do-	24	33	-do-	0.8	Nil	525	163	1.55	-
		/80	8.15	1260	175	-	-	15	-do-	209	3.9	-do-	558	117	1.72	-
		/83	- - - - - - - - - - - - - - - - - - - -							Dry						
		85	8.05	1764	355	-	-	66	45	267	3.5	-do-	811	121	0.90	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
14.	Panatoor	4/78	7.60	1140	286	148	138	82	20	92	1.6	Nil	180	160	1.40	-
		/79	7.60	985	355	200	155	108	21	67	0.4	"	244	124	0.29	-
		/80	7.65	875	325	-	-	89	21	52	3.9	"	275	94	1.10	-
		/81	7.27	878	330	-	-	80	32	49	Trace	"	299	85	0.92	-
		/82	7.00	1040	403	-	-	116	27	53	1.2	0	317	108	-	-
		/83	8.00	858	320	-	-	262	156	-	80	29	46	2	-	-
		/84	8.00	1410	440	-	-	136.3	24.3	124.2	Nil	Nil	183	187.9	-	-
		/85	8.25	855	260	-	-	56	29	67	1.2	Traces	134	106	0.52	-
15.	Paradarami	4/78	7.98	784	147	155	Nil	27	16	95	2.0	Nil	189	108	1.40	-
		4/79	7.95	750	205	185	20	42	24	81	1.6	Nil	226	89	0.84	-
		/80	8.60	505	120	-	-	15	20	71	2.6	15	137	64	0.93	-
		/81	7.50	788	270	-	-	74	21	57	2.0	Nil	354	43	0.96	-
		/82	7.65	845	283	-	-	70	26	64	2.0	0	388	60	-	-
		/83	7.70	833	275	-	-	378	75	-	80	29	46	2	-	-
		/84	8.00	665	155	-	-	42.1	12.2	82.8	1.2	Nil	256.2	74.4	0.93	-
16.	Pallipattm	4/78	8.50	3410	521	268	253	37	103	506	39	50	226	688	0.80	-
		4/79	7.70	2950	721	390	331	100	90	336	47	-	476	596	0.40	-
		/80	7.60	2800	700	-	-	116	100	308	54	Nil	589	532	0.35	-
		/81	7.30	1800	415	-	-	92	45	179	53	"	458	301	0.42	-
		/82	7.35	3790	888	-	-	144	128	402	5.3	0	723	782	-	-
		/83	8.30	2470	393	-	-	247	255	30	20	83	311	55	-	-
		/84	8.00	3260	550	-	-	301	115.4	414.0	58.6	Nil	445.3	634.5	-	-
		/85	7.80	3680	810	-	-	120	124	460	55	"	470	738	0.30	-

1	2		4	5	6	7	8	9	10	11	12	13	14	15	16	17
17.	Nagalapuram	4/78	8.63	1270	199	245	Nil	21	35	179	40	36	226	191	0.50	-
		4/79	8.30	1400	335	355	"	76	35	130	40	-	433	167	0,20	-
		/81	8.20	1300	265	-	-	60	28	145	39	Nil	421	170	0.24	-
		/82	8.41	1310	305	-	-	68	33	150	30	18	384	178	-	-
		/84	8.95	1710	245	-	-	26	44	212	3.9	18	354	238	-	-
		/85	8.05	760	263	-	-	27	47	48	10	Nil	247	103	-	-
18.	Satyavedu	4/77	7.85	340	113	90	23	32	7.9	15	-	-	110	28	-	-
		4/78	8.28	335	98	79	19	29	6,3	21	13	Trace	97	37	0.12	-
		4/79	7.30	169	45	28	17	11	4.3	15	10	-	34	32	0.20	-
		/81	7.30	241	70	-	-	16	7.3	16	11	Nil	43	35	0.30	-
		/82	7.97	380	130	-	-	42	6.1	16	10	0	122	35	-	-
		/84	8.70	307	60	-	-	18	3.7	21	13	18	6 7	46	-	-
		/85	7.85	418	80	-	-	20	7	15	16	Nil	0.85	53	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
19.	Chandragiri	4/78	8.16	495	137	176	Nil	32	13	56	[illegible]0	Trace	214	48	0.28	-
		4/79	8.30	710	328	280	48	11	24	32	[illegible]		342	66	0.60	-
		/80	8.65	495	215	-	-	32	33	18	3.9	21	125	75	0.40	-
		/83	7.25	793	320	-	-	488	32	-	106	13	24	29	-	-
		/84	7.60	1855	505	-	-	122.2	48.6	174.8	36.7	18	390.4	393.5	-	-
		/85	8.20	2010	540	-	-	82	81	179	55	Nil	165	404	-	-
20.	Nagari	4/78	8.86	2110	196	310	Nil	16	38	442	8.0	1.70	269	362	0.78	-
		/79	7.95	2375	390	471	"	72	51	376	11	-	574	412	0.50	-
		/81	7.85	1620	355	-	-	80	38	207	9.4	Nil	500	225	0.70	-
		/84	8.30	3470	395	-	-	44	69	460	11	6.0	250	603	-	-
		/85	8.35	2740	415	-	-	46	72	431	11	3.0	195	482	-	-
21.	Karvetinagar	4/78	8.67	740	188	294	Nil	21	33	86	4.8	1.20	287	47	1.08	-
		4/79	8.20	555	250	270	"	46	33	39	2.0	-	330	16	1.20	-
		/80	7.9	722	283	-	"	56	35	48	3.5	Nil	430	23	1.20	-
		/82	7.1	855	278	-	-	63	29	62	3.1	0	482	39	-	-
		/83	7.25	532	185	-	-	201	53	18	24	30	37	2	-	-
		/84	7.5	843	305	-	-	58.1	38.9	60.95	1.6	6	390	77.9	-	-
		/85	8.00	544	165	-	-	20	28	38	2.3	Nil	293	19	1.25	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
22.	Bangarupalem	4/78	7.73	1810	454	146	308	102	48	154	2.0	-	177	375	1.14	-
		4/79	7.60	350	471	260	211	108	49	100	1.4	-	317	223	0.82	-
		/80	8.60	910	225	-	-	24	40	100	2.0	18	131	176	1.05	-
		/81	7.30	1470	480	-	-	92	61	115	Trace	Nil	397	230	0.74	-
		/82	7.30	1100	340	-	-	72	39	95	2.0	0	415	131	-	-
		/83	7.71	1127	350	-	-	390	163	-	82	35	97	2	-	-
		/84	7.80	1337	345	-	-	82.2	34	147.2	0.8	6	469.7	187.9	0.70	-
		/85	7.60	1455	455	-	-	82	61	133	2	Nil	323	277	-	-
23.	Madanapalle	4/70	7.6	1445	430	-	-	80	50	123	5	-	-	132	-	-
		4/71	7.7	1207	330	-	-	56	46	100	5	-	439	118	1	No=35 3
		4/72	8.2	867	220	-	-	32	34	106	1	-	400	70	2	-
		5/74	7.45	1700	488	880	-	110	52	-	-	-	1092	163	-	-
		1/77	-	-	-	-	-	-	-	-	-	-	-	-	2.50	-
		4/77	8.35	1060	158	420	-	16	29	182	-	-	500	66	-	-
		4/78	8.40	1080	170	411	Nil	18	103	184	1.6	0.83	452	77	3.40	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		4/79	8.00	1100	245	410	Nil	40	35	159	1.2	Nil	500	92	2.20	-
		/80	7.50	1815	360	-	-	62	50	251	1.6	"	793	218	3.15	-
		/82	7.05	1240	325	-	-	75	33	148	1.2	0	589	98	-	-
		/83	7.72	1016	250	-	-	488	75	-	44	34	138	1	-	-
		/84	8.55	1170	215	-	-	20	40.1	202.4	1.9	1.2	359.9	131.2	-	-
24.	Panganoor	4/77	8.10	740	160	275	-	26	23	106	-	-	336	66	-	-
		4/78	8.42	710	121	222	Nil	24	15	110	2.4	0.74	226	75	0.84	-
		4/79	7.65	1140	235	340	"	50	27	161	0.4	Nil	415	156	0.60	-
		/80	7.70	1520	260	-	-	50	33	230	0.4	"	534	252	0.56	-
		/81	7.88	900	230	-	-	42	130	97	Trace	"	360	92	0.52	-
		/82	7.35	900	273	-	-	72	23	97	1.6	0	442	87	-	-
		/83	7.56	1197	230	-	-	427	181	-	42	30	181	Trace	-	-
		/84	7.5	1324	260	-	-	54.1	30.4	188.6	Nil	Nil	463.6	193.5	-	-
		/85	8.2	1468	275	-	-	32	47	163	Trace	"	336	195	0.66	-
25.	Palamner	1/77	-	-	-	-	-	-	-	-	-	-	-	-	0.66	-
		4/78	7.38	4660	1160	194	966	206	158	534	6	Nil	238	1380	1.00	-
		4/79	7.50	4845	1381	170	1211	272	170	492	5.6	"	208	1420	0.42	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		/80	7.15	5100	1460	-	-	312	165	460	5.5	Nil	338	1420	0.50	-
		/81	7.20	1740	1340	-	-	297	145	440	3.9	"	338	1240	0.44	-
		/82	7.20	4900	1380	-	-	282	165	460	5.9	0	802	1100	-	-
		/83	7.55	4390	1010	-	-	397	1250	-	17	142	506	6	-	-
		/84	7.35	4920	995	-	-	130.3	162.8	609.5	5.9	Nil	457.5	1276.2	-	-
		/85	7.5	5540	1227	-	-	200	176	587	5.5	"	360	1404	0.50	-
26.	Tirumala	/82	8.13	400	158	-	-	57	3.7	18	3.9	Trace	201	28	9	-
		/83	8.00	533	208	-	-	278	50	-	55	17	28	9	-	-
		/84	7.90	472	120	-	-	30.1	2.4	35.7	0.96	Nil	183	35.5	-	-
		/85	8.6	377	130	-	-	26	16	26	5.9	60	171	28	0.30	-
27.	Gangatharanellore(BH)	/83	8.20	1044	175	-	-	372	156	-	22	29	163	1	-	-
28.	Perumallagudipalle(BH)	/83	8.06	781	195	-	-	9	28	-	36	26	97	4	-	-
29.	Molakalacheruvu	4/78	8.60	1065	464	323	141	46	85	74	1.20	5.40	384	137	1.42	-
		4/79	8.20	1100	435	306	130	50	75	64	0.20	-	397	114	1.30	-
		/80	7.95	1040	363	-	-	40	64	72	TR	Nil	372	99	1.60	-
		/83	8.15	2280	795	-	-	415	451	-	56	159	159	1	-	-
		/84	7.85	2860	855	-	-	16.2	161.6	216.2	1.9	Nil	677.1	428.9	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		4/78	8.2	615	170	170	-	42	16	51	4.7	Nil	208	89	1.64	-
		4/79	7.62	1375	435	280	155	130	27	105	5.1	-do-	342	248	0.96	-
		4/81	8.25	994	355	-	-	402	-24	-59	1.6	Trace	403	122	1.40	-
		4/82	7.6	916	363	-	-	118	16	52	15	Nil	433	85	-	-
4	Makhthal	4/70	8.0	422	215	-	-	58	17	20	2	-	270	15	0.5	SO_4: 17
		4/71	7.1	530	240	-	-	64	20	35	3	-	340	26	-do-	-do-: 27
		4/72	8.0	511	-	-	-	56	14	27	5	-	290	35	-do-	-do-:6
		4/73	8.1	370	145	-	-	32	16	-	-	-	232	18	-	-
		4/74	7.6	469	225	278	-	66	15	-	-	-	339	14	-	-
		4/75	7.65	638	250	273	-	-do-	21	-	-	-	333	32	-	-
		4/76	7.45	735	273	-	-	84	15	43	7	-	390	25	-	-
		4/77	8.00	445	160	173	Nil	27	19	32	-	-	214	32	0.74	-
		4/78	8.3	754	365	335	30	97	30	29	7.1	-409	55	0.48	-	
		4/79	7.80	890	370	408	Nil	105	26	43	7.8	Nil	497	60	0.68	-
		4/81	7.50	780	320	-	-	88	24	29	1.1	-do-	98	160	0.42	-
		4/84	7.70	1327	455	-	-	124	35.2	85.1	11.3	-do-	439.2	216.2	-	-
		4/85	7.40	1141	460	-	-	130	33	69	8.2	-do-	525	117	0.43	-
5	Vattivelupalle	11/78	8.05	970	345	85	260	78	37	30	65	Nil	104	167	-	-
		4/79	7.95	780	238	68	170	80	9.7	29	52	-do-	82	123	0.26	-
		4/81	7.55	1040	285	-	-	68	28	28	1.4	-do-	98	160	0.42	-
		4/82	7.2	1190	380	-	-	110	26	44	84	Nil	232	167	-	-

