Technical Assistance
HYDROLOGY PROJECT

DHV CONSULTANTS & DELFT HYDRAULICS with HALCROW, TAHAL, CES, ORG & JPS

VOLUME 8
DATA PROCESSING AND ANALYSIS

OPERATION MANUAL – PART V

GROUNDWATER YEAR BOOK

Table of Contents

Groundwater Year Book

Insert a picture

Map

or

graph

or

photograph

that would be relevant to the information provided

<Data updated till >

< Year of publishing>

<Agency Name>

<The Data Storage Centre >

<Mailing Address>

<Tel>

<E-mail>

<Website>

<Fax>

FOREWORD

<The yearbook may include a foreword by an officer considered suitable by the agency. This person can typically be the Director/Chief Engineer who has the overall authority and responsibility of the functioning of the HIS in that agency>

COMPILED BY

<Names of Officers associated with the preparation of Year Book Designations>

Edited by

Name & Address.

PREFACE

The Groundwater Year Book is a compilation of information on the groundwater level and quality monitoring network. The Year Book also provides an interpretation of the hydrogeological system, groundwater resource distribution, water level and water quality trends. The need for the Year Book has been recognised based on regular enquiries received from a variety of groundwater users including managers, planners and concerned citizens. The Year book organises the different data being regularly sought in a systematic fashion.

The Groundwater Year book summarises the details of the monitoring network, comprising of …… monitoring wells, includes …… dug wells, …… bore wells, …… and tube wells. The publication gives details of the locations of …… piezometers for which lithological data is available, summary of seasonal water level monitoring from year …….. to ……., high frequency water level data from ……. piezometers from year ……. to ……., water quality data from year ……. to ……., pumping test data from …… piezometers and groundwater resource estimation updated to…….

The Groundwater Year Book gives details on the data collection network, aquifer systems represented, existing and emerging groundwater issues and an "overview of groundwater development and management strategies". Keeping in view the users from academic circles, information on the administrative setup, physiography, landuse, geology, and soil is also included. The organisation of the Year Book is such that the user will be able to get information on:

- Groundwater levels, fluctuation pattern and comparison with the past,
- Groundwater resource availability in the different districts and the changing trends,
- Potential and emerging issues in ground water quantity and quality,
- Areas for further studies and investigations,
- Institutional and Legal Issues, and
- Integrated Water management for sustainable development-sustainable solutions.

The report has to clearly identify the common concerns of the groundwater user/beneficiary:

- declining water levels in …….. areas,
- declining water quality due to industrial pollution/poor sanitation in …….. areas,
- rising water levels that could lead to water logging in …….. irrigation command,
- over exploitation in ……,
- saline water intrusion in ……,
- arsenic and fluoride issues that need better designs of borewells/ tube wells,
- heavy erosion and gulling leading to reduced recharge in ……,
- water management problems and policies, and
- need for legal instruments in harmonizing opposing interests.

It is earnestly desired that the concerns listed will be appreciated by the different stakeholders and departments, and appropriate remedial actions will be taken. The Department will be only too keen to provide any clarification and detailed interaction on specific issues. The department invites different agencies to interact with it in taking up studies and research in areas of common concern. This report can be made available in electronic format to registered groundwater data users.

1 INTRODUCTION

A fully functional HIS will provide easy access to the different variety of data required for bringing out detailed report/Year book. The main activity with respect to reporting will be analysis and interpretation. The analysed data need to be transformed as information and made available to the data users. The major users are planners, water resource managers, administrators and institutions/individuals concerned with development and protection of the water resource. The ground water year book should aim at providing the answers for the different questions in the minds of the different variety of users. In the past before the implementation of HIS, bulk of the time in the Head quarters was spent on systematic organisation of data received in different formats from the different offices. Implementation of HIS has made this task simple as the data now comes organised in data bases from the different DPC. The effort should be to carry out higher level validations, analysis and interpretation for converting the data into information. The contents and design of Year Book should be such that it becomes an important medium to dissemination of the results of systematic data collection.

It is very important to publish the yearbooks in different forms. The traditional way of bringing out the year book as printed documents shall still be continued but with reduced number. The most popular medium should be as electronic yearbook presented in the form of CD or may even be accessible (in controlled manner as per the guidelines of the agency) through internet. The electronic yearbooks and the printed document shall have the same content.

Keeping in mind the huge volume of data available because of the improved network, high frequency monitoring, improved laboratories and state of art hardware and software in the Data Centre, the style of presentation needs to be in the form of graphs, maps and pictures. Raw field data need not be published in the Year book. The Year book should generate the necessary interest in the readers to approach the Agencies for field data after making the necessary payments/seeking permission. Annexes should contain annual summary of different parameter compared with average/normal values/historical values. The approach should be to present to the viewer significant trends in the ground water resource availability, water level fluctuations, water quality changes and rainfall pattern. The impact of water level/quality fluctuation on the ground water resource availability, water quality contamination, ground water recharge, drought, water logging etc need to be presented pictorially as maps, graphs, photographs.

Issues of common concern like droughts, overexploitation, water quality contamination, lowering of water levels etc need to prioritised for elaboration in the year book. The role of planners, managers, academicians and individual water user in ensuring sustainability of the resource should be clearly brought out. The effort should be to keep the presentation as simple as possible with minimum use of technical jargon. The approach should be to increase the awareness levels as well as identify areas of concern. The year book presented is a model and the text used need not be adopted as such, but should help to define a style for the yearbook. The model provides enough scope for adaptation depending upon the concerns of the area being reported.

1.1 SALIENT STATISTICS

- **Area :** **------- Sq.kms.**
- **Geographical co-ordinates:**
- **Districts :** **(no)**
- **Taluks :** **(no)**
- **Blocks :** **(no)**
- **Villages :** **(no)**
- **Geology :**
- **Major rivers** :
- **Tributaries** :
- **Watershed** :
- **Cropping Pattern** :
- **Irrigation sources** : Tanks
  Canals
  Wells
- **Climate** :
- **Temperature** : Mean Minimum Temperature
  Mean Maximum Temperature
- **Average Annual Rainfall** :

  NE Monsoon Rainfall :

  SW Monsoon Rainfall :

Monitoring System

Piezometers in the network :

Dug Well in the network :

DWLR Installed :

Full Climatic Stations (FCS) :

Automatic Rainfall Stations (ARG) :

Non Automatic Rainfall Stations :

2 DRAINAGE CHARACTERISTICS

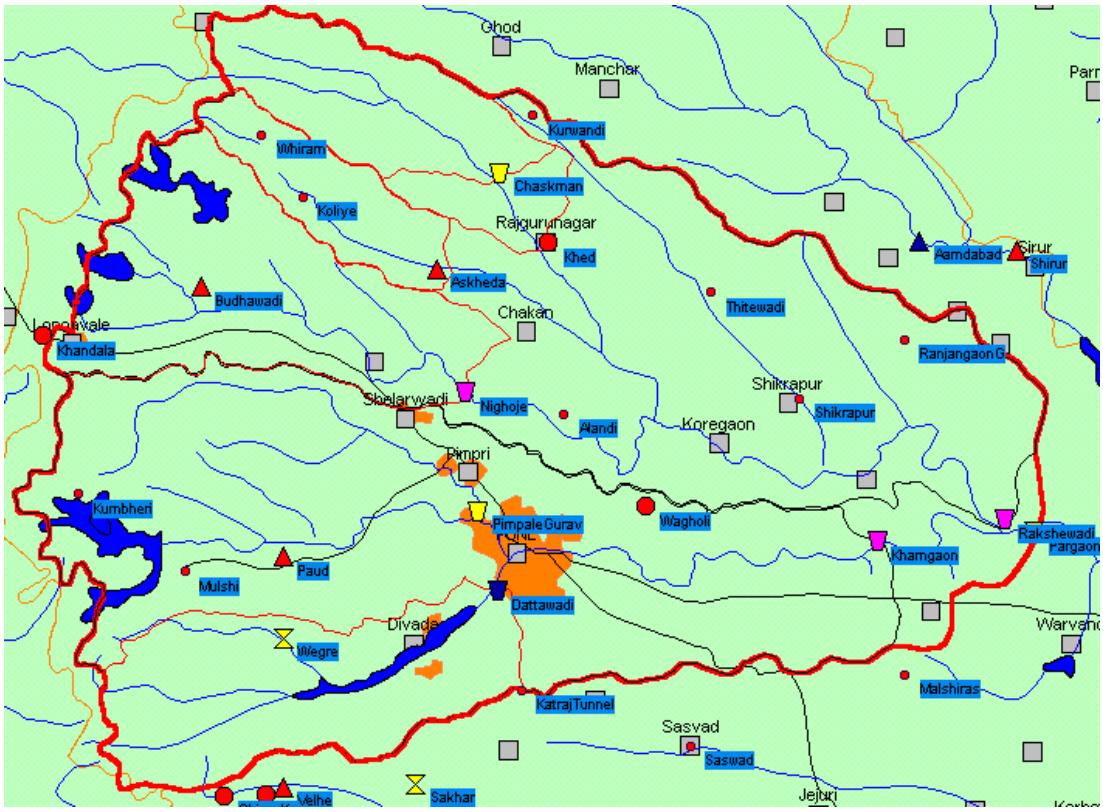


Figure 2.1.: Drainage map showing the major basins and sub-basins

<Describe the major drainage systems, drainage characteristics, delineate basin/sub-basin.>

<Describe the flood patterns and flow periods.>

<Describe the major reservoirs, canals, minor irrigation tanks and water harvesting ponds.>

3 GEOLOGY AND STRUCTURES

<List the main rock types, their distribution and mode of occurrence of groundwater in the different rock.>

