ANNUAL REPORT

2005-2006

CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES
FARIDABAD

ANNUAL REPORT
2005 - 2006

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EXECUTIVE SUMMARY

Ground water play a key role in meeting the water needs of various user-sectors in India. With growing awareness , the dependability on ground water as a sustained resource in nation building reasserts the need for an organization like Central Ground Water Board which is vested with the responsibility of assessing the ground water potential of the country through ground water management studies, exploration, evaluation and monitoring of ground water regime.

The Central Ground Water Board was constituted as a National apex organization in 1972 by the merger of the Ground Water Wing of Geological Survey of India with the erstwhile Exploratory Tube wells Organization (ETO). The main activities of the Board include macro level Hydrogeological investigations, deep exploratory drilling coupled with remote sensing studies, geophysical studies and pumping tests to study the subsurface Hydrogeological features and nation-wide monitoring of the behaviour of water table and water quality through a network of ground water observation wells. The data generated from these investigations provide the scientific base for preparation of ground water development schemes by the State Governments. Besides advising the States on planning, financing and administration of ground water development schemes, the Board undertakes research & development schemes, water balance studies, conjunctive use studies and artificial recharge studies. The Board also organizes training of personnel of different disciplines of Central and State Government Organisations in ground water related activities.

OBJECTIVES

Under the mandate given based on principles of economic, ecological efficiency and equity, the major activities of Central Ground Water Board are to :

- Periodically assess the country's ground water resources.
- Monitor and guide ground water development to promote its sustainable management.
- Develop, refine and disseminate basin specific technologies for sustainable ground water development and management.
- Plan augmentation, conservation and regulation of ground water resources.
- Establish a National Information System to collect, store, process and disseminate ground water data.
- Promote the economic and efficient use of manpower, energy and equipment employed in ground water sector.
- Support and co-ordinate the efforts of State Government for planned development of ground water.
- Foster International co-operation to promote scientific exchanges, acquisition of useful technology.
- Promote environmental awareness and water quality consciousness, impart training and promote applied research.

ORGANISATIONAL SETUP

The Central Ground Water Board is headed by the Chairman and has four main wings namely 1) Exploratory Drilling & Material Management 2) Sustainable Management & Liaison 3) Survey, Assessment & Monitoring and 4) Training and Technology Transfer. Each wing is headed by a Member .

The Exploratory Drilling & Materials Management wing is responsible for the drilling and construction of Exploratory and other type of boreholes required for ground water exploration

including monitoring of stores, consumption and inventory for efficient and economic machine utilization, purchase action in respect of drilling equipment, vehicles, instruments etc.

The Sustainable Management and Liaison wing looks after sustainable management of ground water related policies, issues etc., work related to monitoring of ground water regime and development, conjunctive use of surface and ground water, urban ground water management, drought management, data collection, storage and retrieval etc.

The Survey, Assessment & Monitoring Wing of Central Ground Water Board is vested with the responsibilities for undertaking Ground Water Management Studies, Aquifer mapping and assessment of aquifer characteristics based on exploration and surveys, Hydro- chemical analyses and studies, pollution studies, short term water supply investigations, special studies, preparation of various Hydrogeological maps, Atlases, Master plans, State reports, District reports, etc.

The Training and Technology Transfer Wing is vested with the responsibility of imparting training at different levels to entrepreneurs, professionals and administrators concerned with ground water development and management. The wing is also responsible for formulation of overall training policy, assessment of training needs, conceptualization of the training modules and the programme implementation strategy etc for the organization.

For undertaking the activities in field, 18 Regional Offices, each headed by a Regional Director, have been established in the country. 11 State Unit Offices have also been established in those states having large geographical area for better management of field activities. 17 Divisional offices handle the exploratory drilling and related activities, each headed by an Executive Engineer. Both the State Unit offices and Divisional Offices work under the overall administrative control of the respective Regional offices. The details of Regional office wise field formations and their jurisdiction are given in Annexure- 1. The Board has about 500 Scientists, 200 Engineers; and about 3500 technical & administrative/ministerial supporting staff. The Board has a fleet of 85 drilling rigs (35 Direct Rotary, 37 Down the Hole and 13 Percussion Combination types) for taking up drilling operations.

ACTIVITIES & ACHIEVEMENTS

Various activities of the Board are being pursued on a continuing basis as per National Water Policy (1987) & (2002) and in accordance with the overall development strategy for the X plan. The following activities were undertaken during the period 2005-2006

- Ground Water Management Studies.
- Ground Water Exploration Aided by Drilling.
- Monitoring of Ground Water Observation Wells.
- Short Term Water Supply Investigations.
- Periodic Assessment of Ground Water Resources.
- Technical Documentation and Publication of Hydrogeological Atlases, Maps & Reports.
- Publication of Quarterly Journal, `Bhujal-News'**:**
- Construction of Deposit Wells.
- Organizing Exhibitions, Seminars, Work Shops etc.
- Hydrochemical Analysis.
- Geophysical studies.
- Hydrological and Hydrometeorological studies.
- Conjunctive Use of Surface and Ground Water

- Mathematical Modeling studies.
- Data Storage and Retrieval.
- Artificial Recharge studies.
- Organizing Training of Central and State Government personnel.
- Monitoring of Ground Water Development.
- R & D Studies
- Special studies / Basic Research in Hydrogeology.

Ground Water Management Studies

Ground Water Management Studies are carried out in different districts to assess the impact of ground water development within a period of 5 years. The survey has component of key hydrograph monitoring; pumping tests; collection of statistical data pertaining to irrigation structure cropping pattern, Land use and hydrometeorological data. The entire data generated during survey is analyzed & accordingly the future scenario for development of ground water is visualized to further plan ground water development & management in the area. During the year 2005-2006, an area of 1,98,167 Sq.km. have been covered by the Board under Ground Water Management studies (Reappraisal Hydrogeological Surveys) as against target of 1,94,587Sq km. The Board gave a special emphasis to this study in tribal and drought prone areas and 57424 & 45755 sq km area respectively were covered to assess the status of ground water development in the area**.**

Ground Water Exploration

Exploratory drilling is carried out for establishing the sub-surface aquifer geometry, followed by pumping test to evaluate the aquifer parameters & collection of water samples from different zones. The entire exercise is aimed at quantitative & qualitative evaluation of ground water in aquifers of the area. These studies help in identifying areas worthy of further development and in guiding the States to adopt follow up action with regard to ground water development on a scientific footing.

During 2005-06 the Board carried out the ground water exploration work with a fleet of 85 rigs (Rotary-35, DTH-37, Percussion-13) and a total of 785 (476 EW, 169 OW, 137 PZ, 1 SH and 2 DW) bore holes were constructed departmentally against the target of 812 (467 Exploratory Wells, 213 Observation Wells, 132 Peizometers) boreholes. It is heartening to report that out of 785 wells, 521 bore holes , 246 bore holes and 18 bore holes were constricted in hard rock, alluvium and bouldary formation respectively. 158 wells and 254 wells were constructed for exploration in tribal and drought prone areas respectively. The Board has so far drilled a total of 23847 bore holes to identify areas worthy ground water development in the country till March, 2006.

Monitoring of Ground Water Observation Wells

The Board closely monitors the ground water regime in the Country through about 15500 Ground Water Observation Wells. It monitors changes in water level through these stations 4 times a year (Jan/may/Aug/Nov) and collects water samples once a year in May for water quality analysis. During the year the water level data so generated by these network stations were analyzed to ascertain seasonal and long-term water level changes. Depth to water and water level fluctuation maps were prepared to study the ground water regime for the whole country.

Geophysical Studies

To support and supplement ground water management studies, ground water exploration and water supply investigations, the Board also conducts geophysical investigations through its regional offices. Under surface geophysical studies a total of 1952 Vertical Electrical Sounding (VES) were conducted and resistivity profiling of about 42.91 line km was covered. A total of

126 boreholes were logged while the meterage logged was about 23712 m. The Central Geophysical Cell is located at Headquarter office, Faridabad and is responsible for the planning and programming of geophysical activities of the entire Board.

Hydrochemical Analysis

Water samples collected during the course of ground water management studies , ground water exploration, monitoring of Ground Water Observation Wells, Water supply investigations etc., are analysed at 16 well-equipped chemical laboratories located at its regional directorates. During the year, a total of 16916 samples were analysed for basic / specific analysis, 3541 samples for heavy metal determinations and 117 samples for organic, for evaluating the ground water quality and its suitability for various uses.

Conjunctive Use Studies

Feasibility studies for Conjunctive use of surface and ground water studies were taken up in Sri Ramsagar Command, Andhra Pradesh, in Rushikulya Command, Orissa and in Western Yamuna Canal Command, Haryana. The above three studies have been completed and report writing work is in progress. Report of studies carried out in Western Yamuna Canal Command, Haryana has been submitted to Central Head Quarter, Faridabad.

Artificial Recharge Studies

The Board is carrying out artificial recharge studies in high water demand areas with critical stage of ground water development. Artificial Recharge studies have been completed in most of the Regions and impact assessment of ongoing & completed Schemes, monitoring & report submission are in progress.

Special Studies

During X^{th} plan CGWB had proposed to take up Special Studies/ R&D Studies covering different areas like Urban Hydrogeology, Mapping of water logged areas and feasibility studies for anti-water logging measures, Conjunctive Use, Sea water ingress , Remote sensing, Mathematical Modeling , Isotope Hydrology, Arsenic contamination of ground water etc. Stress has been given for evolving new methodologies during the studies. During 2005-06, the studies have been taken up in collaboration with Scientific institutions, Govt Agencies, Universities and R&D organizations engaged in research and development in ground water. Out of 22 studies, Two studies have been taken up in collaboration with NIH and one with GSI. Such studies have also been taken up in collaboration with NGRI, BARC, Andaman & Nicobar Administration, PHED , etc.

R&D Studies

Central Ground Water Board under its R&D activities is assisting Ministry of Water Resources as a member of a sub-committee of Indian National Committee on Hydrology (INCOH), with a view to accelerate the development programme in ground water sector and giving due consideration to increased need of taking up research in the field of ground water. This Committee examines the project proposals received by INCOH in the field of ground water for their suitability for funding by MOWR and also monitors the research schemes funded by INCOH. During this year, Seven schemes have been scrutinized and sent for comments to experts. Based on the comments of the experts, 5 revised proposals have been received which will be considered in the forthcoming meeting of Research Committee on ground water. Five proposals have been finally cleared for funding the execution of which will be monitored on regular basis .

Reports and Maps

Results of investigations carried out by the Board are suitably documented in the form of reports and maps. All the field offices have been provided with report processing sections which are responsible for the preparation and publication of the reports, maps, atlases etc. During the year, 38 district reports and hydrogeological maps, 23 ground water year books and 5 state reports have been prepared.

Bhujal News, a quarterly journal is published by Central Ground Water Board highlighting the latest advances in Ground Water research. Besides scientific papers the journal also contains technical notes, news items , and regular columns. The journal has more than 1300 readers from all over the country including Central & State Govt, departments, academic institutions and others. During the year 2005-2006, the Vol. No 19, 2004 issue was finalised and printed and Vol. 20, No. 1&2 2005 issue is under final stage of compilation.

Water Supply Investigation

The Board carries out short-term water supply investigations for Government Agencies and helps them in augmenting their water supply. Normally minimum financial implications are charged from all other departments except Defence. The Board has carried out a total of 305 investigations during this year .

Dissemination and Sharing of Technical Know-how

Central Ground Water Board, organized / participated in various Seminars/symposia/workshop/conference with a view to share its expertise in Ground Water field and also for getting exposure to new ideas / technological developments in Ground Water science with others. The officers of the Board also participated in various meetings /committees etc. to provide advice on ground water development in specific area.

Re- Assessment of Dynamic Ground Water Resource

The Dynamic Ground Water Resource of the country has been jointly estimated by State Ground Water Departments and Central Ground Water Board, based on the methodology recommended by Ground Water Estimation Committee-1997 (GEC-97). The Ground Resource is estimated as on March, 2004. The National level report on “Dynamic Ground Water Resources of India” was finalized and approved by the R&D Advisory Committee in its seventh meeting held at New Delhi on 19th August, 2005. As per the report, the Annual Replenishable Ground Water Resource for the entire country is 433 billion cubic metre (bcm), Net Annual Ground Water Availability is 399 billion cubic metre, Annual ground water draft for irrigation, Domestic & Industrial is 231 billion cubic metre and Stage of Ground Water Development for the Country as a whole is 58%.

Scrutiny of Major/Medium Irrigation Project

As per directives of the steering committee on Irrigation projects constituted by Planning Commission, the major and medium irrigation project reports and proposals sent by State Governments through Central Water Commission (CWC)/Command area Development (CAD) Authority were scrutinized and cleared by CGWB from Ground Water Development and impact assessment point of view. Suggestions were made for modification / addition of ground water development in these schemes. During 2005-2006, twelve major irrigation projects of Central Water Commission spread over states of J & K, Assam, Rajasthan, Andhra Pradesh, Uttar Pradesh, Maharashtra, Madhya Pradesh, Himachal Pradesh and Punjab were examined. Three irrigation projects of CADWM were also examined and area specific recommendations were made.

Human Resources Development

It has been the earnest endeavor of the Board to keep its technical personnel abreast with the latest development in all aspects related to ground water and drilling techniques. The Board also includes trainees from State Departments and candidates from abroad.

Publicity and Public Awareness

With a view to generate awareness among the masses, "Water Resources Day" is celebrated every year since 1986. The Board played a very active role in organizing Water Resources Day functions jointly with CWC and other State Govt. Organisations. On these occasions, emphasis was laid on educating the rural population on various aspects of water resources in the country. Important technical achievements of the Board were brought to the knowledge of the public through radio talks, television interviews, telecast of a short film on ground water pollution, Newspaper reports, release of district reports and Atlases at various public functions.

Central Ground Water Authority

Central Ground Water Authority organized Mass Awareness programmes and Training's on Rain Water Harvesting including Roof Top Rain Water Harvesting at different locations of the Country, with the aim of educating the common people about judicious and optimum utilization of ground water. 51 Mass Awareness Programmes and 49 Water Management Training Programmes were organized during the 2005-2006 by the Authority. Directions were issued by CGWA for regulation of ground water abstraction structures in 32 areas. A total of 1,75,110 tube-wells have been registered till March, 2006.

In order to streamline the drilling and construction of tube wells, and to regulate the activity, Central Ground Water Authority carried out registration of persons/ agencies engaged in the business of drilling and allied works all over the country. 57 agencies were registered under this programme during the year. Ground water clearance was accorded to 25 Industries/Projects .

Right to Information Act 2005

The Govt. of India resolved that in order to ensure greater and more effective access to information, the Freedom of Information Act, 2002 must be made more progressive, participatory and meaningful. The National Advisory Council deliberated on the issue and suggested certain important changes to be incorporated in the existing Act. The government examined the suggestion and decided to make a number of changes in the law. In view of significant changes proposed in the existing law, the Government decided to repeal the Freedom of Information Act, 2002 and the, Right to Information Bill, 2005 was introduced. Right to Information Bill, 2005 was passed by Lok Sabha on 11th May, 2005 and by Rajya Sabha on 12th May,2005 and received the assent of the President on 15th June, 2005. It came on the Status Book as THE RIGHT TO IINFORMATION ACT, 2005 (22 OF 2005).

For the smooth implementation of RTI Act, 2005 in Central Ground Water Board the following steps were taken during 2005-06

- Central Ground Water Board prepared and published a booklet entitled as "**Information on Central Ground Water Board**" containing seventeen chapters as envisaged in chapter II, Para 4 of the Act and placed them on the Website of the Board.
- Twenty Public Information Officers and Sixteen Asstt. Public Information Officers were appointed in the Board in its different field offices spread over in the entire country.
- The Board also appointed Appellate Authority and Nodal Officer as required under the Act.

- A system has also been developed in the Board to receive and process the request application efficiently.
- The Board supplied the requisite material to the Ministry of Water Resources for the year ending March, 2006 as required by Central Information Commission under section 25 to enable them to prepare a report on the implementation of the various provisions of the Act.
- Up to the end of March, 2006, the Board received 16 requests seeking the information under RTI and no complaint to the Appellate Authority was received. In all the Board collected a sum of Rs.1894/- (Rupees One thousand Eight hundred Ninty four only) to supply this information.

Budget

Expenditure of 6565.03 lakhsand 7198.98 lakhs of rupees were incurred by the Board during the year under various Plan and Non-plan sub-heads respectively to carry out the entire activities. The achievements were significant during the year and it was possible due to the devotion, hard work, enthusiasm and initiative taken by about 4400 Scientists, Engineers, Ministerial and other supporting staff of the Board. The Board has come a long way and has emerged for development, scientific management and regulation of precious ground water resources of the country. Further, the Board will continue to attain higher levels of achievements in the years to come.

1. INTRODUCTION

1.1 HISTORY OF CGWB

The Central Ground Water Board being the National apex organization under the Ministry of Water Resources, Govt. of India is vested with the responsibilities to carry out ground water management studies, exploration, monitoring of development, management and regulation of country's vast ground water resources. The brief history of the organization follows;

An Exploratory Tubewells Organisation (ETO) was created in 1954 as a subordinate office under the then Ministry of Food, Agriculture, Community Development and Cooperation (Deptt of Agriculture) to carry out ground water exploration in the alluvial areas of the country to delineate the regional aquifer systems and evaluate their yield potential. On 3rd October 1970 the ETO was renamed as Central Ground Water Board. At that time, it was felt that there was need to have a national unified organization for all works related to ground water surveys, exploration, assessment and management in the country. On the recommendations of the committee on Science and Technology, the standing group of Ministers on Science and Technology chaired by Prime Minister Indira Gandhi, in its meetings on Sept 9, 1971 approved the merger of Ground Water Wing of the Geological Survey of India (GSI) with the Central Ground Water Board and it was effected on August 1, 1972 which gave all the administrative and financial powers and flexibility of operation necessary for its effective functioning. In 1972, Central Ground Water Board was constituted as an apex organization at the national level with a whole time Chairman and two whole time Members namely the Chief Hydrogeologist and the Chief Engineer.

Prior to 1980, there was no norms of staff for carrying out different activities in CGWB. In order to streamline staffing pattern SIU carried out detailed study and had given its report on staffing pattern of Headquarters, Regional, Divisional and District Unit Office.

A High Level Multi-disciplinary Committee (HLMC) was set up in 1989 to review the role, functions and responsibilities of CGWB in terms of achievements and developments over the past three decades. The HLMC report (1990) highlighted the importance of ground water development and indicated the measures to be taken for achievement of tasks and mandate assigned to CGWB. The Committee reviewed the functions and gave the revised mandate.

Rajiv Gandhi National Ground Water Training and Research Institute was set up at Raipur with the objective to transfer scientific and technical know how related to development and management of ground water resources, to professionals. The institute has started functioning since August 1997.

The Central Ground Water Authority (CGWA) was constituted on 14th January 1997 by the Ministry of Environment and Forest under Environment (Protection) Act, 1986 as per the direction of Hon'ble Supreme court of India for one year. The mandate given to the authority is regulation and control of Ground Water Management and Development. Now CGWA has been declared as a permanent body through gazette notification of the Ministry of Environment & Forest dated 6th November, 2000.

1.2 MANDATE AND OBJECTIVES

The future of our national food security system as well as the quality of life and livelihood of millions of our people will depend more on our ability to conserve and utilize ground water resources in environment friendly, economically efficient and socially equitable manner. On the basis of the principles of ecology, efficiency, economics and equity, mandate for the Board has been postulated below:

"Develop and disseminate technologies, monitor and implement national policies for the scientific and sustainable development and management of India's ground water resources including their exploration, assessment, conservation, augmentation, protection from pollution and distribution based on principles of economic and ecological efficiency and equity".

Commensurate with the above mandate, the objectives laid down for the Central Ground Water Board are:-

1.2.1 Periodically assess the country's ground water resources and publish once in 3 years a report on the status of India's Ground Water Resources.

1.2.2 Formulation of perspective plan, basin or sub-basin wise for harnessing ground water resources in a phased manner or need based and resolving regional imbalances.

1.2.3 Monitor and guide ground water development in the country to promote its sustainable management on principles of ecology, economics, efficiency and equity.

1.2.4 Develop, refine and disseminate, on its own as well as in coordination with other agencies, basin-specific technologies for sustainable ground water development and management involving priority areas such as major command areas for conjunctive use of ground water and surface water, monitoring, prevention and remedy of pollution and saline ingress and the location, design, operation and maintenance devices, recycling and reuse of waste water, and solutions to other problems of urban areas.

1.2.5 Plan augmentation, conservation, protection and regulation of ground water resources keeping in view the existing and future ground water demand scenario.

1.2.6 Establish a National Information System in collaboration with State Governments and other agencies to collect, store, process and disseminate Ground water data as part of an overall water resources data bank.

1.2.7 Forecast the manpower, equipment, energy and financial requirements for the ground water sector, in the context of demand projections.

1.2.8 Promote the economic and efficient use of manpower, energy and equipment employed in the ground water sector through various measures including setting up performance appraisal and management information systems, training, development of technical and managerial skills, and personal development.

1.2.9 Support and coordinate the efforts of State Ground Water Organizations for the planned development of their ground water resources on the above lines, specially where inter-state issues arise.

1.2.10 Foster international cooperation to promote scientific exchanges, acquisition of useful technologies including the use of renewable sources of energy for pumping ground water and assistance in other developing countries.

1.2.11 Establish benchmarks and methodologies for ground water studies in coordination with the State Governments.

1.2.12 Promote environmental awareness and water quality consciousness.

1.2.13 Establish a National Institute for Ground Water Research, Training & Management and organize All India Coordinated Research Projects involving appropriate institutions and

universities, in order to foster the growth of a national grid of R&D institutions, covering different aspects of ground water conservation and utilization.

1.3 ORGANIZATIONAL SET UP

The Central Ground Water Board is headed by the Chairman and has four full time Members namely, Member (Exploratory Drilling & Material Management), Member (Sustainable Management & Liaison), Member (Survey Assessment & Monitoring) and Member (Training & Technology Transfer). The other Members of the Board are all ex-officio being the nominees of institutions in related fields of expertise. The ex-officio members are:

1. The Joint Secretary (A), Ministry of Water Resources.
2. The Joint Secretary & Financial Adviser, Ministry of Water Resources
3. The Joint Secretary, Ministry of Environment & Forests, Paryavaran Bhawan, New Delhi.
4. The Chief Engineer, IMO (WP & P), CWC, Sewa Bhawan, New Delhi.
5. The General Manager, ONGC, Ministry of Petroleum & Natural Gas, Dehradun.

Central Ground Water Board has four main wings. Each wing is headed by a member level post.

The Exploratory Drilling & Materials Management Wing broadly looks after the drilling and construction of Exploratory Tube wells and other types of bore holes required for assessment of aquifer parameters during ground water exploration. The other activity of this wing includes monitoring of Stores, consumption and inventory for efficient and economic machine utilization, purchase action in respect of drilling equipment, vehicles, instruments etc. This wing also looks for the need of improvement in drilling technology, design of abstraction structures, improvement of efficiency of pumps and other water lifting devices, maintenance and up keeping of drilling machinery and related equipment in the Board.

The Sustainable Management and Liaison Wing looks after sustainable management of ground water related policies & issues, works related to monitoring of ground water regime and development, conjunctive use of surface and ground water for the entire country. It also undertakes studies related to recycling and reuse of ground water, urban ground water management, Drought management, Regulation of ground water development and model legislation, National Information System for ground water data collection, storage and retrieval, Planning and Programme formulation for ground water development including techno-economic studies, analysis and associated aspects of ground water development and technical examination of major, medium and minor Irrigation Projects.

The Survey, Assessment & Monitoring Wing has the responsibility to monitor the works being done in ground water management studies, aquifer mapping and assessment of aquifer characteristics based on exploration and surveys, hydrochemical analysis and studies, pollution studies, short term water supply investigations, special ground water studies, preparation of hydrogeological maps, Atlases, Master plans, State reports, District reports, etc. The other activities of this wing include ground water balance studies, periodic assessment of ground water resources and potential, augmentation of ground water resources including artificial recharge and monitoring of artificial recharge studies, ground water zoning for guiding economic activity areas, rationalization of water rates, forecasting manpower, energy and financial requirements for ground water sector, site selection for Rajiv Gandhi National Drinking Water Mission, dissemination of data & information to various user agencies and publication of quarterly magazine "Bhujal News" by the Board.

The Training and Technology Transfer Wing of the Board is vested with the responsibility for laying the overall training policy, assessment of training needs, conceptualization of the training modules and the programme implementation strategy, identification of thrust area needing technology import from advanced sources, maintenance of effective liaison and interaction with voluntary agencies and Non Governmental Organisations and the other renowned national and international bodies for training and research purposes. The Member heading this wing also functions as the Principal of Rajiv Gandhi National Ground Water Training and Research Institute of the Board.

In order to achieve better results in the Water Resources Sector and have better coordination with the State Government departments, Central Ground Water Board had undertaken various studies in the above mentioned fields being monitored by four wings of the Board through 18 Regional Directorates, supported by 17 engineering divisions, 11 State Unit Offices for carrying out different investigations. The Board had a fleet of 85 rigs for taking up drilling operations during 2005-2006.

1.4 ACTIVITIES OF THE BOARD DURING 2005-2006

The following activities had been undertaken during the period 2005-2006.

1.4.1 Ground Water Management Studies

1.4.2 Ground Water Exploration aided by Drilling.

1.4.3 Monitoring of Ground Water Observation Wells.

1.4.4 Short Term Water Supply Investigations.

1.4.5 Periodic Assessment of Ground Water Resources.

1.4.6 Technical Documentation and Publication of Maps & Reports.

1.4.7 Publication of Quarterly Journal "Bhujal-News".

1.4.8 Taking over of Wells by State Govt.

1.4.9 Organizing Exhibitions, Seminars, Workshops etc.

1.4.10 Hydrochemical Analysis.

1.4.11 Geophysical Studies.

1.4.12 Hydrological and Hydro meteorological Studies.

1.4.13 Mathematical Modeling Studies.

1.4.14 Artificial Recharge studies.

1.4.15 Conjunctive Use of Ground Water and Surface water.

1.4.16 Organizing training of Central and State Government personnel.

1.4.17 R & D Studies.

1.4.18 Basic Research in Hydrogeology/ Special studies

1.5 ANNUAL ACTION PLAN 2005-2006

The activities of the Board are being pursued on a continuing basis as per National Water Policy (2002) and in accordance with the overall development strategy for the X Plan.