1	2.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
MAHABUBNAGAR DISTRICT:																
1.Jadcherla Crossing		4/77	7.55	630	293	235	58	83	21	18	-	-	287	39	1.36	-
		4/78	8.0	490	210	155	55	50	21	16	Trace	Nil	189	43	1.18	-
		4/79	8.18	465	200	143	2.25	45	21	17	1.8	-do-	174	44	1.20	-
		4/81	7.25	796	360	-	-	96	29	16	13	-do-	403	53	1.40	-
		4/82	7.7	733	335	-	-	86	29	17	2.3	Nil	287	57	-	-
2.Kottakota		4/77	7.35	1500	590	208	382	135	61	70	-	-	253	255	0.78	-
		4/78	7.65	2220	830	190	640	192	85	64	Trace	Nil	232	429	0.64	-
		4/79	8.70	1205	451	65	386	66	69	68	1.2	6.0	67	287	0.63	-
		/81	7.25	3070	1250	-	-	288	128	99	5.1	Nil	305	638	0.62	-
		/82	7.5	4410	1870	-	-	404	208	117	3.9	-do-	208	993	-	-
3.Kalvallkurthy		6/69	7.2	362	130	-	-	36	10	28	1	-	184	18	-	SO_4 : Tr.
		4/70	8.2	396	150	-	-	42	11	20	1	-	190	15	2.0	-do-: 17
		4/71	6.9	344	120	-	-	36	7	35	1	-	175	26	1.75	NO_3: 9
		4/72	7.4	346	-	-	-	40	10	23	1	-	190	20	2.5	SO_4 : 30
		4/73	8.45	287	110	-	-	16	17	-	-	-	122	11	-	-
		4/74	7.5	354	153	180	-	39	13	-	-	-	220	14	-	-
		5/75	8.2	629	233	198	-	50	26	-	-	-	241	82	-	-
		4/76	7.35	960	298	253	45	92	-	92		-	308	129	-	-
		4/77	7.95	825	240	243	-	70	16	60	-	-	296	78	2.00	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		4/83	-	571	-	-	-	-	-	-	-	-	-	67	-	-
		4/85	7.1	1005	280	-	-	66	28	35	74	Nil	128	160	0.52	-
6	Maddur	1/81	7.50	780	320	-	-	88	24	29	1.1	-do-	415	39	0.90	-
		/82	8.3	518	235	-	-	34	37	9.2	2.0	Trace	253	28	-	-
		/83	7.3	545	250	-	-	54	20	17	1.2	"	281	28	-	-
		/84	8.30	621	260	-	-	38.1	40.1	24.2	1.6	"	225.7	63.8	-	-
		/85	8.25	730	290	-	-	48	41	30	1.2	"	244	82	0.10	-
7	Gadwal	/81	8.35	497	175	-	-	28	26	29	6.7	60	171	14	0.90	-
		/82	8.4	537	230	-	-	30	38	16	3.5	9.0	-do-	21	-	-
		/83	-	472	-	-	-	-	-	-	-	-	-	21	-	-
		/84	7.75	763	330	-	-	76.2	34	34.5	109.5	Nil	335.5	28.4	-	-
		/85	7.50	740	320	-	-	54	45	25	2.3	"	366	28	0.60	-
8	NagarKurnool	/81	7.80	814	355	-	-	60	50	20	3.9	"	256	99	1.00	-
		/82	7.75	996	435	-	-	94	49	23	-do-	"	330	106	-	-
		/83	-	862	-	-	-	-	-	-	-	-	-	152	-	-
		/84	7.65	1087	495	-	-	102.2	58.3	33.4	187.7	Nil	372.1	124.1	-	-
		/85	8.20	903	385	-	-	76	47	23	1.6	"	159	149	0.31	-
9	Achampet	/81	7.50	982	450	-	-	84	58	23	-do-	"	397	92	1.00	-
		/82	7.7	1140	535	-	-	-do-	79	14	0.8	Nil	372	124	-	-
		/83	-	940	-	-	-	-	-	-	-	-	-	149	-	-
		/84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		/85	8.25	992	445	-	-	58	73	23	Traces	Traces	256	152	0.18	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	Devarkhadra	/81	7.85	1100	270	-	-	42	40	131	1.2	Nil	549	89	1.00	-
		/82	8.0	1020	235	-	-	32	38	140	Trace	-do-	516	75	-	-
		/83	7.85	1102	230	-	-	24	41	150	-	-	537	99	-	-
		/84	7.4	1093	260	-	-	42.1	37.7	142.6	Trace	Trace	500.2	92.2	-	-
		/85	7.85	1192	-do-	-	-	42	38	163	-do-	Nil	580	89	0.22	-
11	Narayanpet	/81	8.05	3160	651	-	-	88	114	400	5.9	-do-	262	539	1.50	-
		/82	7.96	3680	940	-	-	133	148	425	3.9	-do-	445	603	-	-
		/83	7.5	3400	851	-	-	112	139	363	2.7	-	494	657	-	-
		/84	8.30	3310	535	-	-	-	106.9	483	12.5	Trace	549	638.1	-	-
		/85	7.55	3530	580	-	-	86	89	587	8.6	Nil	1043	642	1.25	-
12	Shadnagar	/81	7.35	590	255	-	-	75	16	18	2.7	-do-	281	46	1.35	-
		/82	-do-	693	243	-	-	60	22	39	2.3	-do-	211	110	-	-
		/83	7.05	906	355	-	-	110	19	28	9	-	378	-do-	-	-
		/85	7.20	876	-do-	-	-	-do-	-do-	30	7.0	Nil	390	85	0.35	-
13	Krishna	/81	8.25	5820	781	-	-	112	122	1050	9.4	54	445	582	1.50	-
		/82	7.85	5740	740	-	-	134	90	1200	5.5	Nil	700	590	-	-
		/83	7.6	6020	691	-	-	88	114	1150	4.7	-	702	638	-	-
		/84	8.25	2550	345	-	-	46.1	115.4	1058	6.6	Nil	-	616.8	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
14	Atmakur	/81	8.55	542	200	-	-	44	22	33	3.1	42	128	43	0.80	-	
		/82	7.85	514	165	-	-	46	12	45	2.0	Nil	208	48	-	-	
		/83	7.7	470	180	-	-	40	19	22	1.2	-	244	28	-	-	
		/84	7.25	456	125	-	-	26.1	14.6	-	1.6	Nil	207.4	35.45	-	-	
		/85	7.65	516	175	-	-	36	21	36	1.2	-do-	232	43	0.60	-	
15	Weljorla	/81	7.45	496	223	-	-	78	73	13	6.7	-do-	269	16	3.2	-	
16	Rawalpalle	/81	7.70	597	280	-	-	60	32	12	6.3	-do-	323	28	0.74	-	
		/82	7.65	617	255	-	-	62	24	20	3.9	-do-	317	25	-	-	
		/83	7.55	539	245	-	-	42	34	10	2	-	287	-do-	-	-	
		/84	8.35	472	205	-	-	-	13.8	87.4	4.7	Nil	201.3	38.9	-	-	
		/85	8.00	530	260	-	-	54	30	13	2.7	-do-	323	21	0.20	-	
17	Kodangal	/82	7.6	967	345	-	-	80	35	62	3.1	-do-	387	82	-	-	
		/83	7.75	731	215	-	-	30	34	59	2	-do-	384	43	-	-	
		/84	8.10	1077	315	-	-	50.1	46.2	71.3	3.5	-do-	176.9	223.3		-	
		/85	8.40	678	195	-	-	30	29	62	1.6	6.0	189	92	0.38	-	
18	Kosgi	/82	7.93	2690	725	-	-	122	102	244	94	Nil	574	416	-	-	
		/83	7.40	879	255	-	-	26	46	78	10	-	445	53	-	-	
		/84	7.60	1253	265	-	-	44.1	37.7	142.6	54.7	Nil	549	127.6	-	-	
		/85	7.50	880	270	-	-	59	33	69	70	Nil	458	43	1.23	-	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
19	Koilkonda	/82	7.7	1020	325	-	-	92	23	75	16	Nil	391	85	-	-
		/83	7.4	1077	355	-	-	54	54	81	7.4	-	409	103	-	-
		/84	7.25	927	280	-	-	76.2	21.9	73.6	18.8	Nil	433.1	77.9	-	-
		/85	7.90	660	200	-	-	40	24	64	8.2	-do-	305	32	0.30	-
20	Suraran	/82	7.85	1280	428	-	-	76	58	106	5.1	Nil	372	165	-	-
		/83	7.56	1209	320	-	-	32	-do-	122	6	-	458	131	-	-
		/84	8.00	1260	365	-	-	42.1	63.2	117.3	1.2	Nil	244	226.9	-	-
		/85	7.70	1465	500	-	-	108	56	113	7.4	-do-	500	220	0.60	-
21	Kurumurthy Station	/82	7.85	481	180	-	-	52	12	29	2.0	-do-	229	28	-	-
		/83	7.80	597	245	-	-	58	24	33	3.1	-	305	25	-	-
		/84	7.2	518	200	-	-	60.1	12.2	31.1	1.6	Nil	562.2	31.9	-	-
		/85	8.25	5410	645	-	-	60	120	1.70	3.9	-do-	506	624	-	-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
22.	Kistapur	1982	7.8	2320	378	-	-	62	54	294	141	Nil	720	287	-	-
		1983	7.6	2600	360	-	-	44	61	308	149	-	677	362	-	-
		1984	8.25	2550	345	-	-	22	70.5	322.0	175.9	Nil	799.1	400.6	-	-
23.	Kotakonda	1982	7.8	3090	[illegible]0	-	-	180	75	332	11	Nil	122	601	-	-
		1983	7.1	3960	1052	-	-	272	90	340	16	-	366	706	-	-
		1984	7.25	927	280	-	-	76.2	21.9	73.6	18.8	Nil	433.1	77.9	-	-
		1985	7.85	3560	912	-	-	240	75	345	18	Nil	901	738	0.50	-
24.	Damargidda	1982	7.95	846	270	-	-	62	29	68	13	Nil	378	64	-	-
		1983	7.50	1399	405	-	-	32	79	129	32	-	531	138	-	-
		1984	7.95	1768	350	-	-	46.1	57.1	225.4	2.7	Nil	378.2	255.2	-	-
		1985	7.85	1259	320	-	-	64	39	136	30	Nil	549	124	0.20	-
25.	Gundimal	1982	8.3	784	163	-	-	33	20	110	3.9	Tr.	177	101	-	-
		1983	7.30	823	250	-	-	60	24	67	12	-	378	60	-	-
		1984	7.50	1208	390	-	-	84.2	43.7	87.4	14.9	Nil	488	145.3	-	-
26.	Amrabad	1982	7.85	868	343	-	-	71	40	53	14	Nil	476	46	-	-
		1983	-	764	-	-	-	-	-	-	-	-	-	82	-	-
		1984	8.55	908	265	-	-	28.1	47.4	92	15.2	30.0	244	124.1	-	-
		1985	7.50	1046	355	-	-	78	39	69	12	Nil	537	57	0.10	-
27.	Lingal	1982	8.0	868	275	-	-	48	38	85	2.3	Nil	458	34	-	-
		1983	-	627	-	-	-	-	-	-	-	-	-	25	-	-
		1985	8.50	820	245	-	-	34	39	85	1.6	9.0	421	32	1.60	-
28.	Nandinne	1982	8.3	718	205	-	-	35	29	51	16	Tr.	104	122	-	-
		1983	-	652	-	-	-	-	-	-	-	-	-	99	-	-
		1984	7.10	988	370	-	-	118.2	18.2	56.4	14.9	Nil	372.1	124.1	-	-
29.	Ramapuram	1982	7.62	1130	148	-	-	34	15	212	1.6	Nil	555	76	-	-
		1983	8.60	1071	150	-	-	24	22	186	0.8	18	506	78	-	-
		1984	8.55	1132	165	-	-	20	27.9	184	1.2	60	427	85.08	-	-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
30.	Musapet	1982	7.8	605	200	-	-	52	17	46	2.0	Nil	278	32	-	-
		1984	8.00	839	300	-	-	82.2	23.1	64.4	2.3	Nil	292.8	85.1	-	-
		1985	7.55	747	285	-	-	70	27	49	1.2	Nil	323	60	0.28	-
31.	Alampur	1982	7.75	1680	355	-	-	94	30	218	4.3	Nil	272	234	-	-
		1983	-	1416	-	-	-	-	-	-	-	-	-	245	-	-
		1984	7.70	1886	485	-	-	144.3	30.4	230.0	5.9	Nil	280.6	283.6	-	-
32.	Koduru Railway Station	1983	7.8	1040	210	-	-	24	36	170	0.8	-	561	67	-	-
		1984	7.8	1100	205	-	-	28.1	32.8	174.8	0.78	Nil	555.1	70.9	-	-
		1985	8.8	995	140	-	-	16	24	168	Tr.	Nil	439	64	0.80	-

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
NALGONDA DISTRICT:																
1.	Chotuppal	4/78	8.45	1943	288	558	Nil	27	54	330	7.8	39	601	254	2.0	-
		4/79	8.05	1980	380	661	-do-	56	22	294	8.3	Nil	806	241	2.20	-
		/80	7.65	1127	388	-	-	105	30	70	3.5	-do-	330	117	1.00	-
		/81	8.10	3010	580	-	-	82	91	414	6.7	-do-	890	472	2.80	-
		/82	7.92	4030	851	-	-	124	131	529	5.9	-do-	939	699	-	-
		/84	8.20	2600	415	-	-	68.1	59.5	414.0	17.2	Nil	829.6	389.9	-	-
2.	Kodad(Old)	4/77	7.65	1725	443	298	145	90	53	4.00	-	-	363	287	1.36	-
3	Kodad(New)	8/77	8175	3120	235	391	Nil	23	43	230	-	40	397	418	-	
		/4/78	8.05	1520	320	236	82	63	39	99	168	Nil	290	247	1.04	
		4/79	7.75	6320	1261	471	790	216	87	350	796	-do-	574	-	0.52	F-11/78 1.20 mg/l
		/80	7.90	5000	693	-	-	131	89	345	7.35	-do-	752	830	0.78	-
		/31	8.10	5140	721	-	-	138	91	-do-	7.04	-do-	689	855	0.64	-
		/82	7.92	4450	465	-	-	78	75	290	6.65	-do-	464	794	-	-
		/83	8.81	3490	400	-	-	74	52	265	527	36	616	504	-	-
		/84	8.70	4310	360	-	-	14	78.9	402.5	742.9	78.2	231.8	829.5	-	-
		/85	7.30	2730	225	-	-	38	32	242	450	Nil	811	330	0.52	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
4.	Suryapet	6/69	7.7	1097	375	-	-	54	46	108	1	-	380	155	-	SO_4 :28
		4/70	8.1	1255	360	-	-	66	47	100	1	-	388	189	0.75	" : 37
		4/71	8.2	1254	-	-	-	44	48	120	1	-	330	205	2.0	" : 44
		4/72	7.9	1250	-	-	-	56	48	115	1	-	420	210	1.5	NO_4 : 5
		5/74	7.9	1070	345	355	-	62	46	-	-	-	440	170	-	SO_4 : 38
		5/75	7.4	1354	390	350	-	66	55	-	-	-	427	213	-	
		4/76	7.6	1725	665	203	462	198	41.35	99	31	-	247	239.3	-	
		4/77	7.35	1485	560	125	435	160	40	72	-	-	153	248	0.60	
		4/78	7.60	1860	788	160	628	232	51	78	2.4	Nil	195	392	0.40	11/78
		4/79	8.05	1410	405	340	65	68	57	156	0.8	"	415	266	1.25	0.10 mg/l
		/80	8.10	1434	365	-	-	63	51	166	1.2	"	488	188	1.80	
		/81	8.20	1800	460	-	-	76	66	207	1.6	"	470	284	1.30	
		/82	8.04	2270	846	-	-	262	[illegible]	106	3.5	Nil	390	326	-	
		/83	8.45	1936	415	-	-	74	52	265	527	36	616	504	-	
		/84	8.50	1713	360	-	-	34.1	66.8	239.2	0.78	62.6	128.1	375.8	-	
		/85	7.20	1925	490	-	-	80	71	235	2.0	Nil	580	337	0.88	
5	Peddavoora	4/77	7.90	1855	215	488	-	47	24	326	-	-	595	227	2.34	-
		4/78	8.50	1410	118	458	Nil	16	19	310	8.2	27	503	184	2.20	11/78-F 2.14 mg/l

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		/80	8.00	1848	230	-	-	46	28	332	9.0	Nil	689	216	2.2	-
		/81	8:30	2100	265	-	-	56	30	358	1.10	36	610	230	1.50	-
		/82	8.03	2440	300	-	-	62	36	409	17	Nil	683	323	-	-
		/83	8.84	1488	115	-	-	14	19	273	8	72	494	142	-	-
		/84	7.80	1903	150	-	-	18	25.5	372.6	13.3	62.6	658.8	251.7	-	-
		/85	8.00	1720	120	-	-	-do-	18	317	5.8	66	500	188	0.50	-
6.Narketpalle		4/77	7.90	1125	268	455	-	62	27	139	-	-	555	71	3.25	-
		4/78	8.20	575	165	245	-	34	20	75	2.8	-	299	41	3.54	-
		4/79	8.70	730	105	285	-	16	16	109	2.0	15	317	50	3.50	11/78-F 3.4 mg/l
		/80	7.90	958	180	-	-	71	-do-	143	-do-	-	482	-do-	4.80	-
		/81	8.00	901	-do-	-	-	44	17	115	1.2	-	470	46	5.60	-
		/82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		/83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		/84	8.20	1353	270	-	-	46.1	37.6	156.4	2.3	-	341.6	170.2	-	-
		/85	7.40	3100	1062	-	-	280	88	184	3.1	Nil	561	553	1.55	-
7.Miryalaguda		4/78	8.50	1275	265	388	-	42	39	178	2.4	15	442	190	3.26	-
		4/79	7.70	3000	561	531	30	96	78	453	-do-	Nil	646	510	2.10	11/78-F 1.02 mg/l