<Describe the prominent water bearing zones (weathered, fractured) in the different rock types that act as good aquifers.>

<Describe the major structural features that occur in the area and their role in groundwater occurrence.>

<List the major formations that are tapped by the existing wells. Compute the annual groundwater draft from different geological units.>

Area	Rock Type	Prominent aquifers	Annual groundwater draft

Table 3.1: Geology and aquifer system

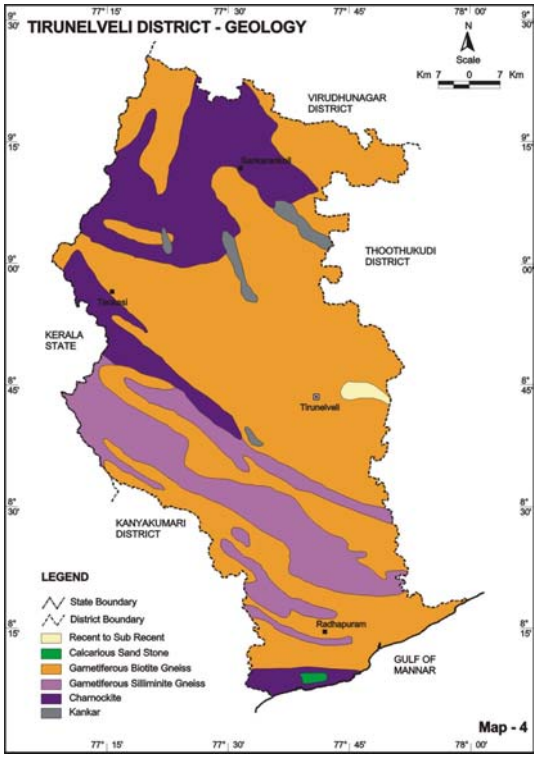


Figure 3.1:
Geology structure map of the area

4 SOIL TYPES

<Describe the main soil types, depth of weathering and the fertility status.>

<List the prominent characteristics of the soil and the nature of weathering and gulling.>

<Identify the soil types that favour groundwater recharge and the mechanisms that can be adopted for inducing artificial recharge.>

<List the areas or irrigation commands that are prone to soil salinity.>

<List the popular in-organic fertilizers, application rate and their impact on the groundwater and surface water quality.>

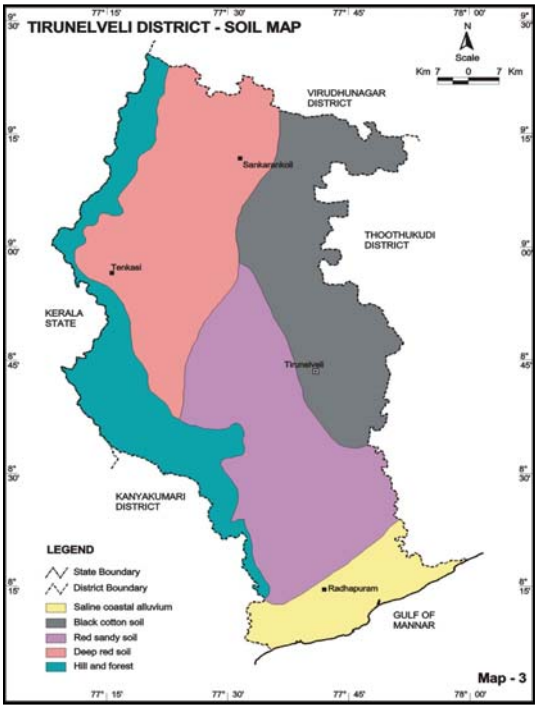


Figure 4.1:
Soil Map of the area

S. No.	District	Saline Coastal Alluvium	River alluvium	Black Cotton soil	Red sandy soil	Deep Red soil

Table 4.1: Distribution of major soil types

Source:

5 SUB-SURFACE LITHOLOGY

<Describe the prominent lithology encountered and their variations if any laterally or vertically.>

<Describe typical lithological cross sections.>

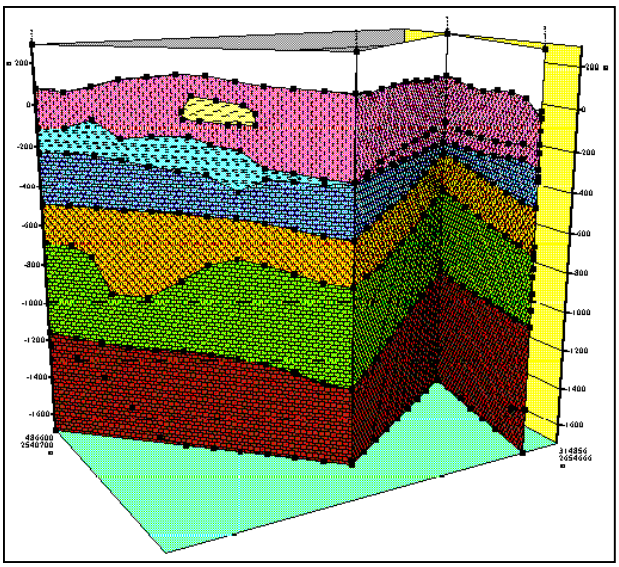


Figure 5.1:
Fence Diagram showing lithological section

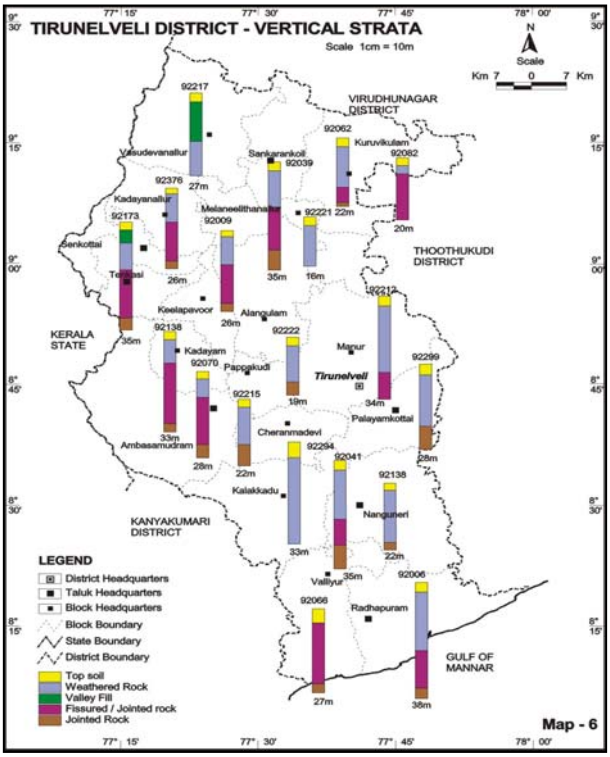


Figure 5.2:
Map showing the major lithological sections of the area

6 TYPICAL GROUNDWATER ISSUES OF THE AREA

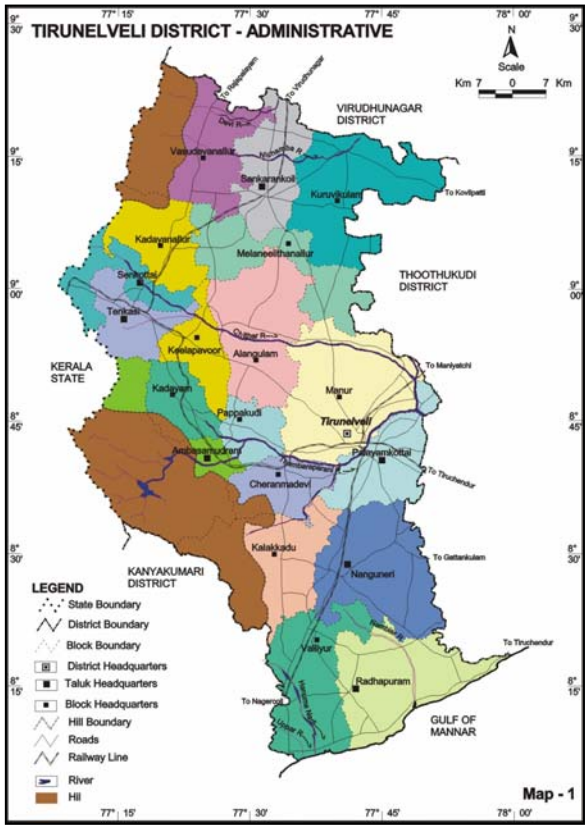


Figure 6.1:
Administrative Map of the State

<Describe groundwater development status in important cities, towns and industrial areas>.

<Identify the role of groundwater in meeting the drinking water supply requirements in the urban and rural areas and the total annual groundwater draft for drinking water supply.>

<Identify the role of groundwater in meeting the agricultural requirements.>

<Identify Periods/Areas of groundwater stress/abundance>

<Identify areas showing groundwater quality problems (pollution, salinity) >

<List areas showing groundwater depletion.>

< List the priorities under the HIS for monitoring all the different issues met with in the area. >

7 SETUP IN THE GROUNDWATER AGENCY

The Groundwater department was established in ……., with the main objectives of:

- Xxxxxxx
- Xxxxxxxx

The head office is located in……. There are ……. district/Division field level offices. The Department has …….. scientific staff and Engineers whose academic background range from Graduate Engineers, Postgraduates and Doctorates in Geology, Chemistry, Physics, and Statistics. The Department has also field level laboratories and Data Centers. The administrative set up of the department is as given in the flow chart.