Ground Water Management studies were carried in more utility oriented way and in areas facing ground water problems like decline in water levels, water logging, salinity ingress and quality deterioration, and other problems were accorded priority.

In ground water exploration, emphasis was given to carry ground water exploration activities on long-term planning and schemes were prepared for different geologic formations and areas. As far as possible, contiguous and composite areas hitherto unexplored, were selected keeping in view scientific requirements and priorities of State Governments were also taken into consideration. Thrust was given to explore areas having artesian flow, bouldary and hard rock formations. Ground Water Exploration in alluvial areas was done to delineate geometry of aquifer systems by constructing slim holes. During the year, special emphasis was given on tribal, drought and desert areas in exploratory program of the Board. Special studies for computation of specific yield of phreatic aquifers in different parts of the country was also the part of exploratory program.
The Central Ground Water Board is implementing the Central Sector Scheme "Studies on Recharge of Ground Water". Under the scheme, recharge structures are constructed by State Government departments, local NGOs, VOs or other beneficiaries under the technical guidance of the Board. Under the scheme, funds were provided by the Board for pilot recharge projects and the implementing agencies were encouraged to replicate similar types of structures in other areas with their own funds.

Conjunctive use studies were taken up with the objectives to ascertain the Hydrogeological conditions in command areas, to identify areas affected by water logging and salinity, to assess the availability of ground water. The studies provided insight of the problem and helped to formulate action plan for coordinated use of surface and ground water to ensure development on optimal level.

Water logging is a common phenomenon in canal command areas, which causes serious social and economic problems. Micro level mapping of a few water logged areas were taken up to understand and mitigate the problem. Feasibility studies were also carried out to suggest anti water logging measures for reclaiming the affected areas.

Remote sensing and application of GIS as supplementary tool has been considerably utilized to map geomorphological feature, change in land use, fracture zones, vulnerable areas of pollution etc which helped in locating promising areas for ground water exploration and development. These studies provided additional update scientific information in synoptic manner about land use pattern and its temporal changes to ground water exploratory programme, reappraisal surveys, ground water pollution studies, water logging condition, erosion problem and artificial recharge studies taken by the Board during the year.

2. GROUND WATER MANAGEMENT STUDIES

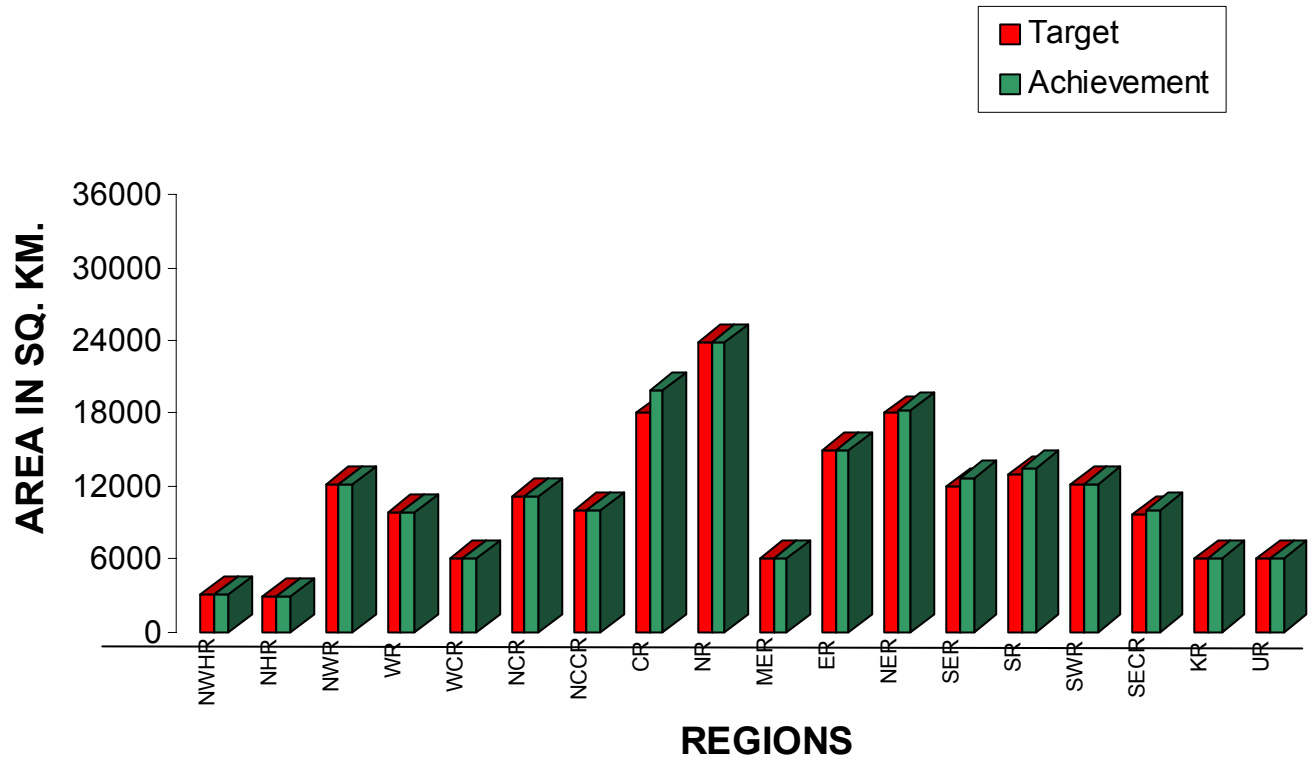
The Ground Water Management Studies are being carried by the Board at district level to evaluate the changes in quantity & quality in the ground water regime owing to development and also to identify related issues for future management strategies. Greater part of replenishment of ground water is from infiltration from rainfall however return flow from irrigation and seepage from surface channels and reservoirs also contribute substantially to the ground water recharge. The effect of ground water withdrawals and out-flows are directly measurable through water table. Since all these inputs and outputs frequently change with time, the ground water situation is being periodically reappraised. Similarly, the development of resource leads to changes in its regime and water quality therefore planning for further development of the resource is done on the basis of findings of the studies, which provide valuable information for reorienting ground water development programme keeping in view the emerging scenarios. During the year 2005-2006, an area of 1,98,167 Sq.km. have been covered by the Board under Ground Water Management studies as against target of 1,94,587Sq km. The targets of the above studies has been covered by most of the Regional offices. Regions/State/District wise targets vis-a-vis achievements during the year 2005-2006 are shown in Table 2.1 and fig. 2.1.

Table 2.1: REGION/STATE/DISTRICT WISE TARGETS AND ACHIEVEMENTS OF GROUND WATER MANAGEMENT STUDIES DURING 2005-2006

Sl. No.	Regions	States	Districts	Target (Sq. km.)	Achievement (Sq. km.)
1	**NORTH WESTERN HIMALAYAN REGION**	Jammu & Kashmir	Leh	3000	3000
2	**NORTH HIMALAYAN REGION**	Himachal Pradesh	Sirmaur	2825	2825
3	**NORTH WESTERN REGION**	Punjab	Bhatinda	3385	3385
			Fatehgarh Sahib	1180	1180
			Ludhiana	3587	3587
		Haryana	Hissar	3983	3983
4	**WESTERN REGION**	Rajasthan	Jaipur	6776	6776
			Jalore	3055	3055
5	**WEST CENTRAL REGION**	Gujarat	Bhavnagar	3800	3800
			Gandhinagar	2200	2200
6	**NORTH CENTRAL REGION**	Madhya Pradesh	Ujjain	6091	6091
			Tikamgarh	5048	5048
7	**NORTH CENTRAL CHATTISGARH REGION**	Chhattisgarh	Koria	5980	5980
			Kawardha	3960	3960
8	**CENTRAL REGION**	Maharashtra	Yavmatmal	12000	13428
			Chandrapur	3000	3199
			Pune	3000	3300
9	**NORTHERN REGION**	Uttar Pradesh	Bahraich	5751	5751
			Ferozabad	2361	2361
			Gaziabad	1956	1956
			Hardoi	5986	5986
			Jaunpur	4038	4038
			Pratapgarh	3717	3717

Fig.2.1

REGION WISE GROUND WATER MANAGEMENT STUDIES DURING 2005-2006



Sl. No.	Regions	States	Districts	Target (Sq. km.)	Achievement (Sq. km.)
10	**UTTARANCHAL REGION**	Uttaranchal	Uttarkashi	6000	6000
11	**MID EASTERN REGION**	Bihar	Kishanganj & parts of Purnea	3047	3047
		Jharkhand	Dhanbad & Parts of Bokaro	3000	3000
12	**EASTERN REGION**	West Bengal	Darjiling & Jalpaiguri	3000	3005
			Malda	3000	3000
			Murshidabad & Malda	3000	3000
			Nadia	3000	3000
			Bankura	3000	3000
13	**NORTH EASTERN REGION**	Assam	Jorhat & Golaghat	3000	3000
			Sibsagar & Jorhat	3000	3200
			Cachar	3000	3000
		Meghalaya	East & South Garo Hills	3000	3000
		Tripura	North Tripura & parts of Dhallai	3000	3000
		Arunachal Pradesh	Changlang	3000	3000
14	**SOUTH EASTERN REGION**	Orissa	Bolangir	3000	3169
			Kalahandi	6000	6105
			Nuapada	3000	3400
15	**SOUTHERN REGION**	Andhra Pradesh	Guntur	5000	5350
			Anantpur	8000	8065
16	**SOUTH WESTERN REGION**	Karnataka	Bijapur	2664	2664
			Raichur	3492	3492
			Mandya	2828	2828
			Mysore	3216	3216
17	**SOUTH EASTERN COASTAL REGION**	Tamil Nadu	Vellupuram	6400	6530
			Tuticorin	3200	3460
18	**KERALA REGION**	Kerala	Kottayam & Parts of Ernakulam	3072	3072
			Alleppy & Parts of Ernakulam	2957	2957

2.1 NORTH WESTERN HIMALAYAN REGION (Jammu & Kashmir)

Ground Water Management Studies was carried out in parts of Leh district comprising the main villages of Tiri, Kiari, Khatpa Thambo,Chhumbathang, Puga, Nyuma, Dungthi falling under Nyuma block. A total area of 3000 sq.km was covered during the survey in order to evaluate hydrogeological conditions of various geological formation. Entire fieldwork was carried out during the month of September and October, 2005.

2.1.1 Leh District

The study area, covering 3000 Sq Km of Leh district lies between North Latitude of 33°30'00" to 33°60'00" and longitude of 78°00'00" to 79°00'00" and is characterized by high peaks and corresponding valleys.The area is rugged and mountainous.and elevation ranges between 6200 to 4200 m amsl. The barren condition prevailing over the study area makes the habitation concentrated along the flood plains of the Indus river. The width of flood plain varies from few meters around Mahe to one kilometer near Nyuma and Loma. The Climate of the district is Sub-Tropical. The mean annual Temperature ranges from 1 °C to 8 °C . The mean temperature in summer and winter are 10.2 °C and – 16.8 °C respectively. The mean annual Precipitation is less than 50 mm, which is received as snowfall as well as rainfall during November to March due to the western disturbances

Hydrogeological Set Up: Hydrogeologically the entire area of Nyuma block is divided into following two aquifer systems:-1. Porous Formations & 2.Fissured Formations

Porous Formations: Porous Formation consist of the unconsolidated sediments. These sediments include fluvial deposits, valley fill deposits, terrace deposits and alluvial fan. These sediments form the potential aquifers. Unconsolidated sediments underlie the Indus valley. The Groundwater conditions prevalent in each deposit were briefly described below:-

- The Indus valley is underlined by unconsolidated sediments wherein ground water occurs in unconfined to semi confined condition. There is no dugwell or any ground water structure available in the area. The aquifer zone mainly consists of sand and scree materials like boulders, cobbles and pebbles admixed with clay. The general ground water movement follows the topography of the area.
- Alluvial fans exist over the contacts between the flood plain and the hard rock formation and create the change in slope. These consist of boulders and cobbles of various geological formations and ground water available within the fans were unconfined which were exposed asthe spring due to gravity flow of water. Hand pumps are drilled by PHE and its depth range varies from 15 mts to 70 mts in Psaga and Nic villages. Water level is in the range between 6 mts bgl at Koyoul Khangshung and 36 mts bgl at Nic respectively, whereas the spring discharge is 0.6 lps at Mahe.

Fissured formation : The Ladakh Granatoids existing over most of the study area mainly Tonalities in composition and fissures developed over the hard rock formations serves as the conduit for ground water. The flow exposed as springs discharging 0.81 to 54 lps. Overall discharge were less when compared with other geological formations.

Ground Water Quality :-During the course of survey water samples were collected from springs/ hand pumps in the study area to assess Chemical quality of ground water. It is inferred that water in the study area is generally potable and suitable for drinking purpose and falls within the permissible limit except samples collected from Puga and Chumbathang.

2.2 NORTH HIMALAYAN REGION (Himachal Pradesh)

The Ground Water Management studies were carried out in Sirmaur district of Himachal Pradesh. The targeted 2825 sq km area was covered during both pre and post monsoon period.

2.2.1 Sirmour district:

Sirmour is the southern most district of Himachal Pradesh and covers an area of about 2825 sq.km. Sirmour district exhibits a rugged mountainous topography. The intermountane valley known as “Poanta Valley” exists between the Lesser Himalayan range and Siwalik foothills. About 150 Sq. Km. area of Poanta valley of Sirmour district forms ground water worthy area suitable for drinking as well as for irrigational development purposes. Giri river flows in central part of valley area equally dividing the valley in two parts. Though rest of the district has plenty of perennial river, the unfavorable topography makes it difficult to utilize the resources fruitfully. In hilly regions springs are the major source of water for drinking and other purposes but again the topography makes the difference in this region. But ever increasing demand of water makes it difficult to met adequate water supply to the peoples. During rainy season the turbidity makes it difficult to water supply for both drinking as well as irrigation purposes. Water scarcity as well as turbidity problems can be overcome by shifting the dependencies more on ground water utilization and water conservation. There exists vast scope of various types of ground water structures in alluvial as well as in hard rock formations.

During the Premonsoon studies in the district, 14 dugwells, 37 springs and 10 handpumps were inventoried. Depth to water level was ranging from 3.0mbgl to 47.0 mbgl and discharge of springs ranging from 0.001 lps to 0.2 lps. EC is ranging from 65 μs to 1285 μs at 25 ^{o}C. During the post monsoon period additional 26 dugwells & 15 springs were monitored. Water level fluctuation varies from 2 m to 6 m and spring discharge from 0.025 lps to 1.0 lps. Three pumping test were conducted in open well in Paunta valley at Shambuwala, Majra and Taruwala. Drawdown was recorded from 0.26 to 2.61 m and recovery of water level was within an hour.

2.3 NORTH WESTERN REGION (Punjab, Haryana & Chandigarh)

Three districts of Punjab state namely Bhatinda, Fatehgarh Sahib, Ludhiana and Hisar district of Haryana were covered under the ground water management studies with total target & achievement is 12135 Sq. Km.

2.3.1 Bathinda District, Punjab

Bathinda district is situated in the southern part of Punjab state.The Bathinda district has 3 Sub-Divisions i.e Bathinda, Rampura phul & Talwandi Sabo and eight blocks namly Bathinda, Nathana, Rampura, Phul, Talwandi Sabo, Sangat, Maur & Bhagta Bhai Ka.

The area is flat and forms a part of Indo-Gangatic alluvial plain. The maximum elevation of the area is 220 m amsl and the minimum elevation is 202 m amsl. The slope of the area is towards south west direction. The area is underlain by the Indo-Gangatic alluvium of Quaternary age. The alluvium is of fluviatile origin, consisting of alternating beds of sand, silt, clay and Kankar. Tubewells in the district are constructed in the depth range of 100 to 150 mbgl by tapping 3 to 7 granular zones.

Main Findings: The followings are the main findings of the study

1. In northern part of the district, at Dialpur Mirza, Siryewala, maximum decline of water level is around 0.40 to 0.55 m/yr. In the Eastern part of the district Rampura and Dadde sites maximum decline of the range 0.27m to 0.33 m/yr observed. In the southern part of the district, at Jajjal and Bagi Bander area is showing the max. rise in water level is around 0.31 to 0.49 m/yr. In the western part of the district at Balluana, Gudda, Jassi Bhagwali and Rai ke Kalan maximum rise is in the range of 0.25 to 0.40m/yr.

2. In the last 24 years water level trend of the district has been changed completely. According to the previous report it was found that the northern segment has the shallow water level and southern segment having deeper water level in contrast to the current water level trend.
3. High percentage of EC has been found in Central and Southwestern parts of the district. Rising or stagnant water level trends of the area are responsible for bad quality of ground water in this part of the district.
4. High percentage of Fluoride has been found in Central ,Southwest and Northwest parts.

Emerging Problem: The following problems have been identified in the district: -

1. The declining water level in the Northern part of the district.
2. The rise in water level in the southern and SW part of the district is also the major concern as it may lead to water logging problems due to use of canal water for irrigation and domestic purposes.
3. It is also found that the quality of ground water being deteriorating due to rise in water level in southern Bathinda.
4. The percentage of Fluoride and EC found to be increasing in the Central and Southern parts of the district.

Suggested Ground Water Management:-For better management of ground water in the district, planned use of surface and ground water (conjunctive use) has to be practiced to overcome both problems of over exploitation and Ground water quality. In the southern part of the district where excess surface water is used and where ground water quality problem is there the usage of ground water is to be encouraged to overcome the water logging problem in future.

In the Northern blocks namely Bhagtha, Nathana, Phul, Rampura and Maur where water level is declining and converted the blocks into over exploited category, there is a need to notify these blocks. The feasibility study for Artificial recharge to ground water should also be taken up in these blocks.

2.3.2 Fatehgarh Sahib District, Punjab

The Fatehgarh Sahib is the latest in the series of the districts created in 1992 by the Punjab Government. The district with an area of 1177 sq. km. is one of the smallest districts in the state. There are five blocks, one Sub-Tehsil and four Tehsils in Fatehgarh Sahib district. The area is almost flat terrain. The general slope is in south to southwest direction with an average gradient of about 0.4m per km. There are two major monsoon streams viz Patiali Rao and Sirhind Choe which drain the whole district.

The principal ground water repository in the district is unconsolidated alluvial deposits of Quaternary age. The ground water occurs under both the unconfined as well as confined conditions. In all 23 dugwell and piezometers were monitored in pre-monsoon and post-monsoon period in Fatehgarh Sahib district. The depth to water level varies between 4mbgl to 28mbgl . Most of the tubewells in Fatehgarh Sahib district are in the average depth range of 120 to 180 mbgl and screen has been placed against 3 to 9 m granular zones with cumulative thickness of 7 to 36 m. In the eastern part of the district down to depth of 200m with an accumulative thickness of aquifer being 48.0 m, the Transmissivity 'T' value is of the order of 1790 m^2/day and Storativity 'S' value is 0.00126x 10^{-3}. In the north eastern part of the district 'T' values are in the range of 700 – 900 m^2/day for the average depth of about 120 m.

The quality of ground water in shallow aquifer is excellent for drinking and irrigation purpose in the entire district. Out of 39 sample collected, specific conductance varies between 355 to 1479 micromhos/cm at 25 ^{o}C. The total 41 treated water samples of Mandi Gobindgarh were collected for heavy metals analysis. Sample survey of Amloh block was conducted to determine the ground water draft in all three sectors. The water supply of domestic and Industrial purposes in the area is entirely dependent upon groundwater which has caused decline in water level.

2.3.3 Ludhiana District, Punjab

Ludhiana district falls in central part of Punjab Plains region. The geographical area of the district is 3790 sq.kms.It is devoid of major topographical features and is a conspicuously flat terrain. The elevation of the Ludhiana district varies from 268m above mean sea level in the eastern part to 216 m above mean sea level in the western part having a gradient of about 0.38m /km towards west.

The district is drained by the Sutlej river and Budha nala, which is minor tributary of the Sutlej. The present mean annual flow of the Satluj is 16775 MCM. In the recent past the river has gone a westward drift, as has been the case with many other rivers systems of western India. Ludhiana district has a very good network of canal system for irrigation. The Sirhind canal system, which enters the district from east, was taken out from the Satluj at Ropar in 1892. The Sidhwan branch, Abohar branch and the Bathinda branch having a discharge of 4.31mcm, 11.8mcm and 6-8 mcm respectively at the take off point are the three main distributaries of Sirhind canal.However the extensive canal network of Ludhiana does not contribute much towards irrigation in the district. Canal irrigation accounts for only 4.3% of the area. The rest is 95.7% being irrigated through ground water. Alluvium of the district is deposited by Satluj River. The Ground Water Exploration work has been done by CGWB at 15 sites in the district. The maximum depth drilled is up to 408 m bgl at Bhaini Rayan. In Ludhiana city area four aquifer groups have been identified. First aquifer group occurs at the depth range of 32-45 mbgl, second aquifer at the depth range of 62- 137 mbgl, third aquifer at the depth range of 157-175 mbgl and fourth aquifer at the depth range of 210-241 mbgl.

During the survey 30 nos. of observation wells were established and monitored. In total 80 water samples were collected for detailed chemical analysis and 30 nos of samples for trace elements analysis. Water level in the north eastern part of the district at Garhi Tikhana in Machhiwara block is 3.18 m and 3.56 m bmp during Pre-monsoon and Post-monsoon respectively and in South Western part of the district at Jhohran of Jagraon block it is maximum 23.58 m bmp and 18.35 m bmp as observed for Pre and Post Monsoon period. The pH value in the area is ranges between 6.98 to 8.10. The Ec value in the area is ranges between 320 to 1971 micromhos/cm at 25 °C. The Fluoride value in the area ranges between 0.20 to 5.22 mg/l.

2.3.4 Hissar District , Haryana

The Hisar district is situated in the west central part of the Haryana State The district head quarter is at Hisar. It is divided into Nine Development Blocks namely Barwala, Narnaud, Bass (Hansi-II), Hansi-I, Hissar-I, Hissar-II, Adampur, Agroha and Uklana. The area forms a part of Indo-Gangetic Alluvial Plain, interrupted by clusters of sand dunes. There is no natural drainage in the area. The area is traversed by a network of canals forms a part of Bhakra Water Services system and Western Yamuna Canal System. The area is also drained by the artificial drains which are in operation during heavy rains.

In all 173 observation wells and 5 piezeometers were monitored. The depth to water level in the district varies from 1.45 m bgl at Gurana to 18.72 m bgl at Basra. Water logging and prone to water logging condition exists in the parts of Bass (Hansi-II) and Hansi-I blocks of the district. The deeper water levels are observed all along the southern boundary of the district. The seasonal fluctuation (June - Nov 2005) ranges from 0.05 to 2.52 m. Overall, there is a rise in water table in the area from pre-post monsoon 2005. At few places, decline in water table upto 0.13 m has also been observed.

The total 156 water samples were collected from shallow aquifer from drinking sector, 57 water samples from deeper aquifer from Irrigation sector to know the changes in quality as a result of ground water development in the area. Also, a total of 43 water samples were collected for heavy metal ions concentration, 8 samples were collected from Hisar City to know the ground water quality in Hisar Urban area . The chemical Analysis of the water samples reveals that the water

from shallow aquifer is overall in alkaline nature. The pH value ranges from 7.15 to 8.25. The specific conductance value varies from 330 to 16400 micromhos/cm at 25 °C. Total hardness as CaCO3 varies from 127 to 3334 mg/l and found in about 35 % of the water samples is more than the permissible limit of 600 mg/l.

The fluoride value ranges from nil to 22.10 mg/l and it was found that in about 34 % of the water samples collected from the area, F values are more than the permissible limit of 1.5 mg/l, precaution is required to be taken before such water is used for drinking purposes. Nitrate contents also found in excess to the permissible limit of 100 mg/l, constitutes 20 % of the water samples and ranges between 0.4 and 3574 mg/l. An overall review of trace element analysis indicates that the ground water is polluted by heavy metals like Iron and lead and to some extent by manganese. Iron concentration varies from 0.01 to 6.86 mg/l and is found in about 40% of the water samples more than the permissible limit of 1.00 mg/l. The Lead concentration varies from nil to 0.08 mg/l and is found in about 27% of the water samples more than the permissible limit of 0.05 mg/l is found.
The drinking water supply schemes in the district are based mostly on canal water. At few places ground water is also being used for water supply purposes. Out of a total of 187 RWS schems, 182 are canal water based and 5 are based on tubewells. Based on village draft sample survey it has been found that in the district depth of shallow tubewells varies from 10 m to 60 m with their discharge from 6 LPS to 15 LPS. The majority of shallow tubewells are of cavity type.

The detailed hydro-geological study was carried out in Narnaund block of the district. During study it has been found that the block is having 11,989 no of MIU's with an average density of 35 MIU/sq km, which is maximum in the district. It has increased many folds during past 10 years, causing over-exploitation of ground water. The issues of concern are:

- Over exploitation of ground water in Narnaund block.
- Improper use of both surface and ground water and poor quality of ground water leading to water logging and prone to water logging conditions in parts of Bass and Hansi-I blocks.
- Deeper water level all along the southern boundary of the district.
- Saline/brackish water and its unsuitability for irrigation.
- Hydrochemical aspects:
  a). Fluoride concentration in shallow aquifer.
  b). Concentration of heavy metal ions like Iron, Lead and Manganese

2.4 WESTERN REGION (Rajasthan)

District ground water development and management studies were carried out in parts of Jalore and Jaipur districts of Rajasthan covering a total of 9,831 Sq. Km area. Districtwise summary of the study is as follows

2.4.1 Jaipur District

Jaipur district is located in the eastern part of the State occupying 10876.78 Sq.Km geographical area. There are 11 tehsils and 13 blocks in the district. Out of these 7 blocks have been covered under Reappraisal Hydrogeological survey, covering 6776 sqkm during 2005-06. The district experiences semiarid type of climate. The average annual rainfall of the district is 562.20mm. The district consists of a fairly open undulating plain with hillocks in the north and northeastern part. The district in general is characterized by low land topography with 0-1% slope. The district is drained by ephemeral rivers namely Sabi , Banganga, Mendha, and Sota and their tributaries.