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		/80	8.00	1375	203	-	-	32	30	230	1.6	Nil	519	138	3.40	-
		/81	8.40	1240	190	-	-	30	28	195	-do-	36	366	82	2.5	-
		/82	8.35	1720	285	-	-	36	47	276	1.6	12	390	241	-	-
		/83	7.91	1348	260	-	-	40	39	177	2	-	433	185	-	-
		/84	8.40	1488	270	-	-	28.1	48.6	230.0	2.3	30.0	305.0	230.4	-	-
		/85	8.25	1155	260	-	-	44	36	140	2.0	Traces	512	99	1.28	-
8	Devarkonda	/80	7.90	1070	258	-	-	38	39	143	1.2	Nil	513	89	1.2	-
		/81	7.70	1830	575	-	-	108	74	161	2.7	-do-	323	330	0.66	-
		/82	7.37	2820	861	-	-	226	72	230	-do-	o	470	503	-	-
		/84	8.40	1676	320	-	-	34.1	57.1	243.8	6.6	18	85.4	361.6	-	-
		/85	7.50	2300	570	-	-	136	56	246	1.2	Nil	537	383	0.66	-
9	Dindi	/81	7.65	474	210	-	-	52	20	17	3.5	-do-	275	11	1.70	-
		/82	8.64	446	-do-	-	-	70	8.5	14	1.6	36	195	3.5	-	-
		/84	8.35	340	125	-	-	24	15.8	23	1.2	18	115.9	10.6	-	-
		/85	7.80	505	220	-	-	62	16	17	Trace	Nil	281	14	0.48	-
10	Tipparthi	/80	7.85	950	350	-	-	68	44	44	3.5	-do-	366	103	1.80	-
		/81	8.15	925	400	-	-	82	47	46	3.9	-do-	445	78	1.70	-
		/82	8.1	883	330	-	-	60	40	54	2.7	-do-	439	5.3	-	-
		/84	7.70	908	260	-	-	54.1	30.4	69	3.1	18.0	402.6	81.5	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
11.	Tirumalagiri	/80	7.70	588	278	-	-	80	19	17	2.0	Nil	-	-	0.78	-
		/81	-do-	656	265	-	-	76	18	22	1.3	-do-	330	28	0.50	-
		/82	7.50	622	275	-	-	66	27	16	2.4	-do-	348	18	-	-
		/83	8.32	531	205	-	-	58	15	20	3	6	275	32	-	-
		/84	7.80	661	200	-	-	60.1	12.2	29.9	11.7	18.0	323.3	42.5	-	-
12.	Damarcherla	/81	7.80	1840	515	-	-	114	56	179	2	Nil	470	255	1.2	-
		/82	8.15	1240	475	-	-	90	61	69	1.2	-do-	342	195	-	-
		/83	7.65	1465	515	-	-	100	64	87	5	-do-	366	266	-	-
		/84	8.25	1160	335	-	-	38.1	58.4	119.6	5.9	18.0	219.6	212.7	-	-
		/85	7.45	1090	340	-	-	68	41	87	2.3	Nil	421	110	0.20	-
13	Bhongiri	/80	7.84	938	323	-	-	80	30	68	2.4	Nil	499	124	1.2	-
		/81	7.40	1060	375	-	-	294	34	69	4.7	-do-	354	142	1.05	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		/82	7.60	1140	385	-	-	90	39	67	2.0	Nil	305	138	-	-
		/83	8.04	1119	375	-	-	98	32	76	2	-do-	354	142	-	-
		/84	8.45	850	225	-	-	38.1	31.6	87.4	2.3	24	176.9	134.7	-	-
14.	Kurumedugate	/83	8,21	861	135	-	-	18	22	135	1.56	Nil	488	32	-	-
		/84	8.25	1176	225	-	-	22	-	1.15	1.9	24	585.6	95.7	-	-
		/85	7.65	1040	190	-	-	24	32	154	Traces	Nil	598	46	0.68	-
		/8														
15	Nalgonda	/85	8.00	636	245	-	-	58	24	20	-do-	Nil	281	53	0.36	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
PRAKASAM DISTRICT																
1. Kanigiri		1/77	-	-	-	-	-	-	-	-	-	-	-	-	6.05	
		4/77	7.67	2650	830	263	562	156	107	205	-	-	326	684	-	-
		4/78	7.92	1365	521	230	291	108	61	71	15	Nil	281	223	4.95	-
		4/79	7.65	2610	861	2 0	601	152	117	175	19	"	317	660	5.60	-
		/80	7.25	5900	1890	-	-	404	214	529	24	"	305	1920	4.60	-
		/81	7.81	2740	891	-	-	196	97	161	23	"	317	645	5.00	-
		/82	7.65	5420	1590	-	-	332	183	437	133	Trace	409	1510	-	-
		/83	8.12	3560	490	-	-	164	19	299	21	-	110	1042	-	-
		/ 4	7.70	5360	1455	-	-	210.4	226	494.5	26.2	Nil	237.9	1545.6	-	-
		/85	8.00	1995	690	-	-	128	90	110	2.3	"	134	447	0.90	-
2. Ongole		1/77	-	-	-	-	-	-	-	-	-	-	-	-	1.46	-
		4/77	7.65	16100	4280	175	4105	560	691	2300	-	-	214	5950	-	-
		4/78	7.65	15655	4144	270	3875	564	664	2150	24	Nil	330	269	2.40	-
		4/79	7.55	16000	4455	300	4155	500	778	1990	19	"	366	514	0,60	-
		/80	7.70	15600	3900	-	-	560	608	1730	20	"	488	5190	0.80	-
		/81	7.73	13630	3020	-	-	468	462	2090	13	"	488	4400	0.80	-
		/82	8.16	12120	222	-	-	312	351	1750	21	Trace	140	3890	-	-
		/83	7.95	10810	1980	-	-	216	350	1610	16	-	265	2208	-	-
3. Podili		4/70	7.5	3327	390	-	-	72	48	370	230	-	590	515	6.0	-
		4/71	8.3	1494	170	-	-	32	22	240	20	15	464	195	0.5	9
		4/72	7.9	1590	180	-	-	40	19	154	62	-	455	170	7.0	-
		4/76	7.97	2175	253	480	-	56	27.4	-	6.2	-	586	294	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		1/77	-	-	-	-	-	-	-	-	-	-	-	-	7.70	-
		4/77	8.26	1200	168	485	-	32	21	265	-	-	592	238	-	-
		4/78	8.12	1514	190	446	Nil	44	20	184	140	Nil	543	199	7.7[illegible]	-
		4/79	8.30	2050	240	440	"	48	29	137	171	"	537	277	8.50	-
		4/80	8.85	2340	175	-	-	17	32	280	258	84	378	355	7.9	-
		4/81	8.20	1450	210	-	-	44	24	175	17	Nil	500	170	7.1	-
		4/82	7.94	1500	140	-	-	28	17	172	205	Trace	529	149	-	-
		/83	8.5	1526	125	-	-	16	21	295	156	30	500	170	2.80	-
		/84	8.60	1800	135	-	-	16	23.1	230	250.2	42	433.1	216.2	-	-
		/85	8.65	1400	135	-	-	22	19	184	117	36	329	184	-	-
4.	Markapur	1/77	-	-	-	-	-	-	-	-	-	-	-	-	2.50	-
		4/77	7.86	5180	965	365	600	136	152	782	-	-	445	1268	-	-
		4/78	8.10	4855	821	330	491	76	153	750	3.6	Nil	403	1120	2.50	-
		4/79	8.05	5650	856	340	516	82	158	874	6.0	"	415	1420	1.00	-
		/80	7.80	5900	11100	-	-	202	147	9201	5.1	"	668	1570	2.70	-
		/81	7.73	6000	853	-	-	120	135	1060	70	"	622	1530	2.85	-
		/82	8.20	11220	930	-	-	152	134	1790	12	24	49	3430	-	-
		/83	7.64	9270	1680	-	-	296	224	1380	10	-	299	2329	-	-
		/84	7.85	6480	810	-	-	118.2	125.2	1127.0	7.8	Nil	-	-	-	-
		/85	8.15	1685	145	-	-	20	23	322	3.5	"	531	195	1.22	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5.	Kandukuru	4/78	8.00	6100	1091	330	761	184	250	930	55	60	281	865	3.35	-
		/79	8.30	8300	1702	250	1452	140	328	1180	66	-	305	2480	2.20	-
		/80	7.75	8900	2200	-		240	389	1150	84	Nil	702	2710	2.25	-
		/81	7.79	8320	1930	-	-	176	363	1260	110	"	671	2530	2.30	-
		/83	7.8	7170	1600	-	-	160	292	943	52	-	625	2014	-	-
		/84	7.9	10170	1900	-	-	220.4	328.2	142.6	101.7	Nil	170.8	2977.8	-	-
		/85	8.45	9000	1600	-	-	112	321	126.5	72	9.0	171	2667	1.12	-
6.	Darsi	1/77	-	-	-	-	-	-	-	-	-	-	-	-	3.30	-
		4/77	7.90	3220	495	240	255	80	72	218	-	-	293	486	-	-
		4/78	8.15	2500	301	440	61	104	58	175	292	Nil	537	355	4.30	-
		4/79	8.05	2400	561	370	101	112	68	191	312	"	452	482	4.10	-
		/80	7.80	4000	930	-	-	180	117	218	422	"	366	801	3.16	-
		/81	7.59	6230	1530	-	-	340	165	368	567	"	391	1310	2.60	-
		/82	8.52	1420	238	-	-	20	46	216	16	66	323	152	-	-
		/83	7.43	9670	2880	-	-	544	370	566	803	-	317	2415	-	-
		/84	7.50	10480	3100	-	-	581.2	401	609.5	801.6	Nil	298.9	2554.2	-	-
		/85	7.35	8880	2432	-	-	495	289	621	665	"	323	1914	1.65	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
7.	PAMUR	4/77	8.23	3900	420	465	-	54	69	724	-	-	568	628	-	-
		1/77	-	-	-	-	-	-	-	-	-	-	-	-	2.90	-
		4/78	8.20	4149	541	471	70	60	95	710	16	Nil	574	712	2.30	-
		4/79	8.30	4065	511	451	60	76	78	-	12	"	549	752	2.10	-
		/80	7.80	4350	660	-	-	36	120	690	13	"	619	823	1.70	-
		/81	7.91	4920	781	-	-	100	129	36	17	"	610	965	1.50	-
		/82	8.65	4810	560	-	-	36	114	883	14	74	299	943	-	-
		/83	8.16	5090	630	-	-	71	110	920	16	-	732	1071	-	-
		/84	7.55	5770	490	-	-	60.1	82	1101	12.9	Nil	933.3	1091.9	-	-
		/85	8.60	5000	640	-	-	28	147	817	16	60	275	993	1.16	-
8.	Adden	/81	7.45	2590	826	-	-	214	71	161	9.4	Nil	296	452	0.65	-
		/82	8.45	2820	510	-	-	162	24	336	141	54	342	440	-	-
		/83	7.9	2470	850	-	-	196	88	150	11	-	119	532	-	-
		/84	7.35	3200	960	-	-	266.5	71	225.4	12.5	Nil	420.9	538.8	-	-
9.	Chirala	/81	7.80	3730	731	-	-	186	65	414	156	"	339	282	0.30	-
		/82	7.95	584	135	-	-	36	11	52	3.5	"	37	13	-	-
		/83	8.45	1582	345	-	-	108	18	147	50	15	153	262	-	-
		/84	7.95	1628	365	-	-	104.2	25.5	188.6	62.6	Nil	372.1	244.6	-	-
		/85	7.70	2050	390	-	-	114	26	230	70	"	378	301	-	-
10.	Gidda-lur	/83	8.3	1110	190	-	-	29	32	167	1	Trace	403	161	-	-
		/84	7.7	1336	290	-	-	52.1	38.9	174.8	1.6	Nil	494.1	184.3	-	-
		/85	-	1205	190	-	-	20	34	198	1.6	"	40	156	0.24	-

Annexure-VI

Particulars of Exploratory wells drilled by C.G.W.B. in the drought Prone districts of Andhra Pradesh

Sl. No.	Location Co-ordinates	Total depth drilled (m)	Fracture zones encountered (m)	Discharge lps	Geology	SWL mbgl	Pumping tests Results Discharge lps	Drawdown (m)	T (m2/d)	'S'
1	2	3	4	5	6	7	8	9	10	11
Anantpur Distt.										
1.	Obulapuram (14°41'46" & 76°51' 4")	67.50	25.0 30.0 31.0 35.0 51.0	6.60	Granite	9.69	5.0	6.46	40.98	-
2.	Tallilsue (13°34'28" & 76°48'8")	40.00	15.0 18.0 31.0	4.33	Granite gneiss	7.95	3.00	1.65	215.59	-
3.	Rayadurg (14°41'40" & 76°30'52")	80.00	26.0 40.0 49.0 64.0	1.86	Granite	17.28	2.50	3.99	72.50	-
4.	Kalugodu (14°35'15" & 76°54'6")	87.50	8.0 15.0 23.0 40.0 45.0	7.40	"	2.10	8.0	1.25	843.0	-

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1	2	3	4	5	6	7	8	9	10	11
5.	Gadekallu (15°0'7"&77°13'54")	70.00	16.0 18.0 55.0	5.55	Granite	4.87	3.0	4.10	59.30	-
6.	Vidapanakallu (15°04'18"&77°10'28")	71.00	15.0 41.0 57.0	1.13	Schist	-	1.13	-	0.49	-
7.	Kottalapadu (15°0'41"&77°13'21")	50.00	8.0 21.0 32.0	1.25	Granite	-	1.25	-	0.53	-
8.	Chabala (15°01'48"&77°16'47")	70.00	10.0 21.0 25.0 28.0	1.40	"	-	1.40	-	2.20	-
9.	Peddahoturu (15°10'20"&76°20'11")	70.00	8.0 24.0	1.00	Schist	-	1.00	-	1.18	-
10.	Guntakal (15°10'26"&76°20'11")	38.00	11.0 19.0 26.0	5.50	Granite	3.62	5.0	9.57	33.64	-
11.	Kamalapadu (15° 3'50"&77°24'15")	61.00	22.0 35.0 44.0	0.20	"	-	-	-	-	-
12.	Kanekal Cross (14°46'35"&77°0'29")	52.00	23.0 29.0 34.0 40.0	8.00	"	3.40	12.0	6.50	142.64	-
13.	Havalgi (14°58'50"&77°07'27")	62.50	18.0 28.0	0.38	"	-	0.38	-	-	-

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1	2	3	4	5	6	7	8	9	10	11
14.	Palturu (14°58'12" & 77°09'47")	41.00	20.0 25.0	5.0	Granite	-	0.19	-	-	-
15.	Uravakonda (14°55'56" & 77°14'29")	55.00	8.0 24.0 32.0	0.30	"	1.55	3.50	7.15	23.45	-
16.	Nimbagallu (14°52'54" & 77°12'09")	62.50	13.0 18.0 30.0	0.38	"	-	0.38	-	-	-
17.	N.Gundlapalle (14°42'16" & 77°3'33")	49.50	13.0 18.0 22.0 32.0 38.0 45.0	9.05	"	7.23	12.00	9.40	271.0	-
18.	Kalyandurg (14°30'57" & 77°7'14")	74.30	21.0 27.0 34.0 50.0 56.0	3.15	"	11.25	3.0	5.31	52.70	-
19.	Cherlopalle (14°25'11" & 77°3'11")	67.80	15.0 22.0 33.0 41.0 57.0	3.20	"	2.98	2.75	9.66	10.17	-
20.	Lattavaram (15°55'44" & 77°16'7")	65.00	7.0 17.0 25.0	1.25	Granite Gneiss	-	1.25	-	-	-

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1	2	3	4	5	6	7	8	9	10	11
21.	Ragulapadu (14°53'34":77°20'08")	73.00	6.0 54.0 57.0	0.33	Granite	-	1.25	--	-	-
22.	Rolla (13°50'23":76°6'20")	48.50	22.0 43.0	3.00	-	5.26	3.0	10.62	17.57	-
23.	Haraganadona	138.30	35.0 52.0 67.0	17.50	Schist	8.72	15.0	31.13	66.61	-
24.	Daduluru (14°22'40":77°38'36")	305.00	61.40-63.50 106-107, 112-113, 157-158	0.5 1.0 2.0 3.3	Gneiss & pink granite	4.953	1.67	2.465	53.16	-
25.	Damajipalli (14°18'21":77°37'55")	139.60	77.60 78.60 133.50-135.40	3.0 7.0	Gneiss, Metabasic rock	4.38	1.5	1.69	13.17	-
26.	Gollapalle (14°22'23":77°42'28")	200.00	24.20-25.20 31.90-33.00	2.0 3.0	Gneiss, pink granite, basic dyke	6.89	4.0	6.94	283.69	($S=7.4x10^{-5}$)
27.	Puttaparti 14°10'11";77°48'42"	88.00	13.60-14.60, 69.50-70.00, 71.00-72.00	4.0 8.0 9.0	Gneiss Schist basic dyks	5.487	6.0	6.73	75.88	($S=3.7x10^{-4}$)

1	2	3	4	5	6	7	8	9	10	11
28.	Enumalapalli 14°09'00"; 77°48'50"	120.00	37.00-38.00 54.50-55.50	2.0 6.0	Gneiss basic rock	7.20	5.67	14.59	12.48	-
29.	Kanumukkala (14°18'00"; 77°45'15"	200.00	12.00-13.00 67.00-68.00	0.5 2.5	Gneiss & pink granite basic rock(dyke)	9.88	3.0	7.10	135.61	-
30.	Kadiri 14°06'30": 78°09'16"	200.0	20.80-21.80 58.40-59.40	3.0 6.0	Gneiss & basic rock (dolerite)	5.24	4.0	11.96	46.27	-
31.	Pamudurthi (OW) 14°16'10":77°58'12"	164.40	13.10-14.20, 74.60-75.00, 92.90-94.00 113.30-114.00, 131.60-132.60	0.5 4.0 5.0 5.5 6.0	Gneiss & pink granite	6.65	3.4	25.27	3.92	-
32.	Siddarampuram 14°15'22": 77°58'12"	121.40	13.60-14.70 111.20-112.30	1.0 3.0	Gneiss & basic dyke	3.15	1.7	10.34	146.016	-
33.	Upparlapalle 14°27'48": 77°52'06"	200.00	8.00-8.60 12.60-13.60 109.20-110.20 177.30-178.30	0.5 1.5 3.5 4.0	"	2.94	3.0	4.24	306.22	(S-3.68x 10^{-3}
34.	Adavi Brahmanapalle 14°21'20": 78°02'15"	145.80	31.9-33.00, 45.20-46.20, 49.20-50.20	4.0 4.5 5.0	Granite gneiss	4.56	4.9	7.67	7.91	(S=2.25x 10-2)

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1	2	3	4	5	6	7	8	9	10	11
35.	Nallamada 14°08'50" : 77°59'15"	190.00	20.80-26.90 36.00-37.00 110.2 -111.20	4.0 3.5 4.5	Granite Gneiss, Migmatite basic dyke	5.71	3.0	21.74	23.73	(S=1.21x 10^{-3}
36.	Ingaluru 14°03'00":78°02'20"	124.50	54.3-55.30 57.4-58.4 67.5-68.5 83.8-84.8	5.0	Granite Gneiss	2.46	3.0	16.57	13.56	(S=1.98x 10^{-4}
37.	Ithodu (13°54'24":78°09'15"	183.00	18.7-19.7 182.22-183.0	0.5 4.0	Gneiss & dyke (basic rock)	7.59	3.0	15.54	118.66	
38.	Gorantla (13°59'15" &77°46'15"	196.80	19.0 86.0-87.0 94.0-95.0 155.0-156.00 196.00-196.80	15.7	Granite gneiss	5.82	5.0	14.90	83.28	7.7x 10^{-5}
39.	Galumipalli 13°48'40" &77°35'40")	155.0	18.70-19.70 19.70-20.80 47.20-48.20 150.90-151.90	6.25	"	8.69	3.0	18.30	89.7	1.96x 10^{-3}
40.	Hindupur (13°49'40" &77°30'50")	200.0	25.80-27.90	4.0	"	18.52	2.5	17.0	9.30	-
41.	Pochinapalle (13°48'30"&77°28'40")	200.00	67.50-68.50	0.40	"	8.28	-	-	-	-

1	2	3	4	5	6	7	8	9	10	11
42.	Nimkampalli (13°49'50" & 77°28'40")	207.0	68.50-69.60	0.40	Granite gneiss	17.42	-	-	-	-
43.	Penukonda (14°4'20" & 77°36'20")	200.0	41.10-42.10	6.25	"	5.39	4.0	8.70	285.0	5.5×10^{-2}
KURNOOL District :										
1.	Halalgundi (15°29'27" & 77°28'12")	40.50		1.24	Granite	4.50	1.0	5.55	13.70	-
2.	Alur (15°24'00" & 77°13'30")	40.00		5.0	Granite gneiss	4.15	10.0	5.12	197.60	-
3.	Haradagere (15°18'20" & 77°11'23")	51.00		2.27	"	9.03	3.0	5.62	87.02	-
CHITTOOR DISTRICT :										
1.	Paluru (13°10'30" & 79°10'40")	60.00	10.0-15.0 25.0-33.0	7.8	"	5.02	7.8	3.70	143.0	1.5×10^{-9}
2.	Mitturu (13°21'45" & 79°05'40")	58.5	33.0-33.6 49.0-49.50	3.1	"	1.77	3.1	9.41	-	-
3.	Paka la (13°11'15" & 79°05'40")	60.40	41.49	0.60	"	G.L	0.60	16.61	1.68	-