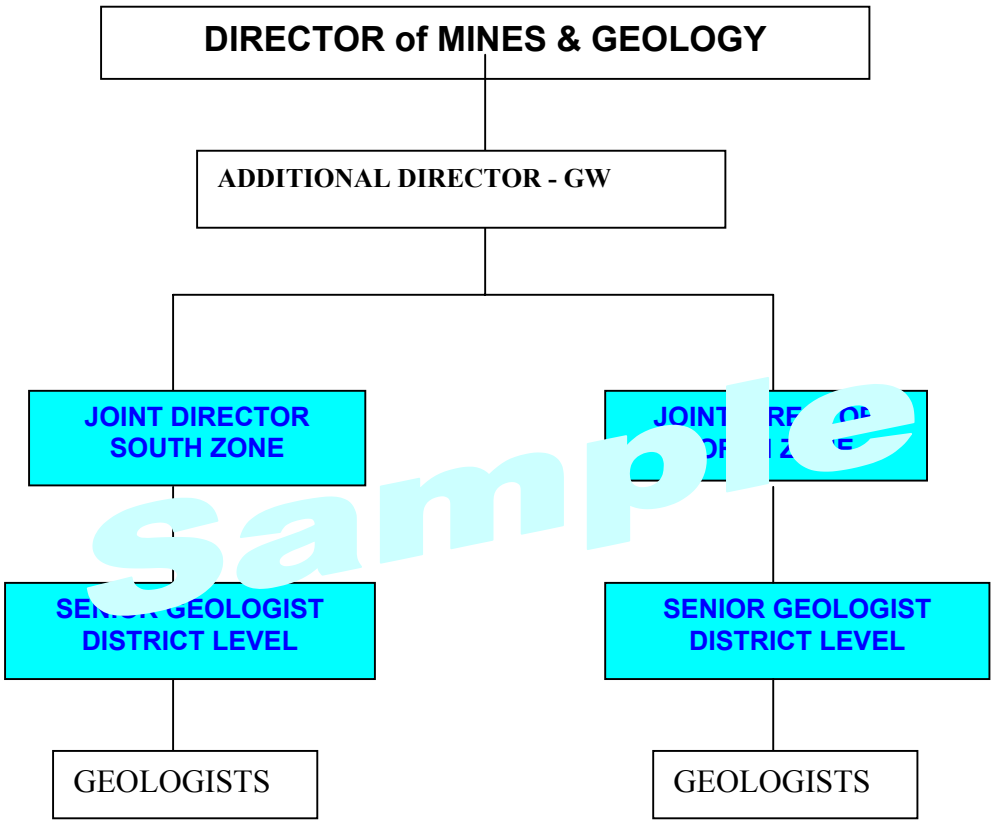


Figure 7.1: Organisational chart

The monitoring is carried out by trained field staff who operate from the different field offices. The field data are systematically organised, validated and analysed in the District Data Processing Centre (DDPC). The data from the DDPC is transferred to the State Data Processing Center (SDPC) for higher level validations and integration with neighbouring districts/basins. The data will be made available to the registered Hydrology Data User Group (HDUG) member agencies through the State Data Storage Centre (SDC)

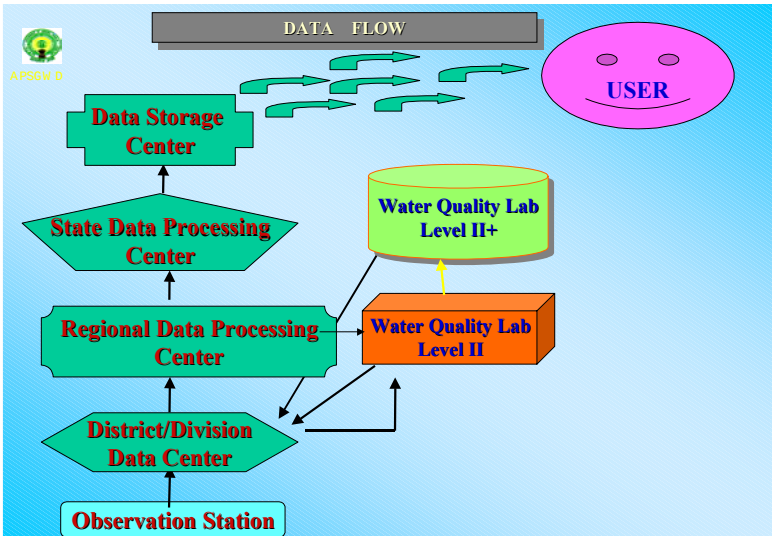


Figure 7.2: Data mobility diagram

Major tasks undertaken by the Groundwater Agency include:

- Groundwater Exploration
- Remote Sensing Study
- Exploratory Drilling
- Groundwater level Monitoring
- Groundwater quality Monitoring
- Groundwater Resource Estimation studies
- Consultancy Service
- Watershed Management
- R&D Studies

The variety of dynamic data being monitored include is as given in Table 2.1:

1.	Rainfall	Daily rainfall data collected from ……. raingauge stations.
2.	High Frequency Water Level	Hourly/ 6 hourly water level data from ……piezometers.
3	Manual Water Level	Manual water level ……. readings a year from …… dug wells
3.	Water Quality	Water Quality data from …… stations for trend, ……surveillance, ……
4.	Lithology	Lithological data from ……..bore holes drilled
5.	Pumping test	Hydrogeological parameters from the borehole drilled.
6.	Village wise Hydrogeological particulars	Hydrogeological particulars of the villages falling in this district.
7.	Groundwater Estimation	Block level groundwater recharge, extraction and the balance potential available for future development.

Table 7.1: Listing of dynamic data being monitored

8 HYDROLOGICAL INFORMATION SYSTEM - HIS

8.1 WATER LEVEL NETWORK

8.1.1 NETWORK STATUS FOR THE REPORTING YEAR

The water level monitoring network consists of ……..observation dug-wells which are privately owned, tapping the phreatic aquifer down to a maximum depth of …… mtrs. Apart from the dug wells the network comprises of …… dedicated piezometers, which have been constructed exclusively for water level and water quality monitoring. The piezometers tap the shallow unconfined aquifer/confined aquifer down to a depth of ……. mtrs.

8.1.2 MONITORING AND PROCESSING

The objectives of the water level monitoring is to:

- detect impact of groundwater recharge and abstractions,
- monitor the groundwater level changes,
- assess depth to water level,
- detect long term trends,
- compute the groundwater resource availability,
- assess the stage of development
- design management strategies at regional level.

8.1.3 DATA COLLECTION FOR THE REPORTING YEAR

Mention the number of monitoring wells that generated

- complete data,
- partial data
- the number of observation wells where monitoring was affected due to repair or failure of the monitoring structure,
- repair of the instrument,
- new sites added
- sites that were affected due to natural calamities
- sites affected due to vandalism.

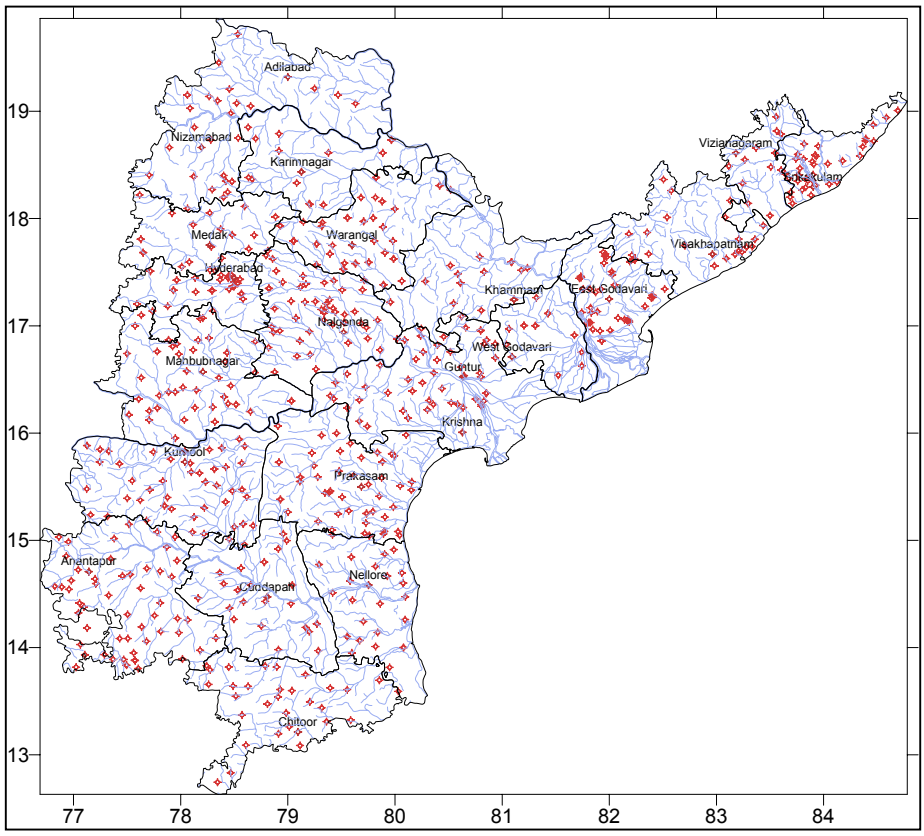


Figure 8.1: Location map of water level and quality monitoring network

9 WATER QUALITY NETWORK

9.1 NETWORK STATUS FOR THE REPORTING YEAR

The water quality monitoring network consists of ……..observation dug-wells which are privately owned, tapping the phreatic aquifer down to a maximum depth of …… mtrs. Apart from the dug wells the network comprises of …… dedicated piezometers, which have been constructed exclusively for water level and water quality monitoring. The piezometers tap the shallow unconfined aquifer/confined aquifer down to a depth of ……. mtrs.