The Principal water bearing formation in the study area is Quaternary alluvium. However consolidated formation e.g. quartzite, schist , gneiss also occur in the north eastern and western and south western part of the district. These form poor to moderate aquifers containing water in weathered zones & joints. Groundwater occurs in unconfined to confined conditions in the district. The depth to water level in the alluvial formation varies from 13.60 m bgl to 67.70 m bgl

(Govindgarh block) whereas in quartzite and consolidated formation it ranges from 11.00 m bgl (Dudu) to 28.40 m bgl.

Comparison of last 10 years Water level data reveals that maximum depletion of ground water has occurred in Govindgarh block which is 1.18 m/year that is due to higher withdrawl of ground water for irrigation use and less recharge in comparison of draft. The minimum decline rate of 0.41 m/year is observed in Kotputli block. The yield of wells in consolidated formation is generally below 35 m^3/day and in alluvium it varies from 100 to 130 m^3/day.

Ground water quality is generally fresh and potable except in Dudu, Phagi and Sambhar block areas where EC ranges from 6,000 m mhos/cm to 22000 m mhos/cm at 25 °C. In rest of the blocks namely Kotputli , Bairath, Shahpura & Govindgarh, it ranges between 1000 and 3000 m mhos/cm. The quality deterioration has been seen in the western and south western parts where salinity and fluoride problem exists. High value of Flouride(>1.5 mg/litre) have been observed in parts of Jhotwara,Govindgarh, Kotputli, Bairath and Shahpura block. The stage of groundwater development in various blocks had reached to the over exploitation stage and in all the blocks it is above 150% except in Dudu block where it is 93.71% (as on 31.03.04) and categorized as critical block, which is due to salinity problem. Maximum stage of ground water development has been found in Sambher block i.e.268.23% (as on 31.3.04), which is due to extensive ground water withdrawl in the area by private tubewells for the production of salts. This is a matter of concern. Excessive withdrawl of ground water has resulted into declining trend in water level and depletion of the precious resources.

From the ground water management point of view, there is a lot of scope of artificial recharge in the area. In eastern, north and north western part Sub Surface Barrier and Anicut structures may be constructed on Sabi-,Sota river etc. for harnessing the surface runoff rainfall. In urban areas roof top rainwater harvesting technique is best suited.

2.4.2 Jalore district

Ground Water management studies have been undertaken in Sanchore block of the Jalore district. Sanchore Block is situated between East longitudes 71°11'00" and 72°00'00", and North latitudes 24°36'45" and 25°07'30", covering an area of 3055 Sq Km. The climate is arid, with normal rainfall being 390.5mm. The rainfall recorded in 2004 and 2005 are 249mm and 352mm respectively. Luni River enters the block from Northeast, flowing NE-SW and branches out into several distributaries, spreading in the Rann area. In general, the area has gently rolling topography. Along the western margin of the block, presence of sand dunes renders the landscape undulating. About 99% of the area is covered with alluvium, comprising of fluvial deposits and aeolian sand. Rocks belonging to Malani Igneous Suite occur around village Doongri, which makes only about 1% of the area.

The groundwater occurs under unconfined and semi-confined conditions. Water level is comparatively shallow in the vicinity of Luni River. In the southwestern part (Rann), water level, in general, varies from 2-6 mbgl. Shallowest water level, however, is encountered at Bhawatra, where it is 1.05 mbgl. Moving away from the Rann area, water level varies from 8-12 mbgl in the western and northwestern part of the block. Towards east, there exists a gradual deepening of water level, with deepest water level recorded as 40.60 mbgl in the key well at Tentop near southeastern margin. Pre-monsoon to post-monsoon fluctuation in water level varies from +0.06m to –1.04m. Discharge of wells (DW, DCB & TW) ranges from 40 m^3 per hour to 560 cub m^3 per hour. The stage of groundwater development as on 31.03.2004 is 187.21%, bringing the block under over exploited category.

Water quality is generally brackish (66% samples-EC above 3000, 16% samples- Between 2000 and 3000 micro Siemens/cm) Maximum EC has been reported in the sample from Bichhawari towards the south of the block. High to very high fluoride concentration has been observed in the south-central part of the block, the highest being 8.4 ppm in the sample from Daval. The highest concentration of nitrate has been found in the sample from Golassan in the southern fringes of the

block where it reaches 260mg/L. As a result of the quality problem due to one factor or the other, drinking water supply is from a few select points where quality is comparatively better at deeper levels.

Previous Ground Water Management studies were undertaken during 1995-96. A cursory comparison with the findings of previous survey brings into relief following salient differences.

- In the west, northwest, south and central part of the block, the decline in water level is in the range of 1-3m in 10 years. Heavy decline has been noticed in the eastern part. For instance, spot decline at Tentop in the southeast is of the order of 16m. General decline in the eastern part ranges from 10-16m over 10 years. Apparently, such a considerable decline in eastern part is partly due to availability of better quality water at deeper levels in this zone, leading to heavy withdrawals. It is also noted in this part that most of the drinking supply wells are located.

- In 1995, high fluoride and nitrate were restricted to northwestern part of the block, whereas during the present studies, such cases have been observed scattered all over the block, having sporadic occurrences in entire area. There is a patch in south-central part where fluoride concentrations are considerably high.

- Most of the part of Sanchore Block falls under Command Area of Narmada Canal Project, which is to start in near future. Wells have been established, and water level and sample collected adjacent to or nearby canal courses. Changes taking place in groundwater quality and level, *if any*, are likely to be registered in these wells. The data can be used in future to assess the impact of canal in the area.

- Present cropping pattern in select villages falling under proposed command area have also been documented for future comparison.

2.5 WESTERN CENTRAL REGION(Gujarat)

Ground Water Management studies were taken up in Gandhinagar district and part of Bhavnagar district (Botad Taluka) covering an area of about 6000 Sq. Km (2200 Sq.km in Gandhinagar district and 3800 Sq.km in Bhavnagar district) Detailed hydrogeological study was carried out exclusively in Gandhinagar taluka comprising about 650-sq.km approx.

2.5.1 Gandhinagar District

Ground Water Management studies have been carried out in the district of Gandhinagar covering four talukas namely Gandhinagar, Dahegam, Kalol and Mansa.The area under survey is part of North Gujarat Alluvial plain with a flat monotonous topography. Sabarmati, Khari, Vatrak and Meshwo are the prominent rivers draining the district.

Geologically it forms the part of Cambay basin and there are no hard rock exposures. It is characterized by thick Quaternary alluvium comprising of silt, sand, clay, gravel and kankar, which is underlain by Tertiary sediments followed by Deccan traps and Himmatnagar sandstone.

Gandhinagar forms a multi-layered aquifer system, which exists both in unconfined and confined condition. Seven aquifers have been identified designated as “A”, “B”, “C”, “D”, “E”, “F”, & “G”. Aquifer A is phreatic to semi confined in nature but has dried up in many parts of the district. Aquifers “B” and “C” occurring within a depth of 200m are the most exploited aquifers in the district and most of the tube wells constructed tap these aquifers. Aquifer “D” and “E” which occur within a depth of 300m and more are also being developed in parts of Mansa and Kalol talukas.

Ground water development in this area is mainly through tube wells & dug cum bore wells. The phreatic aquifer is almost de-saturated due to overexploitation. Hence most of the dug wells have become dry. At present towards the eastern part of the district particularly in Dahegam taluka

shallow tube wells are feasible where as in the western part only deep tube wells are feasible. It is observed that the depth of the tube wells gradually increases from east to west.

The depth of the tube wells ranges between 60 and 300m bgl. However in parts of Kalol and Mansa taluka tube wells of depth even up to 350m bgl and above exists. The thickness of quaternary alluvium is less towards eastern part where tube wells range in depth from 60-180m bgl and towards western part thickness of alluvium is more and depth of tube wells range from 200-350m bgl. The depth to piezometric surface ranges from 40-150m bgl. The quality of ground water is in general potable, field EC varying between 600-2500 μs/cm. Drinking water supply in these areas is mainly met by canals (Narmada Main Canal) and tube wells.

A pumping test was conducted in a large diameter well. Depth to piezometric surface during pre monsoon period varies between 60 to 155.5m bgl where as during post monsoon period it varies between 63.5 to 137.3 m bgl. Fluctuation (seasonal) is between 1.05 to 8.10m.The yield of the tube wells varies between 28-72m^3/hr.

In Gandhinagar taluka ground water occurs both in semi-confined to confined condition. The depth of the tube wells range between 150 - 270m and PWL varies within 80-120m bgl. EC varies within 600-1500 μs/cm. However in the villages towards eastern part of the taluka namely Kanpur, Chandrala, Giyod etc. the EC value is high. (2200 - 2500 μs/cm).

Gandhinagar taluka has been declared as notified area by CGWA where in aquifers below 200m is declared as “Protected Aquifer” and should be used exclusively for drinking and domestic water supply. Gujarat Ground Water Authority (GGWA) has also notified all the four taluka. However, during survey it was observed that awareness of this notification is mildly felt amongst the farmers. Irrigation wells, even after notification are found to have penetrated below this notified depth as a result of which the piezometric decline continues to exhibit the same trend. As per estimation of the resources the ground water development was 184% during 2004. The water level is declining at a rate of 3 to 4m per year.

Strict implementation of the directives of CGWA and awareness at the grass root level is necessary. Remedial measures like construction of artificial recharge structures to augment ground water resources & conjunctive use of water resources are going on for sustainable development of water resources. Ground water recharge through artificial recharge structures, rainwater harvesting, and construction of check dams have been taken up by Capital project, state agencies and NGOs. 175 recharge wells have been constructed by Capital Project to augment ground water resources. GWSSB has constructed 15 recharge wells in Dahegam taluka and 15 percolation wells in ponds in Gandhinagar taluka.

In Dahegam taluka, towards northeastern part, hard rock (Basalt) is encountered at a depth of 65-80m bgl limiting the depth of tube wells. In the exploratory well drilled by CGWB at Bardoli village, Basalt was encountered at a depth of 65m bgl. During survey in Dahegam taluka it was observed that in villages like Hathijan, Ingraji na muvada, Bardoli, Kothi, Harsoli etc. brought under the canal irrigation, fast decline in water level was noticed earlier due to heavy pumping from tube wells. However, since last two years the area has seen substantial rise in water level (about 6-8m) was reported. This rise is attributed to less pumping from tube wells and lift irrigation from canal passing through these villages.

Field investigation in Mansa taluka revealed that the tube wells constructed by farmers for irrigation failed within a short span of time (two to six years). In village Lodra,it is reported that the screens used in the construction of tube wells are damaged at a depth of 152-180m. In Charada village the pipes are found to be compressed in some tube wells at a depth of 120m to170m, which does not allow lowering of pump in the well. In some of the villages segregation of calcium between screen and pump is also observed causing reduction in yield and breaking down of assembly. Detailed study through exploration is needed in near future to address this problem.

2.5.2 Bhavnagar District

Ground Water Management Studies were taken up in parts of Bhavnagar district covering the talukas of Shior, Palitana, Gadhada, Gariyadhar, Unralla, Vhalbhipur and Dhasa,during 2005-2006. The total area covered under survey is 3800 sq.km.

The study area in general has a moderately undulating topography with dissected hilly terrain in the central part. Mud flats and creeks exist along the north eastern boundary of the study area. The rivers draining the area are Shetrunji, Ghelo and Kallubhai of which River Shetrunji is the most prominent river. The average annual rainfall in the area is about 733 mm. Geologically, 80% of the area is covered by Basalts and the remaining 20 % by alluvial formation.

The groundwater within the aquifers of the study area existed in unconfined conditions. The groundwater development is mainly by dugwells wherein most of the dugwells in basalts had horizontal bores ranging between 10 to 30 m in length. The survey revealed that the water level in basalts ranged between 5 and 30 m bgl while in case of alluvial formation, the water level ranged between 30 and 90 m bgl. In areas of heavy and continuous pumping, the pumping water level ranged between 400 and 120 m bgl. The groundwater quality of the study area were found to be good and potable with the EC ranging between 600 and 2200 µS/cm. However, is some alluvial regions, the water is brackish to saline with EC ranging between 3000 and 6000 µS /cm. The yield of the dugwells in basalts mostly varied between 15 and 30 m^3/day.

Rainfall forms the main source of groundwater replenishment. The groundwater fluctuations ranged between 3 and 15 m and are more pronounced in basalt. The dugwells in the hard rock region registered remarkable recharge by rainfall, but the residence time (2 to 3 months) of the recharged water is quite less indicating the less storage capacity. The checkdams constructed by the state government in the hard rock area has remarkable impact on groundwater recharge as the dugwells sustained more than 2 months period than normal which in turn led to increase in agricultural production.

The detailed study covering the parts of Umralla, Sihor and Vallbhipur talukas were carried out since this area experiences fast depletion in groundwater level. The area was closely monitored by fixing more number of dugwells for monthly monitoring of water level. The dugwells in this region ranged between 50 m to as high as 130 m bgl. The area is plain and falls within a faulted zone. The thickness of the alluvial bed is about 300 m thickness and tapers near the contact with basalt. The groundwater level ranged between 40 and 100 m bgl while EC ranged between 400 and 6000 µS/cm. The groundwater decline is rapid which on field enquiry revealed about 2 to 4 m/year. Due to intensive pumping for agricultural activity, cone of depression exists within the central part of the detailed area indicating that aquifer is under high hydrologic stress. Study also revealed the saline front bordering the area (mudflats) towards east poses threat to the aquifer over a period of time. Water marketing also exists and is sold at Rs. 100 – 150 per 10,000 litres. As this area in under intensive irrigation there arises a need to safe guard this fast declining aquifer system

2.6 NORTH CENTRAL REGION (Madhya Pradesh)

Districts Ground Water Management studies were takenup in Ujjain and Tikamgarh districts of Madhya Pradesh in 11139 Sq. Km. area. Districtwise summary of the studies is as follows

2.6.1 Ujjain District

Badnaar, Khachod & Ghatia blocks :- The studies was carried out in parts of district Ujjain covering an area of 3111 sq km in Badnagar, Khachrod & Ghatia blocks. The blocks Badnagar is an over exploited block for Ground Water Development while Ghatia block falls in the Semi critical category for ground water development and Khachrod block falls in the safe category. The chemical quality is deteriorated between the rivers Chambal and Chamla near village Dunalia and village Bakheda towards Nagda town. The DTW in entire study area ranges from 3.00 mts. to 20

mts.The phreatic aquifer has become almost dry in Badnagar area due to steep declining of water levels.

About 30 sites for construction of artificial recharge structures like subsurface dykes, percolation tanks & recharge shaft have been identified to recharge the ground water in the area where the ground water levels are more than 15 m bgl. The unit draft of the tube wells in the area has been calculated and ranges between 0.4 to 2 ham/year.

Mahidpur, Tarana and Ujjain blocks: - Ground Water Management Studies were taken up in parts of Ujjain district in Mahidpur, Tarana and Ujjain blocks. These blocks constitute an area of 2980 sq.km The whole area in underlain by Deccan Trap basalts and is drained by Gambhir, Kshipra and Choti Kali Sindh rivers of the Chambal sub-basin, Ganga basin.

In the pre-monsoon period, about 67% of the wells had water levels greater than 15 mbgl, 22% of the wells had water levels between 10-15 mbgl and 11% had water levels between 5-10 mbgl. As far as quality of ground water is concerned, high fluoride was found in only one sample (Harsodan 3.11mg/l), nitrate pollution was widespread (36 water samples) with 8 stations showing nitrate values higher than 100 mg/l.

The study in the area has brought out the fact that the phreatic aquifer in the area has more or less dried up. This can be attributed to indiscriminate exploitation of ground water for agricultural purposes. This indiscriminate exploitation is also verified by the state of ground water development in the aforementioned three blocks. The stage of development in Ujjain block in the year 1994 was 47.6%, which has now gone upto 144%. Similarly, stage of ground water development in Mahidpur block was 17.8% (1994) and presently it is 72%. Similar is the case of Tarana block (36.5% in 1994 & 82% presently).

About 35 sites for artificial recharge structures have been identified for conservation and augmentation of ground water resources. In addition, recommendations for watershed management coupled with changes in cropping patterns, enhanced irrigation efficiency will be made to the appropriate authorities.

2.6.2 Tikamgarh District

Prithivipur, Niwari and Jatara Blocks : - Tikamgarh district is located in the Bundekhand Region. An area of 2414 sq. kms covered in three administrative blocks viz Prithivipur, Niwari & Jatara blocks of Tikamgarh district. Geologically, the area covered by Bundelkhand granite and gneisses. Granites are pink and gray in color, fine to coarse grained in texture and outcrop is in hemispherical. Intrusive bodies of pegmatite and quartz reef develops joints and fractures in the granitic host rock that controls the occurrence and movement of ground water. These fractures deserve careful appraisal in the prospecting of ground water. From the hydrogeological studies three ground water environs have been identified:- i) Upland and hilly tract of the granite ii) Granitic tract between two intrusive bodies and iii) Weathered granite occurring in plain and low-lying areas.

Ground water occurs mostly under water table conditions. In the study area weathered mantle ranges from 6 to 20 m.b.g.l.which controls the ground water occurrence.Pre-monsoon water level, depth of wells and post monsoon water level varies from 3.70 to 18.20 m.b.g.l., 5.25 –19.65 & 2.15-12.90 in the area respectively.

An area of 80 kms in Chandokha nala watershed was studied in detailed. Based on hydrogeological investigation few sites for construction of artificial recharge structures are selected. In general the quality of ground water is good except high salinity, nitrate & hardness at 5 places due to local pollution.

Baldeogarh, Palera & Tikamgarh blocks:- Ground Water Management Studies were taken up in Baldeogarh, Palera & Tikamgarh blocks Tikamgarh district (M.P.) covering 2634 sq. Km

In course of studies 92 key wells were established during pre monsoon period (May & June 2005) and collected 40 Nos. water samples for chemical analysis to assess the quality of ground water. Also post monsoon water level measurement of these wells were also carried out and about 121 nos. of open wells have been inventoried/monitored to increase the density of observation wells. Depth to water ranges from 5.31 to 19.55 m.bgl. during pre-monsoon period. Depth to water ranges from 0.90 to 11.90 m. bgl. during post monsoon period. Total depth of open dug-wells ranges from 7.75 to 21.00 m. Diameter of open wells ranges from 3.40 m to 10.60 m.

Geologically, most of the area is underlain by granitic terrain constituting different units like hard massive, fractured, weathered rocks and a part of the area also covered by alluvial & lateritic soil. Weathered & highly weathered unit of granites forms potential ground water aquifer in the area. Mostly potential open dug wells & tube wells up to 60 mts. in depth constructed in weathered granite. Thickness of weathered mantle varies from 40 to 60 mts.

Ground water occurs in phreatic zones in the study area. Geomorphologically area is covered by uneven and undulating terrain. A few surface storage irrigation Tanks for irrigation exists in the study area. In most of the villages ponds & tank do exists for domestic uses. Under Rajeev Ghadhi watershed mission programme a few artificial recharge structures constructed. Few sites for construction of suitable ground water recharge structures have been identified in an area of about 150 sq. km. of Tikamgarh block (over exploited block).It was observed that some villages (Kurila Sarkai, Hivdehasu etc. are affected due to presence of high fluoride (More than 2 mg./lit) in ground water.

2.7 NORTH CENTRAL CHATTISGARH REGION (Chattisgarh)

During 2005-06, the Koriya and Kawardha districts have been covered under the Ground Water Management Studies in 9940 Sq. Km. Area.The district wise summary of the study follows;-

2.7.1 Koriya district

Ground Water Management Studies were taken up in Koriya district covering an area of about 5980 sq. km, which is located in northwestern of Chhattisgarh state. The study area has tribal population above 63% of the total population. The study area has subtropical climate characterized by hot summer and cold winter season. The normal average rainfall ranges from 1228-1442 mm. The study area is drained mainly by Banas, Gopad, Neur, Odari, Baniya, Bijadur rivers that comes under Ganga (61%) and Hasdo that comes under Mahanadi (39%) basins. Drainage is dendritic to sub dendritic in nature. Nearly 67% area of the district covered with dense forest.

Geomorphologically the area is characterized by highly rugged topography comprising high hills and dissected plateau with steep slopes and scarps. Rocks of Gondwana and Deccan traps of cretaceous to palaeogene mainly covers the area. Ground water occurs in unconfined, semi-confined to confined conditions in these formations.The pre monsoon water level ranges between 1.30 mbgl to 11.70 mbgl in dug wells whereas post monsoon water level ranges between 0.90 mbgl to 9.20 mbgl. Eight pumping tests were carried out in dug wells in Suprabarakar and Raniganj formation to know the aquifer parameters. The tests reveals low to moderate transmissivity in Supra Barakar however moderate in Raniganj. Specific capacities of the tested dug well found in the range of 0.003245 to 0.009546 m2/minutes. At six places soil infiltration tests were carried out, which reveals very low infiltration rate in inceptisols (2 to 3 cm/hr), medium in ultisols (6.5 to 9.5 cm/hr) and high in alfisols (25.4 to 50 cm/hr) present.

Irrigation is poor in the district and ground water development is very low but the aquifers don't provide sustainable yield for agriculture. Adoption of Artificial Recharge and Rainwater Harvesting techniques can enhance the ground water potential of the area as it receives good amount of

rainfall. Construction of Rainwater Harvesting structures like storage tanks, reservoir etc. are recommended at the places where inceptisols occurs as they are found as discharge area and construction of Artificial Recharge structures like check dams, stop dams, gabion structures etc. are recommended where alfisols exists as they are recharge areas.Few springs with less than 1 lps discharges in hilly regions of Janakpur and Sonhat are structurally controlled and Artesian condition prevailing in area like Chutki and Kasauda can be utilised for the ground water management . The water quality analysis reveals that ground water is potable except in bore wells of Sonhat and parts of Janakpur i.e. (Chutki and surrounding area) where high iron content is higher than permissible limit. So in this area the drinking water from dug wells can be utilised, which ultimately helps in aeration

2.7.2 Kawardha district

Ground Water Management studies were carried out in Kawardha district covering an area of 3960 sq. km. The area has sub tropical climate. The normal rainfall of the district is 1200. mm.,The major part of the study area is drained by Hanp river which is a tributary of the Seonath river.The area is covered by rocks belonging to Basement crystalline, Lametas, Deccan traps and rocks of Chhattisgarh Supergroup overlain by sub recent to recent alluvium. The Archaean Group of rocks are exposed sporadically. Ground water generally occurs under phreatic condition in the weathered mantle, jointed and fractured zones ranging between 10-15 mbgl. Gneisses and granodiorites are susceptible to weathering and have weathered, Jointed and fractured zones extending up to 15-25 mbgl. Impervious bands of siliceous phyllites with vertical foliation at places acts as sub surface barrier for ground water.

Development of ground water in the district is carried out through dugwells and bore wells for domestic and irrigation purposes. Shallow dug wells in the depth range 5-20 m bgl, tapping limestone and sandstones can give a yield range of 15 to 25 m^3/day. The depth to water level in these wells ranges between 4 to 16 m bgl. The general range of water level in the phreatic aquifer varies from 4.5 to 12.8 m bgl with seasonal fluctuation varying between 0.15 to 7.0 m. Ground water quality is good. The Transmissivity varies between 50 to 250 m^2/day 55 and at some places it as high as 500 m^2/day. Infiltration test reveals that rate of infiltration ranges from 1.2 to 3.4 cm/hour. The water required to create field capacity is between 20 to 25 litres per unit volume of the soil. Iron contamination is the most prevailing problem in almost all the villages situated in Chilpi formation. The Rain water Harvesting and Artificial Recharge has to be taken up to arrest the declining water level. In addition to these sprinkler irrigation should be adopted for rabi crop to minimize the water input.

2.8 CENTRAL REGION (Maharashtra)

2.8.1 Yavatmal District

Ground Water Management Studies were undertaken in 13429 sqkm area of Yavatmal district in 4 parts as follows:-

Parts of Ralegaon, Kelapur, Maregoan and Wani talukas :- 3406 km^2 area comprising 16 watersheds falling in parts of Penganga and Wardha sub-basin of Godavari basin was covered.The area includes 16 watersheds namely PGK-3, PGK-4, PGK-5, PGK-6, PGK-7, WR-5, WR-6, WR-7, WR-8, WRN-1, WRN-2, PGV-1, PGV-2, PGV-3, PG-11, PG-12.

The area is underlain by formations belonging to Archaeans, Penganga Group, Gondwana Super Group, Lametas, Deccan Traps and alluvium. A total of 88 key wells were established in the studied. The pre-monsoon depth to water level ranges from 1.80 to 17.50 m.bgl. while the DTW during post-monsoon period ranges from 0.78 to 14.5 m.bgl. The seasonal water level fluctuation varies from 0.50 to 7.60 m.

Quality Problem:- During pre-monsoon a total of 70 water samples were collected from shallow

aquifers and almost 50 samples were taken from deeper aquifers incluidng the problematic area and towns. Duirng post-monsoon season, 25 samples were taken from deeper aquifers. The EC observed in field from the dug wells varies from 400 to 6300 mhos/cm and the pH varies from 7.2 to 8.7. Natural water quality problem like occurence of Flouride in watershed Nos PGK-3, PGK-4 and PGK-6 and the Salinity problem in WRN-2 watershed are observed where mining of coal is rampant.

Ground water Studies in Towns:- The study was carried out in Wani and Pandharkawada towns. In order to study the quality problem in the town, ground water samples were collected from both the towns from handpums and dugwells. As such, there is no quality problem in Pandharkawada but prelimanary study and observations indicates that there may be salinity problem in the Wani town.