1	2	3	4	5	6	7	8	9	10	11
4.	Gundlapalle (18°27'06" & 79°03'5 6")	70.0		0.30	Granite gneiss	0.07	0.30	9.51	-	-
5.	Damalacheruvu (13°28'42" &79°02'52")	56.15	8.0 23.0	3.50	"	1.63	3.5	13.47	22.98	-
6.	Janglapalle (13°09'30" &79°13'00")	60.0	4.48-6.92 7.22-9.96 15.44-18.14 26.74-29.48	0.10	"	1.13	0.10	8.77	-	-
7.	Puthalapatte (13°45'00" &79°01'00)	55.20		1.5	"	1.73	1.5	8.45	8.70	-
8.	Kalvagunta (13°17'00" &79°08'00")	71.44	17.00-19.0	4.2	"	0.82	4.2	9.18	5.27	-
9.	Mattapalle (13°20'50" &79°01'15")	60.00	4.0-5.0	5.9	"	4.94	5.9	11.41	68.45	-
10.	Aragond (13°16'45" &78°57'30")	60.0	11.0-14.0 22.0-23.0 26.0-27.0 32.0-38.0	7.7	"	8.41	7.7	5.67	253.6	-
11.	Chittoor (13°12'00" &79°06'00")	56.05	14.0-15.0 21.0-22.0	9.5	"	2.22	9.5	6.37	53.28	-
12.	Ugranampalle (13°19'00" &79°11'30")	60.0	9.0-13.0 17.0-18.0 19.0-23.0 28.0-29.0 29.0-30.0 31.0-32.0	7.0	"	1.02	7.0	12.06	181.7	-

1	2	3	4	5	6	7	8	9	10	11
13.	Patnamvaripalle (13°18'50"&78°54'00")	60.0	30.0-31.0 55.0-56.0	1.1	Granite gneiss	8.05	1.1.	9.07	5.86	-
14.	Ayyala (13°23'15"&78°59'00")	70.0	26.0-27.0 28.0-29.0 29.0-33.0	7.8	"	3.75	7.8	16.87	75.98	-
15.	Mogili (13°11'00"&78°50'00")	52.6	22.0-28.0 28.0-33.0 44.0-46.0	9.4	"	0.30	9.4	5.49	145.2	-
16.	Yadamarri (13°08'00"&79°02'00")	59.38	8.0-11.84 14.69-14.99 14.99-15.94 56.64-59.38	12.2	"	5.85	12.2	25.75	136.62	-
17.	Mallireddi Kandriga (13°11'15"-79°04'00")	42.79	-	3.5	"	1.63	3.5	13.47	-	-
MAHABUBNAGAR Distt.										
1.	Yerrakunta (17°08'40"&78°13'40")	34.0	13.0 24.0 30.0	4.0	"	3.12	4.0	20.0	16.0	-
2.	Chandrayanguda (17°09'25"&78°14'40")	32.50	14.0 16.0 26.0 32.0	12.50	"	1.53	12.50	7.7	19.0	-

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1	2	3	4	5	6	7	8	9	10	11
3.	Narasappaguda (17°09'25"&78°14'40")	24.0	16.0	5.30	Granite gneiss	2.75	5.0	7.6	6.0	-
4.	Pidikyal (17°03'05"&78°10'10")	32.0	15.0 22.0	4.0	"	1.28	5.0	0.90	41.0	-
5.	Mohammadaliguda (17°04'45"&78°10'00")	40.50	19.0 27.0 40.0	1.64	"	0.92	2.22	3.20	7.0	-
6.	Shad Nagar (17°4'10"&78°12'30")	43.0	32.0	4.40	"	9.20	4.0	1.10	9.5	-
7.	Chatanpalli (17°03'45"&78°13'36")	64.0	14.0 64.0	0.75	"	1.22	0.95	18.4	-	-
8.	Kuknur (17°55'05"&76°19'18")	46.0	23.0 31.0	.0	"	1.80	-	-	-	-
9.	Rajpet (17°51'00"&78°15'10")	35.0	22.0 28.0	1.5	"	2.20	-	-	-	-
10.	Tallaguda (17°11'00"&78°16'40")	43.0	22.0 37.0	1.0	"	5.40	1.0	10.8	14.0	-
11.	Mykaguda (17°06'08"&78°17'00")	41.0	21.0	1.40	"	3.55	0.84	1.0	13.0	-
12.	Madanpalle (17°11'45" 78°19'22")	48.0	15.0 34.0	2.70	"	2.56	2.72	-	-	

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1	2	3	4	5	6	7	8	9	10	11
13.	Kothur (17°08'45" &78°17'25")	43.0	20.0 26.0	0.66	"	2.35	-	-	-	-
14.	Pinjerla (17°06'30"&78°19'25")	43.0	24.0 27.0 35.0	1.60	"	5.60	1.38	4.0	3.2	-
15.	Chinnatapra (17°09'18"&78°19'38")	27.0	-	Meagre	"	-	-	-	-	-
16.	Ameerpet (17°39'20"&78°19'56")	45.0	15.0 27.0 45.0	0.98	"	1.45	1.0	7.0	1.5	-
17.	Welijorla (17°02'10"&78°16'30")	54.0	17.0 33.0	6.0	"	9.14	6.67	2.5	23.0	-
18.	Enmul Nara (17°04'50"&78°18'05")	43.50	23.0 43.0	2.50	"	4.75	2.50	3.7	9.0	-
19.	Subhanpur (17°06'14"&78°21'22")	43.0	11.0 17.0 21.0 34.0	2.25	"	2.64	2.0	4.5	2.8	-
20.	Nagulapalli (17°05'40"&78°12'05")	32.0	23.0	4.0	"	1.44	4.0	8.2	-	-

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1	2	3	4	5	6	7	8	9	10	11
	NALGONDA Dist.									
1.	Pedda Voora (16°43'30" &79°12'54")	79.0	8-15.0 16.50 40.0-41.0 48.0-51.0	0.75	Granite gneiss	2.0	0.45	29.8	2.37	-
2.	Dugiyal (16°40'40" &79°05'50")	69.5	8.0-10.0 10.0-11.0 18.8-20.0	4.0	"	4.46	4.0	5.48	60.23	-
3.	Kondabheemanpalle (16°41'30" &78°53'37")	90.0	8.0-15.0 27.0-28.0 31.0-33.0 40.0-43.0 45.35-46.0 47.0-51.0	1.6	"	0.93	1.60	17.47	1.31	-
4.	Mynampalle (16°40'40" &79°05'50")	73.0	9-9.6 11-12 19-20 26.6-27.0 66-67	6.0	"	3.88	6.0	2.8	282.0	-
5.	Ghanapur (16°44'20" &79°07'12")	90.0	10-14 15-16 17-20 32-34 67-68	0.8	"	6.40	0.8	12.08	11.3	-

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1	2	3	4	5	6	7	8	9	10	11
6.	Polepalli (16°57'00"&78°49'00")	80.0	7.0	0.37	"	7.57	0.37	25.03	0.62	-
7.	Parmatpalle (16°41'25"&78°47'20")	90.0	13.6-20.0 33-35 39-40	0.5	Granite dyke	4.26	0.7	63.89	1.77	-
8.	Azampur (16°37'08"&79°04'00")	90.0	8-10 10-11 53.0	5.0	Granite gneiss	3.02	5.0	4.61	79.0	-
9.	Cherukupalle (16°35'30"&78°45'43")	80.0	26-27 44-47.20 64-65	0.56	"	3.27	0.56	15.20	5.90	-
10.	Pothnur (16°42'15"&79°10'10")	90.0	26 54	2.5	"	4.25	2.5	30.0	1.5	-
11.	Pulicherla (16°39'50"&79°09'50")	55.0	19-20	5.5	"	5.4	5.5	1.1	55.0	-
12.	Mushtipalle (16°46'00"&78°58'00")	57.6	15-16 39-40 41-42 42-43	5.72	"	2.4	5.7	6.5	8.0	-

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1	2	3	4	5	6	7	8	9	10	11
13.	P.A. Palle (16°41'22" 79°04'33")	90.0	-	4.0	Granite gneiss	8.96	2.0	16.16	5.45	1.5×10^{-3}
14.	Kothabhavi (16°43'54" 78°58'12")	90.0	-	0.6	"	-	5.0	42.0	5.0	-
15.	Vinjamuru (16°51'00" 78°48'45")	65.0	-	6.0	"	2.5	6.0	2.9	90.0	-

Annexure-VII

Hydrochemical data of exploratory wells drilled in the drought prone districts of Andhra Pradesh

Sl. No.	Location	Date of collection	PH	E.C. mS Cm^{-1} at 25°C	Total hardness as $CaCO_3$ Mg/l	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3	HCO_3	Cl	SO_4	NO_3	F Mg/l
						mg/l									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Anantpur Dist.:															
1.	Obulapuram	-	7.6	1480	-	130	61	101	1.5	-	311	174	163	155	1.3
2.	Tallikere	-	8.3	1050	-	48	47	115	4.3	-	549	71	17	29	2.2
3.	Rayadurg	-	7.9	1250	-	74	28	92	7.3	-	302	114	88	129	1.1
4.	Kalugodu	-	-	1410	-	44	41	189	3.9	-	485	18.3	50	3.1	2.7
5.	Gadekallu	-	7.8	710	-	43	29	64	2.0	-	317	32	41	-	0.7
6.	Vidapanakallu	14.12.76	7.8	4610	-	128	134	805	1.6	Nil	519	262	1230	-	3.2
7.	Kottalapalli	8.12.76	8.0	2820	-	40	16	495	0.4	"	946	203	Nil	-	2.3
8.	Chabala	-	8.2	1200	-	10	20	253	0.8	-	543	34	38	-	5.1
9.	Peddahoturu	2.2.77	7.9	1050	-	38	35	136	3.5	Nil	427	46	51	-	2.3
10.	Kamalapadu	18.2.77	7.5	630	-	50	23	37	2.4	Nil	244	35	5.3	-	1.9

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
11.	Kamekal Cross	-	7.6	540	-	32	6.7	76	1.4	-	278	14	10	29	2.3
12.	Havalgi	10. .76	7.8	2670	-	60	55	397	4.7	-	513	348	226	-	2.9
13.	Patturu	11.12.76	8.3	880	-	28	13	115	18	30	171	106	25	-	-
14.	Uravakonda	21.1.77	7.8	5280	-	160	132	828	2.7	Nil	424	808	1100	-	2.9
15.	Nimbagallu	5.1.77	7.7	2370	-	172	41	282	37	"	296	657	657	-	1.8
16.	N. Gundlapalle	,	7.8	500	-	31	18	52	0.8	-	265	1.4	7.7	20	1.2
17.	Kalyandurg	-	7.7	450	-	29	12	53	1.3	-	256	11	10	8.1	2.6
18.	Cherlopalle		7.6	910	-	51	23	124	1.7	-	519	46	15	1.8	2.6
19.	Lattavaram		8.2	496	-	40	24	18	2.7	-	177	25	38	-	1.7
20.	Ragulapadu	7.2.77	7.7	1420	-	36	35	224	2.0	-	491	106	55	-	3.9
21.	Rolla	-	7.8	720	-	46	27	54	0.8	-	323	64	4.8	-	1.2
22.	Dadaluru	14.3.86	7.50	1065	133	26.052	16.40	184.0	0.782	Nil	555.1	44.31	-	-	-
			7.70	1040	148	39.27	18.83	172.5	00.78	"	536.8	51.40	-	-	-
23.	Dahajipalle	28.2.86	7.40	870	225	32	35	115	Trace	"	525	28	-	-	-
24.	Gollapalle	1.9.86	8.15	670	95	22	10	113	1.2	"	293	35	-	-	1.5
			8.15	690	100	22	11	115	1.2	"	293	35	-	-	1.45
25.	Puttaparthi	11.3.86	8.2	1547	215	24	38	251	5	"	464	195	-	-	2.8

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
26.	Enumulapalli	5/85	8.1	1512	205	25	37	247	6	Nil	408	187	-	-	
27.	Kanumukkala	8.11.86	7 85	1000	143	26.052	13.83	163.30	1.173	"	451.4	74.445	-	-	1.6
			7.85	995	150	30.06	18.23	158.70	1.173	"	451.4	63.81	-	-	1.9
28.	Kadiri	26.4.86	7.45	2590	605	140.28	63.19	313.4	3.9	"	414.80	567.4	-	-	
29.	Pamudurthi	27.5.86	7.30	1180	135	22	19	214	Trace	"	586	74	-	-	4.0
30.	Siddarampuram	5/86	8.05	1045	265	62.124	26.73	118.45	0.782	"	494.10	67.355	-	-	-
31.	Upparlapalle	18.10.86	8.25	2250	345	78	36	382	1.6	"	775	316	-	-	3.2
			8.25	2200	340	76	36	377	1.6	"	760	301	-	-	3.5
32.	Adavi	3/86	8.10	1364	360	46.10	59.54	149.50	Nil	-	628.30	70.90	-	-	-
	Brahmanapalli		8.50	1320	350	43.10	58.94	140.30	"	63.0	475.80	92.17	-	-	-
33.	Nallamada	7/86	8.00	1320	125	17.034	20.05	246.10	-	-	622.20	106.35	-	-	-
34.	Ingaluru	8/86	7.75	1787	3 8	60.12	45.57	247.25	13.685	Nil	460.55	246.37	-	-	1.85
			7.95	2130	240	16.03	48.60	345.00	54.74	"	555.10	407.675	-	-	1.55
35.	Ithodu	1/87	7.8	893	260	46	35	97	2.7	"	476	39	-	-	-
			7.85	918	270	54	33	102	2.7	"	488	43	-	--	-
36.	Gorantla	29.1.87	7.60	2210	500	148	32	276	2	"	366	163	-	-	-
			8.40	2060	608	116	77	193	2	36	488	311	-	-	-

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
37.	Galimpalli	9.3.87	7.35	1530	425	80	55	154	3	Nil	528	195	-	-	-
			7.45	1598	460	86	60	155	3	"	540	213	-	-	-
38.	Hindupur		6.55	1202	270	18	55	145	1.2	18	159	248	-	-	-
			7.70	1700	505	102	61	161	2	Nil	457	271	-	-	0.55
39.	Penukonda		7.70	510	170	54	9	39	Nil	"	275	18	-	-	0.98
			7.75	505	168	54	8	39	"	"	290	18	-	-	0.50
KURNOOL Dist. :															
1.	Alur		7.4	607	-	46	18	62	1.6	-	305	177	6.2	-	2.4
2.	Hardagere		7.8	996	-	48	45	89	7.4	-	366	55	33	-	2.0
Chittoor Dist.:															
1.	Paluru		8.05	920	208	1.6	2.55	-	-	Nil	8.55	1.8	428	-	-
2.	Mittiri		6.75	465	100	26	9	-	-	"	146	46	-	-	-
3.	Pakala		7.20	2002	818	285	26	-	-	"	223	99	-	-	-
4.	Gundlapalle		7.5	895	243	82	27	-	-	"	467	36	-	-	-
5.	Damalcheruvu		7.80	1023	-	-	-	-	-	-	-	-	-	-	-
6.	Janglapalle		7.8	1532	320	67	36	225	2	"	635	220	75	-	0.75
7.	Putalapattu		7.5	1475	160	2.0	1.2	10.4	-	"	9.75	4.85	-	-	-

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
12.	Kalvangunta	-	8.65	2012	145	31	16	-	-	66	653	220	-	-	-
13.	Mattapalle	-	7.50	780	115	1.35	0.95	-	-	Nil	6.1	1.5	-	-	-
14.	Aragonda	-	6.9	1020	245	52	28	-	--	"	433	89	-	-	-
15.	Chittoor	-	8.1	521	155	32	18	-	-	"	262	31	-	-	-
16,	Ugranampalle	-	No Data available												
17.	Patnamvaipalle	-	7.65	7.07	225	52	23	-	-	"	360	39	-	-	-
18.	Ayirala	-	7.8	823	260	66	23	-	-	"	36	76	-	-	-
19.	Mogili	-	7.8	650	185	1.8	1.9	-	-	"	5.6	8.05	-	-	-
20.	Yadamarri	-	8.4	892	-	35	41	140	-	45	518	60	25	-	-
21.	Mallireddi Kundriga	-	7.8	1080	192	27	225	-	2.0	Nil	620	105	59	-	1.0
Mahabubnagar Dist.:															
1.	Yerrakunta	2/75	7.9	650	-	75	23.1	23	2	-	56	7	4	20	0.70
2.	Chandrayanguda	"	7.56	561	240	60	22	36	2	-	542	1	5	1.2	0.70
3.	Narsappaguda	3/74	7.72	604	220	45	26	60	1	-	515	25	8	6.3	1.10
4.	Pidikyal	10/74	7.6	760	-	108	7.3	37		-	469	9	10	0.8	0.47
5.	Mohammadaliguda	7/73	7.6	505	-	30	34	25	3	-	414	27	5	16	0.7
6.	ShadNagar	5/74	8.10	462	-	52	16	31	1	6	414	25	3	14	0.80

...6

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7.	Chatanpalli	2/74	8.10	489	200	56	15	50	2	21	566	20	8.0	7	0.60
8	Kuknur	3/75	7.2	1330	-	99	31	106	-	-	607	106	55	82	0.7
9.	Rajpet	4/75	7.4	594	-	50	23	40	-	-	386	60	10	2	0.9
10.	Tallaguda	7/74	8.7	1350	-	8	15.8	240	4	-	856	120	47	Tr	1.4
11.	Mykaguda	7/74	7.30	678	85	78	22	21	13	-	442	36	16	36	1.1
12.	Madanpalle	2/75	8.0	704		72	23	30	13	-	589	18	9	Tr	1.2
13.	Kottur	10/73	9.9	385		15	06	63	26	-	193	34	28	5.7	1.3
14.	Pinjerla	2/75	7.5	714		76	20	51	-	-	552	28	23	22	0.1
15.	Chinnatupra	9/74	7.5	261		26	04	23	7	-	184	18	6	.9	1.1
16.	Ameerpet	4/74	8.6	358		7	4	69	5	-	212	25	23	8.8	0.4
17.	Welijorla	10/74	8.2	491		86	2	16	11	-	396	23	11	15	0.1
18.	Enmulnara	-	7.7	787		65	44	49	2	-	713	30	6	9.6	0.2
19.	Subhanpur	7/74	7.9	840		30	44	68	2	-	736	71	Tr	Tr	2.0
20.	Nagulapalli	5/74	7.5	1240		55	38	184	4	-	938	114	23	4.4	1.1