9.2 MONITORING AND PROCESSING

The objectives of the water quality monitoring network is to:

- establish the bench mark for different water quality parameters, and
- compare the different parameters against the national standards,
- detect water quality changes with time,
- identify potential areas that show rising trend,
- detect potential pollution sources
- study the impact of land use and industrialization on groundwater quality.
- Data collection for the reporting Year

The frequency of monitoring for groundwater levels:

Dug wells: ……times a year

Piezometers: …… hourly

The frequency of monitoring for groundwater quality is:

……. Wells for Base level monitoring (……. times a year)

……. Wells for trend monitoring (…….. times a year)

…….. Wells for surveillance monitoring (…… times a year)

10 HYDRO-METEOROLOGY NETWORK

10.1 NETWORK STATUS FOR THE REPORTING YEAR

List the Hydro-meteorology network details on number of FCS, ARG and SRG.

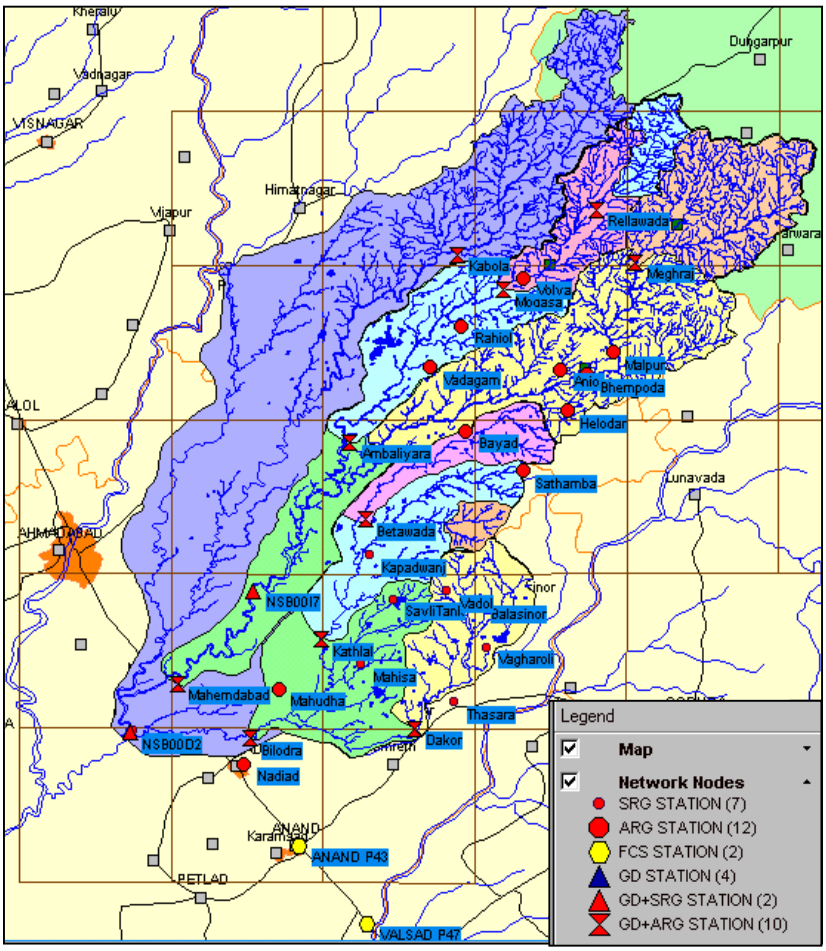


Figure 10.1
Drainage network map

10.2 MONITORING AND PROCESSING

List the objectives of the Hydro-meteorology network:

10.3 DATA COLLECTION FOR THE REPORTING YEAR

Summarise the major meteorological events and its influence on the ground water system

11 ORGANISATION OF GROUNDWATER DATA IN HIS

The monitoring data are systematically organised in the HIS data base, including:

- well inventory
- exploratory drilling
- pumping test data
- logging
- water level,
- water quality
- rainfall data
- meteorological data

The database contains …… groundwater level data from …….. wells and …… groundwater quality analysis results. The data has been systematically validated and has passed through strict quality checks. It has also been ensured that the monitoring wells are systematically maintained. GIS dataset generated on 50,000 scale is also part of the database. A dedicated Groundwater Evaluation and Management Software (GEMS) with analytical and statistical software is used for making two dimensional hydrogeological sections, cross sections, maps and graphical plots. The software also computes the groundwater resource availability for specified administrative/ drainage units. GIS data sets on 50,000 scale for 10 different themes are also used for understanding the interaction of different components in groundwater occurrence and movement.

The monitoring data are systematically organised in the HIS data base, including:

- well inventory
- exploratory drilling
- pumping test data
- logging
- water level,
- water quality
- rainfall data
- meteorological data

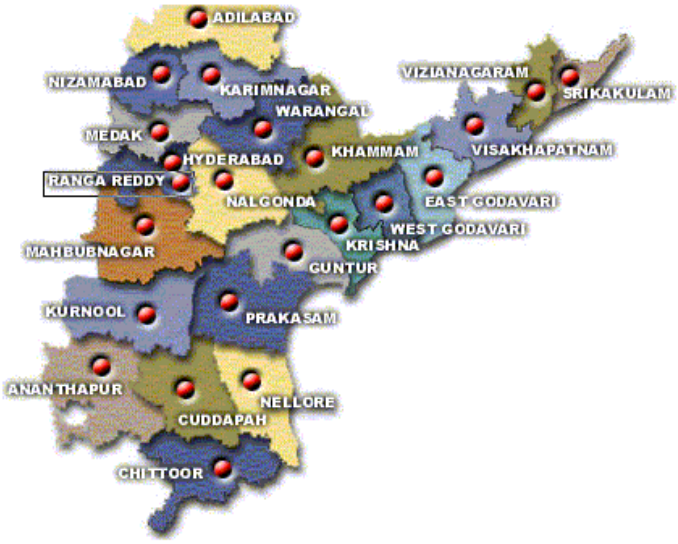


Figure 11.1:
Location of District Data Processing Center (DDPC)

12 SEMI-STATIC DATA

12.1 CROPPING SYSTEM FOR THE REPORTING PERIOD

<List the areas based on groundwater for irrigation, crops cultivated, type of wells, cropping season and total annual draft.>

<Mention the areas under dry crops, and critical irrigation if any from groundwater.>

<Compare the groundwater requirement for different crops.>

<Estimate the total evapotranspiration from different crops.>

<Estimate the return flow available as recharge from flooding in rice and sugarcane field plots.>

<Identify the scope for improving the irrigation efficiency.>

<Mention the role of watershed management in prolonging soil moisture availability and thus reducing crop water demand.>

S. No.	District	Percentage of major soil group	Cropping pattern

Table 12.1: Crops grown in major soil types

13 DYNAMIC DATA

13.1 REVIEW OF CLIMATE AND RAINFALL FOR THE REPORTING PERIOD

<Describe the characteristics of the rainfall and its distribution>

<Average annual rainfall: …….mm.>

Seasons	Period	Rainfall in mm		Percentage deviation
		Reporting period	Normal	
Winter				
Hot weather period				
Southwest Monsoon				
Northeast Monsoon				
	Total			**100.00**

Table 13.1: Season wise normal rainfall (50 years)

Source:

<Construct an Isoheytal map for the reporting year and compare with the normal rainfall to understand the deviation from the normal.>