Ner, Yavatmal, Kalamb, Babhulgaon and Ralegaon talukas:- GWMS was carried out over an area of 3344 sq.kms in parts of Yavatmal district against the target of 3000 sq.kms The area includes 17 watersheds namely PGA-4, WRBM, PGW-1, PGW-2, PGW-3, PGA-5, PGA-7, WR-1, WR-2, WR-3, WR-4, PGK-1, PGK-2, WRB-3, WRB-4, WRB-5, WRB-6.

The entire area is occupied by basaltic lava flows known as Deccan Traps, belonging to Cretaceous to Eocene except along the banks of Wardha and Bembla rivers where alluvium occurs. The major drainage is the Wardha, Bembla and Waghadi rivers. The normal annual rainfall over the area ranges from 850 to 1150 mm. Ground water occurs under semi-confined to unconfined conditions in weathered/fractured, vesicular and massive basalts. The depth of dug wells ranged from 3.90 to 15.35 m.bgl. The pre-monsoon depth to water level ranges from 2.35 to 14.25 m.bgl, while the post-monsoon DTW ranges from 1.00 to 8.61 m.bgl. The pre- and post-monsoon water level fluctuation varies from 0.35 to 9.93 m. For assessing the quality of ground water, 73 water samples were collected from the dug wells. Under special study urban hydrogeological and ground water quality conditions in Yavatmal town were undertaken.

Darwha, Digras, Arni, Ghatanji, Ner and Pandharkawada talukas :- The studies in parts of Penganga and Wardha Sub-basin covering parts of Yavatmal district were carried out over an area of 3254.30 sq. kms

The study was carried out based on watershed as a unit hydrogeological feature, including two watersheds of Wardha sub-basin namely WRB-1 and WRB-2 and sixteen watersheds of Penganga sub-basin viz; PGA-1, PGA-2, PGA-3, PGA-6, PGA-8, PGA-9, PG-8, PG-9, PG-10, PGW-4, PGW-5, PGAA-1, PGAA-2, PGAA-3, PGAA-4, PGAA-5 The comparison of current land use pattern (2002-03) with earlier (1995-96) indicates that there is no major change in the land use pattern in the area. The area experiences tropical to sub-tropical climate.

Basaltic lava flows of Deccan Trap occupies the major part of the area. The other rock types include granite-gneiss, limestone, shale, dolomitic limestone ,cherty limestone, grit and sandstone.Two piezometers were drilled in study area under Hydrology Project. Ground Water Exploration was carried out during 1990-93 in which 13 exploratory wells and two observation wells were drilled.

The depth of dug wells in the study area varies from 4.7 m.bgl (Arni) to 26.10 m.bgl (Arli) The pre-monsoon depth to water level ranges from 3.7 m.bgl (Arni) to 16.8 m.bgl (Loni) and 7 dug wells (9.85%) were dry. The post-monsoon depth to water level ranges from 0.85 m.bgl (Bhulai) to 15.15 m.bgl (Arli). The seasonal fluctuation in depth to water level observed from 0.70m at Ghoti to 12.35 m at Sawargaon. The detailed hydrogeological survey was carried in 231.69 sq.kms

Urban Hydrogeological study in Darwha Town was carried out to know the impact of urbanization on the ground water regime. It is observed that the northern and southern area of city are showing deeper water level both during pre-monsoon (>14m bgl) and post monsoon season seasons (>6m bgl). The water levels in the range of 6-14 m.bgl was observed in main city areas, while the water

GROUND WATER MANAGEMENT STUDIES

Spring flow channelized for irrigation in dolomitic limestone terrain (Penganga beds) near Kayar village in Wani taluka, Yavatmal district, Maharasthra

Artesian well near Sindiwadhona in dolomitic limestone terrain (Penganga beds) used for drinking purposes in Wani taluka, Yavatmal district , Maharasthra

levels in the range of 4-10 m.bgl was observed in southern outskirts of city. It is observed that the ground water is fresh, potable and safe for domestic and irrigation purposes.

Pusad, Mahagaon and Umarkhed talukas: An area of 3425 sq. km. was studied The area includes 13 watersheds namely PGP-1, PGP-2, PGP-3, PGP-4, PGP-5, PGD, PG-1, PG-2, PG-3, PG-4, PG-5, PG-6, PG-7. The area experiences the sub-tropical to tropical monsoon climate.

During 1994-95 Ground Water Exploration was carried out, under which 11 exploratory wells and 4 observation wells were drilled. The discharge of the exploratory wells ranges from 0.14 lps to 49.4 lps. The depth of dug wells in the area varies from 5.27 m bgl (Katkheda) to 18.77 m bgl (Kanherwadi) The pre-monsoon depth to water level ranges from 3.8 m.bgl (Isapur) to 17.9 m.bgl (Kanherwadi) The post-monsoon depth to water level ranges from 0.3 m.bgl (Dhanaj) to 11.27 m.bgl (Temburdhara). The seasonal fluctuation varies from 0.35 m at Wedad to 15.59 m at Kanherwadi. The detailed hydrogeological survey was carried in watershed PG-2 .Urban Hydrogeological study in Umarkhed and Pusad Town was carried out to know the impact of urbanization on the ground water regime. It is observed that the ground water is fresh, potable and safe for domestic and irrigation purpose.

2.8.2 Chandrapur District:

Ground water management studies were carried out in parts of Chandrapur district covering an area of 3300 sq. kms. The entire study area includes 14 watersheds namely WRE-1, WRE-2, WRH, WR-16, WR-17, WR-18, WR-19, WR-20, PG-1, PG-2, PRP, PR-5, PR-6, PRJ and falls under Balarpur, Chandrapur, Gondpipri, Rajura, Korpana and Jeoti talukas. Deccan traps and Gondwana formations underlie the area.

The pre-monsoon depth to water level ranges from 2.24 m.bgl to 15.53 m.bgl and perched water table (1.63 m.bgl.) condition is observed in part of WRH watershed. The post monsoon DTW ranges from 0.90 m.bgl to 14.87 m.bgl. A total of 230 dug wells were examined during the course of survey. Samples were collected for estimation of iron and fluroide from both water table and confined aquifer. Spot values of EC vary from 200 to 10,200 mmhos/cm. 14 pumping tests were conducted on dug wells The permeability values ranges from 0.018163 to 0.715654 m/hour. The discharge of dug wells ranges from 1.12992 to 122.84 m^3/day.

2.8.3 Pune District:

Ground water management studies were carried out in parts of Pune district covering an area of 3300 Sq. kms. The watersheds covered were BM-49, 50, 51, 52, 58, 59, 60, 70, 72, 73, 74 and 75 and falls in Haveli, Daund, Purander, Baramati and Bhor talukas. Bhima and Nira rivers and their tributaries namely Mula, Mutha and Karha drain the area.

The area is underlain by the Deccan traps and alluvium along the river courses. The depth of dug wells ranges from 4.7 to 19.5 m.bgl. The pre-monsoon depth to water level ranges from 1.10 m.bgl to 16.20 m.bgl and during post-monsoon the DTW ranges from G.L. to 10.05 m bgl. It is observed that major part of the area is having annual fluctuation in between 0.80-12.34 m. Negative fluctuation is observed in canal command areas where shallow water levels are observesd during the summer as in these areas the application of water is maily through canals and there is no withdrawal through ground water structures. The yield of dug wells ranges from 5 to 100 m^3/day.

2.9 NORTHERN REGION(Uttar Pradesh)

2.9.1 Ghaziabad District

The ground water management studies were carried out in 8 blocks of Ghaziabad district covering an area of 1956 Sq.km. The area occupies central part of the Ganga – Yamuna Doab and presents

diversified hydrogeological problems in the central and western parts of the district.The main constituting sediments present are clay, kankar and sands of various grades. The results of deep exploratory drilling carried out in the area reveal that 4 tier aquifer system exists down to the depth of 600 mbgl.

A total of 55 nos.of key wells were established for measurement of pre-monsoon and post monsoon water levels in all blocks of the district. The Depth to water level varies from 1.10 mbgl to 23.37 mbgl in pre-monsoon whereas it ranges between 1.33 mbgl to 23.37 mbgl during post-monsoon period. Deep water level more than 10 mbgl is found in Ghaziabad city, parts of Hapur, Simbhaouli and Garhmukteshwar blocks. Shallow water level 2 to 3 mbgl occurs in the flood plain of Ganga, Yamuna and command area of irrigation. The ground water occurs under water table conditions in phreatic aqufiers whereas in deeper aquifers it occurs in semi-confined to confined conditions. The river Ganga, Yamuna and Hindon are effluent i.e. gaining from ground water while canal system namely Upper Ganga and Anupshar branch are influent (Feeding ground water in nature).

The quality of ground water is good for domestic purposes. However the quality of ground water seems to be deteriorated in the Industrial area of Sahibabad and in southern west parts of the district in between Yamuna and Hindon doab. Pollution of shallow aquifer in urban and industrial centers has also been observed.

It was observed that the quality of ground water in shallow 1st aquifer is suitable for domestic and irrigation purposes in three blocks namely Razapur, Loni and Hapur. However, in deeper aquifers it is found brakish to saline in nautre. Isolated cases of high content of fluoride in ground water is also reported from some areas.

2.9.2 Bahraich district

The area falling under Central Ganga Plain is underlain by thick pile of Quaternary alluvium. Its major parts become water logged during the post- monsoon period. Quality of ground water is generally fresh except for arsenic contamination (4.95-50 ppb) at sporadic locations specially in the vicinity of Ghaghra river. The most affected areas experiencing water logging and Arsenic contamination fall in Belha block (area-304 Sq.km) and Fakarpur block (area-351 Sq.km). The depth to water level in the pre-monsoon period varies from 2.20 to 10.40 mbgl while during the post-monsoon period it ranges between 2.07 and 11.40 mbgl. Broadly three tier aquifer system exists in the area to the depth drilled of 453.82 .mbgl. The yield of moderately deep tube wells varies from 2400 to 3700 lpm at economic drawdowns while the yield of shallow/private tubewells ranges between 300 to 1000 lpm. The area holds promise for further ground water development.

2.9.3 Firozabad district

The area falling under Central Ganga Plain is underlain by thick pile of sediments belonging to Quaternary alluvium. Three tier of aquifer system has been identified in the district. The Ist aquifer group is occurring within the depth of 80.00 mbgl, the IInd aquifer group between 100-140 mbgl and the IIIrd aquifer group between 180-300 mbgl. The cumulative thickness of the most promising aquifer zones occurring down to 220 m depth mbgl over the district ranges in between 60 and 80 meter.The IIIrd aquifer is generally not utilized due to poor quality of the formation water.The discharge of private tubewells/borings being ranges between 10-13 lps and normally a shallow tubewell with 10 H.P. capacity pumping set takes 5 to 6 hours to irrigate one acre of agriculture land. The parts of the area have deep water levels and salinity in deeper aquifers. Urban areas have shown contamination of shallow aquifer due to industrial/domestic effluents. Two blocks falling under Critical and Semi- Critical category of ground water development, Firozabad (area-272 Sq.km) and Tundla (area-250 Sq.km) experience the problems in greater magnitude.

2.9.4 Hardoi district

The area falling under Central Ganga Plain is underlain by thick pile of sediments belonging to Quaternary alluvium.

The results of ground water exploration carried out reveal that three tier aquifer system exists in the area to the depth drilled of 428.00 mbgl. The ground water occurs under unconfined to confined conditions. The yield of moderately deep tubewells varies from 2332 to 4315 mbgl. The depth to water level during pre-monsoon period varies from 0.70 to 12.06 mbgl while during the post-monsoon period it ranges between 0.30 to 11.43 mbgl. The area holds promise for further ground water development. There is need to adopt conjunctive water use strategy to use water resources in the area.

Studies have indicated that the major parts of the area suffer from water logging conditions and salinity resulting from canal irrigation. The most affected areas experiencing water logging in Sharda canal command falling in parts of Kachhona, Bahendra Khurd and Sandila blocks (Area-350 Sq.km) and Todarpur (Area-212 Sq.km), Pihani (Area-219 Sq.km) and Bawan (Area-200 Sq.km) blocks. The studies will also help in identification of locations for construction of tubewells for augmenting water in the tail end areas of the canal system where there is generally shortage of surface irrigation water.

2.9.5 Jaunpur district

The area occupies parts of Central Ganga Plain and is underlain by thick pile of sediments belonging to Quaternary alluvium. Broadly three tier aquifer system exists in the area to the maximum depth of drilling of 752.90 mbgl. The bed rock has not been encountered to this depth. The ground water occurs under confined conditions. The yield of exploratory wells ranges between 2596 to 4845 lpm at moderate drawdowns. The depth to water level in the pre-monsoon period varies from 1.91 to 14.65 mbgl while during the post-monsoon period it ranges between 1.07 and 12.15 mbgl. The investigations have indicated overall quality deterioration in major parts of the area. High Nitrate values greater than the permissible limit have been reported from the Dharampur block due to application of Nitrogenous fertilizers and discharge of domestic effluents in an unscientific manner.

2.9.5 Pratapgarh district

The area falling under Central Ganga Plain is underlain by thick pile of sediments belonging to Quaternary alluvium. Broadly three-tier aquifer system exists in the area to the maximum depth of drilling of 608 mbgl. The bed rock has not been encountered to this depth. The ground water occurs under unconfined to confined conditions. The yield of exploratory well constructed down to 110 mbgl was measured to 947 lpm at draw down of 26.21 m while yield of wells tapping IInd and IIIrd Aquifers varies from 2750 to 3706 lpm at drawdowns ranging between 5.07 and 10.35 m. The yield of exploratory well constructed to 334 mbgl and tapping IIIrd Aquifer was measured to be 2690 lpm at drawdown of 8.41 m. The depth to water level in the pre-monsoon period varies from 2.25 to 15.50 mbgl while during the post-monsoon period it ranges between 1.95 and 13.00 mbgl.

Pre-monsoon studies have indicated that parts of the area suffer from water logging conditions, salinity resulting from canal irrigation as well as high Fluoride concentration. The most affected areas experiencing water logging and quality problem fall in parts of Babaganj (area-321Sq.km) and Sadar (area-192 Sq.km) blocks. Effect of canal seepage and soil characteristics has been studied to know the reason for water logging or prone to water logging. In Sadar block two villages namely Domipur-Bhualpur and Usaraha were identified for fluoride contamination in ground water. Four water samples have shown fluoride concentration beyond permissible limit in handpump/open wells. The physical symptoms of tooth decay among children are common in these two villages.

2.10 UTTARANCHAL REGION (Uttaranchal State)

District Ground Water Development and Management Studies were carried out for the first time, covering 6000 sqkm of Uttarkashi District of the the State.

2.10.1 Uttarkashi District

The district is represented by highly undulating topography, which includes high hills, deep valleys, spurs and steep slopes. The northernmost part is perennially under the snow cover and for the same reason out of 8016 sq. km only 6000 sq.km area could be covered under District Groundwater Management Studies.

The average normal rainfall of the district is 1706 mm. The major part of the district is represented by the rocks of Lesser Himalayas.The main rock types are phyllites, schists, gneisses, quartzites, shales, meta-sedimentaries of calcareous, argillaceous, arenaceous and calc-arenaceous compositions.

The groundwater is developed through hand pumps and the area is yet to be explored for deep tubewells. The pre-monsoon and post-monsoon water levels range from 0.39 to 56.28 m bgl and from 0.11 to 53.58 m bgl, respectively. The depth of the hand pumps ranges between 60 and 90 mbgl, and the discharge varies from 5 to 250 lpm. The pre-monsoon and post-monsoon water level fluctuation varies from –15.4 to 12.63 m. A tubewell at Mahi-ka-Danda having depth of 103 m, disharge is 800 lpm. The area should be explored for the potential aquifers.The pre-monsoon and post-monsoon discharges of 74 springs range from 2 to 216 lpm and 5 to 232 lpm, respectively. The temperature of the springs varies from 12 to 64ºC in pre-monsoon period and 4 to 64ºC in post-monsoon period.In the Central Himalayan terrain of Uttarkashi district, four thermal springs (sulphurous) have been studied with temperatures ranging between 28.5 to 83ºC. The discharge of these springs located at Yamunotri, Janakichatti, Kotimanep(Gangatari) and Gangnani, varies from 30 to 240 lpm.

Based on the electrical resistivity surveys, the following conclusions are drawn

The thickness of unconsolidated/weathered/fractured formation is estimated to be around 31.0 m underlain by granite gneisses/muscovite schists (basement) in Dharali area (Bhatwari block). The thickness of unconsolidated/weathered/fractured formation is about 90.0 m underlain by massive quartzites/phyllites (basement) in Naugaon area (Naugaon block) and Chiniyalisaur area (Chiniyalisaur block). The groundwater in these areas is expected to be fresh and suitable for domestic and irrigational purposes. The areas are also feasible for construction of tubewells with sustainable yield when drilled up to a depth of 100 – 120 m bgl.

2.11 MID EASTERN REGION(Bihar and Jharkhand)

Ground water management studies were undertaken in 6047 Sq. Km. area during 2005-2006 in Kishanganj and part of Purnea districts of Bihar state and Dhanbad and part of Bokaro districts of Jharkhand state.

2.11.1 Kishanganj and parts of Purnea districts, Bihar (Normal):

An area of 3047 Sq.Km covering entire Kishanganj district (1884 sq.km.) and parts of Purnea district (1163 sq.km) was studied .

The study area covers a part of the lower Ganga plain. The soil of the study area is mainly alluvial or sandy loam. The climate of the area is characterized by moist humid. The normal annual rainfall of Kishanganj is 2250 mm and of Purnea is 1411.5 mm.The area falls in the sub-basins of rivers Mahananda and Kosi draining the area besides other streams like Kankari, Ponnar, Meehi and Kaul.

View of Khurmola Gad in Dunda Block of Uttarkashi taken up for detailed study (GWMS, Uttarkashi, district ,Uttaranchal)

Valley identified in Chinyalisaur block of Uttarkashi for Ground Water Exploration (GWMS, Uttarkashi, district,Uttaranchal)

The depth to ground water level ranges from 1.42 to 9.76 mbgl in pre-monsoon period, and it ranges from 1.64 to 7.74 mbgl in post-monsoon period. Sand, gravel and pebble beds form excellent and prolific aquifers. In the study area ground water occurs under unconfined to semi-confined condition. Study of lithologs of water well drilled by state government and other agencies upto 100 m depth indicates that cumulative thickness of the sandy zone varies from 60 to 100 % in the area

By and large ground water is suitable for irrigation and domestic uses. However, at three places concentration of arsenic in water exceeds the permissible limit (>50 ppb). These places are Nakasadar Police Chowk, Motiganj Birina and Uttarpalli Durga Mandir in Kishanganj. Manganese (Mn) and Iron (Fe) are also above permissible limit in some ground water samples.

2.11.2 Dhanbad and Parts of Bokaro District, Jharkhand (Tribal)

An area of 3039 sq.km. was studied in entire Dhanbad district (2089 sq.km.) and parts of Bokaro district (a total of 950 sq.km) The area represents rolling topography with altitude varying from 582 m amsl near Tundi to 140 m amsl near Chirkunda. Two major rivers, Damodar and Barakar drain the area. The study area falls under Damodar river sub-basin. During pre-monsoon season depth to water level varies between 3.20 mbgl and 16.10 mbgl. During post-monsoon season depth to water level varies from 2.1 m bgl and 8.8 mbgl. Ground water flow direction is from northwest to southeast. Weathered and fractured zones are good repository of ground water. The thickness of weathered zones varies from 10 to 15 m. In the weathered zone the ground water occurs under unconfined condition.Ground water is generally potable in nature. Shinghidih, Karmatanr, Bario and Mahubani villages are having nitrates concentration above 100 mg/l. Mahuda, Kalapathar, Salgadih Bhawanipur and Kurra villages and Chandankiyari township of Chas and Chandankiyari blocks are having fluoride concentration higher than the permissible limit (1.5 mg/l).

2.12 EASTERN REGION (West Bengal & Sikkim)

2.12.1 Darjeeling and Jalpaiguri districts

An area of 3005 sq. km. falling mainly in Bhabar zone (Older Alluvium) in parts of Siliguri subdivision of Darjeeling district (about 465 sq. km.) and Alipurduar subdivision of Jalpaiguri district (about 2540 sq.km.) was covered.

Ground water occurs under water table condition down to 50 mbgl and under semi-confined to confined condition down to the explored depth of 211 mbgl. The aquifers consist of poorly sorted boulders, pebbles, gravels and medium to coarse sands admixed with occasional clay. Depth to water level, in general, rests within 4 mbgl during both pre- and post-monsoon and in foothill areas lies at depth more than 20 m. Fluctuation of water level, in general, varies from 0.5 to 2.0 m. Yield of the tube wells is as high as 97 m^3/hr with economic drawdown. Discharge decreases towards northern part of the area underlain by Older Alluvium (Bhabar zone) with high drawdown to the tune of 25 m. Transmissivity of the aquifers also varies from 2.5 to 964.70 m^2/day.

The detailed study was carried out in an area of 500 sq.km. in parts of Madarihat-Birpara-Kalchini blocks.It is observed that water level occurs at very greater depth and drawdown in the tube wells is high (>20 m). in an area about 170 sq.km. in the foothills of Bhutan Himalaya in the northern part of Madarihat-Birpur block of Jalpaiguri district, forming the recharge zone. Because of occurrence of very deep water level and high seasonal fluctuation of water level there is no dug well and shallow tube well for local water supply and hence the area is experiencing acute water scarcity. In few villages, situated very close to Indo-Bhutan border, local water supply is done from perennial springs. Conservation of rainwater, preferably in plain land, may be encouraged, particularly where water level is very deep.Precaution needs to be taken in designing of the tube well, where water level is very deep & having high water level fluctuation. Check dams may be constructed on streams at favorable locations to augment the drinking water sources

2.12.2 Malda district

An area of 3000 sq.km. falling in arsenic infested areas, underlain by Recent Alluvium, & Older Alluvium (known as Barind tract) was covered under the Ground Water Management Studies

Physiographically the area is subdivided into three distinct geomorphic units-Barind, Diara and Tal. Depth to Water Level in dug wells varies from 5.26-24.30 mbgl and in tube wells (within 85 m depth) 3.08-6.75 mbgl during pre-monsoon period and that of during post-monsoon varies from 1.60-7.51 mbgl and 2.14 - 4.46 mbgl respectively. Seasonal fluctuation is minimum (1.17 m) in Recent Alluvium at Paranpur, Ratua-II block and maximum (19.34 m) in Older Alluvium at Hatimari, Gajol block. Long term water level trend in parts of Manikchak, Bamangola and Habibpur blocks shows decline in pre-monsoon water level. In arsenic infested blocks, hard rocks generally encountered within 100 mbgl. The aquifer, in the depth range of 20-95 mbgl. are having sporadic occurrence of high Arsenic (0.007-0.67 mg/l) concentration. In Barind tract, the formation is characterized by huge thickness of clay with subordinate sandy horizons, holding limited potentiality.

Detailed study. was taken up in Arsenic infested area (710 sq.km) of Manikchak & Barind tract of Habibpur blocks. Due to possibility of absence of Arsenic free deeper aquifers, conservation of rainwater through suitable structures is feasible.Use of surface water to a large extent needs to be explored for catering potable drinking water in Arsenic infested areas. At present, river water is being used from Kalindri river at Mathurapur to cover a good portion of population through pipe line supply.In Barind area, storing of rainwater in the clay dominated terrain would provide a good support to water supply for domestic as well as irrigation purpose.

2.12.3 Murshidabad and Kaliachak-I, II & III blocks of Malda districts

An area of 3000 sq.km in arsenic infested areas in parts of Malda & Murshidabad districts & also in the blocks where the stage of groundwater development is under Semi-critical to Critical category in Older Alluvium of Murshidabad district, was studied. This study was done with a view to know the changes in ground water regime and water quality as well as quantity & socio-economic perspective.

Western part of Murshidabad district is underlain by Older alluvium of Pleistocene age and characterized by dominance of clay and calcareous materials. Kaliachak I. II, III of Malda district is underlain by Younger alluvium of Recent age and characterized by various grades and clay, dark grey in colour. *D*epth to water level during pre-monsoon varies from 2.67 to 20.85 mbgl.In part of Murshidabad district ground water occurs both under confined and unconfined condition, whereas in Kaliachak blocks of Malda district ground water occurs under unconfined condition. Long term trend analysis of hydrograph stations in the area shows a falling trend in both pre-monsoon and post-monsoon periods.Two groups of aquifer are encountered - upper one extends upto 100 mbgl and the second group of aquifer occurs within the depth range between 120 - 200 mbgl.Ground water problems in the area are two folds - Arsenic problem and water table depletion problem. Out of totat 86946.45 ha irrigated area, by ground water schemes it self 76385.12 ha area is being irrigated. Transmissivity ranges from 3000-7000 m2lday and Storativity ranges from 0.74x10-4 to 4.98x10-4

Detailed study in about 560 sq.km. was taken up in ground water depleted area of Barwan, Bharatpur-I & II blocks.

In water level depleted area, indiscriminate withdrawal of ground water from particular aquifers may be stopped & development may be done in controlled manner, supported by total ground water management suitable in the area, so that further deterioration and depletion of water level can be restricted. Rainwater harvesting will augment the groundwater resources in the dewatered aquifers. In Arsenic infested areas, tube wells are to be constructed in proper hydrogeological condition by

tapping deeper arsenic free aquifers by adopting cement sealing method. Use of surface water needs to be explored for catering potable drinking water in the area.

2.12.4 Nadia district (except Haringhata & Chakdaha blocks)

An area of 3000 sq.km. falling in arsenic infested areas, underlain by Recent Alluvium, was covered. The area is underlain by thick alluvial sediments of Quaternary age and is composed of clay, silt, sand of various grades, gravel etc. and is characterized by multi aquifer system. Depth to water level during pre-monsoon period ranges from 2.7 to 9.25 mbgl. Ground water in the area occurs under unconfined to semi-confined conditions down to 150-170 mbgl depth & thickness of aquifers gradually increases from western to south-eastern part. Another aquifers, confined in nature, occur within 250-270 mbgl in Kaliganj block. The impact of ground water development for agriculture purpose on ground water regime is observed from the declining trend of ground water level during the last decade to the tune of 0.065 m/yr in pre-monsoon & 0.142 m/yr in post-monsoon. Despite of declining trend, there is no significant dearth of ground water resources in the area of study owing to the occurrence of huge thickness of Recent Alluvium.The yields of deep tube wells vary from 150 to 200 m^3/hr with draw down ranging from 2 to 4m. The value of Transmissivity ranges from 1500 to 8000 m^2/day and that of Storativity from $0.74X10^{-3}$ to $6.2X10^{-3}$.