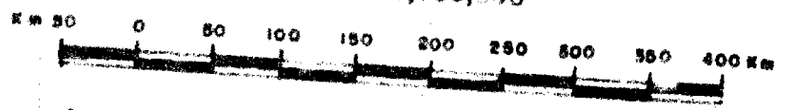
...7

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Nalgonda Dist.:															
1.	Peddavoora	28.9.83	8.75	936	135	14	24.32	165.60	26.91	62	445.3	-	-		
2.	Dugiyal	-	7.39	600	250	78	13	29	8.9	Nil	299				
3.	Konda Bheemanpalle		8.25	1485	140	20	22	308	1.6	Tr	610				
4.	Mynampalle	25.5.83	7.80	577	215	52	21	37	1.2	Nil	305				
5.	Ghanapur	3.9.83	7.57	1012	235	40	33	122	5.9	"	336				
6.	Polepalli	25.5.84	8.51	2580	380	10	86.33	423.2	0.78	111.60	1012.60	194.98		-	-
7.	Parmatpalli	8.3.83	8.3	773	263	34	43	59	4.3	Nil	400	34	-	-	-
8.	Azmapur	28.8.83	7.75	660	185	44	18	58	1.6	"	230	64	-	-	-
9.	Cherukupalle	13.4.84	8.08	846	190	26.05	30.38	115	1.56	"	390.4	60.26	-	-	-
10.	Potnur	15.12.87	7.52	632	205	54	17	51	2.0	"	329	25	-	-	-
11.	Pulicherla	26.12.86	8.05	1718	32	40	54	143	180	"	702	160	-	-	-
12.	Mustipalle	6.12.86	7.70	890	200	40.08	66.83	112.7	2.74	"	463.6	40.76	-	-	1.15
13.	P.A. Palle	20.10.82	7.66	711	235	58	22	59	4.3	"	293	53	-	30	1.04
14.	KothaBhavi	28.6.83	8.48	1155	195	24	33	196	Tr	30	604	35	24	-	-
15.	Vinjamuru	11.1.87	7.65	1005	258	41	38	113	Nil	Nil	525	36	-	-	-

PLATE

AREAS COVERED UNDER EXPLORATORY DRILLING IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH UPTO 31.3.1987

SCALE 1:5,000,000



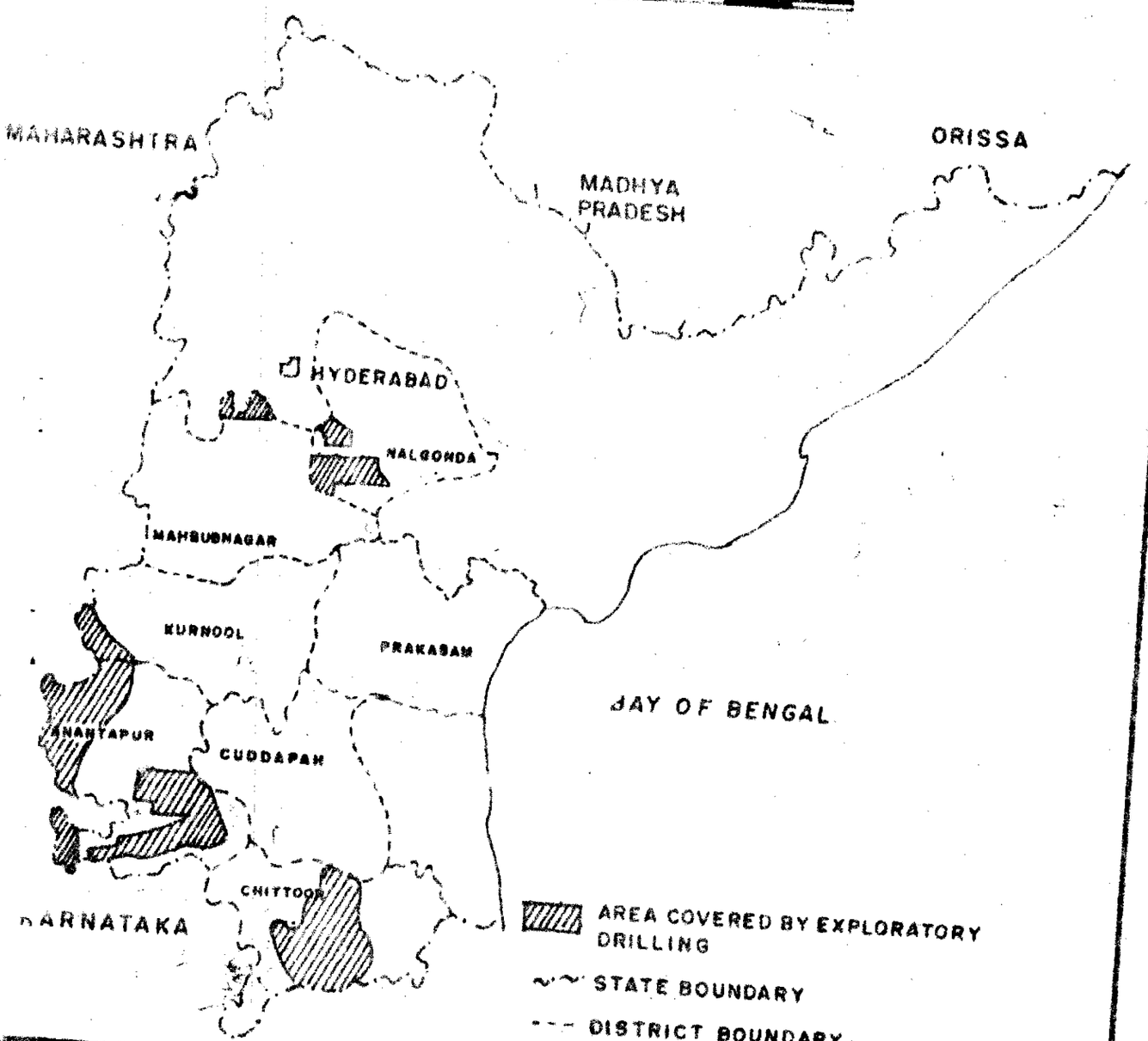


PLATE IV

AREAS COVERED UNDER REAPPRAISAL SURVEYS IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH UPTO 31. 3. 1987

SCALE 1:5,000,000

Km 50 0 50 100 150 200 250 300 350 400Km

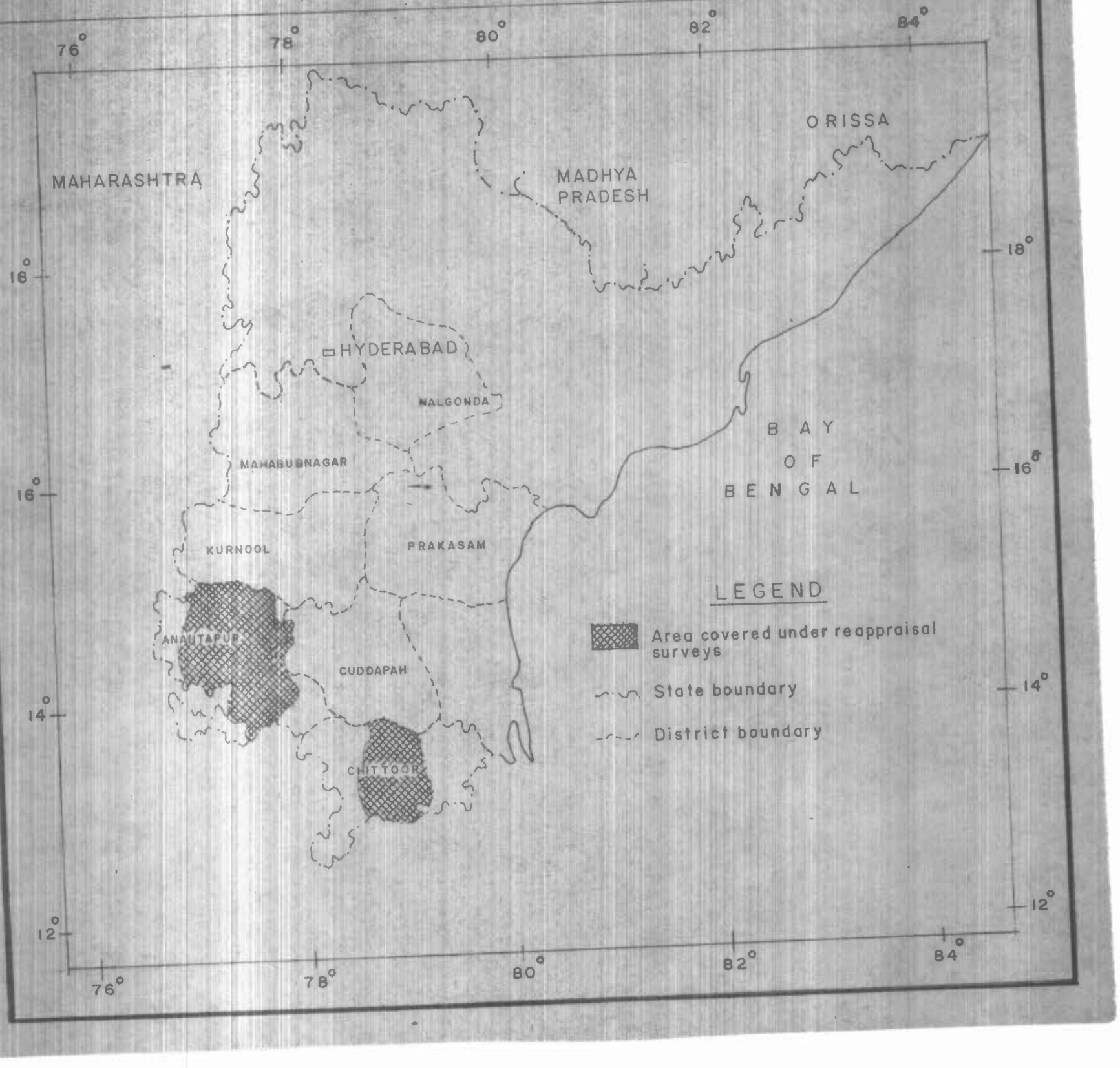


PLATE III

AREAS COVERED UNDER SYSTEMATIC HYDROGEOLOGICAL SURVEYS IN DROUGHT PRONE DISTRICTS OF ANDHRA PRADESH

UPTO 31.3.1987

SCALE 1:5,000,000

Km 50 0 50 100 150 200 250 300 350 400 Km

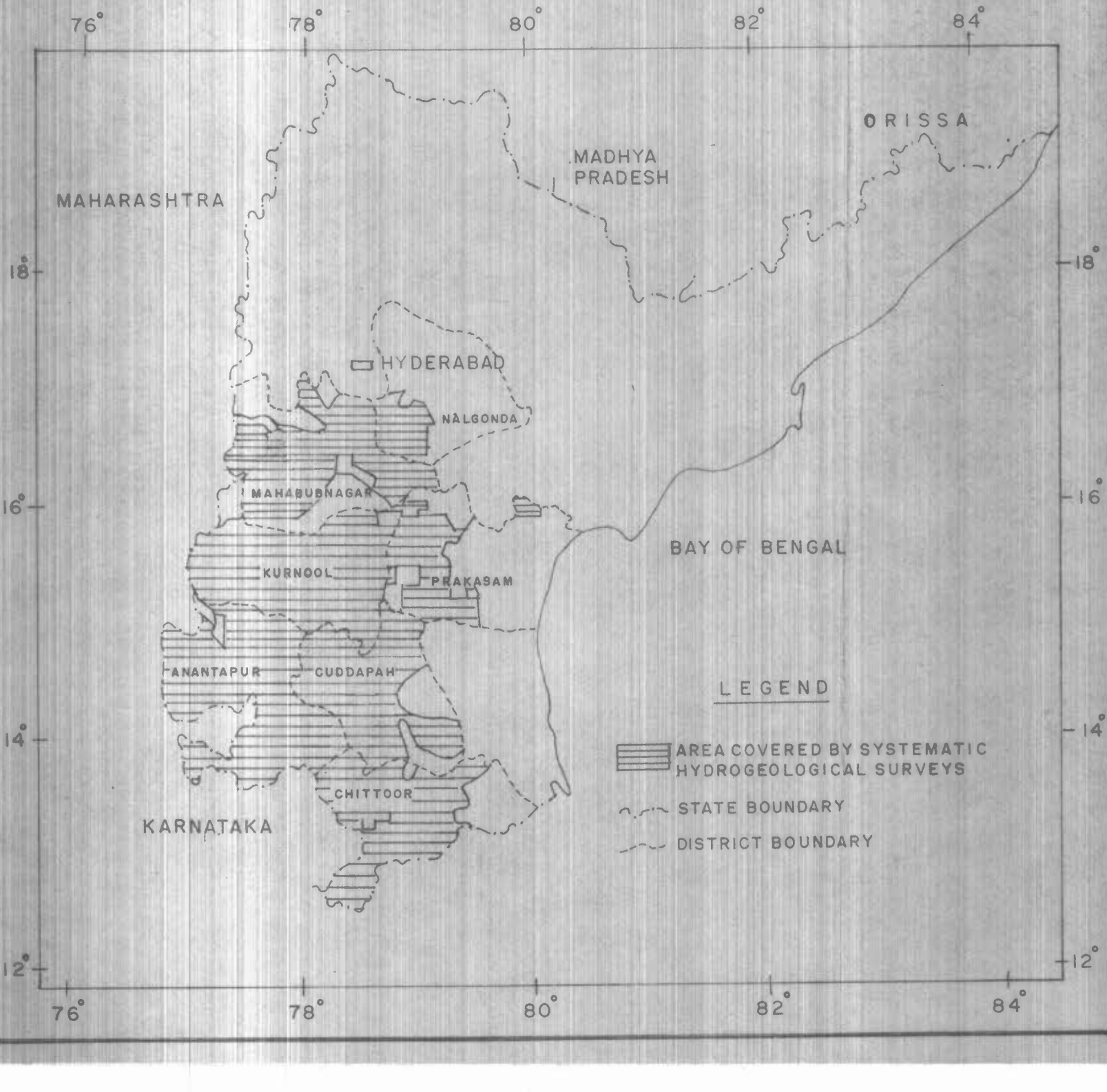


PLATE - 2

HYDROCHEMICAL MAP

OF

DROUGHT PRONE DISTRICTS, A.P.

SCALE - 1 : 2,500,000

LEGEND

A	E.C. < 750 microsiemens/cm at 25°c.
B	E.C. 750–1500 microsiemens/cm at 25°c.
C	E.C. 1500–2250 microsiemens/cm at 25°c.
D	E.C. 2250–5000 microsiemens/cm at 25°c.
E	E.C. > 5000 microsiemens/cm at 25°c.

Area where fluoride in ground water exceeds 1·5 p p m

Area where fluoride in ground water exceeds 3·0 p p m

Saline Zone (Cl^- greater than 500 ppm)

Brackish Zone (Cl^- between 250 and 500 ppm)

CGWB, SR, DO No. 204/87

Fig 17 (c)

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS
MAHABUBNAGAR DISTRICT, A. P.
1979-86

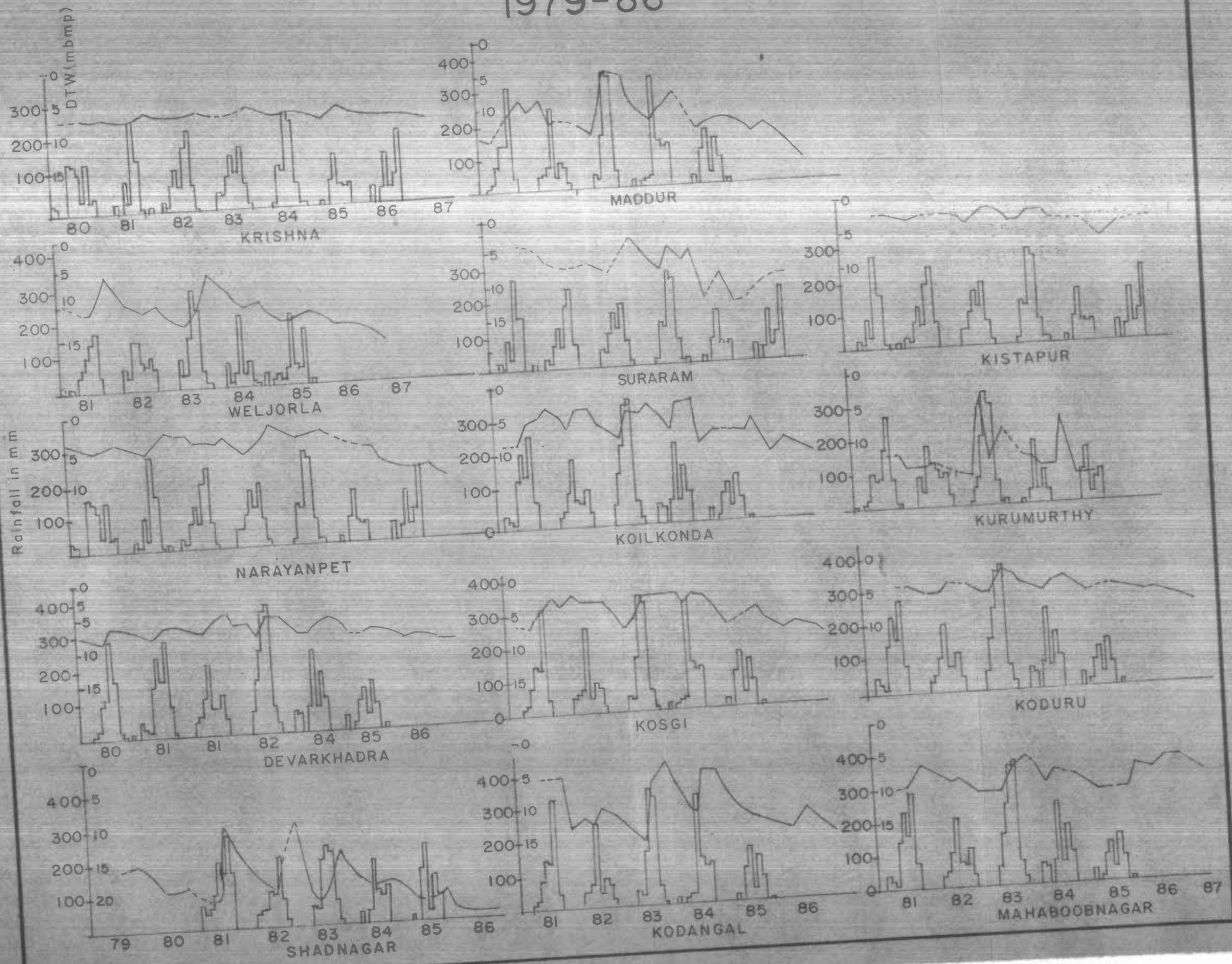


Fig-16

DEPTH TO WATER
MAHBUBNAGAR DISTRICT, A.P.
SCALE - 1:1000,000

CGWB, SR, DO NO. 206/87

Fig.15

RAINFALL TREND DURING 1901-85 ALONG WITH 5 YEAR AND 10 YEAR MOVING AVERAGES FOR THE MAHBUBNAGAR STATION MAHBUBNAGAR DISTRICT