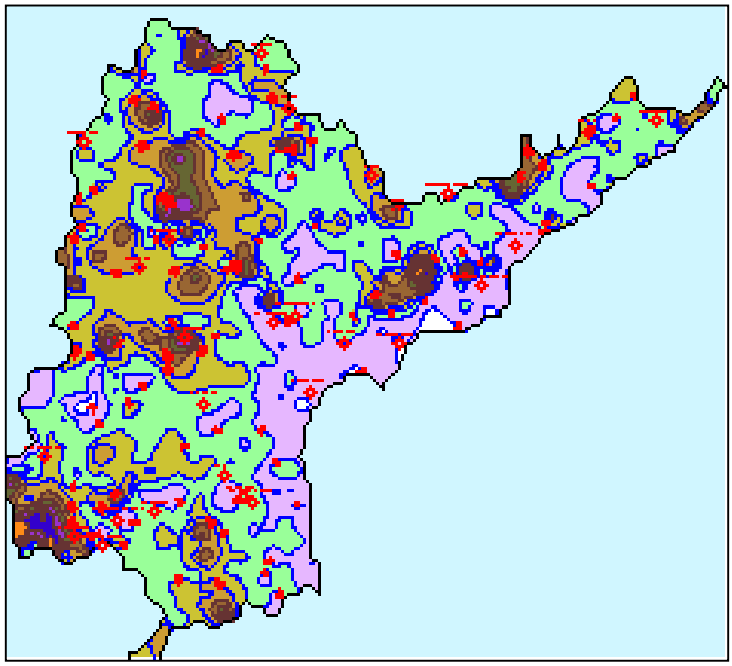


Figure 13.1: Isoheytal map

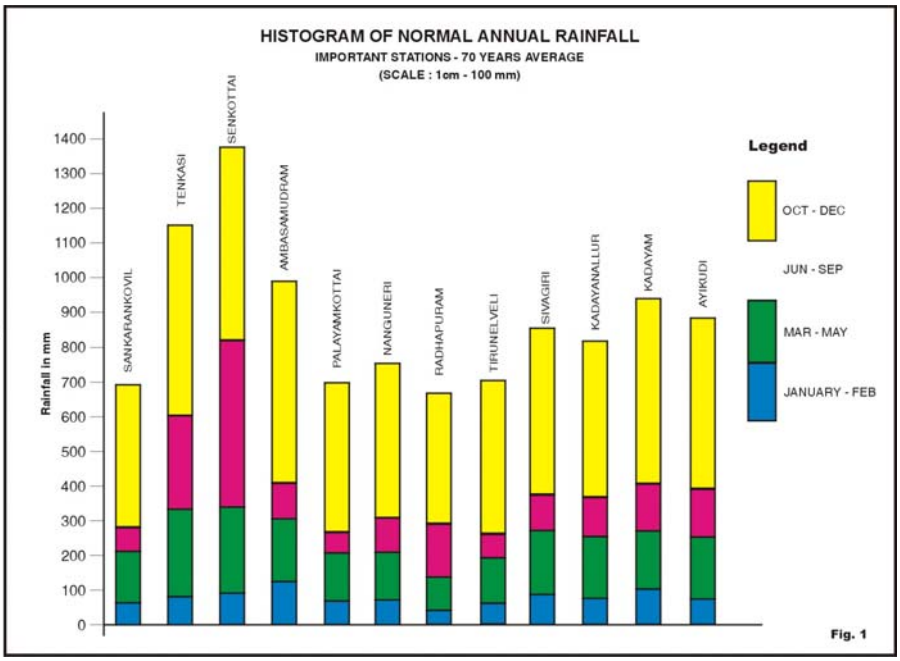


Figure 13.2: Histogram of normal annual rainfall

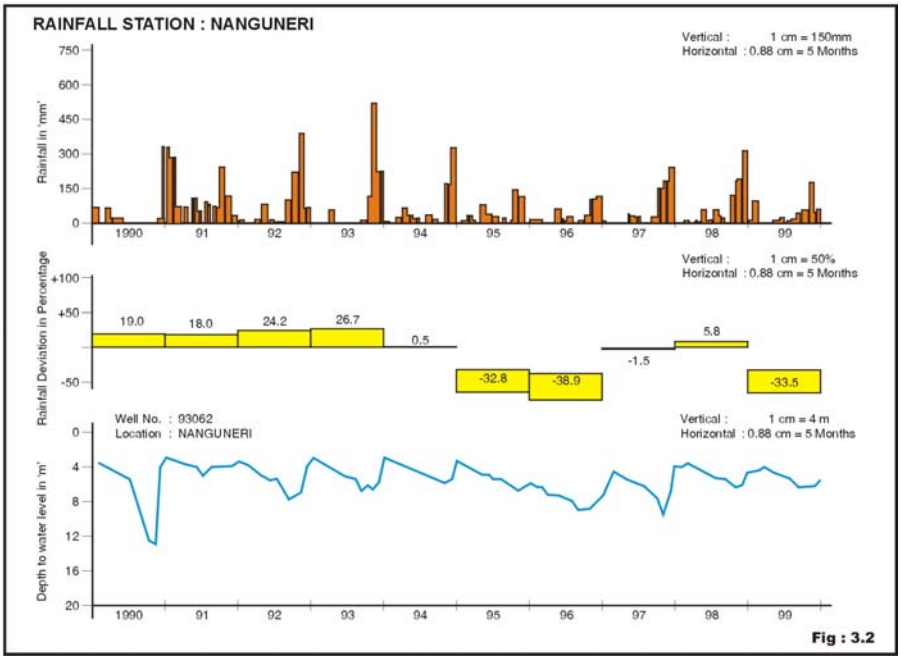


Figure 13.3: Composite Rainfall and water level graph

13.2 REVIEW OF SURFACE RUN OFF FOR THE REPORTING PERIOD

<Assess total run off generated (select stations) for the reporting year and compare with the last year or few years (Discharge Hydrograph).>

<Assess the erosion pattern, flooding and recharge pattern.>

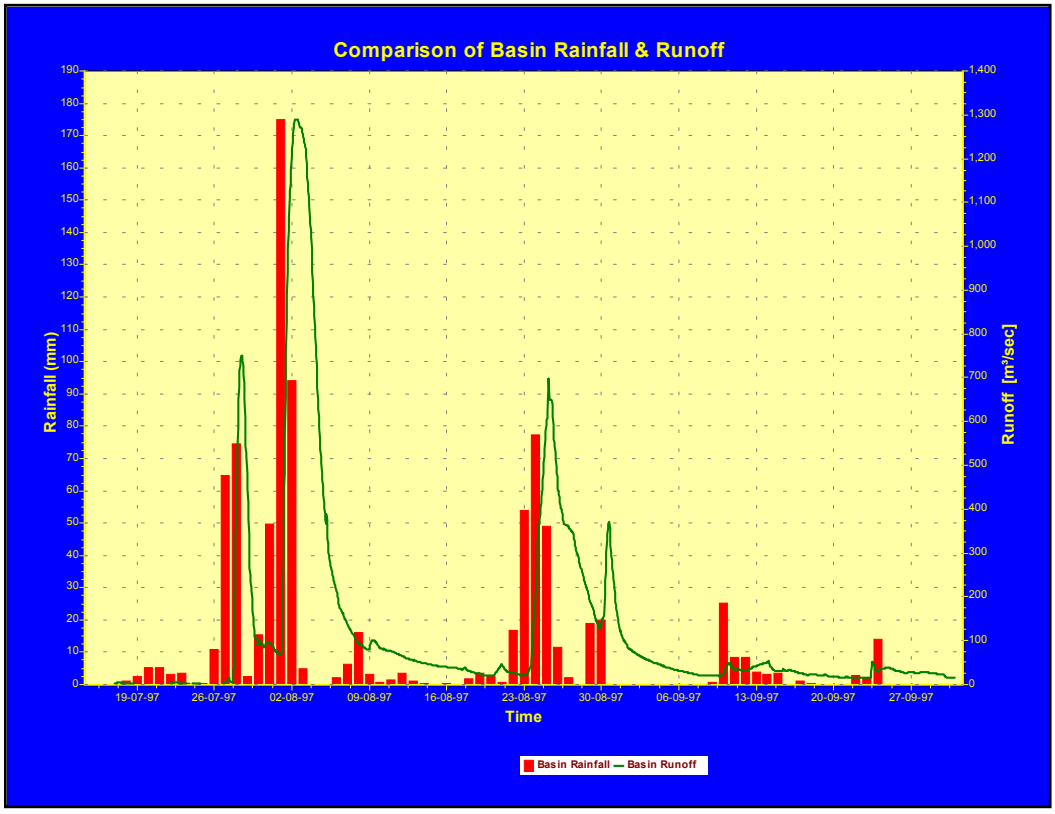


Figure 13.4: rainfall-run off hydrograph

14 REVIEW OF GROUNDWATER LEVEL CHANGES FOR THE REPORTING PERIOD

<Describe the typical long-term water level hydrographs. Show typical examples of villages showing rising water level trends and declining water levels trends.>

<Describe the typical long-term water level hydrographs for typical areas (coastal areas, irrigation commands, over-exploited areas, delta areas, areas close to riverbeds).>

<Study multiple hydrographs from a number of wells within a watershed to understand the groundwater dynamics. Assess the water level chages in multi-aquifer system.>

<Delineate areas showing typical long-term water level trends (enclose list of villages).>

<Describe typical high frequency water level monitoring hydrographs and their significance.>