In Nakashipara, Krishnanagar-II & parts of Nabadwip blocks. In the area, there are 3 aquifer systems- (i) shallow aquifers between 10-30 mbgl under unconfined condition, (ii) intermediate aquifer system between 55-80 mbgl is under unconfined to semi-confined conditions & (iii) deeper aquifer system between 105-165 mbgl under semi-confined to confined conditions. Sporadic occurrences of Arsenic in ground water, in general, is reported in shallow & intermediate aquifers & it has been observed that maximum percentage of tube wells, groundwater of which is contaminated with Arsenic concentration having more than 0.05 mg/l are available in Karimpur-II block & minimum percentage of tube wells suffering from this problem are available in Tehatta-II block. Arsenic free ground water can be obtained from deeper aquifers separated from the upper aquifers by thick clay layers & suitable cement sealing at proper depth should be provided in the tube wells to minimize the chances of vertical percolation of Arseniferous water from the upper aquifers.

2.12.5 Bankura district

An area of 3000 sq.km was covered by hydrogeological survey falling in Patrasayer, Indus, Sonamukhi, Joypur, Kotalpur, Bishnupur, Simlapal, Taldangra, Sarenga and Raipur blocks.Major part of the area is covered by Older Alluvium and the remaining part is by hard rocks. In alluvial part, a large number of irrigation tube wells are in operation. A numbers of auto flow tube wells exist in marginal tract of Bishnupur, Patrasayer, Simlapal areas. The discharge from these auto flow tube wells ranges from 30-102 lpm, and the piezometric head ranges from 0.65 – 0.90 magl. Detailed study was taken up in Bishnupur area. In the area near Bhedua village, a nala, having perennial flow (base flow), has been found and the sources of the water are a few springs located near the nala. The nala water is being used for boro paddy cultivation. More area can be brought under cultivation after construction of suitable structure like check dams along the nala.

2.13 NORTH EASTERN REGION (Assam, Arunachal Pradesh, Meghalaya & Tripura)

Total 18200 Km^2 area was covered in parts of Assam State (9200 Km^2), Arunachal Pradesh (3000 Km^2), Meghalaya (3000 Km^2) and Tripura (3000 Km^2) during 2005-06. The Salient features of the study follows

2.13.1 Jorhat and Golaghat Districts:

The area covered under the present study lies on the southern bank of the Brahmaputra river bounded by river Janji in the east, Naga hills in the South-East, Dhansiri river in the west and Mikir hills in the South –West. An area of 3243 Sq. km has been covered which includes 1540 Sq. kms of Jorhat district and 1694 Sq. kms of Golaghat district.

The climate of the area is humid sub tropical characterized by high rainfall and high humidity. The area shows very fine textured parallel drainage to the east of the Kakdonga river flowing almost through the center of the study area while to the west of the Kakdonga river the drainage texture is relatively coarser. Geomorphologically the study area can be divided into five units such as : Flood plain,Younger alluvial plain,Older alluvial plain,Piedmont plain, &Structural hills.

The water level during the post monsoon period showed the range between 0.46 and 7.22 m bgl while during pre monsoon it showed the level between 0.53 and 10.32 m bgl. The seasonal fluctuation for the area showed the range between 0.07 and 8.5 m.

The area under study is underlain by unconsolidated alluvial sediments of the quaternary age, which can be differentiated into older and Younger alluvium. There exist prolific aquifer system down to depth of 300m.The aquifer system of the study area is broadly divided into three groups as per depth range of 0 - 50 m bgl, 50 – 200 m bgl, 200- 300 m bgl.

In the first and second group, granular zones constitute about 45% and 30% respectively. The granular zones in respect of both shallow and deeper aquifers have tendencies to become finer grained and decrease in thickness towards the southern part of the area. A great deal of facies variations and lateral intercalations are prevalent.

2.13.2 Sibsagar and parts of Jorhat District, Assam:

An area of 3200 sq .km has been covered during 2005-2006 in Sibsagar and parts of Jorhat district of Assam. Geologically Quaternery alluvium and Tertiary group of Sedimentary rocks underline the area. During pre monsoon nearly half of the district has a shallow water level of less than 2 m bgl mostly in the area adjoining to the Brahmaputra river because of early monsoon. In the same period, water level of 2.5 m bgl was recorded in the central part, whereas deeper water level of more than 5 m bgl occur in the area near Naga –Patkai hill ranges in the east. During post monsoon the water level became shallow i.e. near surface to 2 m bgl. It is also observed that the pre monsoon and post monsoon water level fluctuation ranges from 0.2 to 1.5 m and higher fluctuation of 5m was observed only on topographic high areas of Geleki-Rajabari area. Ground water generally flows towards north. The yield of the shallow tube wells ranges from 30 to 50 m^3/hr. The piezometric surface of deep tube wells ranges from 1.6 to 11.6 m bgl and is capable of yielding 120 to 210 m^3/hr having a drawdown of 0.8 to 8.4m. Quality of ground water in general is potable for drinking purpose except iron concentration which is at higher side.

2.13.3 Cachar District:

An area of 3000 Sq. km has been covered during the course of study. The area is mainly occupied by the sedimentary rock formations of Tertiary and Quaternary succession belonging to Surmas, Tipam, Dupitila and alluviam groups. The Surma and Tipam formations occupy the anticlinal hills while Dupitila and Alluvium represents the synclinal valleys and undulating plains. The anticlines are asymmetrical and narrow and intervened by broad and symmetrical synclines. The Barak river and its tributaries control the drainage of the study area. Ground water occurs under semi-confined condition. A total of 52 key wells were established to monitor the behavior of ground water movement. During pre monsoon ground water level in dug wells varies from 0.60 to 4.5m bgl. and in deep tube wells, it varies from 4.2 to 8.6 m bgl. Overall ground water is suitable for irrigation and drinking purposes. Ground water is slightly alkaline with PH ranges from 6.6 to 8.15 and EC is less than 500 micromhos /cm

2.13.4 Changlang District

An area of 3000 sq. km has been covered during the course of study. The study area lies within the North latitude $26^0 40^/$ - 27^0 $40^/$ and east latitudes $95^0 11^/$- 97^0 $10^/$. The geological formation of the study area mainly comprised of semi consolidated formation of Dihing on the hills and Recent deposits like clay, silt, sand, pebbles and gravels in the plains which have low to moderate ground

water potential. Therefore, in the plains constructions of shallow tube well to the depth of 10 to 15 m bgl can fulfill the domestic water requirement. However, a large dug wells having 1-2 m diameter with a depth of 8-10 m bgl is recommended for the purpose of water supply.

2.13.5 North Tripura and parts of Dhalai District

The area under study is covered by unconsolidated sediments of Quaternary age and semi consolidated sediments of Late Tertiary age. Water level in the dug wells varies from 0.38 to 11.25 m bgl during pre monsoon and from 0.94 to 9.46 m bgl during post monsoon period. Piezometric head of the deep tubewells having a depth of 250m bgl varies from 1.03 m agl to 11.94 m bgl during pre monsoon and from 1.03 m agl to 11.92 m bgl during post monsoon periods.

Artesian wells tapping the granular zones from 9 to 98 m bgl are mainly found in Kadamtala, Panisagar, Gournagar, Kumarghat and Dasda blocks of North Tripura district. Piezometric head of these wells are found to vary from 0.31 to 1.15 m agl. Discharge of these wells varies between 0.02 and 1 lps during pre-monsoon period. The artesian wells are mainly used for drinking and domestic purposes. Deep tube wells are found to be in artesian condition in Kadamtala, Pecharthal, Gournagar and Dasda blocks of North Tripura District and Salema block of Dhalai district. The piezometric head varies between 0,05 and1.03 m agl. Discharge of these wells varies between 0.63 and 10 lps during pre monsoon period and 1 to 10 lps during post- monsoon period. Springs/seepage zones are found in Kadamtala, Kumarghat, Gournagar and Dasda blocks of North Tripura district. Springs are mainly used for irrigation. Pumping test of dug wells revels that Specific capacity of the dug wells varies from 1.66 to 20.10 lpm/m/dd.

In general ground water quality in the area is good . However concentration of iron in deeper aquifer is very high, i.e. more than 22ppm. It is also observed that ground water development is very meager in the area. Hence there is ample scope for ground water development. Roof top rainwater harvesting method should be adopted in the hilly areas for domestic purposes.

2.13.6 East and South Garo Hill District;

Out of a total target of 3000 sq. km area, 2003 sq. km in East Garo hills and 400 sq. km in parts of South Garo hills were covered during the course of study. The district is mostly occupied by moderate to low denudational hills. The average annual rainfall is more than 3000 mm per annum. The area consists mostly of consolidated formation like Archaen gneissic complex with patches of semi consolidated Tertiary sandstone, siltstone and shale. Ground water structures are dug wells and springs. Dug wells are mostly confined to the weathered zone adjacent to the valleys and alluvial sediments in the valley. Ground water occurs mostly under water table and semi confined conditions. The water table rest within 2-4 m depth and shallower in the northern part. The discharge of the spring is high along lineaments/fractured zones while low in normally depressed terrain. The area has enough potential for ground water exploitation through shallow tube well down to a depth of about 25-30 m with an expected yield of 10-20 m^3/hr. Dug wells and springs can be developed along selected places and along the line of fractures.

2.14 SOUTH EASTERN REGION (Orissa State)

Total 12674 sq. km. was covered against the target of 12000 sq. km. in Bolangir, Kalahandi & Nawapada district in 2005-06

2.14.1 Nawapada District

Nawapara district covers a geographical area of 3408 sq. km comprising of 5 blocks - Boden, Khariar, Komna, Nuapada and Sinapalli. The study area presents conspicuous geomorphic variation comprising moderately high hills, isolated hillocks, undulating plains, intermontane valleys etc. The district is underlain by the hard rock of two distinct group of Formations - Eastern Ghat Group and the Chattisgarh(Purana) Group.

The pre-monsoon water level varies from 1.02 mbgl (Bhojpurghati, Komna Block) to 11.94 mbgl (Khariar Road, Nawapara Block) The post-monsoon water level varies from 0.3 mbgl (Bhojpurghati, Komna Block) to 6.7 mbgl (Khariar Road, Nawapara Block).Long term data for 20 years (1985-2005) shows that there is no alarming changes in the depth to water level in both pre and post monsoon. A number of springs are present in the study area - the major being the Patalganga spring at the contact of Eastern Ghat Mobile Belt and the Bastar Craton which represents a lineament of the first order. The electrical conductivity of the water samples varies from 148 to 1434 µS/cm. Fluoride concentration ranges from 0.14 to 7.2 mg/L. Other parameters are within the permissible limits for domestic uses.

Studies was carried out in Telejhar and Chakopada watershed of Nawapada Block where contour bunding and check dams have helped to raise the water level upto 2 m. There is decrease in soil erosion, which, helps in reclaiming land for cultivation. As a result of this vegetables, fisheries and duck farming have been started. The looming Fluorosis problem in the district was taken up to demarcate the areas under endemic Fluorosis problem. Earlier reported case of Fluorosis came from the Karlakot Gram Panchayat. The study carried out reveals that endemic Fluorosis affected areas exist in Nawapada. The source of fluoride is geogenic and the source rocks are granite and alkaline rocks with fluoride in ground water in the range of 1.4 to 7.2 mg/L. The fluorosis problem is obsereved in Sinapalli, Boden, Komna, Khariar & Nawapada blocks.

2.14.2 Bolangir District:

The Ground Water Management Studies in Bolangir district covered a geographical area of 3169 sq. km comprising of 7 blocks viz. Saintala, Tentulikhunti, Deogaon, Titlagarh, Bongamunda, Muribahal and Tureikela. The study area can be divided into two broad physiographic units - undulating plains dotted with residual hills and scattered hills and areas with high relief. The study area mainly forms a part of the Eastern Ghat Group of rocks comprising of granites, granite gneissis and khondalites. The pre-monsoon depth to water level varies from 2.19 mbgl (Gandharla) to 9.2 mbgl (Muribahal). The post-monsoon water level varies from 0.46 mbgl (Barabandha) to 5.68 mbgl (Tentulikhunti). The pre and post monsoon water level fluctuation varies from 0.75 m(Karlikhani) to 5.5 m(Chhatabhata). Long term depth to water level data for 20 years(1985-2005) shows that there is no alarming changes in the depth to water level in both pre and post monsoon.

Detailed study in the Titlagarh Block shows that the maximum amount of rainfall is wasted as run-off causing less ground water recharge. The study in the Manigaon watershed reveals that contour bunding, check dam, infiltration tank are the feasible structures to enhance the ground water recharge.

2.14.3 Kalahandi District:

Ground Water Management Studies in Kalahandi District was divided into two separate parts to carry out the study and cover the district as a whole.

North Eastern Part:- It consisted a geographical area of 3105 sq Km. in the blocks. of Bhawanipatna, Kesinga, Narla, Madanpur Rampurand Karlamunda. The area is having the dubious distinction of having frequent occurrence of draught and erratic rainfall pattern. The normal annual rainfall is 1378 mm, Physiographically the area is divided into Eastern Ghat hills, pediplain along with residual hills / Inselbergs and lateritic uplands.The area is underlain by the hard rocks of granite gneiss, khondalites, charnockites and quartzites. Quaternary alluvium occurs in thin pockets restricted to major drainage channels.

The pre-monsoon depth to water level varies from 2.52 to 10.58 mbgl. In major parts of the study area it is more than 5 mbgl (more than 60% of the wells). In the post monsoon the depth to water level is within 5 mbgl. The pre and post monsoon water level fluctuation in most parts of the study area is 2 to 4 metres. Depletion of phreatic aquifer is due to erratic rainfall and less aquifer thickness is the route cause for the non-occurrence of ground water in the study area. Wells at

Ghungrabahali Narla Block) have Fluoride above permissible limit and many wells in Kesinga, Bhawanipatna and Narla blocks have nitrate concentration above permissible limits.

A small watershed(Degari Stream) of a part of the Tel sub basin was studied in detail. Weathered zone is thin in some parts of the area which is responsible for ground water scarcity in summer. Most of the wells are not tapping the entire aquifer thickness and large diameter - deep dug wells should be constructed in valley fills and pediplains to harness the ground water resources. Rain water harvesting and artificial recharge structures should be taken up for augmenting recharge to ground water in these places. Suitable structures like subsurface dykes, cement plugs in specific locations are to be constructed. Few check dams in some of the northward flowing major tributaries may be designed for efficient flood control.

South West Part:- It consisted a geographical area of 3000 sq. km. blocks of Dharamgarh sub-division - Golamunda, Junagarh, Dharamgarh, Kalampur, Koksara, Jaipatna and some parts of Thuamal Rampur(mostly inaccessible). The area is underlained by the Pre-Cambrians and Quaternaries. Alluvium occurs in pockets and lenses by the side of courses of major tributaries whereas laterites occurs as top cappings on the Pre-Cambrians.

Thickness of overburden / weathered residuum ranges upto a maximum thickness of 20 metres bgl (in granitic rocks) and it ranges from 6 - 10 metres bgl in khondalites and charnockites. The depth to water level ranges 0.57-10.89mbgl in pre-monsoon and 0.11-8.01 mbgl in phreatic aquifers of different formations. Long term trend of ground water in 12 observation wells show fall in both pre and post -monsoon and Six wells show rise in both pre and postmonsoon due to impact of the command area of U. I. I. P.(Upper Indravati Irrigation Project).

In the consolidated formations, 3 - 5 numbers of joints / fractures have been encountered upto 200 m in the bore wells. The yield of these wells ranges within 3 - 18.6 lps in granite(and its variants), 1 - 4 lps in khondalites and poor in charnockites. In the present area, blocks of Kalampur, Jaipatna and Koksara have been found to be successful from ground water exploration point of view.Detailed study has been carried out in parts of Golamunda Block for drought proofing since this block has so far not been covered by the U. I. I. P.

2.15 SOUTHERN REGION (Andhra Pradesh)

Total 13415 sq. km. area was covered against the target of 13000 sq. km. in parts of Guntur and Anantpur districts of Andhra Pradesh during 2005-06. Districtwise summary follows:

2.15.1 Guntur District:

Ground water management studies were taken up in the central and coastal parts of the Guntur district, in an area of 5350 sq.kms in 36 mandals. Hydrogeologically most of the area is underlain by the Recent Alluvium in the eastern part and Archaean rocks in central part of the District. Potential aquifers to the depth of 80m. occur in the area. The general depth to ground water level in the area varies between 5 and 12 m bgl and shallow ground water levels are developed due to influence of Nagarjunasagar and Krishna west delta canal command area. Water logging conditions (<2 mbgl) occurs in the Eastern part of the area in Duggirala, Peddakakani, Guntur, Vattichekuru, Kukumanu, Kallipara, Bapatla and Nizampatnam mandals. In addition to this, water logging conditions also occur in parts of Muppala and Pirangipuram mandals in western part of the area. Deeper water level conditions beyond 50 m bgl occurs in isolated patches between Midumukkala, Anantavaram in Tallur and Tadikonda mandals respectively. Seasonal water level fluctuations are not much and the long term trend of fluctuation only shows nominal rising trend in deltaic areas, as there is no over draft conditions.

The quality of the water is the main problem in the area with EC values ranging from 750 to 18900 micro siemens/cm in shallow aquifers and it ranges between 500 and 1800 micro siemens/cm in deeper aquifers. Potable water occurs in western most part and eastern part, where the paleo channels are present. Salinity ingression is also observed in the area towards N-W direction in

comparison to 1994 chemical quality data, which is more prominent along the Krishna river, leaving paleo channels. The reasons for salinity ingress is due to increasing ground water draft for meeting the requirements of both agricultural and domestic purposes and non-supply of canal water for 2-3 years. In Guntur urban area most of the water samples contain high EC values and also E-coli bacteria, due to poor drainage conditions.

2.15.2 Anantapur District:

An area of 8065 sq.km was surveyed covering 25 mandals in southern and north eastern parts of the district. The average rainfall of the area is 580 mm. Major part of the area is underlain by granitic gneisses, Ramagiri schists and Peninsular Gneisses of Archaean Age. The average depth to water level ranges between 10 and 25 m bgl during pre monsoon period and 5 to 15m bgl during post monsoon period, depending on the recharge conditions. Ground water aquifer zones are restricted to lineament zones down to a depth of 40 m with yields ranging from 1 to 4 lps. In general, most of the dug wells are dry and shallow bore wells have come up in recent years for Horticulture. In general, ground water quality is good and suitable for all uses except in Dharamavaram mandal, where high incidence of fluoride is reported. Salinity problems are also reported in the black cotton soil area of Uravakonda and Vajrakarur mandals.

Micro level studies in 300 sq.km area of Garladinne mandal outlined the possibility for increasing the irrigated area by diverting the water of Mid Pennar Dam. Hydrogeological data of 130 inventory wells revealed the ground water scenario of the over-exploited mandal. Micro level studies in an area of 377 sq.km. in Dharmavaram mandal revealed the excess Fluoride problems in five villages. An area of 283 sq.km was covered in over-exploited B.K. Samudram mandal for suggesting artificial recharge structures in suitable areas to enhance the irrigation prospects in mid-Pennar command.

2.16 SOUTH WESTERN REGION (Karnataka)

During 2005-2006, a target area of 12200 Sq.Km in four drought prone districts were for Ground Water Management studies and the same was fully achieved. The area covered are part of Raichur, Mandya, Mysore and Bijapur districts and summary of the study follows;

2.16.1 Bijapur district

An area of 2664 sq.km is covered in the Bijapur taluk of Bijapur district. Bhima, Don and Krishna rivers drain the area. Drainage pattern is dendritic and drainage density varies from 0.8 to 1.81 km/km^2. The area receives a normal rain fall of 550mm. Geologically the area comprises of Deccan traps. Alluvial deposits of sand and gravel are observed along palaeo river courses. Depth of weathering ranges from 5 to 20.0m. Ground water occurs under phreatic to semi-confined conditions in weathered, fractured, jointed and vesicular zones of deccan traps.

The development of ground water is through dug wells, dug cum bore wells and bore wells. Depth to water table during premonsoon varies from 7.2 to 25.5mbgl and during post monsoon water level varies from 2.65 to 20.85mbgl. Water level fluctuation varies from 1.25 to 6.91mbgl. The hydrographs of all the 10 observation wells showed fall in ground water levels, which was in the range of 0.2 to 16.00m.

Yield of dug wells ranges from 20 to 250 m3/day and specific capacity ranges of 5 to 127 lpm/m/mdd. CGWB drilled 8 EW and one OW in the study area with depth range from 30 to 90 mbgl and static water level from 3.01 to 28.83mbgl.Potential fractures were encountered between 40 to 65 mbgl and discharge of the wells ranged from 1.0 to 7.6 lps for draw down of 0.82 to 14.33 m. Transmissivity ranges from 3.3 to 150 m2/day. For rural water supply PHE, Bijapur has about 1718 bore wells on working condition for a population of about 3 lakhs in 118 villages. Depth of these bore wells ranges from 60 to 120 mbgl and 80% of the wells yield 2 lps. Quality of ground water in general is moderate to good however, at places brackish in nature with EC exceeding 3000 micro mhos/cm at 25°C.

Micro level surveys were carried out in villages namely, P.N.Tanda, Jelgere, Dhakkalvasti, Takkalki, Hubnur, Tikota, Aliyabad, Hanchinal,, Nagthana, Gunaki, Bommanahalli, Sirwal, Arkeri, where the stage of ground water development is semi critical to critical due to over exploitation of ground water in deficit rainfall area, need ground water management and recharge activities.

2.16.2 Raichur district

Ground Water Mnagement Studies were carried out over an area of 3492 sq.km in Deodurg and Lingsugur taluks of Raichur district. The normal annual rainfall for Deodurg and Lingsugur is 756 mm and 608 mm respectively. Majority of the area forms a part of Krishna basin. The drainage pattern is dendritic with dissected outcrops predominately exposed in the area.

Granites and Gneisses are predominately exposed in the area and show moderate weathering. Dolerite dyke at places are predominately exposed and intrude these rocks. Falling trend vis a vis last surveys in the ground water levels have been noticed, However it is rising in the command area. Depth to water levels less than 2.0 m have been observed in the command area. The depth to water level ranges from 0.60 m bgl to 15.0 m bgl during pre-monsoon period, while the post-monsoon values range from 0.05 m bgl to 10.0 m bgl. There is a general rise of water level during post-monsoon period.

In general ground water in the study area is potable, except at places with high inland salinity. Deodurg taluk has been classified as safe while parts of Lingsugur taluk is classified as semi critical and critical. The villages under the critical category indicate overexploitation of ground water resources by ground water structures. Information from the locals indicates isolated pockets of ground water having higher Fluoride content in the area. Natural spring exists at Aidbhavi village of Lingsugur taluk. Micro level study was carried in the overexploited and critical areas of Lingsugur taluk.

2.16.3 Mandya district

Studies were carried out in Sriranga patna, Pandavapura, K.R.Pet and Nagamangala taluks of Mandya district covering a geographical area of 2,827 sqkm (Nagamangala- 1,035 sq km, K.R.Pet – 897 sq km, Pandavapura – 522 sqkm, and Srirangapatna – 373.7 sq km). The average annual rainfall in the study area varies from 1025 to 1079mm. The study area falls in Cauvery river basin. Shimsha, Lokapavani and Cauvery Rivers show dendritic to sub – dendritic drainage pattern, drain the area. These rivers originate in Western Ghats and flow towards east or northeast direction. Topography of the Srirangapatna and Pandavapuru taluks is predominantly plains with few hillocks, where as the topography of K.R.Pet and Nagamangala taluks is highly undulating. The main soil types found in this area are red soil, black soils and mixed soils, underlain by crystalline metamorphic rocks of Archean age. Small patches of alluvium are also found in Srirangapatna Taluk along the banks of Cauvery River. The pre-monsoon depth to water levels ranges from 22.11m (Kundur) to 1.4 (Naguvanahalli). The post monsoon water levels range from 18.5 m (Kundur) to 1.23m (Naguvanahalli). The annual water level fluctuation ranges from –0.51 (Arekeri) to 10.85 m (Madapura Koppalu). An area of 522 sq. km. falling in the taluk Pandavapura in the Cauvery command area has main problem related to Quality of drinking water.

2.16.4 Mysore District

An area of 3216 sq.km was covered under Ground Water Development & Management Studies in the above taluks of Mysore district, Karnataka. The study area falls in Cauvery river basin. Geologically, Crystalline metamorphic rocks of Archean age. Sandy alluvium as a valley fill occurring along the river kabini and other major tributaries.Soils are red soil, black soil and fixed type of soils in the area. Depth to water varies from 2.03m to 44. 64 m in dug wells and 14.60 to 43.38 m in bore wells during premonsoon. Similarly water level variation is from 0.48 to 9.86 m in dug wells and 8.00 to 21.30 m in bore wells during post monsoon period. Yield of the dug wells ranges from 20 to 300 m^3/day. The current annual water level fluctuation ranged from 0.65 to 9.60

m in dug wells, 100 m to 14.35 m in bore wells. Falling trend in Post monsoon water levels are being observed in two wells. Ground water development in the area is through bore wells, which are considered to be high when compared to dug wells for both irrigation and drinking water. Most of the dug wells are found to be dry/abandoned. Ground water chemistry in the study area is found to be alkaline and in general suitable for all purposes.

An area of 635 sq. km covering parts of H.D. Kote, Nayangud, and T.Narsaripur taluks(overexploited) were studied in detail. The study envisaged that area in Nayalkund followed by T.Narasipur adjoining to either Kabini river or falling under canal command to be considered as safe instead of over exploited. Detailed studies have been taken up around Magnasite mines located near Karya village of Nayalgund taluk and inventoried 13 OWs with all relevant hydrogeological data. Collected 13 ground water samples around mining area and adjoining areas.