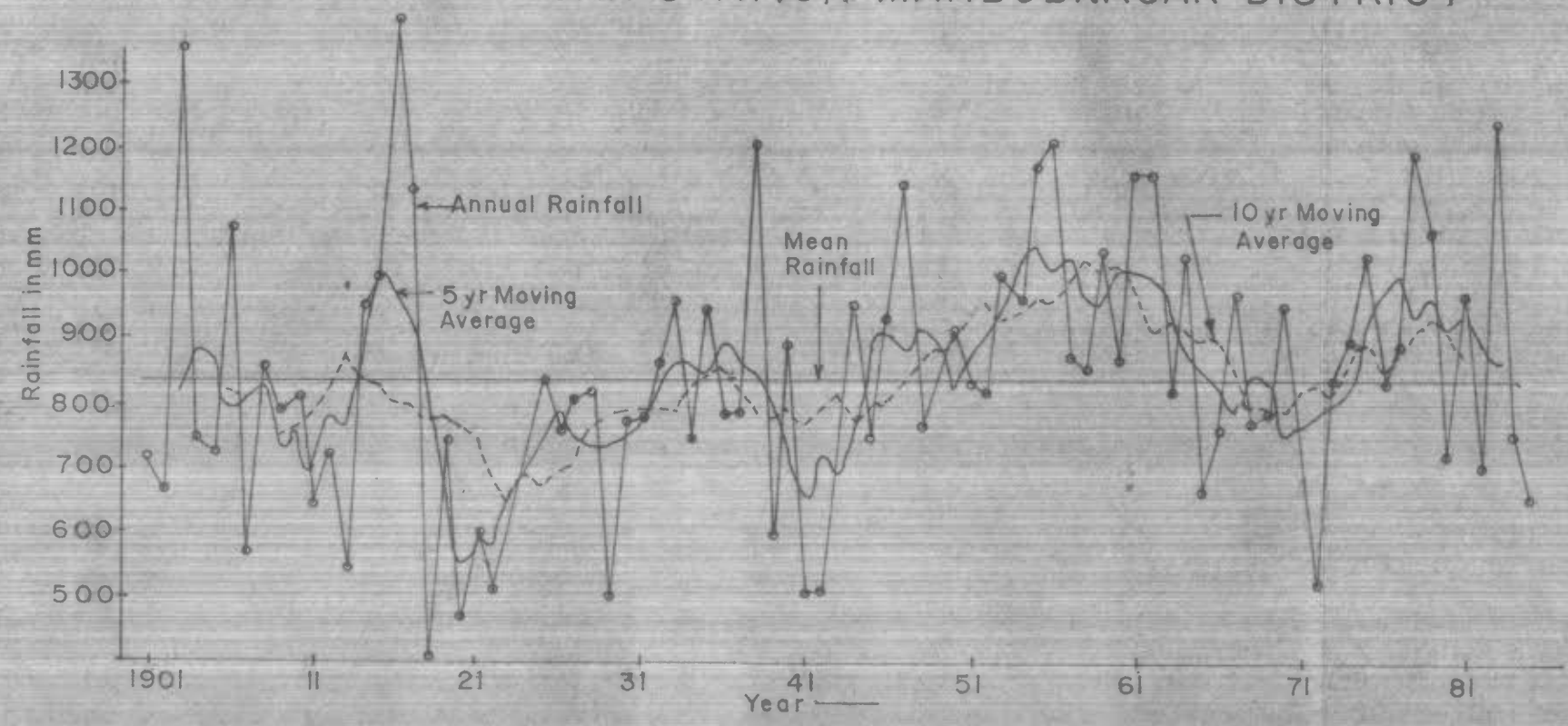
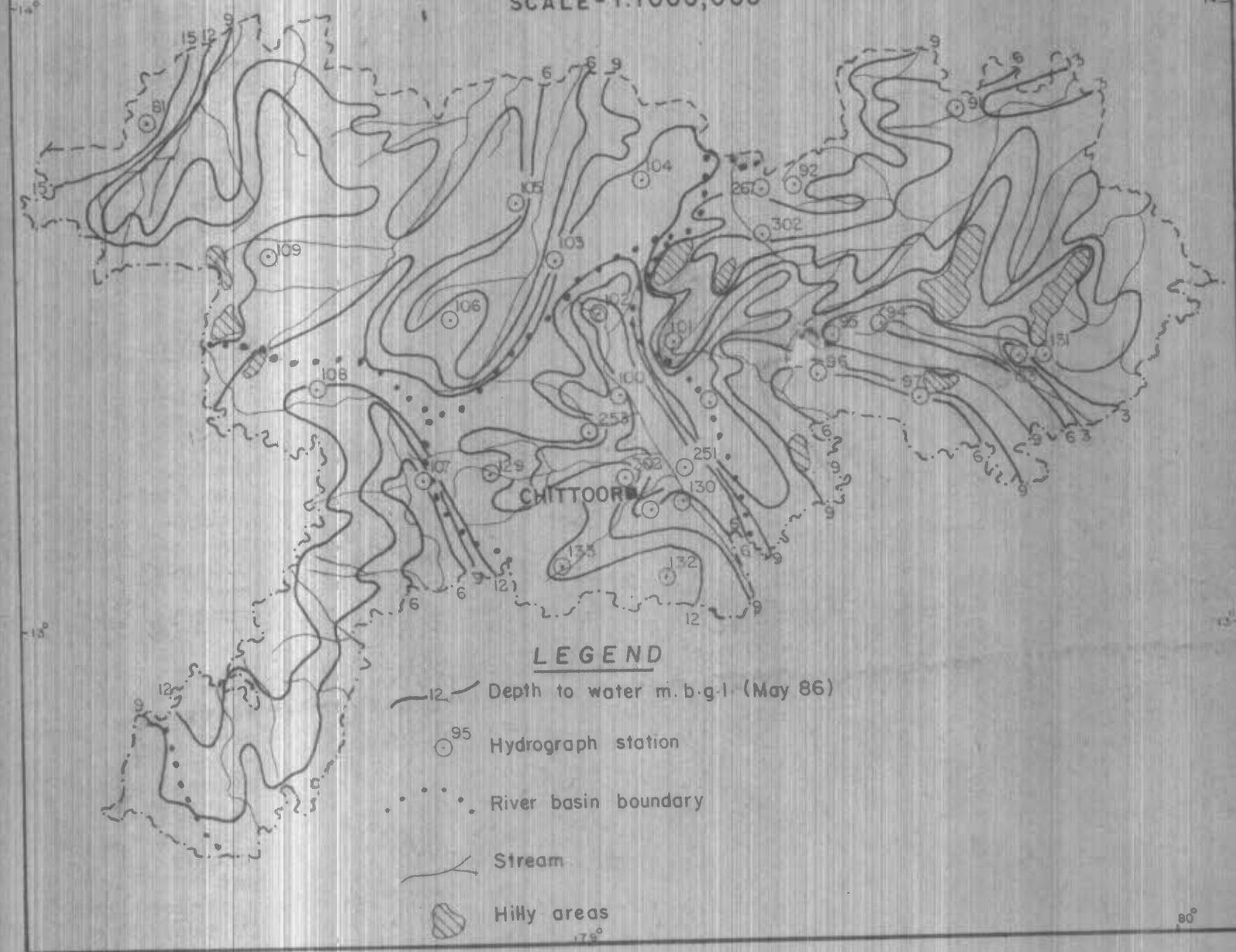


Fig-13

DEPTH TO WATER
CHITTOOR DISTRICT, A.P.

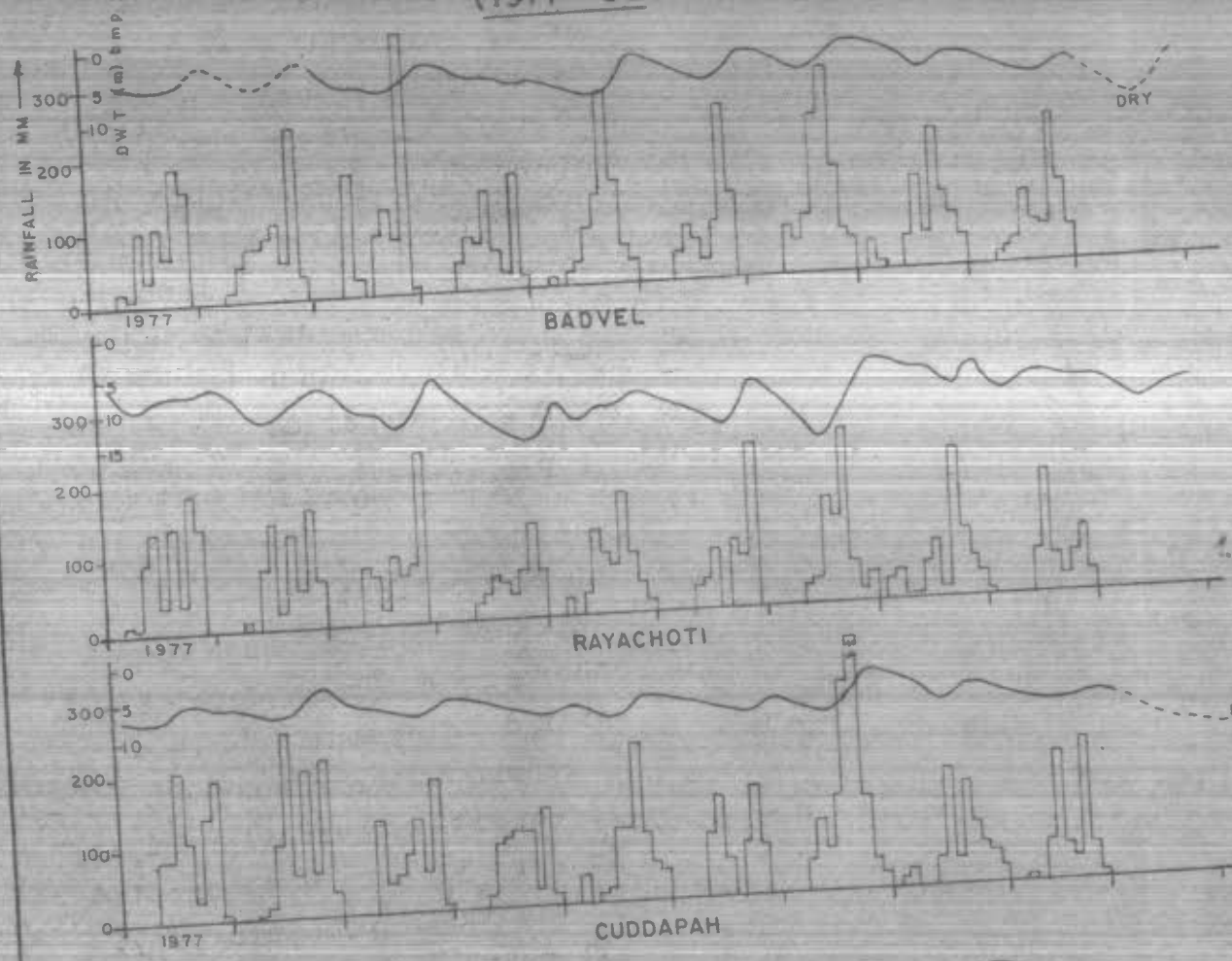
SCALE- 1:1000,000

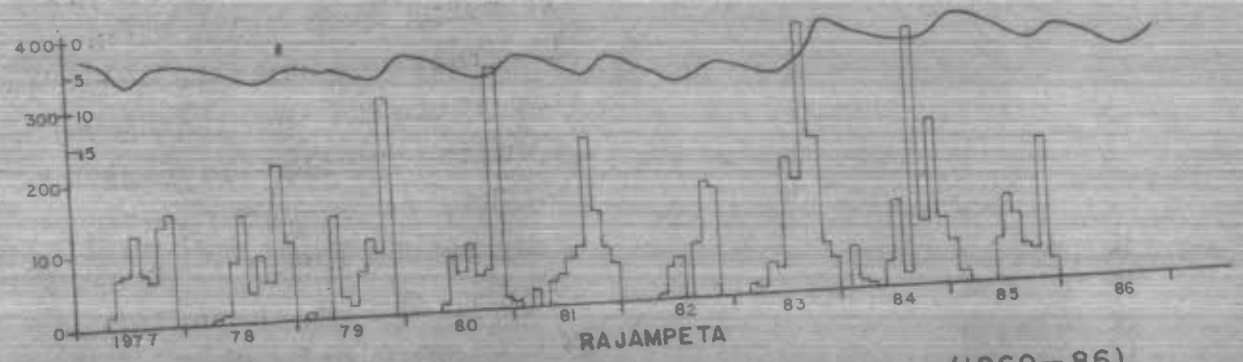


CGWB, SR, DO. No. 207/87

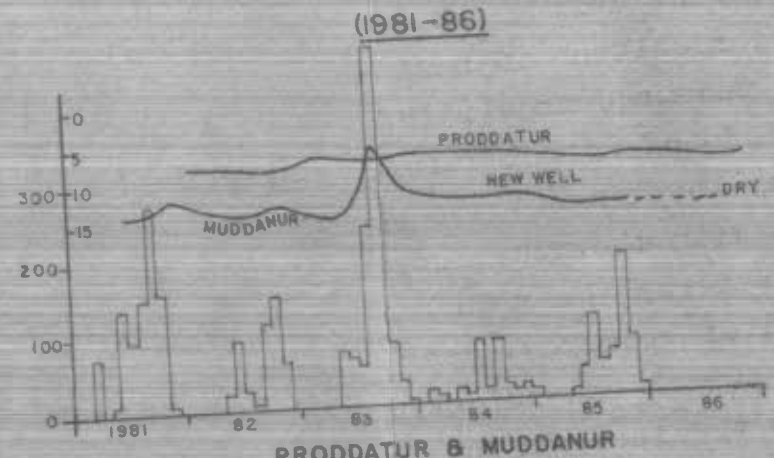
RAINFALL Vs WATER LEVEL OF NETWORK STATIONS , CUDDAPAH DISTRICT , A.P.

(1977 – 86)

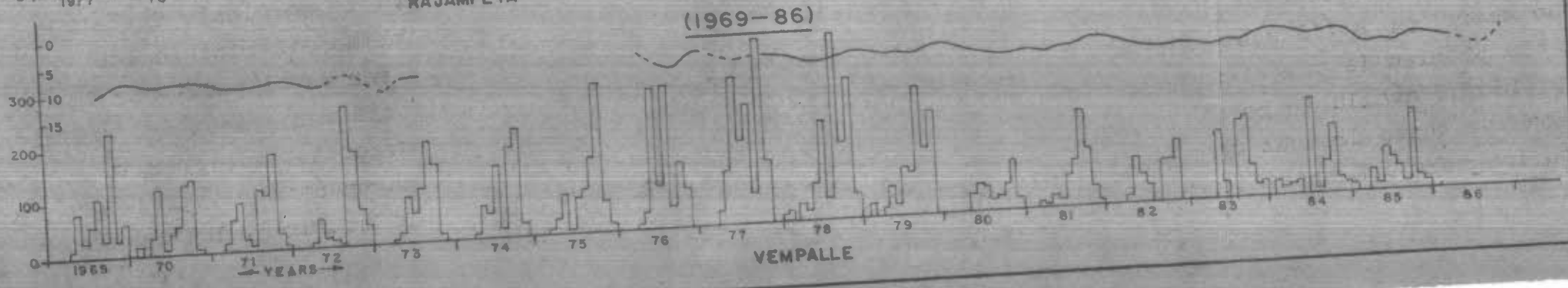




(1981-86)



(1969-86)



CGWB, SR, OO No. 223/87

Fig-10

DEPTH TO WATER
CUDDAPAH DISTRICT, A.P.