<Explain the recharge – rainfall response for different rainfall intensities>

<Explain the recharge –rainfall response for different rainfall intensities.>

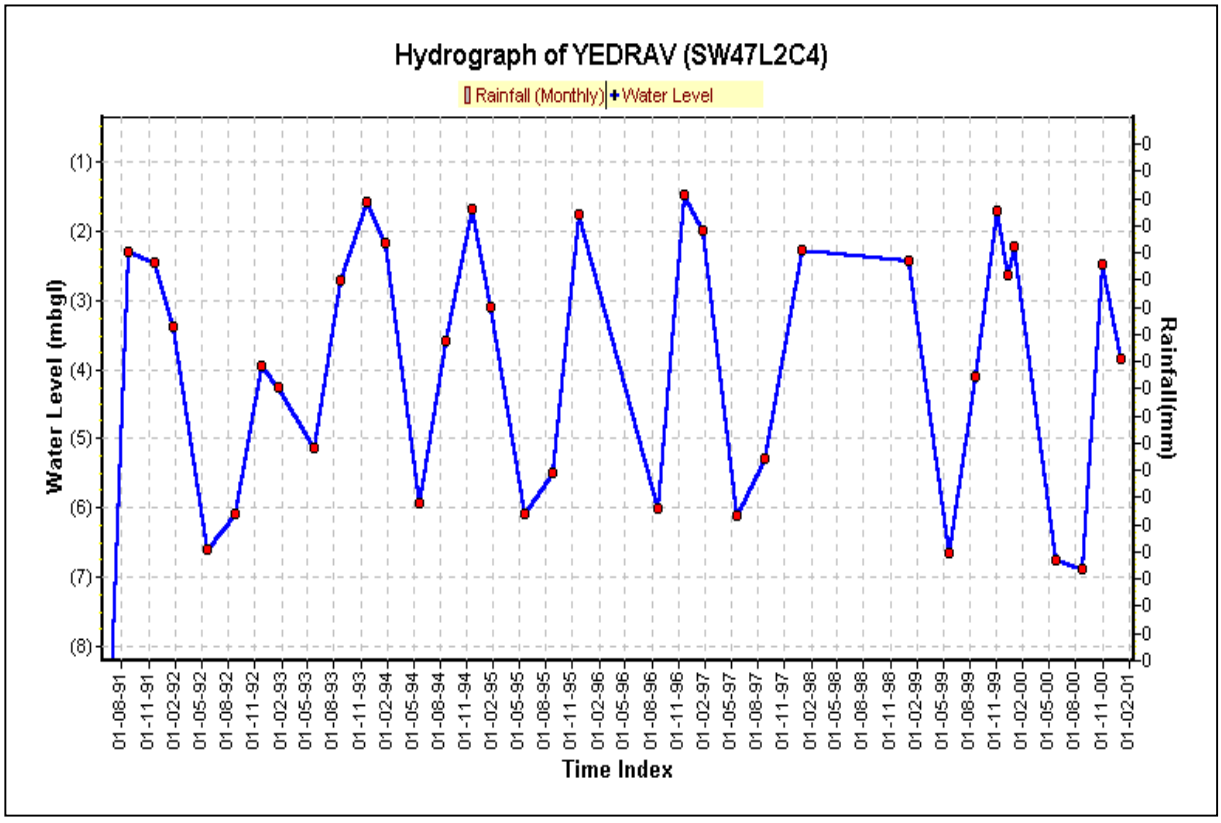


Figure 14.1: Long term Water level hydrograph from observation well

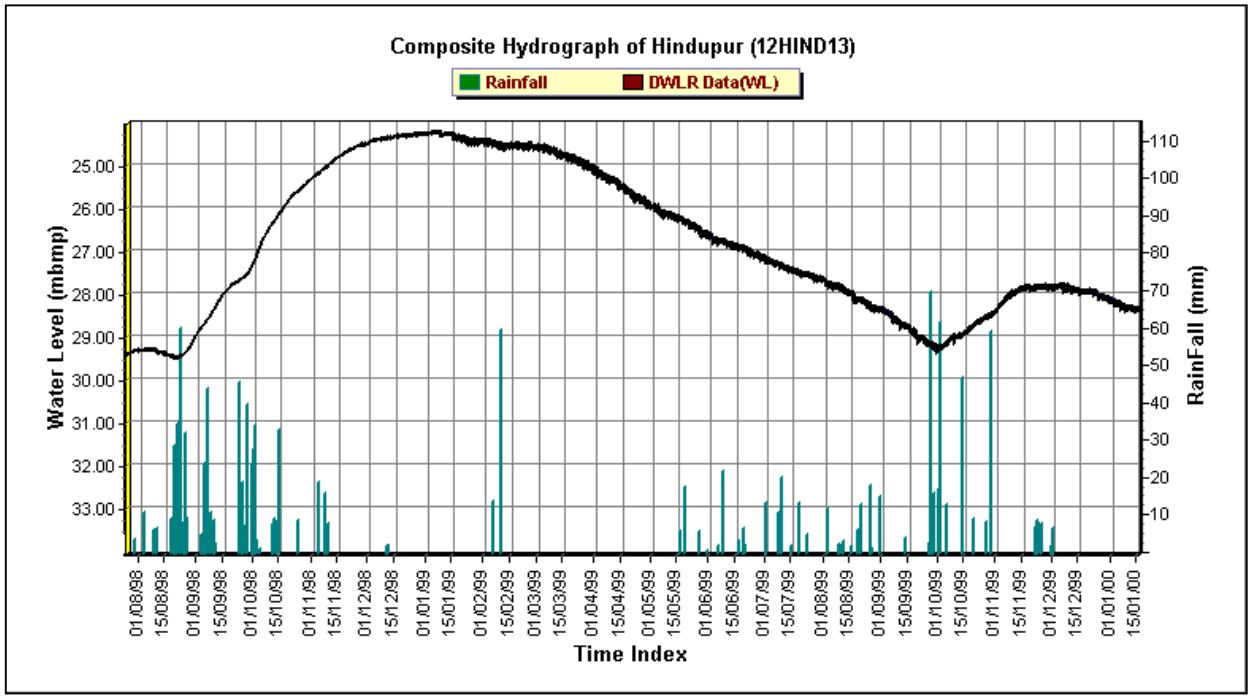


Figure 14.2: Composite hydrograph of high frequency water level monitoring

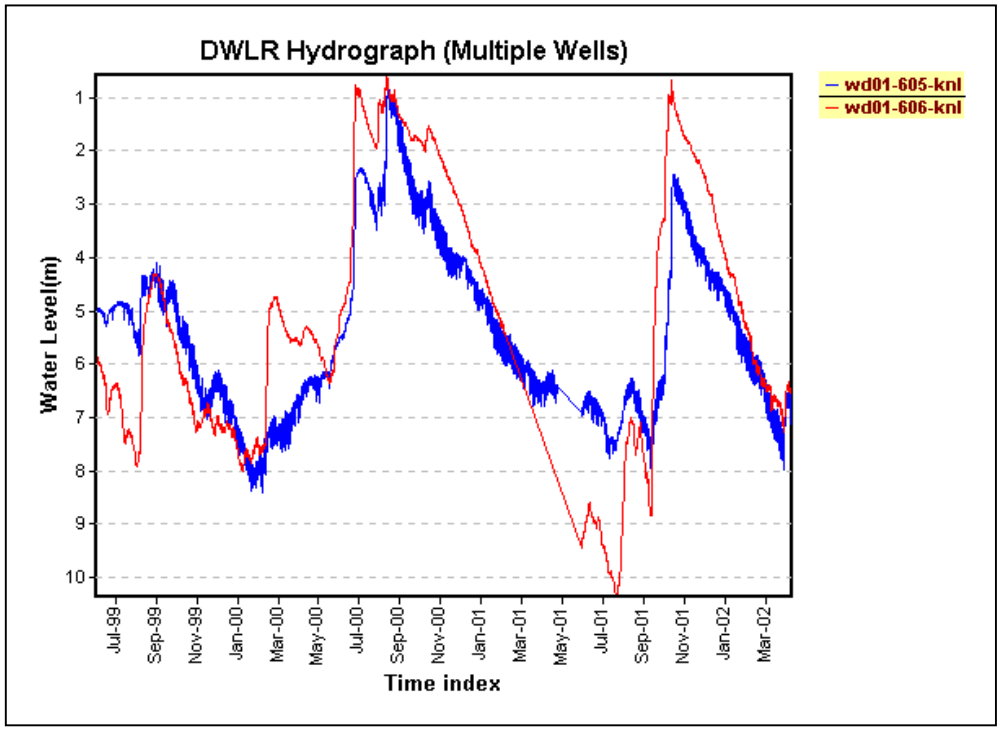


Figure 14.3: Multiple hydrograph of high frequency water level monitoring

15 REVIEW OF GROUNDWATER FLOW SYSTEM CHARACTERISTICS FOR THE REPORTING YEAR

<Generate water level fluctuation contour maps using data for the reporting period and the last year/year average (pre and post monsoon) from all the monitoring wells tapping a single aquifer in the network.>

<Generate water level elevation contour maps using data for the reporting period (pre/post monsoon) from all the monitoring wells tapping a single aquifer in the network.>

<From the generated map assess the gradient of groundwater flow, determine the flow path, and delineate the recharge and discharge area. Detect any change in flow gradient or path as compared to the previous years.>

<Generate maps for all the different aquifers and assess the gradient of groundwater flow for the different aquifers. Assess nature of contact/mixing between aquifers.>

<Assess the groundwater flow through the aquifer system using supporting data (rainfall, runoff, recharge, and draft).>

<Generate Groundwater worthy map.>

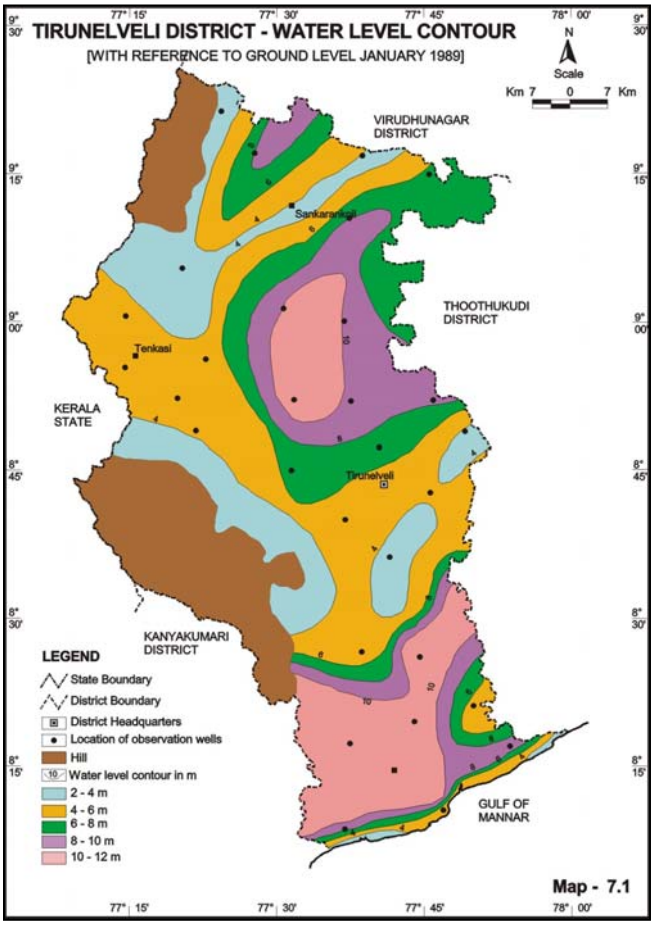


Figure 15.1:
Water Level Elevation Contour Map

16 REVIEW OF THE GROUNDWATER, GROUNDWATER QUALITY CHANGES FOR THE REPORTING YEAR

<Describe the groundwater quality monitoring network, frequency of monitoring, list of laboratories and parameters analysed.>

<Show sample hydrograph depicting the changing trends in water quality for different parameters. List the parameters that show higher levels of concentration or show increasing trend.>

<Describe the chemical quality of groundwater in the different aquifers; assess the parameters that show higher levels of concentration or show increasing trend.>

<Generate water quality contour maps for specific parameters using analysed results of the reporting period (pre/post monsoon) from all the monitoring wells tapping a single aquifer in the network.>

<From the generated map assess the pattern of contaminant transport, delineate areas showing high concentration, identify polluting sources if any (natural/industrial).>