2.17 SOUTH EASTERN COASTAL REGION (Tamil Nadu)

2.17.1 Villupuram district

Ground Water Mnagement Studies were carried out in 6530 Sqkm are of Villupuram district.About 72% of the study area is covered by crystalline formation and the rest by sedimentary formations. Depth of the dugwell ranges from 5.46-21.3 mbgl. Depth of the bore wells in Hard Rocks:40 – 210 mbgl, in Sedimentary Rocks:60- 150mbgl. Depth to Water level (mbgl) in Pre Monsoon (June. 2005) and Post Monsoon(Jan. 2006) are in the range of 2.7-18.6 & 0.2-15.4 repectively

A comparison of the studies with those of earlier studies reveal that there is a very sharp decline in the depth to water levels in over exploited blocks namely Ulundurpet, Thirunavalur, Thiruvennainallur. Sankarapuram, Rishivandiyam, Olakkur, Marakkanam, Mailam, Vallam, Melmalayanur, Gingee and Mugaiyur. There is an urgent water conservation and artificial recharge measures.

A study was carried out on the possibility of recharging Vanur formations from distant surface water body. Vidur dam is 20 km away from the area and its canal running 17 km exists 2 km away from Vanur. The canal enters into crystalline-sedimentary contact zone near Suttikanni village. The flow data of the dam from 1960 was analyzed and it was found that at least 10,000 cusecs water flows off as excess runoff during monsoon period in normal year. This excess water can be utilized for artificial recharge. Possible locations for the artificial recharge shafts were identified near Pudukuppam & Lingareddipalayam (Pondicherry State). The ground water is potable, in general. The electrical conductivity of formation water in the key wells ranged from 450 to 2600 µs/cm at 25^{o}C. However the quality deterioration is noticed in the area near to a cooperative sugar mill

2.17.2 Tuticorin district

Ground Water Mnagement Studies were carried out in 3460 Sqkm are of Tuticorin district. Vaippar and Tamiraparani Rivers and their distributaries drain the study area. About 1010 sq. km area is underlain by alluvial deposits whereas about 2150 sq. km is underlain by crystalline rocks.Depth of the dugwell ranges from 3.65-20.75 mbgl. Depth to Water level (mbgl) in Pre Monsoon (June. 2005) and Post Monsoon(Jan. 2006) are in the range of 1.5-16.60 & 0.2-15.35 repectively.The fluctuation of water level varies from 0.0 (Servakaramadam) to 9.75 mbgl (Ayyan Karisalkulam) and -0.20 (Pattanammarudur) to 2.85 mbgl (Panchalamkurichi). Studies were earlier carried out in the area during 1993-94 and Comparison with reveals that there is a declining trend in water level.

The E.C.values (µS/cm at 25°C) ranges from 180 (Solamalaiyanpatti) to 32500 (Sippikulam) during pre monsoon and from 162 (Maniyatchi) to 38300 (Sippikulam) in Post monsoon. Choloride (mg/l) varies from 4 (Solamalaiyanpatti) to 13333 (Sippikulam) during pre monsoon and 7 (Kailasapuram) to 11950 (Sippikulam) during post monsoon. Kovilpatti, Villathikulam, Kayathar, Ottapidaram and Pudukottai blocks are over exploited. Pudur block is in critical category.

2.18 KERALA REGION(Kerala State)

2.18.1 Kottayam & Parts of Eranakulam district

The study area occupies 3072 sq.km covering Kottayam district and the three blocks of Ernakulam district (viz. Koovabady, Kothamangalam and Muvattupuzha blocks).

The average annual rainfall of the study area is more than 3000 mm in a year. The potential evaporation in the area is 1424 mm. Meenachal river drains most of the area and tributaries of Muvthupuzha and Pamba river drain southern and northern parts of the district respectively. The drainage patterns of the area are dendritic and sub dendritic.

The groundwater occurs under water table condition in the alluvium and weathered crystalline formations and occurs under confined to semi-confined condition in the deeper fractured aquifers. The depth to water level varies during pre-monsoon from 1.47 to 11.10 mbgl during pre monsoon and the post monsoon depth to water level ranges between 0.30 and 6.20 mbgl. The depth to water level is deep where ever the laterite thickness is more. Groundwater exploration indicates that the potential fracture zone encountered up to a depth of 112 mbgl. The yields of dug wells range from 2 to 3 m^3/day and the bore wells up to 72 m^3/hr. The major ground water abstraction structures of the area are open wells and bore wells. Water quality is generally good and suitable for drinking, domestic irrigation and industrial purposes. There are 10 springs in Kottayam district and 2 springs in parts of Ernakulam district and the spring water is suitable for drinking and domestic purposes.

The total annual groundwater recharge is 521.06 MCM and availability of groundwater is 470.86 MCM. The gross groundwater draft for irrigation is 66.30 MCM. The stage of groundwater development is 28.37 and all blocks are falls in safe category.

One watershed falling Kothamangalam and Muvattupuzha blocks of Ernakulam District have been selected for detailed study in 451 sq.km.

Main Findings are as follows;

Koovapady block, which is categorised as semi critical block as per GEC 2004. The stage of development and the premonsoon water level of available NHS data in and around Koovapady block indicate that it may not fall under semi critical block.The Primary Health Centre has reported dental fluorosis that in and around Vengoor and Mekkapala area of Koovapady block. Different sources of water samples have been collected and analysed. The samples are showing higher Fluoride value compared to adjacent areas. (Mekkapala B/W 0.67 mg/l, Kariyeli D/W 0.21 mg/l, Panamkuli D/W 0.27 mg/l, Panamkuli H/P 0.25 mg/l, Panmkuli River 0.41 mg/l, Pudumanna D/W and Vengoor 0.40 mg/l. The trace metal concentration is with in the permissible limit for different sources of water.

2.18.2 Alleppey district and parts of Ernakulam district

The study area occupies 2957 sq.km in Alleppey district and parts of Ernakulam district (excluding Koovabady, Kothamangalam and Muvattupuzha blocks). The average annual rainfall of Ernakulam district is 3348 mm and that of Alleppey district is 2884mm. The amount of potential evaporation in the area is 1424 mm. The area experiences a tropical monsoon climate. Five major rivers i.e., Achenkovil, Pamba, Manimala, Muvattupuzha, and Periyar, which unload their sediment load to the Vembanad Lake, drain the entire study area. The drainage pattern of the area is dendritic to sub dendritic. Major part of the study area is underlain by the crystalline rocks of Archaean age in the east while western fringes are occupied by sedimentary formation of Vaikom groups. The patches of riverine alluvium are also seen along the river courses.

The groundwater occurs under water table condition in the alluvium and weathered crystalline formation and under semi confined to semi-confined condition in the deeper fractured aquifer. The weathered zone generally ranges from 2-10 m in thickness while the fracture zone is located at depth more than 30 –40 m bgl (There is a general rise in water level during April-August and a decline from August/September onwards. The decline during the November- April period ranges from 0.30 m to 3.5 m in alluvial and weathered crystalline aquifers. The fluctuation in the wells tapping laterites ranges from 1.7 to 10.10m. The depth to water level is at deeper level where ever the laterite thickness is more. The elevation of the piezometric surface of deep-confined aquifers varies from 0.6 to 14.33 m amsl. Groundwater in the floodplain is shallow, generally less than 2 m bgl. In the low terrace areas groundwater occur mainly in gravel sand beds and the level is around 5 m bgl. During rainy season, the water level reaches the surface and fluctuates between ground level and 2.5 m bgl.

Water level in rubber plantations reflects the effect of water use by rubber trees. These are characterized by sharp rise and fall and fluctuate from 0.10 m to more than 6.0 m. water level fluctuation is controlled by water use of the rubber tree and is more pronounced in mature trees (fluctuation ranging between 3.5 to 6.0m) as compared to younger trees (fluctuation generally less than 3.5m).

The aquifers in the foot slope area consist of poorly sorted valley filled deposits with coarse sand and gravel. This area is characterized by very high and quick response to rainfall primarily due to the high conductivity of the coarse sand. The water level ranges from 1 to 4 m bgl in rainy season with a recession of 2.3 m in dry season. The rapid rise of the water levels in response to rainfall events over most of the soils in different areas indicate high rate of recharge. The major ground water abstraction structures of the area are open dug wells and bore wells. Water quality is generally good and suitable for drinking, domestic irrigation and industrial purposes. Pampakuda and Mullunthuruthy blocks of Ernakulam District were also studied under detailed study in 465 sq.km area.

Findings in brief are as follows

The demand for groundwater is steadily increasing specially for urban and rural water supplies, irrigated agriculture, industrial needs, aquaculture, small and medium enterprises and urban housing schemes. The rapid expansion of these schemes is extracting much more pressure on the available groundwater resource.The rapid rise in tourism, in Alleppey district, during the last two decades depend primarily on the groundwater present in the coastal sandy aquifers. Quality deterioration in the groundwater from dug wells has been reported from many places in Alleppey town due to the proximity to septic waste disposal.The rapid expansion of industrial estates urban housing schemes and bottle water projects and the high degree of settlements in the suburban areas like Mullunthuruthy, Ramamangalam, Piravam, Kuthattukulam, Thrippunithura etc is causing tremendous pressure on the laterite aquifers of the area. This laterite aquifers face the most severe dewatering in the area. The water table in several urban wells tapping laterites have receded to depth beyond 15 m bgl during prolonged dry period of more than 65 day. Hydrochemical studies revealed the serious pollution in the creek and well waters of the island of Eloor, which houses the biggest industrial estate in the state know n as the Udhyogamandal, with toxic and persistent heavy metals like Fe, Cu, Zn, Cd and Mn. Contaminants are for the first time recorded to be passing the whole breadth of the island to enter the Periyar river at its southern shore.

Contact Spring at Rayamangalam, Ernakulam District, Kerala

Gabbro Dyke at Rayamangalam, Ernakulam District, Kerala

3. GROUND WATER EXPLORATION

Ground water exploration aided by drilling is one of the major activities of the Board with an objective to discover aquifers in different hydrogeological conditions and determination of hydraulic parameters. The exploratory drilling operations have enabled demarcation of aquifers both in lateral and vertical extensions and evaluation of various aquifer parameters, designing of suitable structures and assessment their yield capabilities in various hydrogeological set ups. These studies helped in identifying areas worthy for further ground water development. Ground Water Exploration contributes to a large extent in guiding the States to adopt ground water development and its utilization.

During the year the Board carried out the exploration work with a fleet of 85 rigs (Rotary-35, DTH-37, Percussion-13) and a total of 785 (476 EW, 169 OW, 137 PZ, 1 SH and 2 DW) boreholes were constructed departmentally as against the target of 812 (467 Exploratory Wells, 213 Observation Wells, 132 Peizometers) boreholes. It is heartening to report that out of 785 wells, 521, 246, 18 boreholes were constrcted in hardrock, alluvium and bouldary formation respectively. 158 and 254 wells were constructed for exploration in tribal and drought prone areas respectively. The Board has so far drilled a total of 23847 bore holes to identify areas worthy for ground water development in the country till March, 2006.

Region wise & Division wise status of bore holes drilled during 2005-2006 is shown as graph in fig. 3.1, 3.2 & 3.3 . The statement showing State-wise distribution of boreholes drilled / completed during 2005-2006 in the country is presented in Table 3.1.

Table 3.1 : STATE-WISE WELLS CONSTRUCTED BY CENTRAL GROUND WATER BOARD DURING THE YEAR 2005-2006

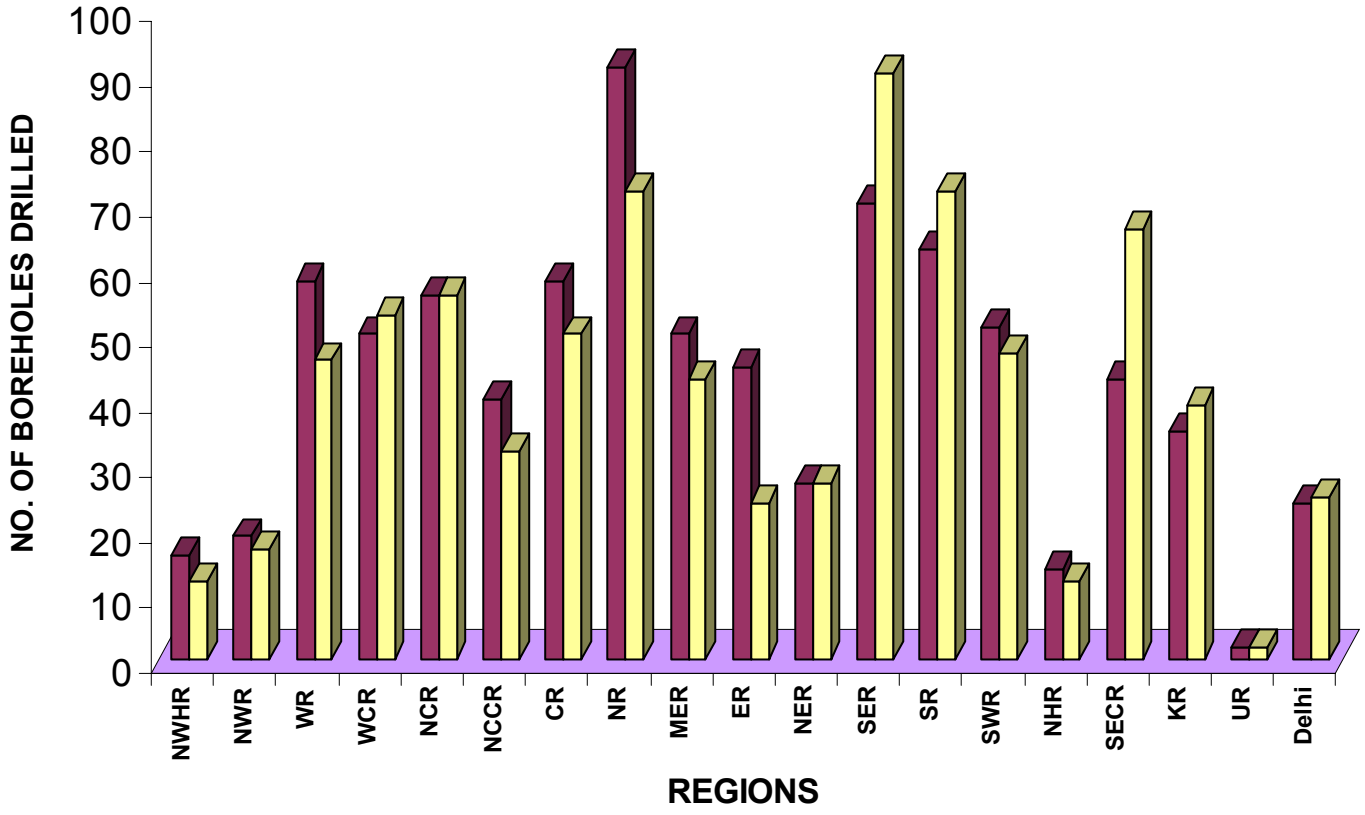
Sl No.	State	EW	OW	PZ	SH	DW	Total
1.	Andhra Pradesh	42	13	17			72
2.	Arunachal Prades	1					1
3.	Assam	8	5				13
4.	Bihar	12	10	6			28
5.	Chhattishgarh	26	1	5			32
6.	Goa						
7.	Gujarat	20	10	23			53
8.	Haryana			11			11
9.	Himachal Pradesh	7					7
10.	Jammu & Kashmir	16	1				17
11.	Jharkhand	7	8				15
12.	Karnataka	35	12				47
13.	Kerala	13	4	22			39
14.	Madhya Pradesh	32	24				56
15.	Maharashtra	36	6	8			50
16.	Manipur						
17	Meghalaya	9	1				10
18	Mizoram						
19.	Nagaland						
20.	Orissa	75	15				90
21.	Punjab	3					3
22.	Rajasthan	27	4	15			46
23.	Sikkim						
24.	Tamilnadu	44	15	7			66

Sl No.	State	EW	OW	PZ	SH	DW	Total
25.	Tripura	2	1				3
26.	Uttaranchal	2					2
27.	Uttar Pradesh	34	25	13		2	74
28.	West Bengal	15	9				24
TOTAL		466	164	127	0	2	759
UNION TERRITORIES							
1	Andaman & Nicobar						
2.	Chandigarh			2			2
3.	Dadra & Nagar Haveli						
4.	Delhi	10	5	8	1		24
5.	Daman & Diu						
6.	Pondicherry						
TOTAL		**10**	**5**	**10**	**1**	**0**	**26**
GRAND TOTAL		**476**	**169**	**137**	**1**	**2**	**785**

EW - **Exploratory Well**
OW - **Observation Well**
PZ - **Piezometers**
SH - **Slim Holes**
DW - **Deposit Well**

Fig.3.1

REGION WISE STATUS OF GROUND WATER EXPLORATION (DURING 2005-2006)



3.1 NORTH WESTERN HIMALAYAN REGION (Jammu & Kashmir)

Groundwater exploration were undertaken during the AAP 2005-06 in Jammu & Kashmir and total 17 bore wells were constructed

The Summarised details of exploratory wells drilled during the Annual Action Plan 2005-2006 are given in Table 3.2 .

Table 3.2 : SUMMARISED DETAILS OF EXPLORATION IN JAMMU & KASHMIR

Sl. No.	District	Depth drilled (m bgl)	Depth of Casing (m bgl)	Zones encountered (m bgl)
1.	Jammu	45-85	40-85	6-82
2.	Kathua	37-78	37-77	3-73
3.	Leh- Ladakh	10-86	Upto 85	32-81
4.	Rajouri	37.50	23.50	5-18.5
5.	Doda	80.00	80.00	-

3.1.1 Leh district

Ground water Exploration work in Leh area was started by CGWB in the year 1973-74. A first tubewell was drilled in the I.T.B.P. Campus in Leh town. Keeping in view the Defence priority, the Groundwater Exploration work in Leh and Nubra Valley (Siachin Base) taken up by Central Ground Water Board during 2005-2006 under Ground Water Exploration Programme. Two DTH Rigs have been shifted to Leh area. Earlier Ground water exploration by CGWB was confined in the vicinity (100 to 120 Kms) of Leh town only but during the year 2005-06, 7 number of Exploratory Wells constructed in the Nubra Valley (Siachin Area) for the first time in the depth range of 43-86 mbgl. Three well were located in the difficult terrain of the Siachen Glacier where discharge of 1584-1728 lpm was recorded

The aquifer performance tests were conducted in 4 exploratory wells of Kathua &Leh district. The details of the analysis are given in Table 3.3

Table-3.3 : Details of Aquifer performance test in J&k

S.No.	Location	Discharge of APT (lpm)	Duration of APT (minutes)	SWL (mbgl)	Draw Down (m)	T (m^2/day) Jacob's
I KATHUA DISTRICT						
1.	**Dhoku Chak**	**408.78**	**420**	**47.93**	**3.35**	**179.73**
2.	**Ghatti**	**378.51**	**300**	**2.15(bmp)**	**21.10**	**23.79**
II LEH DISTRICT						
1.	**Siachin Base III**	**1584**	**500**	**10.63(bmp)**	**0.77**	**28465.64**
2.	**Siachin Base II**	**1728**	**550**	**6.23(bmp)**	**2.07**	**3862.73**

3.2 NORTH WESTERN REGION (Haryana, Punjab & Chandigarh)

Ground Water Exploratory drilling was undertaken at 3 locations in Hoshiarpur district of Punjab.The details are given in the table 3.4

Table-3.4 : Hydrogeological Details Of Exploratory Wells In Hoshiarpur district,Punjab

Location/ District	Depth drilled(m bgl)	Granular Zones deciphered (m bgl)	Static water level (m bgl)	Discharge (lpm)	Draw down	Aquifer Parameter (T in m2/d)
Bringly	108	34-43,45-52,57-68,75-82	-	994	62.06	1613
Hazipur	107.5	73-76,78-83	-	-	-	-
Shahpur	261	99-105,126-132,141-148	35.69	950	3.28	865 -

Piezometers were constructed at 11 location in Bhiwani district of Haryana in the depth range of 117-157 m. In Chandigarh , 2 piezometers were constructed in the depth range of 20-180mbgl

3.3 WESTERN REGION (Rajasthan)

Groundwater exploratory drilling operations were undertaken during the AAP 2005-06 in order to delineate various water bearing formations, their geometry, potentiality, quality aspects, bridging the gap of information as well as to render assistance to the State Government for mitigating the drought situations.

A total of 27 exploratory wells, 04 observation wells and 15 piezometers have been constructed during Annual Action Plan 2005-06, in 7 districts of Rajasthan. The district wise findings of the exploration are as follows in Table-3.5

Table-3.5: District wise details of groundwater exploration (in range)

Sl. No.	District	Depth Drilled	Zones Tapped	SWL (mbgl)	Discharge (m^3/hr)	Drawdown
1	Alwar	129-148	Naked hole	18-33	85-760	2.6-3.5
2	Dausa	110-125	Naked hole	6-43	5-10	-
3	Hanumangarh	87-200	28-175	10-26	100-1200	2.0-5.6
4	Jalore	191	Naked hole	17	50	-
5	Jhunjhunu	97-120	67-112	47-63	180-400	3.4-9.4
6	Rajsamand	n.a.	Naked hole	n.a.	n.a.	-
7	Sikar	69-122	63-106	11-54	250-650	-

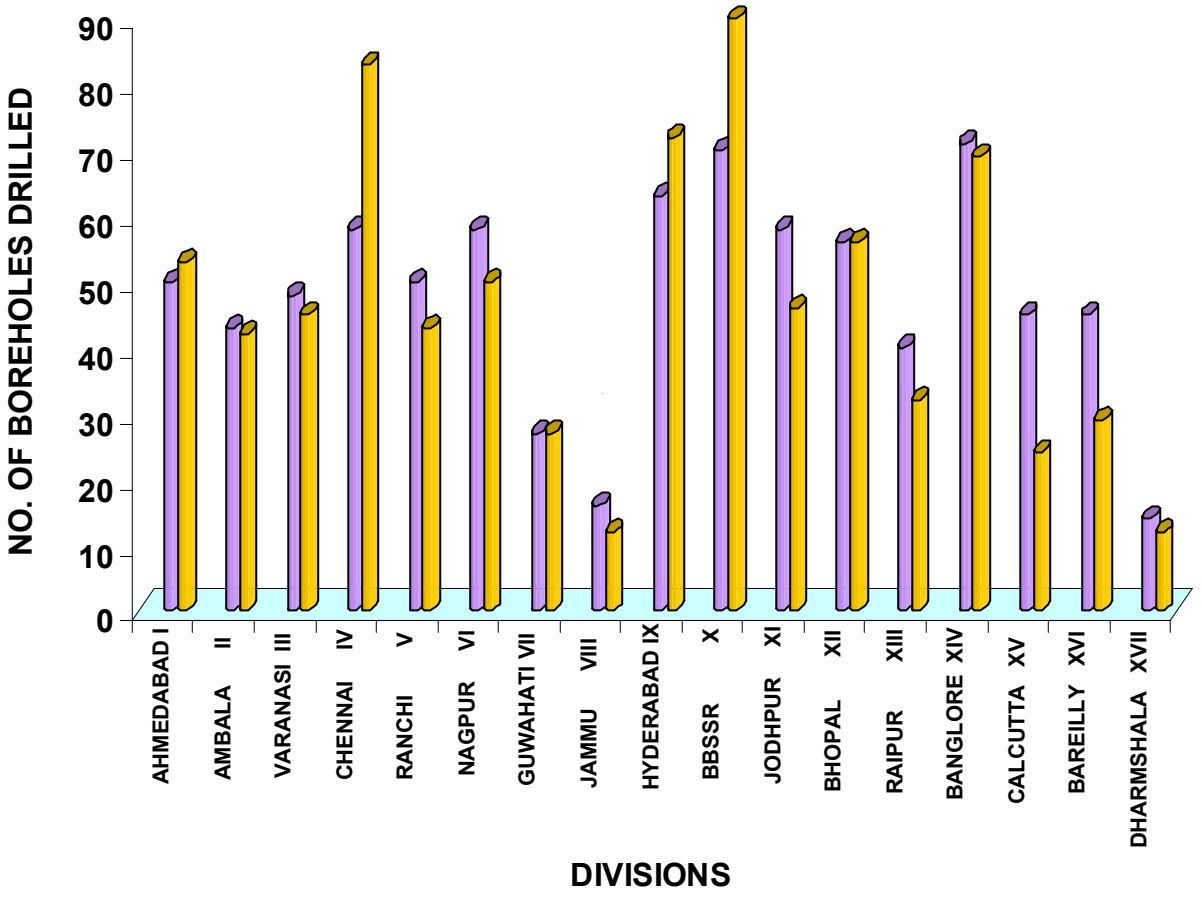
3.3.1 Alwar district:- A total of 3 exploratory wells, and 1 piezometer were constructed in Alwar district in consolidated quartzite formation. Chemical quality of groundwater is generally fresh having electrical conductivity from 455 to 545 micro.mhos/cm at 25^0c. Fluoride content is within the permissible limit.