SCALE :— 1:1,000,000

78°
79°
15°
14°

Cuddapah

LEGEND

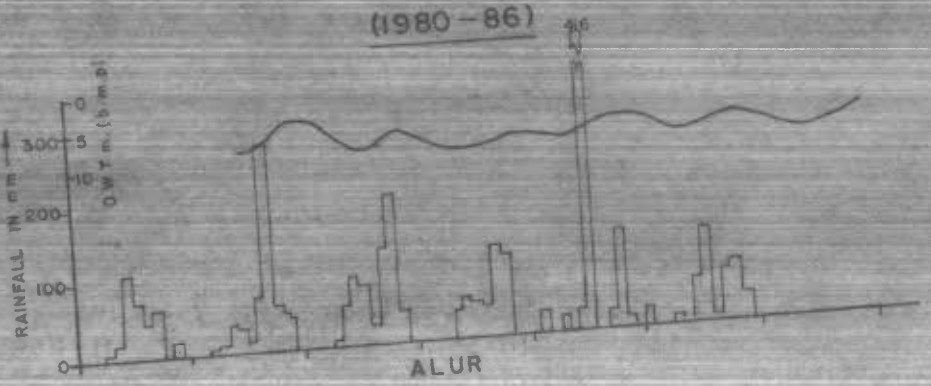
- 9 — DEPTH TO WATER m.bgl. (May 1986)
- 82 HYDROGRAPH STATION
- RIVER BASIN BOUNDARY
- STREAM
- HILLY AREAS

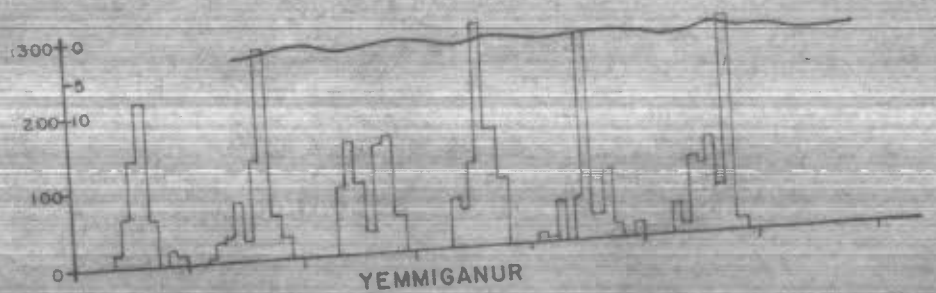
CGWB, SR, DO No-208/87

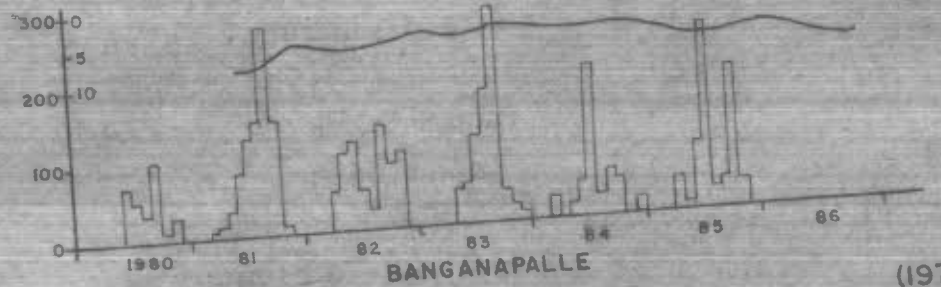
Fig-8(a)

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, KURNOOL DISTRICT, A.P.

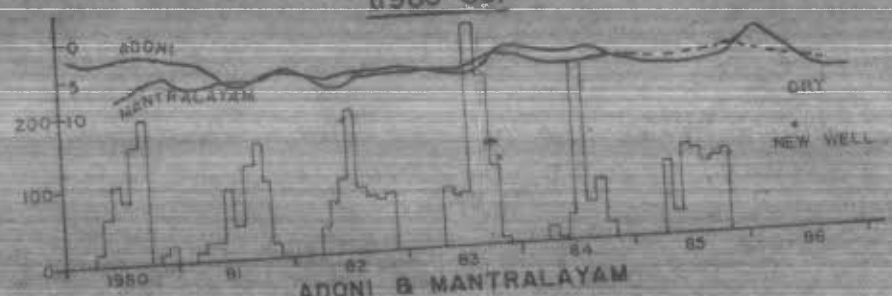
(1980-86)

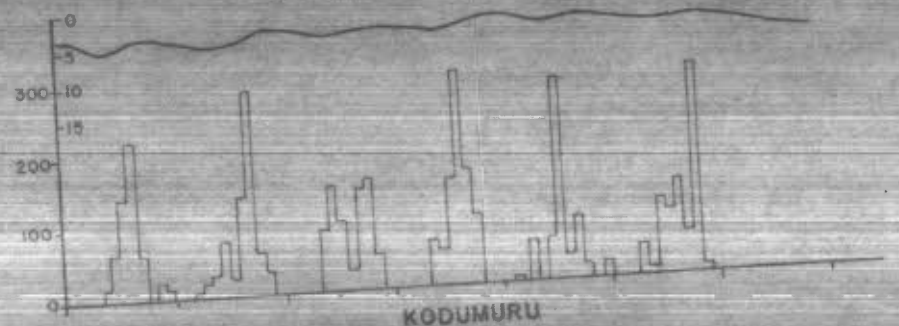


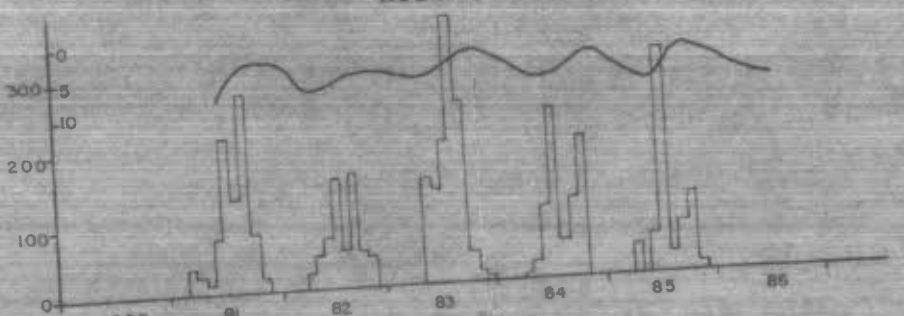




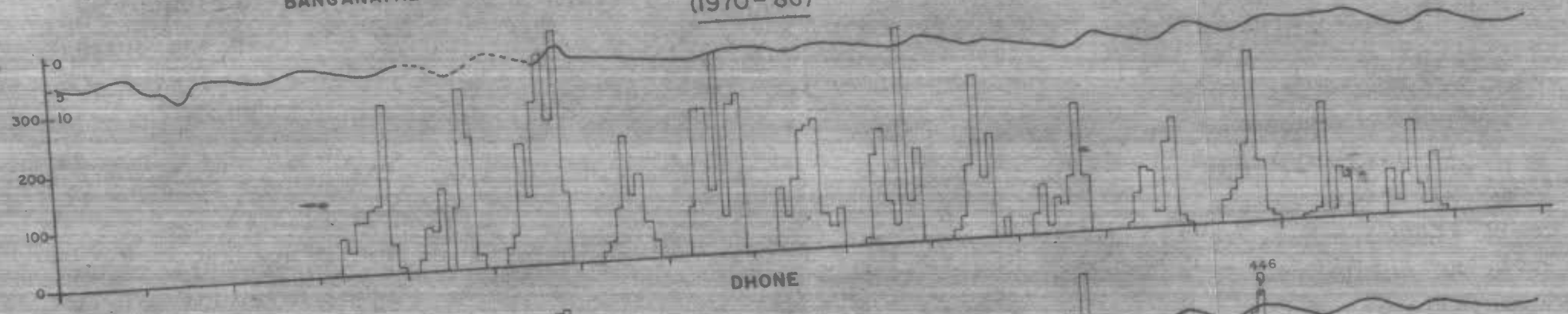
(1980-86)

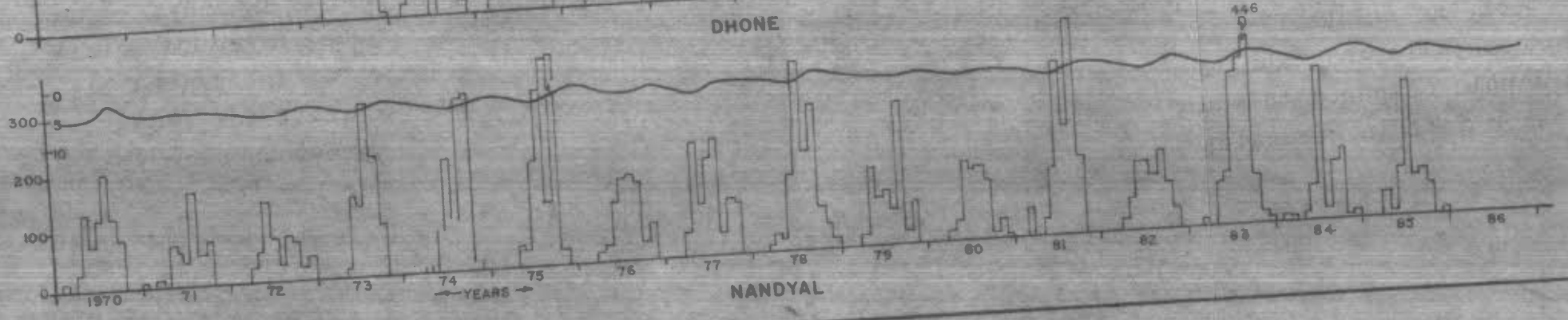






(1970-86)

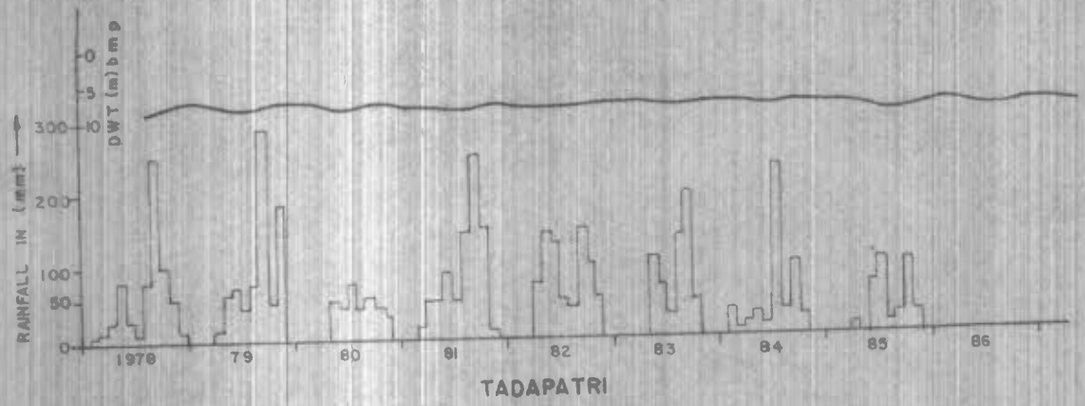




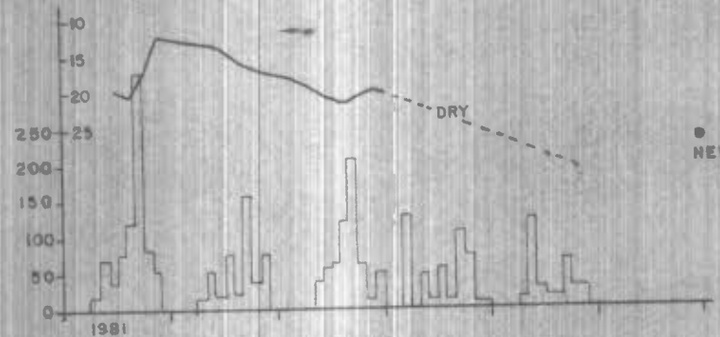
CGWB, SR, DO No. 215/87

Fig-5(b)

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, ANANTAPUR DISTRICT, A.P.

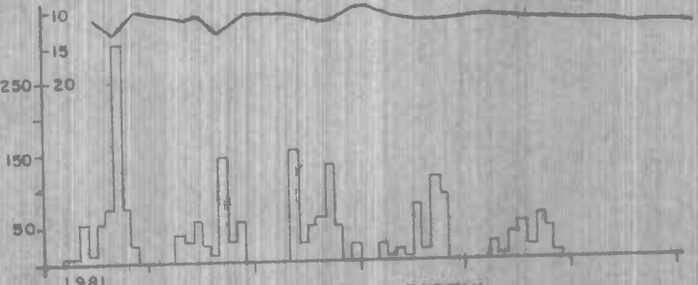


TADAPATRI

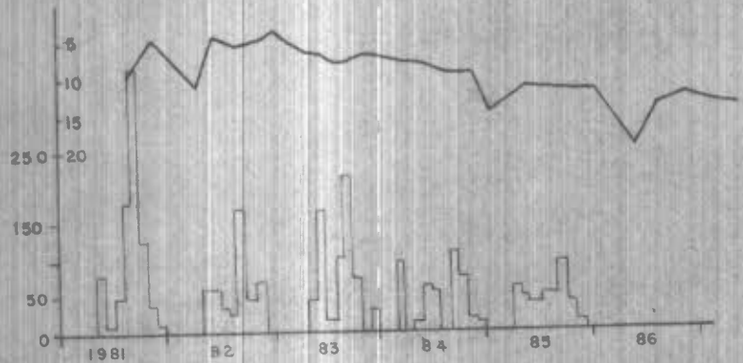


HINDUPUR

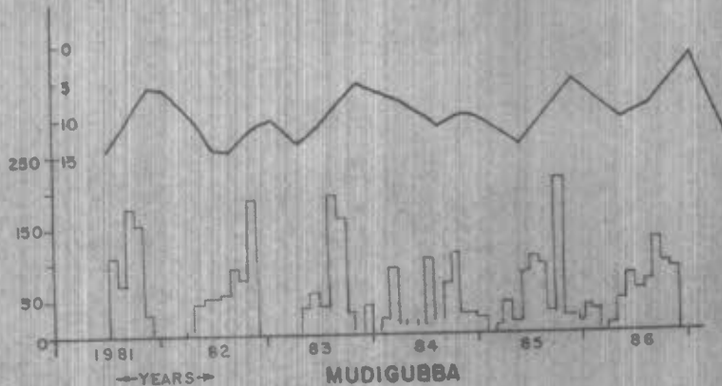
NEW WELL



THAGGUPARTHI



MADAKASIRA



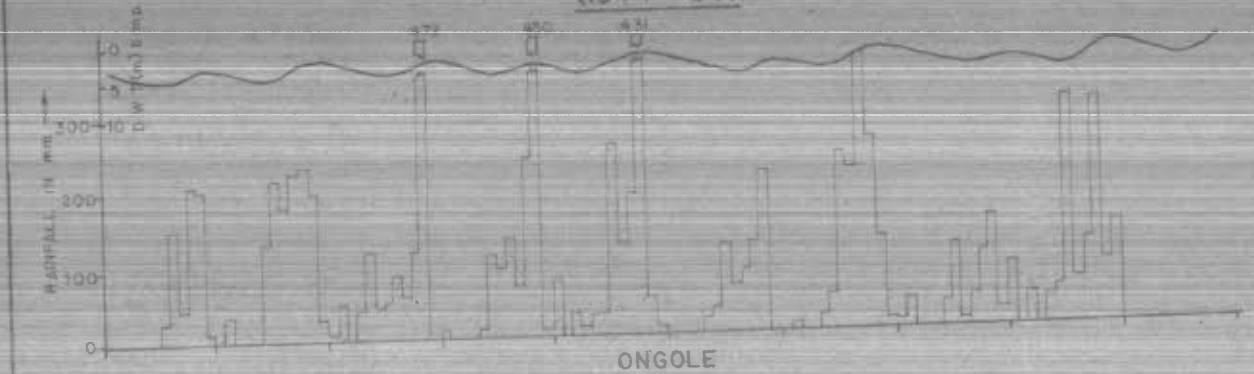
MUDIGUBBA

CGWB, SR, DO. No 219/87

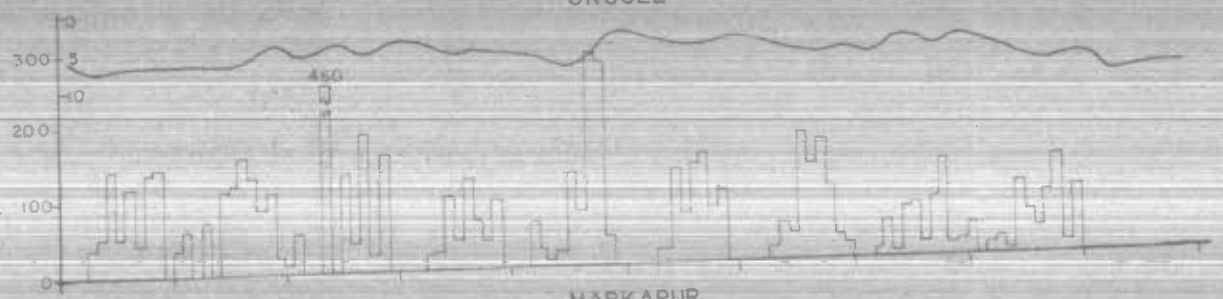
Fig - 23 (a)

RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, PRAKASAM DISTRICT, A.P.