<Generate water quality maps, diagrams for the different aquifers. Assess nature of contact/mixing of contaminants if any between aquifers.>

<Assess the rate of dilution or increasing concentration. Study the impact of rainfall, surface face water bodies, and recharge and excess draft on groundwater quality.>

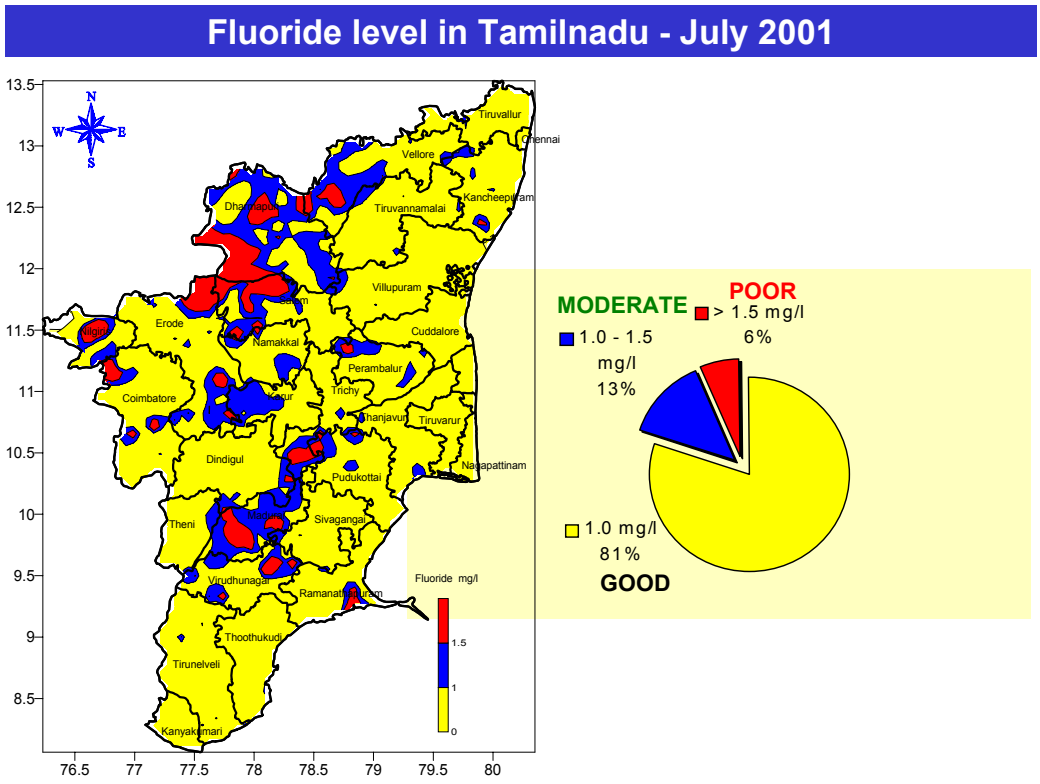


Figure 16.1: Groundwater quality map

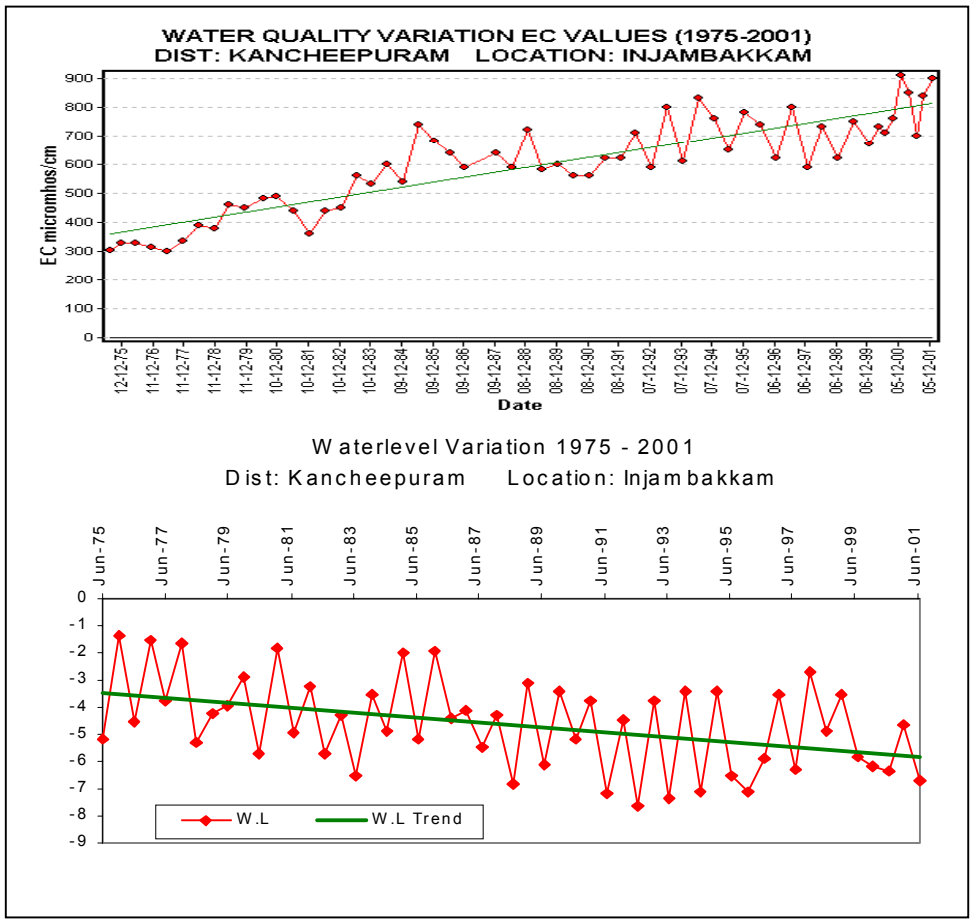


Figure 16.2: Long term Water quality trend

17 ESTIMATION OF GROUNDWATER RESOURCE AVAILABILITY FOR THE REPORTING YEAR

<Carry out groundwater resource estimation for the reporting period based on the GEC norms.>

<Identify watersheds/administrative units subjected to overexploitation as compared to previous years.>

<Identify areas that are showing heavy increase in draft.>

<Identify stage of development.>

<Generate notified area map.>

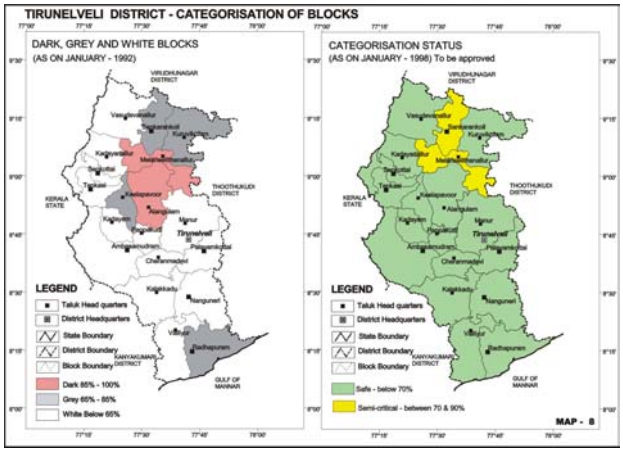
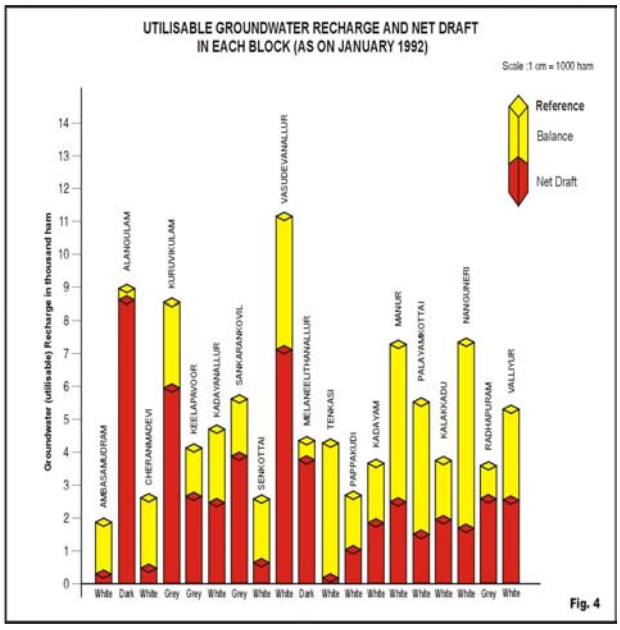


Figure 17.1:
Groundwater categorization map



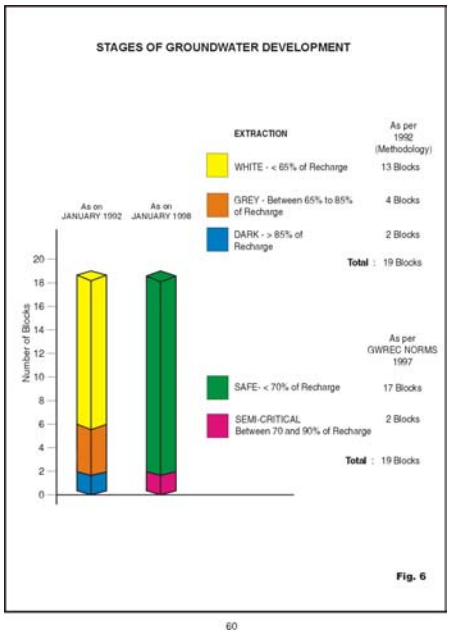


Figure 17.2: Utilisable ground water recharge, draft and ground water development status

18 RECOMMENDATION FOR SUSTAINABLE DEVELOPMENT OF GROUNDWATER

<Based on the different analysis list the administrative blocks showing declining and rising water levels.>

<Delineate recharge and discharge areas.>

<Identify the technically appropriate programmes that need to be considered for containing the declining water level trend, increasing contamination, containing depletion of resources, reducing erosion and increasing recharge.>

<Recommend the appropriate designs for efficient wells, artificial recharge structures/water harvesting ponds that can be taken up in different areas.>

<Recommend sustainable groundwater development programmes for ecolgically fragile areas like coastal/Urban/ industrial areas).>

<Identify specific research projects that need to be considered for tackling serious groundwater related issues.>

<Recommend to the administrators/planners the appropriate Groundwater Policies and legislation that can ensure equity and ensure groundwater sustainability.>

ANNEX I: TABLE GROUNDWATER OBSERVATION WELLS

(List updated to ……..….)