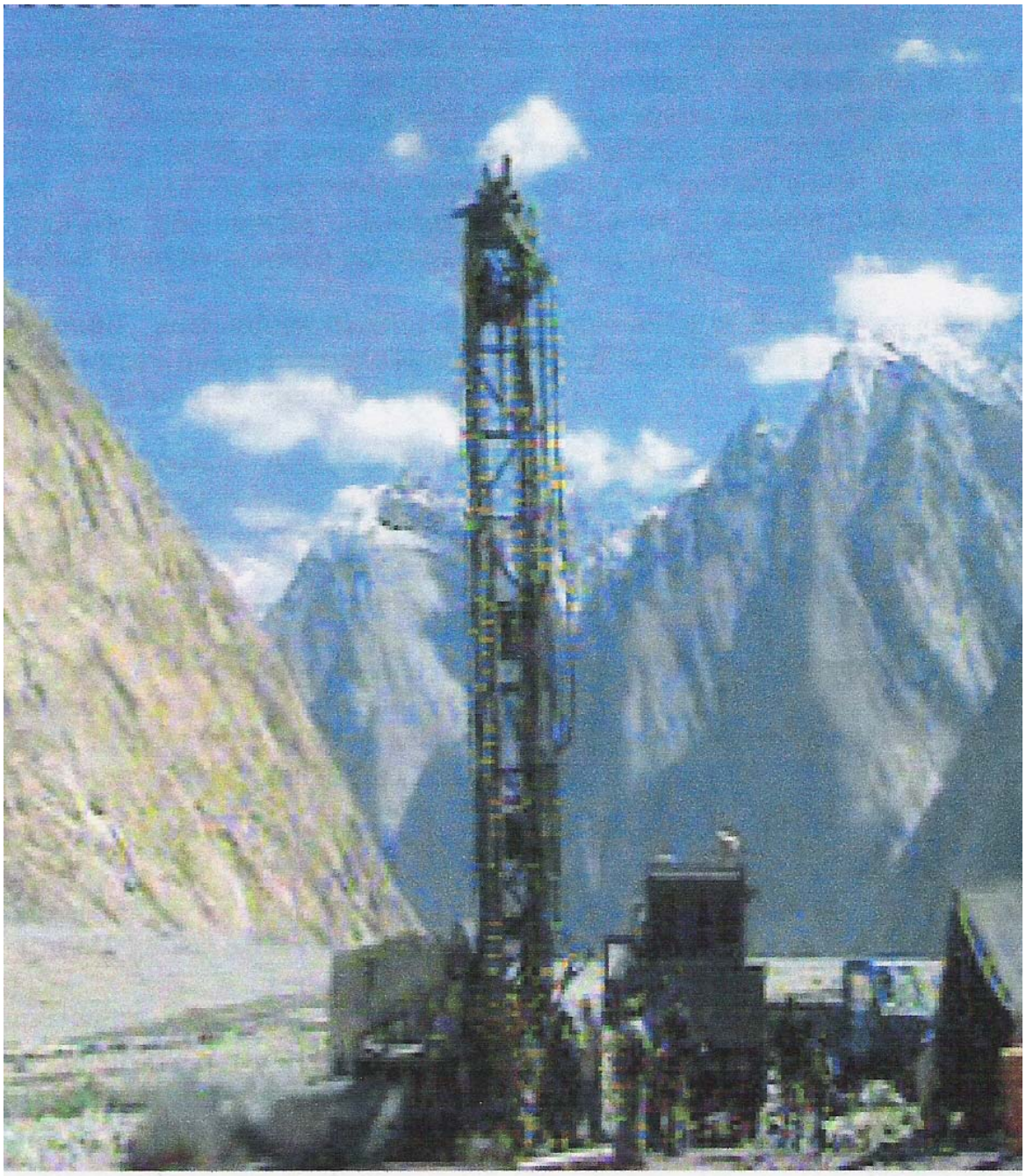
3.3.2 Dausa district:-A total of 2 piezometers were constructed in consolidated limestone and schist formations. Chemical quality of groundwater is generally fresh having electrical conductivity from 1610 to 2650 micro. Mhos/cm at 25^0c. Fluoride content is beyond the permissible limit(2.15ppm) at Khuri Khurd.

3.3.3 Hanumangarh district:- A total of 6 exploratory wells, 1 observation well and 2 piezometers were constructed in Hanumangarh district in unconsolidated alluvial formation. Chemical

Fig 3.2

DIVISION WISE GROUND WATER EXPLORATION (DURING 2005-2006)





CGWB Drilling Rig at Siachin Base Camp, J&K

quality of groundwater is fresh to saline, having electrical conductivity variation from 590 to 14170 micro. Mhos/cm at 25^0c. Fluoride content in general is within the permissible limit and is slightly higher 1.85 mg/ lit at 2 PBN

3.3.4 Jaisalmer District:-Two exploratory wells and one Piezometer have been constructed at Diggari, Sobh and Akal locations in Lathi formation and Jaisalmer formation. Jaisalmer formation comprises limestone, sandstone and shales and having poor quality of ground water. Along the fringe area of Jaisalmer formation, Lathi formation encountered below the depth of 100-125m and having potable quality of ground water. Exploration of the area reveals new geometrical orientation of occurrence of potable quality Lathi aquifer below Jaisalmer formation, which is brakish to saline in quality.

3.3.5 Rajsamand and Jalore district:-During exploration in hard rock formation, most of the tubewells have been successfully drilled in phyllite & slate formations in the range of 62-203 m. Quality of groundwater is potable.

3.3.6 Jhunjhunu district:- A total of 3 exploratory wells, one observation well and 4 piezometers were constructed in unconsolidated alluvial formation. Chemical quality of groundwater is generally fresh having electrical conductivity 1005 to 1850 micro. Mhos/cm at 25^0c. Fluoride content in general is with in the permissible limit and is slightly higher 1.59 mg/ lit at Dundlod exploratory and observation well.

3.3.7 Sikar district:- 4 exploratory wells, 2 observation well and 4 piezometers were constructed in unconsolidated alluvial formation. Chemical quality of groundwater is fresh to brackish having electrical conductivity variation from 1060 to 2940 micro. Mhos/cm at 25^0c. Fluoride content in the area varies from 0.75 to 3.49 mg/l.

3.4 WEST CENTRAL REGION (Ahmedabad)

Ground water Exploration is carried out by deploying 6 Rigs (2-DTH, 4-DR) and 53 (20-EW, 10-OW, 23-Pz) wells have been constructed during aap 2005-06.

Ground water exploration was carried out in the districts of Vadodara, Amreli, Rajkot, Surendranagar and Ahmedabad and their details are given in Table-3.6.

Table3.6: District wise Details of Ground Water Exploration

Sl. No	District	Depth drilled (m bgl)	Zones tapped/ Fractures encountered (m)	SWL (m bgl)	Discharge (lpm)	Draw down (m)	Formation
Details of Exploartory Wells driiled in Gujarat							
1	Ahmedabad	410	352-406	30.9	132	1.6	Alluvium
2	Amreli	44-300.8	8.0-239.0	2.44-101.5	132-1680	1.6-105.1	Basalt
3	Surendranagar	154.7-200.0	65.0-121.0	16.4-102.3	48-96	2.21-5.9	Sandstone
4	Rajkot	115.0-200.7	29.0-184.0	3.32-10.1	264-720	3.5-5.2	Basalt
5	Vadodara	75.0-432.0	29.0-208.7	2.6-22.1	9.6-720	1.1-91.8	Basalt/Granite-gneiss/Phyllite/ Schist/Meta sediments

District Wise Salient Features of Ground Water Exploration are as under:-

3.4.1 Ahmedabad District:- The area explored down to the depth of 450 mbgl tapping the F/G aquifers of Gujarat Alluvium The objective was to explore the resource potential and quality of the water in the deeper unexplored Tertiary aquifers.Qualitatively the aquifer is potable with EC values ranging from 1200 to 1940 μS/cm. Quantitatively the aquifer yields varied from 70 LPM to 180 LPM by compressor. The Transmissivity estimated from APT varies from 46 (EW II) to 109 (EWI) m^2/day. An artificial recharge test was also conducted at Bhawda (Ahmedabad district) by pumping water from one well and injecting into the other for estimating the intake capacity of deeper aquifers.

3.4.2 Amreli District:- The study was aimed to correlate the distribution of saline zones at depth and the lateral and vertical distribution of fluoride around Amreli which is affected by fluoride. Three Exploratory wells and Four Observation wells were constructed .The compressor discharge was 390 LPM at Luvariya OW II and 1680 LPM at Ishwaria EW. The quality was very good (TDS 700 ppm) at Luvariya OW II to Brackish (TDS- 3100 ppm) at Gavadka EW.At Luvariya site one EW and three OWs were constructed to understand the vertical variation of Fluoride concentration with depth. It was observed that Fluoride concentration declines with depth. Here the Fluoride concentration declined from 4.4 ppm (OWII with 44.00m Depth) to 1.47 ppm (EW with 300.80m depth). However overall quality of ground water deteriorates with depth.

3.4.3 Surendranagar and Rajkot Districts:- The ground water occurs in Unconsolidated and Semi-consolidated formations. Ground water quality is variable in Alluvium and Tertiary formations. In Alluvium the fresh water floats over the saline water. Ground water quality is relatively fresh in Dhrangadhra formations. The ground water is developed through dugwells/ dug-cum-bore wells and shallow bore wells. As the area is drought prone and the ground water is brackish to saline in the upper formations there is need of exploring the fresh water resources in the deeper unexplored zones. The objective emphasizes on the delineation of the lateral extension of inland fresh water aquifers in the coastal areas

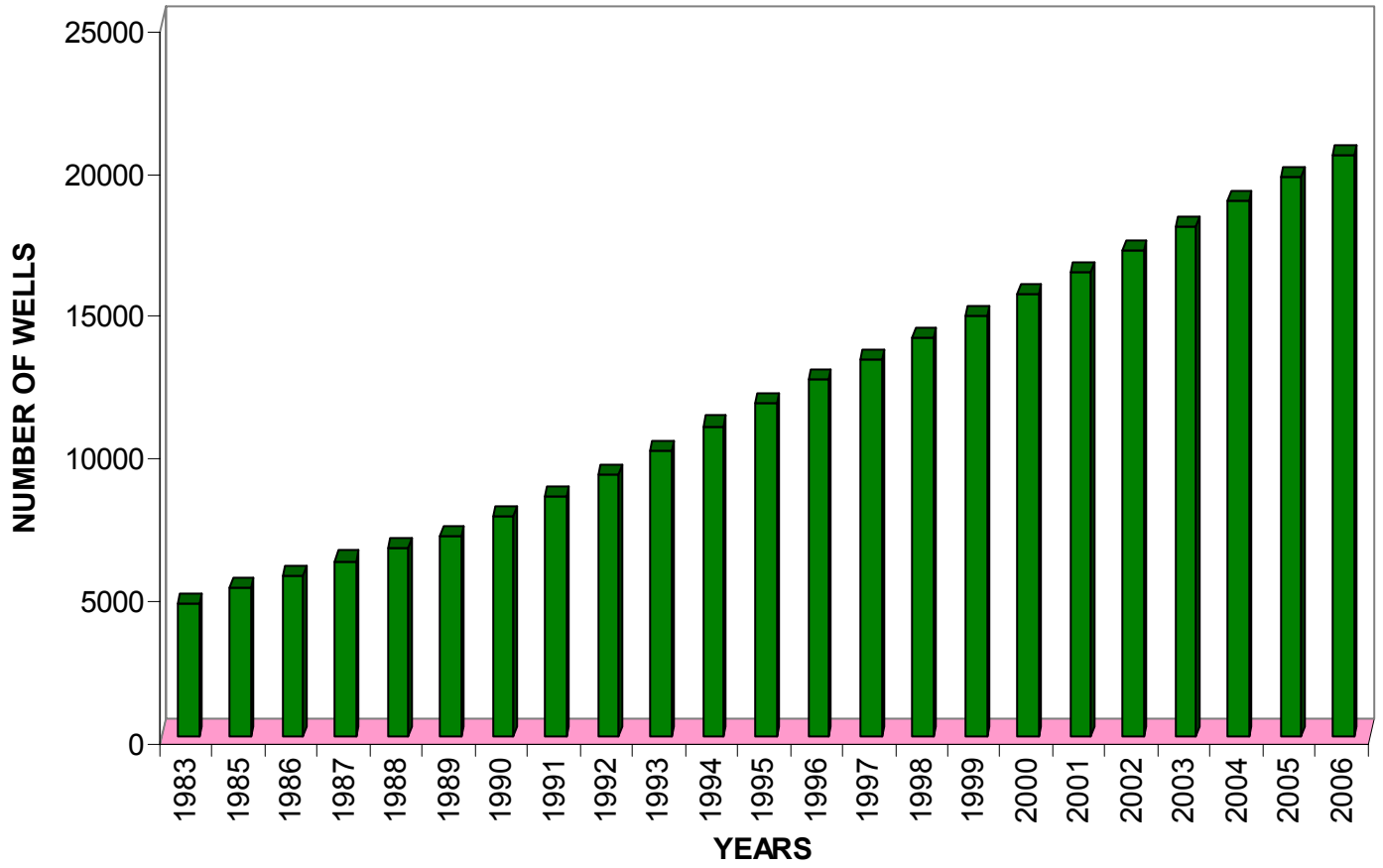
In Surendranagar district 3 wells (2 EW & 1 OW) were drilled in the soft rock areas.. The depth explored was 200 mbgl. AT Lakhamachi EW entire depth of 200 mbgl was consisted of Sandstone, the quality is poor with TDS of 3300 ppm . At Tikar Deccan Traps/ Sill was encountered at 155.00 mbgl. The well yielded poor quality water with 3300 ppm TDS. The compressor discharge of 60-90 LPM was observed.

In Rajkot district, 2 Exploratory wells were drilled in the soft rock areas in the district. At Bahadurgadh EW Deccan Trap was encountered at 114.00 mbgl. The Ground water was saline from the top. At Kumbhariya the quality of ground water was saline with TDS 7450 ppm. The compressor discharge of 720-265 LPM was observed.

3.4.4 Vadodara District: Detailed exploration for ground water was carried out to delineate the deep seated aquifers with potable quality of ground water, at sustainable yields. 11 Exploratory Wells and 5 observation wells were constructed. Fractures were encountered at different depth ranging from 18.0 to 166 m. The compressor discharge varies from nil (Jherwan EW) to 450 lpm (Lachharas EW). The quality of water is generally good with TDS varying from 444 ppm (Someshwarpura EW) to Saline with TDS 9501 ppm, (Amaliyara EW). At Gugaliapura the quality of ground water was good upto 80 mbgl (TDS 1119 ppm) and it is poor below that (TDS 2332 ppm), similarly the fluoride also increases with depth.

Fig 3. 3

CUMULATIVE PROGRESS OF EXPLORATION DURING 1983-2006



Piezometers Construction

Gandhinagar, Mahesana, Banaskantha and Patan districts form parts of the North Gujarat region and the future of ground water resources in this region are undr stress due to recurrence of drought and excessive dependency of ground water. Adequate density of the monitoring network is necessity and to achieve this construction of piezometers at close interval is taken up for reliable Ground Water Regime Monitoring purpose. During the year 2005-06 a total number of 23 piezometers were constructed in North Gujarat tapping different aquifers. Details of piezometers are given in table-3.7

Table-3.7 Details of Piezometers driiled in Gujarat

Sl. No	District	**Depth drilled (m bgl)**	**Zones tapped/ Fractures encountered (m)**	**SWL (m bgl)**	**Discharge (lpm)**	**Draw down (m)**	**Formation**
1	Ahmedabad	39.0	27.0-36.0	21.12	8.4	8.5	Alluvium
2	Gandhinagar	200.0-450.6	161.0-387.0	96.9-121.4	19.2-67.8	0.41-1.87	Alluvium
3	Banaskantha	46.0-200.0	11.0-190.0	16.5-74.2	30.0-540.0	0.1-17.8	Alluvium
4	Mehsana	60.0-450.4	32.0-434.0	28.8-130.4	Dry-103.2	0.1-4.1	Alluvium
5	Patan	114.0-200.5	79.0-184.0	95.6-133.4	Dry-15.6	0.17	Alluvium

Two major aquifer units have been identified in the area. The upper unit is mostly unconfined and designated as aquifer 'A'. The lower unit, comprising a few hundred metres of alternating sandy and argillaceous beds, form confined aquifer system and the aquifer system has been designated as 'B', 'C', 'D' and 'E' within post Miocene sediments and 'F' and 'G' in the Miocene sediments. Aquifer 'A' shows the most favorable hydraulic parameters and contains the best quality of ground water in the vicinity of the recharge zone in the northeast. It deteriorates towards southwest. The same trends are noticed in the confined aquifers also.

3.5 NORTH CENTRAL REGION (Madhya Pradesh)

32 exploartory wells and 24 observation wells are constructed in Madhya Pradesh in 2005-06**.** The district wise details are given in table-3.8

Table-3.8 Distrcit wise break up of wells drilled in Madhya Pradesh

Sr. No	**District**	**EW**	**OW**	**TOTAL**
1.	Satna	5	3	8
2.	Dindori	3	5	8
3.	Mandla	13	11	24
4.	Betul	11	5	16
	GRAND TOTAL	**32**	**24**	**56**

The summary of exploration is given in following table-3.9

Table-3.9 District Wise Details of Ground Water Exploration

Sl. No.	**District**	**Depth Drilled Range (m,bgl)**	**SWL Range (M.bgl)**	**Discharge Range (M^3/hr.)**	**Drawdown Range(m)**	**Formation**
1.	Mandla	11.4 –182.1	1.8 –24.7	2.2 -56	0.68 – 45.4	Vesicular Basalt, Fractured Sandstone Weathered granite Lameta Formation

2.	Betul	134.2 – 305.0	8.8 – 49.7	Negligible To 36	2.8 – 45.2	Fractured & Jointed Granitic Gneiss Lemata formation Fractured & Jointed Basalt
3.	Satna	32.3 – 201.3	2.8 – 16.0	Neglible to 15.4	9.1 – 13	Fractured Sand Stone & shale
4.	Dindori	56.0-135.9	Dry –25.0	10.40-14.9	**-**	Contact between Deccan Trap & Lameta formation and Weathered Granite

The salient features of exploration of each district are as follows:-

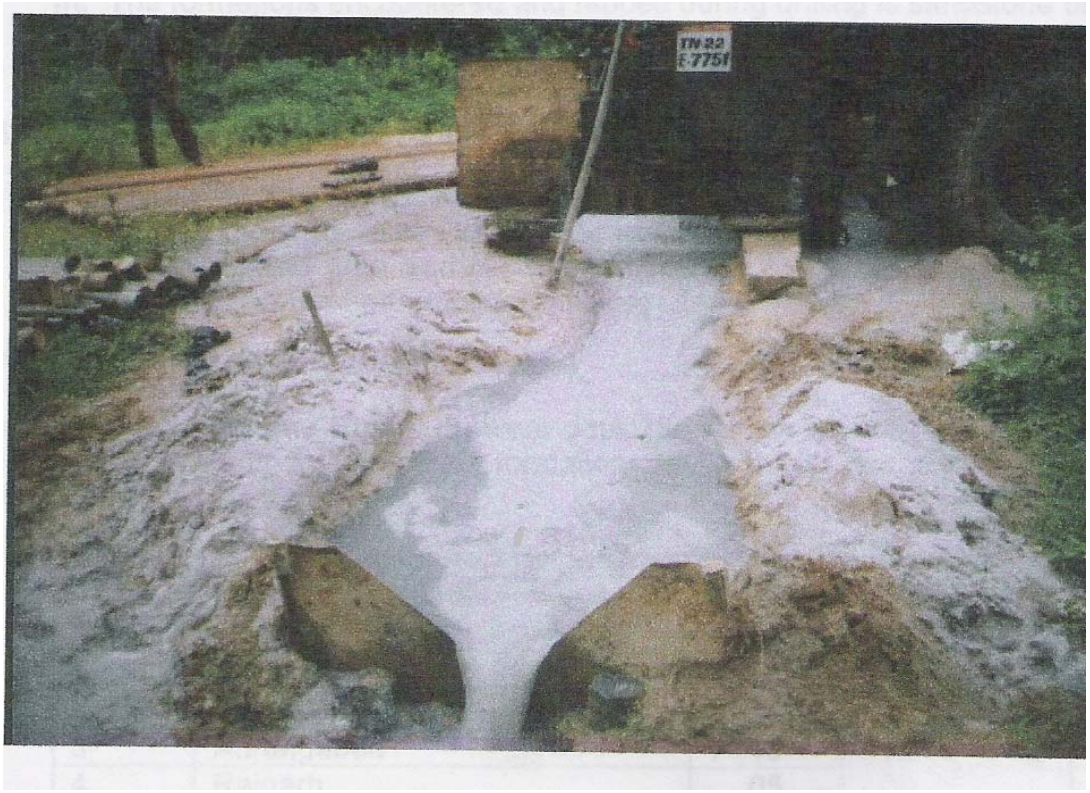
3.5.1 Mandla District:- Ground Water Exploration have been taken along the bank of Narmada river. Out of the 24 bore wells, 4 were abandoned due to collapsible strata problem and loss of bit. Three aquifers system viz. basaltic lava flow, Lameta sandstone and basement rock (granite) are encountered at different depths. The ground water occurs under semi confined to confined conditions. Free flowing wells have been constructed in Pondilinga village with the piezometric head 1.80 m above bgl.. The well construction techniques have been evolved to separate fluoride bearing aquifers. Fluoride bearing aquifers occur between 33 to 45 m and 65-72 in the basaltic lavas , between 90 to 110 mbgl in granitic formation and between 47 to 110 mbgl in Lameta sandstone.A fresh water zone occurring below fluoride bearing zone (between 47 to 110 mbgl) in Lameta Formation have been identified in the area for the first time. The discharge of the fresh water zone varies between 2.47 to 7.0 lps. Nearly 32 villages having the population more than 70,000 will be benefited by identification of fresh water zone.

3.5.2 Betul District:- A total no of 16 wells were constructed in the district. Ground water exploration established existence of aquifer in Archeans and Deccan Trap in the depth range of115-122, 143-149, 296-298 m.bgl .The transmissivity and storage co-efficient have been calculated the range of 4 –18 m2/day and $1 * 10^{-3}$ to $6*10^{-5}$ respectively. In Athner area gave an exploratory well with 16 lps discharge (at 32 m draw down). Design and construction of this well involved sealing of collapsible red bole zones from 52-55 mand 125-128 m. with part casing lowered by reserve socket technique. At Bagudhana, ground water was fluoride concentration of 3.74 ppm was diluted with surface water in ratio 2:1. The fluoride content of the mixed water was 0.8 ppm and it is now being supplied to the residents of the area.

3.5.3 Satna District:- A total no of 8 wells were constructed in the Maihar and Uchhera blocks. High yielding well was constructed at Uchhera (OW I). It is significantly noted at Uchhera site, four boreholes were constructed, out of which OW I is having a discharge of 41.4 cubic meter/hr while the discharge at other boreholes is less than 15 cubic m/hr. in similar depth and same aquifer conditions. Therefore, such sites in Vindhyan formation are recommended for hydro fracturing at a depth of 91-93 mbgl. for opening of fractures and to achieve lateral connectivity.

3.5.4 Dindori District:- A total no of 3 exploratory wells and 4 observation wells are constructed. The area is covered by Granite, Lameta & Deccan trap formations. The ground water occurs under unconfined conditions in weathered Lemata sandstone and at the contact between Basaltic lava flow & Lameta sandstone, and under confined condition at the contact between Lameta bed and Granite.High yielding well was drilled at Kuda @ 14.4 m3/hr a the contact between Deccan Trap and Lameta bed.

A high discharge Zone (16 lps) struck at depth of 263 meters in a dry area (Deccan traps) at Athner, Betul (M.P.)



High Yielding Exploratory Well in Khondalite terrain at Neyyattinkara, Ttrivendrum district, kerala

3.6 NORTH CENTRAL CHHATTISGARH REGION (Chhattisgarh)

32 wells were drilled under Ground Water Exploration programme, out of these 26 were EWs ,one was OW and 05 were Piezometers in Jashpur, Raigarh, Rajnandgaon & Korba districts of Chhatisgarh. District wise Summarized details of ground water exploration

3.6.1 Rajnandgaon District and Jashpur Districts:- In Rajnandgaon and Jashpur Districts, 10 wells were drilled at sites selected on the basis of distribution of Arsenic contamination in Chouki Block of Rajnandgaon district for the construction of Arsenic free water for the domestic water supply. In Jashpur, depth of wells was 40-152 mbgl and casing was lowered in the depth range of 15-70m. The discharge of the well was 0.5-6.3 lps and static water level was 1.2-2.5 mbgl. Rajnandgaon district is mostly occupied by acid to basic formations of Nandgaon Group. Weathered zone is encountered down to 26.00 mbgl. Yield of the formation is poor to moderate , fractured zones are observed at depth of 23-24,32-38,42-45,114-118 and 135-136 m bgl .

3.6.2 Raigarh District :- 17 wells were drilled in hard rock and four piezometers were drilled in soft rock. Salient features of wells drilled in hard rocks & soft rocks of Raigarh distrct are give in table-3.10

Table-3.10: Salient features of wells drilled in hard rock & soft rock formation in Raigarh distrcit

Particulars	Range(Soft Rock)	Range(Hard Rock)
Depth (m)	65-200	21-201
Casing (mbgl)	65-200	6-22.3
Discharge (lps)	0.5-3.5	0.5-6.5
S.W.L. (mbgl)	2.9-14.4	2.3-36.18

The District is covered with granite, gneiss schist and shale limestone of the Archaean age. Ground water occurs under unconfined conditions in weathered mantle and semi confined to confined condition in fractured zones, potential zone recorded in 20-28, 55-60, 90-95 Raigarh formation form potential aquifer in the area yield varies from 5- 20 lps with a draw down of 30 m. The formations encountered and tapped during drilling is sandstone of Barakar formation. Exploration data of existing bore wells drilled in the area marked presence of potential granular zones below 100 mbgl, yield varies from 0.5 to 3 .5 lps. With a draw down of 30 m.

3.6.3 Drilling underSpecial Studies programme

Nine wells were drilled for identification of Arsenic free aquifer in Chouki Block of Rajnandgaon district, in each site three wells were constructed which have tapped various zones, water and litho samples were collected to identify Arsenic. Pumping test were conducted to determine yield potentiality.