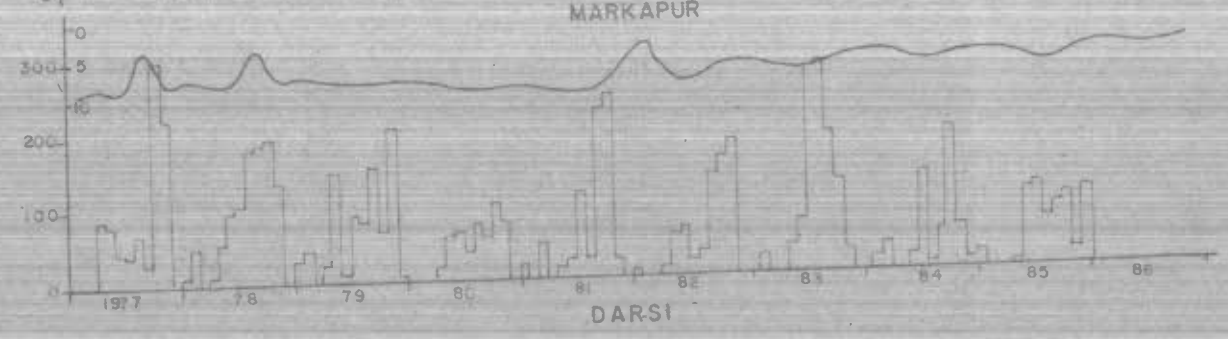
(1977-86)



ONGOLE

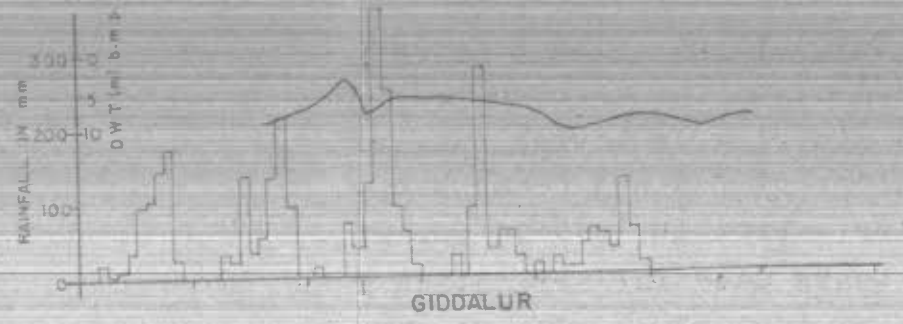


MARKAPUR

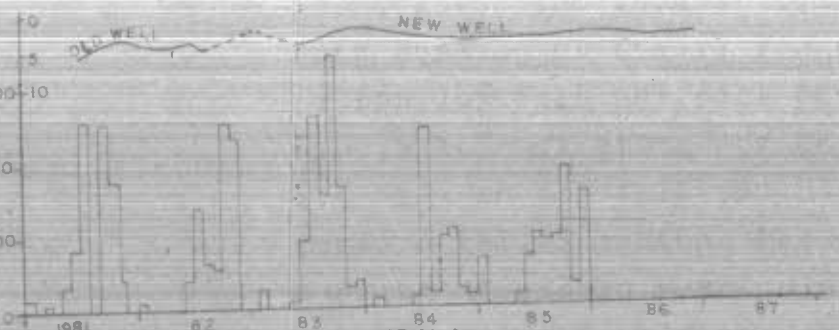


DARSI

(1981-86)

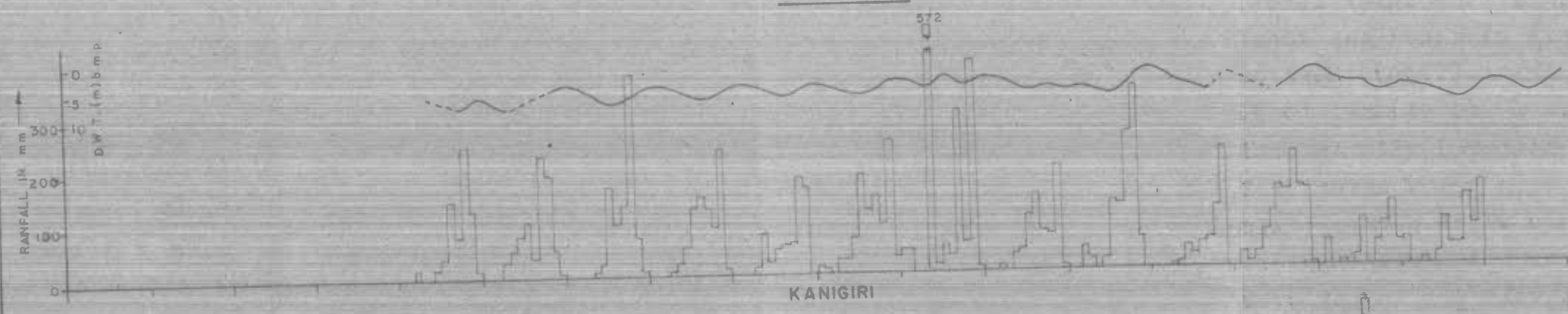


GIDDALUR

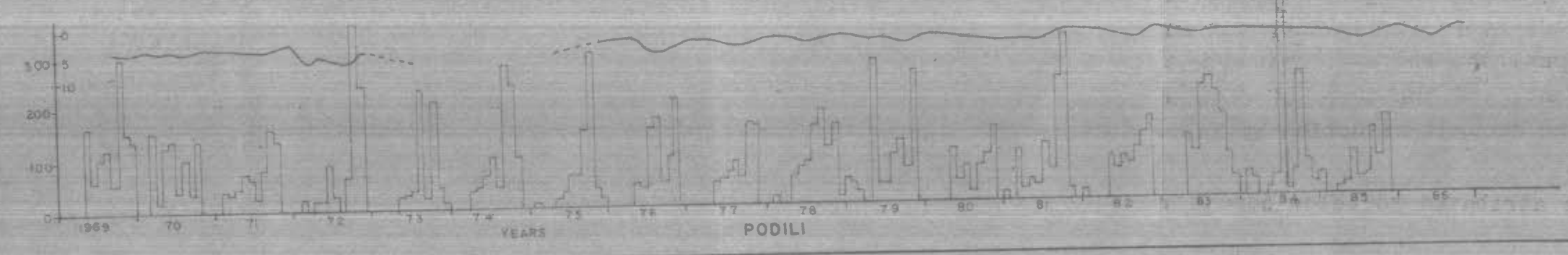


CHIRALA

(1969-86)



KANIGIRI



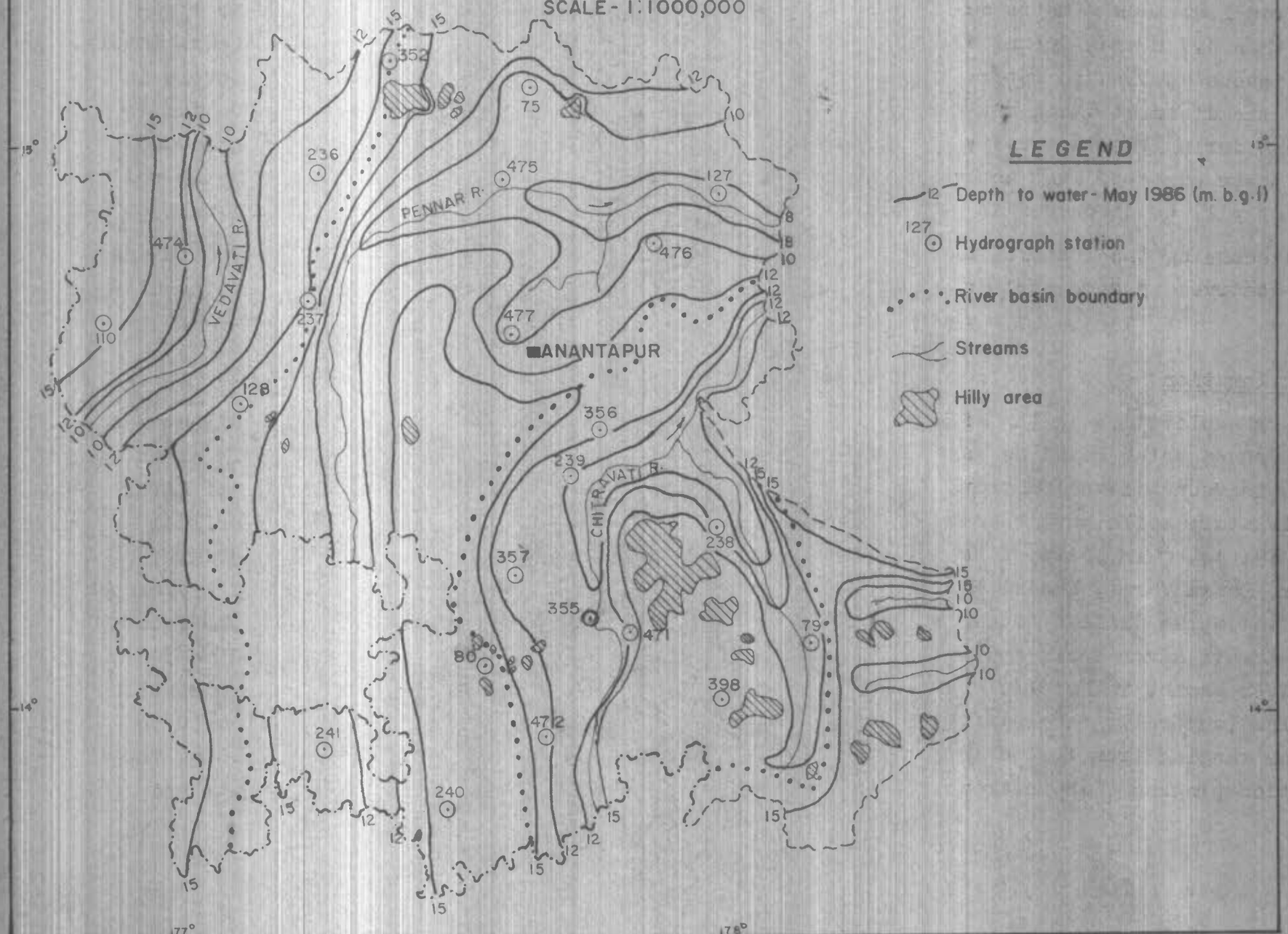
PODILI

CGWB, SR, DO No 211/87

DEPTH TO WATER

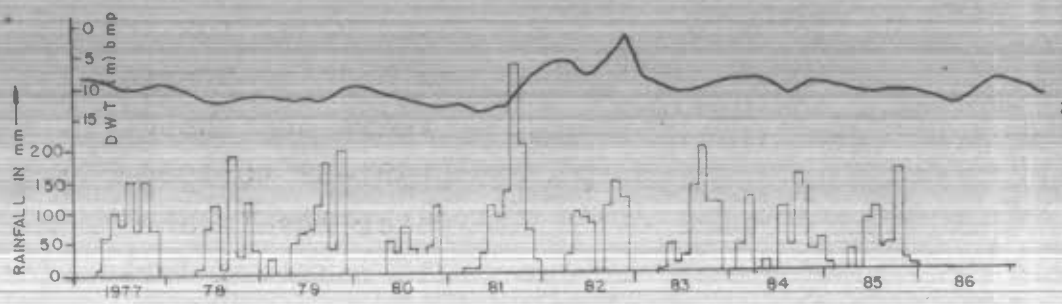
ANANTAPUR DISTRICT, A.P.

SCALE - 1:1000,000

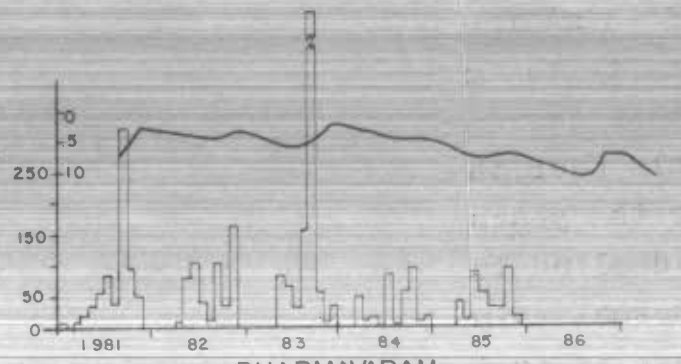


CGWB, SR, DO No. 201/87

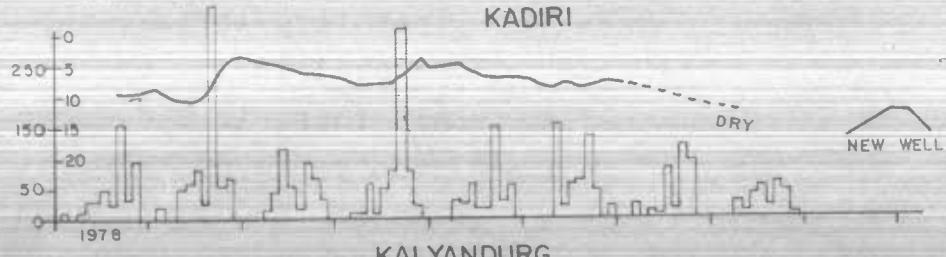
RAINFALL Vs WATER LEVEL OF NETWORK STATIONS, ANANTAPUR DISTRICT , A.P.



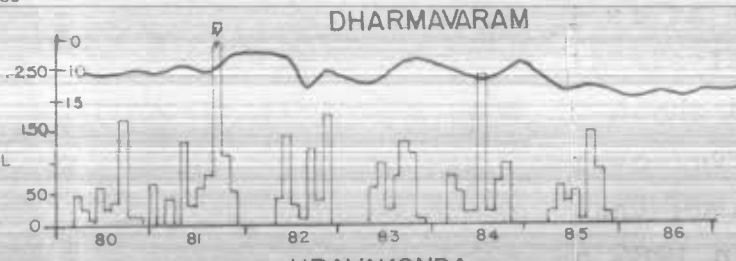
KADIRI



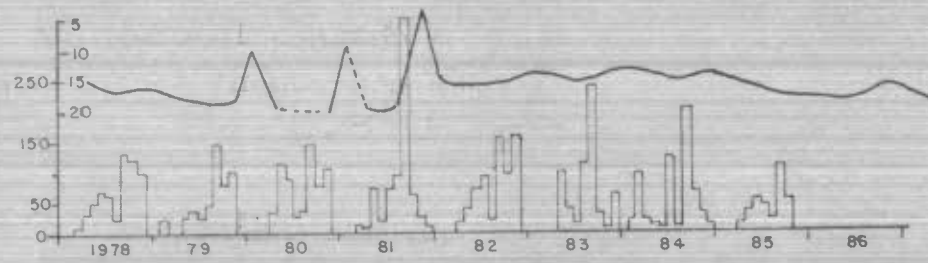
DHARMAVARAM



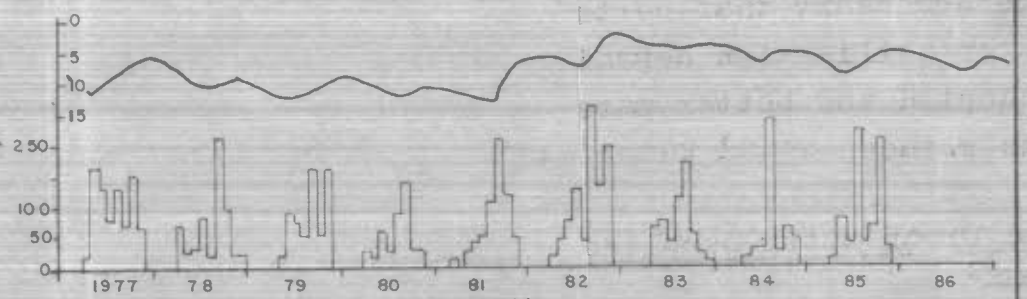
KALYANDURG



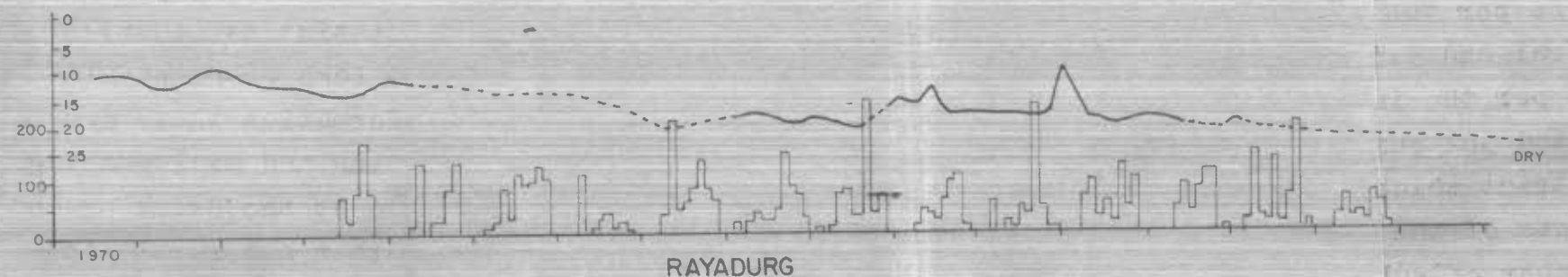
URAVAKONDA



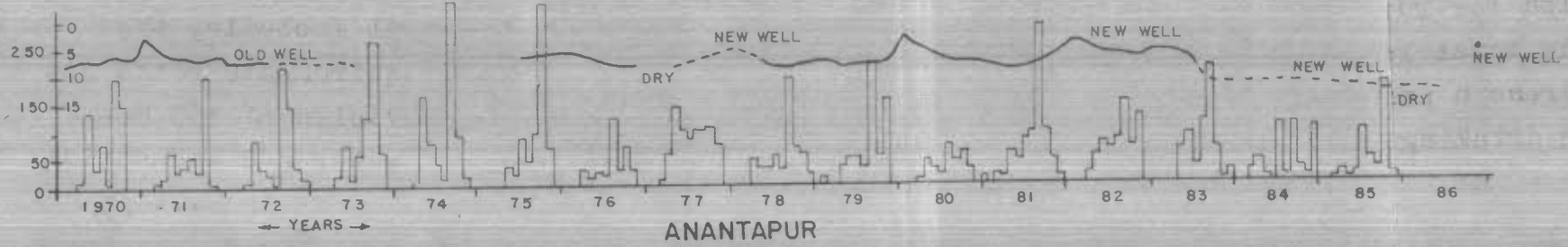
PENUKONDA



GOOTY



RAYADURG



ANANTAPUR

CGWB, SR, DO No 218/87