State: Andhra Pradesh **District: Anantpur** **Agency: APSGWD**

Mandal	Village	Well No	Latitude	Longitude	Topo-Sheet No	Welltype	Geology	Basin
Gandlapenta	Gajulavaripalli	12GAJU20	14°05'15"	78°19'45"	57J/08	Bore Well	Granite	Pennar
Gummagatta	Tallakera	12TALL42	14°34'25"	76°49'15"	57B/14	Bore Well	Granite	Krishna
Agali	Madhudi	12MADH11	13°49'01"	77°01'25"	57G/01	Bore Well	Granite	Pennar
Amadagur	Amadagur	12AMAD21	13°53'35"	78°01'00"	57K/01	Bore Well	Granite	Panner
Amarapuram	Basavanahalli	12BASA10	14°01'39"	77°03'52"	57F/04	Bore Well	Granite	Panner
Anantapur	Kurugunta	12KURU08	14°40'57"	77°31'48"	57F/10	Bore Well	Granite	Panner
Atmakur	Vaddupalli	12VADD09	14°40'10"	77°27'25"	57F/06	Bore Well	Granite	Panner
B.k.samudram	Rotarypuram	12ROTA25	14°44'18"	77°41'04"	57F/10	Bore Well	Granite	Panner
Bathalapalli	Kattakindapalli	12KATT23	14°26'53"	77°53'31"	57F/15	Bore Well	Granite	Panner
Beluguppa	Beluguppa	12BELU04	14°42'30"	77°08'35"	57F/02	Bore Well	Granite	Krishna
	Gangavaram	12GANG39	14°38'35"	77°12'05"	57F/02	Bore Well	Granite	Krishna
Bommanahal	Unthakal	12UNTH41	14°59'10"	76°57'40"	57B/13	Bore Well	Granite	Krishna
Brahmasamudram	Brahmasamudram	12BRAH37	14°32'30"	76°57'20"	57B/14	Bore Well	Granite	Krishna
	Kannepalli	12KANN38	14°37'30"	76°58'50"	57B/14	Bore Well	Granite	Krishna
	Vepulaparthy	12VEPU03	14°33'55"	76°53'15"	57B/14	Bore Well	Granite	Krishna
Bukkapatnam	Pamudurthi	12PAMU29	14°16'20"	77°58'15"	57F/15	Bore Well	Granite	Panner
Chennakothapalli	Kanumukkala	12KANU28	14°17'50"	77°45'20"	57F/15	Bore Well	Granite	Panner

ANNEX II: TABLE GROUNDWATER QUALITY OBSERVATION WELLS

(List updated to ……..…..)

State: Andhra Pradesh **District: Anantpur** **Agency: APSGWD**

Mandal	Village	Well No	Latitude	Longitude	Monitoring Type	Monitoring frequency	Data available from
Ramagiri	Ramagiri	12RAMA06	14°18'33"	77°30'18"	Baseline	Annual	1998
Raptadu	Hampapuram	12HAMP07	14°33'16"	77°37'34"	Baseline	Annual	1998
Rayadurg	Baginayakanahalli	12BAGI43	14°39'45"	76°54'58"	Baseline	Annual	1998
	Veparala	12VEPA40	14°43'32"	77°02'39"	Baseline	Annual	1998
Roddam	Roddam	12RODD48	14°05'10"	77°25'52"	Baseline	Annual	1998
	Thurukulapatnam	12THUR47	14°05'05"	77°30'15"	Baseline	Annual	1998
Rolla	Ranganahalli	12RANG46	13°46'55"	77°09'10"	Baseline	Annual	1998
Setturu	Cherlopalli	12CHER16	14°24'55"	77°03'25"	Baseline	Annual	1998
Singanamala	Tarimela	12TARI65	14°54'50"	77°41'40"	Baseline	Annual	1998
Somandepalli	Chalakuru	12CHAL49	13°57'03"	77°33'40"	Baseline	Annual	1998
	Somandepalli	12SOMA69	14°00'50"	77°36'40"	Baseline	Annual	1998
Tadimarri	Tadimarri	12TADI61	14°33'40"	77°51'08"	Baseline	Annual	1998
Tanakal	Cheekatimanipalli	12CHEE32	13°49'45"	78°14'32"	Baseline	Annual	1998
Vajrakarur	Vajrakarur	12VAJR59	15°01'00"	77°22'45"	Baseline	Annual	1998
Yadiki	Nittoor-1	12 23/2NITT57	15°01'55"	77°57'05"	Baseline	Annual	1998

ANNEX III: CONTACT ADDRESS OF THE DATA PROCESSING CENTRES

District/ Region	DPC Address	Name of the Officer	Phone No	e-mail address

ANNEX IV: TABLE SHOWING LIST OF RAINGAUGE STATIONS

Location	Latitude	Longitude	Raingaugetype	Measuring frequency	Data available from
Ranganahalli	13°46'55"	77°09'10"	Non automatic	Daily	1997
Cherlopalli	14°24'55"	77°03'25"	Non automatic	Daily	1997
Tarimela	14°54'50"	77°41'40"	Non automatic	Daily	1997
Chalakuru	13°57'03"	77°33'40"	Non automatic	Daily	1997
Somandepalli	14°00'50"	77°36'40"	Non automatic	Daily	1997
Tadimarri	14°33'40"	77°51'08"	Non automatic	Daily	1997
Cheekatimanipalli	13°49'45"	78°14'32"	Non automatic	Daily	1997

Monthly Rainfall Report

Station name : Hindupur

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
1997	17.6	25.2	3.8	113.0	20.6	16.8	222.2	69.8	54.4	32.2		
1998	41.5	34.6	65.8	136.8	234.2	263.4	107.2	45.6	4.0			
1999	74.0	31.0	50.0	52.0	76.2	117.8	199.2	41.4				
2000	115.0	17.0	31.6	27.2	28.2	300.6	162.6	138.0	22.0	14.0		
2001	108.0	11.4	15.6	41.0	47.2	283.0	189.0					

ANNEX V: TABLE SHOWING LIST OF PIEZOMETERS FORMING PART OF MONITORING NETWORK

Village	Well No	Drilled Depth	Casing Type	Dia	Casing	
					From	To
Amadagur	12AMAD21	35.00	Mild Steel	127.00	0.80	8.45
Amalladinne	12AMAL26	37.50	Mild Steel	127.00	0.30	10.80
Aplepalli	12APLE35	31.00	Mild Steel	127.00	0.16	13.19
Baginayakanah	12BAGI43	30.00	Mild Steel	127.00	0.60	9.60
Basavanahalli	12BASA10	40.00	Mild Steel	127.00	0.40	12.2
Beluguppa	12BELU04	37.00	Mild Steel	127.00	0.50	10.75
Brahmasamudr	12BRAH37	43.00	Mild Steel	127.00	0.70	10.00
Chalakuru	12CHAL49	45.00	Mild Steel	127.00	0.50	13.75
Cheekatimanip	12CHEE32	32.00	Mild Steel	127.00	0.40	6.80
Cherlopalli	12CHER16	31.00	Mild Steel	127.00	0.70	6.00
Chilamathur	12CHIL68	34.00	Mild Steel	127.00	0.50	11.50
Chinnapappur	12CHIN19	19.70	Mild Steel	127.00	0.50	6.70
Dharmavaram	12DHAR66	45.00	Mild Steel	127.00	0.60	7.15

ANNEX VI: GROUNDWATER LEVEL CHANGES FROM 1995 TO 2001 AND 2000 TO 2001

Water table data of Hydrograph stations

Location	Well No	Water Level			Water level Variation	
		Jan 2000	Jan 1995	Jan 2001		
1	2	3	4	5	3-5	4-5
Thaikattusseri	58C 5 80	1.67	1.75	1.63	0.04	0.12
Thakazhi	58C 7 20	1.06	1.33	1.53	-0.47	-0.20
Thamarakulam	58C12 90	3.78	3.65	3.46	0.32	0.19
Thevery	58C 7120	1.70	1.89	1.48	0.22	0.41
Thuravur	58C 5 60	2.48	2.45	2.41	0.07	0.04
Trikkunnapuzha	58C 7131	0.44	0.65	0.36	0.08	0.29
Valavanad	58C 6 10	0.97	0.90	0.93	0.04	-0.03
Venmani(thazha	58C12 70	1.28	1.55	1.80	-0.52	-0.25
Aranootimangal	58C12 20	8.68	8.65	9.57	-0.89	-0.92

ANNEX VII: GROUNDWATER RESOURCE ESTIMATION

Block/Watershed	Annual groundwater recharge	Net groundwater recharge available for irrigation	Gross Groundwater draft	Balance of Groundwater available for further development	Stage of development

ANNEX VIII: CHEMICAL ANALYSIS DATA REPORT

Well	Date of Sampling	pH	EC	Ca	Mg	Na	K	Cl	$S0_4$	CO_3	HCO_3	NO_3		