3.7 CENTRAL REGION(Maharashtra)

Three DTH rigs and one Rotary rig were deployed for the construction of 50 bore wells and tube wells in hard rocks and sedimentary formations respectively. The district wise details are given in Table-3.11

Table-3.11: District-wise Status of Exploratory Wells Constructed during 2005-2006

Sl. No.	Name of District	No of wells constructed			
		EW	OW	PZ	TOTAL
1	Nagpur	01	00	08	09
2	Solapur & Sangli	14	02	-	16
3	Aurangabad	16	01	-	17
4	Raigarh	05	03	-	08
	Total	36	06	08	50

The Summary of Results of Exploration in Hard Rocks Formations are in Table-3.12

Table 3.12: Summary of Results of Exploration in Hard Rocks Formations

Sl. No.	SALIENT FEATURES	SOLAPUR	SANGLI	AURANGABAD	RAIGARH
1	No. of Exploratory Wells drilled	1	13	16	4
2	Depth range (m.bgl)	200.0	150.0 – 200.0	175.0 -200	140.6-200.0
3	Depth of casing (m.bgl)	5.80	5.7 –15.00	3.00-18.10	5.50-12.10
4	Number of zones encountered	1	1-3	1-2	2-4
5	Thickness of individual zone (m)	0.40	0.40-6.10	3.22-15.2	1-2
6	SWL range (m.bgl)	5.80	2.70 – 85.05	3.22 - >100	0.60-4.00
7	Yield range (lps)	0.14	0.14 – 10.49	0.02 - 1.86	Traces to 12.18
8	No. of EW's with yield more than 3 lps	-	1	-	2
9	Formation	Deccan basalts	Deccan basalts	Deccan basalts	Deccan Basalts

Out of 36 exploratory bore wells drilled, 35 EW were drilled in hard rocks and 1 EW in Sedimentary formation of which 3 EW's have yielded more than 3 lps which is 9 % of total wells constructed. In Raipur 2 EW were yielding as 8.75 and 12.18 lps

3.8 NORTHERN REGION (Uttar Pradesh)

The exploratory drilling were undertaken in Northern Region covering states of Uttarpradesh. The district-wise targets and achievements are as follows in Table-3.13

Table-3.13:- Wells constructed in U.P

District	No of wells constructed			
	EW	OW	PZ	Total
Ballia (N)	4	6	-	10
Maharajganj	-	1	-	1
Balrampur(N)	3	5	-	8
Gonda(N)	2	2	-	4
Kanpur(N)	1	-	-	1
Sant Ravidas Nagar (N)	1	1		2
Chandauli (N)	5	4	-	9
Lalitpur(D)	10	1	-	11
Banda (D)	1	2	-	3
Hamirpur (D)	5	-	-	5
Mahoba (D)	1	-	-	1
Siddarth Nagar(N)	1	2	-	3
Ghaziabad (N)	-	1	11	12
Muzaffer Nagar(N)	-	-	2	2
TOTAL	**34**	**25**	**13**	**72**

District wise summary of exploratory drilling

3.8.1 Ballia District:- Arsenic contamination in ground water at sporadic spots obseved in the villages located mostly in recent flood plain of Ganga and Ghaghra rivers, two rigs (350 m drilling capacity) were deployed for delineation of arsenic free for safe drinking water supply. Four sites viz. Ramgarh, Sultanpur, Dalan Chapara and Chain Chapara (Rajpur Ekauna) were explored. At each site three tube wells (about 70 m, 150 m & 300 m depth), tapping granular zones of shallow, middle and deeper aquifers separately, were constructed to find out Arsenic concentration at different depths. The collapsing nature of the sediments of shallow aquifer group was the big constraint in construction of deep tubewells. Due to domination of finer sediments in deeper aquifer group, slotted pipe with 0.75 mm slot opening were found most suitable for this area. Although, the tube wells are yet to be finally tested for hydrological parameters and quality of formation water, it appears that the ground water occurring below the depth of 100 mbgl is almost Arsenic free.The discharge of deep tube wells through air compressor varies from 774 to 2116 lpm.

3.8.2 Balrampur District:- A total of three sites were explored and at each site three tubewells of varying depths, tapping shallow/middle/deep aquifer groups separately, were constructed to find out the variation of arsenic concentrations in their formation water. At Mahadeo Gosai site, located in the central part of the district, the exploratory tubewell of 318 m depth, on tapping the granular zones below 235 m depth, yields 2679 lpm at 8.97 m drawdown. The transmissivity (T) value has been computed as 1363 m^2/day. The middle and deep aquifers are almost having arsenic free formation water. By and large, in the entire district the arsenic concentration is decreasing with depth and ground water in aquifer occurring below 100 m depth is safe for drinking water supply.

3.8.3 Siddharth Nagar District:- Occurrence of high Arsenic concentration had been reported therefore one rig of 350 m drilling capacity was deployed at arsenic affected village Pipri Buzurg for delineation of aquifer having arsenic free formation water. By and large, three tier aquifer system exists down to the maximum drilling depth of 354 mbgl. Three tubewells of 294 m, 117 m and 50 m depths were constructed at this site, tapping granular zones encountering between depth range of 178-283 mbgl, 84-114 mbgl and 43-49 mbgl respectively for determining the variation in arsenic concentration in different aquifer groups. Static water levels in these tubewells have been recorded as 4.08, 4.85 & 4.45 mbgl respectively. Determination of hydrological parameters of aquifers and quality of formation water therein waunprogress..

3.8.4 Gonda District:- Ground Water Exploration was taken up in parts of Arsenic effected areas of Gonda district with a view to know the extent of contamination of Arsenic in ground water in addition to disposition of aquifer and its hydrological characteristic. One rig of 600 m drilling capacity was deployed and two sites namely COLONEL GANJ and KANAKPUR located in the vicinity of Ghaghara River were explored. On the basis of Exploration following group of aquifers have been deciphered.

- Phreratic Aquifer **Occurs under unconfined condition upto depth of 40 to 50 mbgl. Consisting of mainly sand, medium to coarse grain with gravel. Depth to water level is 2.23 mbgl.**

- **I- Group of Aquifer** Occurs under semi confined condition upto depth of 250 mbgl. Consisting of sand, medium to coarse grain and gravel with thin intercalation of clays. Depth to water level is 2.06 mbgl.

- **II -Group of Aquifer -** Occurs under confining condition upto depth of 470.0 mbgl consisting of sand, fine grain in nature with intermittent layer of clay Ground Water head is 1.46 mbgl.

- **III -Ground of Aquifer**- Occurs under confining condition, consist of mainly clays with thin layer of sand, fine grain texture.

3.9 UTTARANCHAL REGION(Uttarancha)

During 2005-06 2 EW has been constructed in Dehradun district and details are given in Table-3.14

Table-3.14 Summarized Details of Ground Water Exploration in the State

Sl. No.	Location & District	Depth Drilled (m)	Zones tapped/ Fractures encountered	SWL (m bgl)	Discharge M^3/hr	Draw down	Aquifer parameter (T&S)
1.	Doiwala (Dehradun)	107.00	41.0 – 47.0 49.0 – 55.0 62.0 – 68.0 71.0 – 77.0 80.0 – 88.0	32.61	138.01	2.38	T=11989.7 m^2/day S=1.3
2.	Kesarwala (Dehradun)	49.50	15.0 – 21.0 22.0 – 28.0 31.0 – 34.0 37.0 – 45.0	16.26	-		

3.9.1 Doiwala Exploratory Well, Draun district:- The Doiwala area lies in the eastern part of intermontane Doon valley. The area, around the exploratory well site, is represented by Recent to Sub Recent Doon gravels, which overlie the Upper Siwalik sediments.

The area is drained by the tributaries of Ganga River, namely Song and Jakhan Rao. River Song, perennial in nature with N-S extension is about 400 m west of the exploratory well site. Jakhan Rao, an ephemeral stream, flows about 4 to 5 km NW off the well site.It runs in NE – SW direction and flows southerly in the lower reaches before joining Song River . These Rivers are highly braiding in nature and form wide channel beds. The area has a general NE – SW slope. The gradient of the land surface varies from 1:50 to 1:70 and the elevation varies from 450 – 550 m above MSL.

Groundwater, in the area, generally occurs under water table and semi-confined conditions. A comparison of water levels with the position of granular zones encountered in the boreholes, in the surrounding area, shows that all the granular zones may not be saturated. This observation does not support occurrence of confined aquifer system. The hydraulic gradient is very steep in the North and South and generally decreases towards the central part of the valley. Water levels in the areas around the exploratory well site generally ranges from 25 to 35 m bgl. Since the well lies adjacent to the Song River, fluctuations in the water levels may be comparatively low. On examining the drill cutting of the exploratory well and lithologs of the near by tubewells, it can be concluded that the sediments are heterogeneous in nature and granular zones forming aquifers occur as irregular beds and lenses. The percentage of clastic sediments ranges between 50 and 60 %.

3.9.2 Kesarwala Exploratory Well, Dehradun district:- Kesarwala area is represented by Doon gravels of Recent to Sub Recent age, which overlie the Upper Siwalik sediments. The Doon Gravels have been divided into Older and Younger Doon gravels. The Older Doon Gravels consist partly of crushed upper Siwalik cobbles, angular pebbles of quartzites, slates and shales from the Naghthat, Chandpur and Tal Formations and limestone pebbles from the Krol Limestone alternating with clay beds. The Younger Doon Gravels rest unconformably over the Older Doon Gravels in the northern part of the area and this relation gradually disappears in the southern part. The Younger Doon Gravels are characterized by very large

boulders in the alluvial fans, debris flow deposits and consist of moderately sorted mixture of clay, sand, boulders and gravels. Clay beds separate the sand and gravel units from each other. The major part of Doon valley is occupied by the Younger Doon Gravels except the isolated occurrences of Siwalik and older sediments at places. The exploratory well site is flanked by the Mandhali formation (Palaeozoic) on the West and Naghthat Quartzites on the East. The Mandhalis occur as an isolated hillock and are separated from the Himalayan ranges by the Song River.

The area is located in the interfluve of the Song (east of the EW site) and Nala Paniki Rao (west of the EW site) Rivers. Minor tributaries arising from this interfluve give rise to highly dissected topography. The area is characterized by high rate of infiltration being covered by unconsolidated and unsorted material of Doon gravels having high degree of porosity and permeability. Groundwater in the area occurs mostly under water table conditions and semi confined conditions. The semi-confined condition may be presumed due to the presence of clay beds/lenses. The static water levels in the area varies from 15 to 20 m bgl and the thickness of saturated zones may be around 25 to 30 meters based on the observations of lithologs of tubewells existing near the exploratory well site drilled down to a depth of 150 m approximately.

The hard rocks, at Kesarwala, encountered at a depth of 27 m below ground surface. The hard rocks are slates of Mandhali formation. The tubewell is yet to tested for its yield and aquifer parameters.

3.10 MID EASTERN REGION(Bihar & Jharkhand)

Ground Water Exploration has been carried out in Bihar and Jharkhand states. Against the annual target of 32 exploratory wells and 10 observation wells, for the year 2005-06, a total of 43 well (19 Exploratory Wells, 18 Observation Wells and 06 Piezometers)were drilled The DTH rigs were deployed mainly in tribal areas of Jharkhand and in fluoride contaminated areas of Jamui district, Bihar. A total of 13 EWs and 18 OWs were drilled. The rotary rigs were deployed in Arsenic affected areas of Bihar. A total 06 EWS and 06 PZs were drilled. The piezometers have been drilled as a part of Special Study on arsenic in parts of Bhojpur and Patna districts. The details of exploration are given in Table-3.15 &3.16

Table-3.15 Summarised Details of exploration in Bihar

Sl. No.	District	Depth Drilled	Depth of construction/Depth of casing	Zones tapped /Fracture encountered	SWL (mbgl)	Discharge (m^3/hr)	Drawdown
1	Munger	75-234.5	67	42-224	7.50		
2	Patna	252.70	191	92-188			
3	Bhojpur	250	205-218	136-215	7.43	188.7	9.9
4	Jamui	17-190	6-20	12-137		0.28-24.78	
5	Piezometers (Bhojpur District)	21-250	19-250.8	16-215	3.6-7.38		0.4-6.76
6	Piezometers (Patna District)	38-258.00	32-194	24-187			

Table-3.16 Details of exploration in Jharkhand

Sl. No.	District	Depth Drilled	Depth of construction/Depth of casing	Zones tapped/Fracture encountered	SWL (mbgl)	Discharge (m^3/hr)	Draw down	Aquifer Parameter (T & S)
1	Ranchi	176-199	9.75-17.5	97-112	10.45-12.34	Upto 15.8	8.24-21.02	21-22 - m^2/hr & 1.9-2.25x10^{-4}
2	West Singhbhum	154-199	21-50	55-175	8-10.93	Low-25.20	2.48-21.73	4.7-74 m^2/day & 5.8-12.4x10^{-5}
3	Gumla	22-199	12-39	55-124	7.12-8.32	1.56-8.82		

Ground Water Exploration in Bihar

The ground water exploration in the state of Bihar was carried out to study the natural contamination of aquifer/fractures with Arsenic and Fluoride.

3.10.1 Bhojpur, Buxar and Patna districts- In the Arsenic affected areas two rotary rigs were deployed in Bhojpur, Buxar and Patna districts which drilled 5 peizometers and 3 exploratory wells. The peizometers were drilled for monitoring of concentration of As in aquifers disposed at various depths. The exploratory wells were drilled upto depth of 250 m tapping sufficient thickness of arsenic free aquifer for water supply in the affected villages. It has been observed that the aquifers are affected with As down to a depth of 80 m (considering max. permissible limit as 50 ppb). The aquifers are potential and very high yielding. The transmissivity is observed to be about 5000 m^2/day and the Storativity value is about 1.2x$10^{-3.}$ at Kernamepur, Bhojpur district. The exploratory wells drilled in the alluvial formations in the Indo-Gangetic Plain in Bihar are very high yielding.

3.10.2 Jamui district:- In fluoride affected areas of Jamui district wells have been drilled in consolidated formations (mainly Pre-cambrian granite gneiss) upto a depth of 200 m through deployment of one DTH rig. The objective of exploration is to tape fluoride free fractures so that the wells are used for water supply to the affected villages. High discharge wells (> 3 lps) have been drilled at Sondipi9 (24.78 m^3/hr) Manjway(15.71 m^3/hr) and Nabinagar(24.78 m^3/hr). In Nabinagar fractures have been encountered at depth range of 19-21; 37-41.25; 99-101; 107-113.55.

Ground water exploration in Jharkhand

Ground water exploration in the unexplored tribal areas of Jharkhand was carried out. Exploration was carried out in parts of West Sighbhum, Gumla and Ranchi district. The targeted depth of exploration was 200 m but in some places drilling was stopped before targeted depth wherever high yielding fractures were encountered. High discharge wells were located at Bundu in Ranchi district and Narsanda, Mehulsai, and Kumardungi in W.Singhbhum district. The depth to water levels in these wells rests within the 12 mbgl. In general discharge of 15m^3/hr has been obtained from the wells located in these areas. Transmissivity is observed to vary from 25 to 75m^2/day. The storativity is observed to vary from 2.25x10^{-4} to 12.4x$10^{-5.}$

Table-3.17: Aquifer parameters of exploratory wells tested in Bihar.

Sl. No.	Locations	District	SWL (m bgl)	Discharge (m^3 /hr)	Draw down (m)	T (m^2/day)	S
1.	Nazari Laxmipur	Jamui. Bihar	5.36	15	12.08	31.82	$2.15x10^{-4}$
2.	Nargada, Narayanpur	Bhojpur, Bihar	4.64	188.70	9.62	5529.11	
3.	Bariswan	Bhojpur, Bihar	4.56		6.35	10238	0.004
4.	P.P.K. college, Bundu	Ranchi, Jharkhand	10.38	15.84	22.57	13.13	
5.	Maner	Patna, Bihar	6.20	188.70	2.67	9735.12	$4.46x10^{-4}$
6.	Amrahi Nawada	Bhojpur, Bihar	3.09	188.70	8.55	5918.51	

3.11 EASTERN REGION (West Bengal)

Ground Water exploration was taken up in 6 distrcit of West Bengal nad 24 wells were drilled , details are as follows in Table-3.18 &3.19

Table-3.18: Details of wells constructed in West Bengal

Sl. No.	District	No of wells constructed				
		EW	OW	SH	PZ	Total
1	North Bengal	2	-			2
2	Uttar Dinajpur	3	1			4
3	Barddhaman&Hugli	3	2			5
4	Noth 24 Pargana	3	2			5
5	Murshidabad	4	4			8
6	Arsenic infested N-24 Pargana	-	-			-
Total		**15**	**9**			**24**

Table-3.19 District-wise Summarised Details of Ground Water Exploration in West Bengal (in range)

District	Depth drilled (mbgl)	Zones tapped / fracture encountered (m bgl)	SWL (m bgl)	Discharge in m^3/hr	Drawdown (m)	Aquifer Parameters (T & S)	Forma-tion
North 24 Parganas	62-248	36-240	4.4-10.8	46.8-154			Alluvium
Uttar Dinajpur	58-248	36-232	3.1-10.8	25-111	3.2-3.98	T-1592m2/day (Islampur)	Alluvium
Darjeeling	183	79-177	8.34	72.0	3.39	1816 m2/day	Older Alluvium(Bhabhar zone)

Jalpaiguri	75.0	44-68	4.27	56.55	-	-	Older Alluvium(Bhabhar zone
W-Medinipur	250	62-202	6.38	26.10	7.15	76m2/day	Alluvium
Barddhaman	102-226	58-221	6.85-8.95	37-50	-	-	Alluvium
Nadia	264-351	121-238	4.51-4.94	41.4-45.0	1.51-4.725	337-4666 m2/day	Alluvium
Haora	248	188-235	7.01	24.96	2.77	2500 m2/day	Alluvium

3.12 NORTH EASTERN REGION (Assam, Arunachal Pradesh & Tripura)

A total of 20 Exploratory and 7 observation wells were constructed during AAP 2005-2006. Out of which 14 Exploratory and 7 observation wells are successful. Distrcit wise details are given in Table-3.20.

Table-3.20: District wise achievements during 2005-06

SL No	State	District	No. of wells drilled				
			EW	OW	SH	PZ	T
1	Assam	Jorhat & Golaghat	3	2	-	-	5
		Bongaigaon	5	3	-	-	8
2	Arunachal Pradesh	Lohit	1	-	-	-	1
3	Meghalaya	Jaintia & East Khasi hill	9	1	-	-	10
4	Tripura	West Tripura	2	1	-	-	3
Total			**20**	**7**	**-**	**-**	**27**

Salient Features of Ground Water Exploration:

3.12.1 Lohit district, Arunachal Pradesh::- One exploratory well was constructed at Piyong village in Lohit district of Arunachal Pradesh.The exploration activities carried out by CGWB, NER in Lohit district revealed that the area is underlain by semi-consolidated rocks of Tertiary age covered with varying thickness of Recent alluvium. The alluvial sediments are found to be potential for exploration of ground water.

3.12.2 Jaintia and East khasi Hill, Meghalaya- A total of 8 exploratory wells and 1 observation well were drilled in Jaintia and East Khasi Hill Districts. The depth of the wells varies from 61.8 to 202.5 m and the rocks encountered were mostly Gneiss along with minor schist belonging to Archaean Gneissic complex in Ribhoi district and quartzite and Phylite belonging to Shillong Group of rocks in Jaintia and Khasi hill districts. Fractures zones found to occur from 11.5 to 178m. The yield of the wells varies from 8.77 to 38.79m^3/hr. The static water level varies from 0.82 to 5.92m bgl.

3.12.3 West and North Tripura,Tripura:- A total of 2 exploratory wells and 1 observatory well were drilled down to the depth of 197.45m in the district of West and North Tripura. The formation encountered is mostly Tertiary sediments comprising of semi consolidated sandstone, shale, siltstone and clay. In both the areas two prominent aquifer zones are found to occur from 100 to 148m depth having yield of 37 m^3/hr. The static water level varies from 4. to 5.92m bgl.Transmissivity (T) value is 504.43 m2/day

3.12.4 Bongaigaon district,Assam : - A total of 2EW and 2 OW were constructed. The formation encountered is mainly consist of Sands, clay, gravel and pebble. The depth of the wells varies from 17 to 100.95 m bgl. Deep tube wells tapping 30 to 40 m granular zones may

yield 40 to 45 m^3/hr having drawdown for about 5m. Transmissivity (T) value is 1347 m2/day

3.13 SOUTH EASTERN REGION (Orissa)

Ground Water Exploration (Through Departmental Rigs): Ground water exploration was undertaken in 5 districts by deploying 50TH rigs in the hard rock areas of Angul, Sambalpur, Ganjam, Kalahandi, Balasore district and 1 DR rig in the alluvial tracts of Balasore district. District-wise achievements of ground water Exploration are given in Table-3.21

Table-3.21 District-wise achievements under following heads (Tribal, Drought, Normal)

Sl No.	District	Achievement				
		EW	OW	SH	PZ	TOTAL
1	Ganjam (D)	10	3			13
2	Sambalpur (D)	24	1			25
3	Angul (D)	13	3			16
4	Balasore (N)-Hard Rock	11	2			13
5	Balasore (N)-Soft Rock	5	4			9
6	Kalahandi (T,D)	12	2			14
	Total	75	15	-	--	90

District wise salient features of Ground Water Exploration in Orissa

3.13.1 Angul District: In the Angul district, 13 exploratory wells and 3 observation wells have been drilled. The depth of drilling varies from 38.07 mbgl at Jarpada-OW to 153.85 mbgl (at Tubey, Khandsar, Balipata, Chhendipada, Koshala, Bamur). Formations encountered are granite, granite gneiss, shale, sandstone and coal seams. Water bearing fracture zones are encountered in the depth range of 20 to 136 metres below ground level with the sandstones yielding water all through its occurrence. Cumulative discharge of wells varied from dry(Bauligarh) to 23 lps(Pandarbharania). Static water level varies from 0.99 metres below ground level at Tubey to 8.40 at Chhendipada. Drawdown varies from 2.85 metres(koshala-OW) to 13.3 metres(Koshala-EW). In the wells tested, the transmissivity varies from 10.94 m2fday(Chhendipada) to 46.13 m2fday(Koshala).

3.13.2 Balasore District: In the hard rock terrain of Balasore district, 11 exploratory wells and 2 observation wells have been drilled. The depth of drilling varies from 37.10 mbgl(Anandapur) to 154 mbgl (Pithahata). The formations encountered are in general granite and granite gneisses with dolerite and fine grained basic rock in some places, specially in the western part of the district. Water bearing fracture zones have been encountered within the depth range of 15.80 to 81.90 mbgl. Cumulative discharge of wells varies from negligible(Gujudiha) to 25 lps(Siadimal). The static water level varies from 3 mbgl (Betkota) to 19.95 mbgl (Gopinathpur). The residual drawdown varies from 3.35 metres to 25.10 metres In one well, at Anandapur, alluvial formation of intercalated black and yellow sticky clay and sand was encountered, in which the 2 metre thin sand zone was tapped and developed. Further drilling was not possible with the DTH rig due to the sticky nature of the subsurface formation.

In the alluvial tract of the district, 5 exploratory wells and 4 observation wells have been constructed through the rotary rig, deployed in the area. The depth of drilling of pilot hole varies from 66 mbgl (Gopinathpur) to 103.37 mbgl (Kasbajaipur). The depth of construction varies from 63 metres below ground level to 84 metres below ground level. Formation encountered are alternate layers of sands and clays with occasional presence of thin semi

consolidated arenaceous and calcareous materials. Sand and gravels are very fine to coarse in texture, angular to sub-angular and sub-rounded in shape with moderate sorting. These are mostly quartzo-feldspathic in composition with ferruginous concretion at shallow depths. The granular zone ranges from 25 - 70 mbgl with average thickness of 12 - 22 metres. The yield of these wells varies from 7 - 16 lps with drawdown of 2 to 9 metres. The transmissivity varies from 202 to 490 m2/day with permeability varying from 19 to 32 m/day. The static water level varies from 10 to 14.46 mbgl

3.13.3 Ganjam District: In Ganjam district, 10 exploratory wells and three observation wells have been drilled during 2005 - 06. The depth of drilling varies from 57 mbgl (Nimakhandipentha EW) to 166.7 metres below ground level (Chhanamari-EW). Formation encountered are mainly granite, granite gneiss and their variants. The yield of the wells varies from 0.5 lps (Sanakhemundi-EW) to 10 lps(Padmanavapur-EW). Two to three sets of saturated fractures zones exists within a depth of 120 metres below ground level. The drawdown varies from 12.52metres(Chhanamari) to 27.85 metres(Pudamari). The transmissivity values vary from 3.92 m2/day(Chhanamari) to 6.2 m2/day (Nimakhandipentha, Madanmohanpur). The static water level varies from 1.06 mbgl (Patapur) to 4.23 mbgl (Gokarnapur).

3.13.4 Kalahandi District: In Kalahandi District, 12 Exploratory wells and 2 observation wells have been drilled during 2005 -06. The depth of drilling varies from 99.07 mbgl (Kinerkela OW) to 184.47 mbgl ((Bhoothkoothi EW). Formation encountered are granite, granite gneiss and its variants like augen gneiss. The yield of wells varies from negligible to 7.5 lps(Kurlupada EW) with most of the s average of 2.5 lps. Fracture zones are mostly encountered in the range of 30 - 100 mbgl. The transmissivity value varies from 7.6 m2f day(Kurlupada) to 9.58 m2f day(Kinerkela). The static water level varies from 2.7 mbgl (Kusrupada) to 4,71 mbgl (Boriaghat). The drawdown varies from 14- 22 metres.

3.13.5 Sambalpur District: In Sambalpur District, 24 Exploratory wells and 2 observation wells have been drilled during the year 2005 -06. The depth of drilling varies from 20 mbgl to 170 mbgl. Formation encountered are granite, granite gneiss, granodiorite, amphibolite, quartzite, sandstone, shale and pebbly grit. The yield of the well varies from negligible to 61ps (Girishchandrapur). Shale and sandstone are poorly yielding. Granite and granite gneiss have moderate yields. One to two fracture zones within 100 mbgl are of most common occurrence. In two places at Gogua and Paikamal where shale is encountered at shallow depth, the wells have to be abandoned due to formation collapse. The transmissivity values vary from 4.8 m2/day to 87.89 m2/day(Gogua). The static water level varies from 2.45 mbgl to 9.45 metres below ground level with a wells at Gogua showing seasonal autoflowing characteristics.

3.14 SOUTH WESTERN REGION(Karnataka)

Total 47 wells have been drilled in the state. The details are shown in Table-3.22.

Table-3.22. The details of ground water exploration in Karnataka

SL No	District	Achievement		
1	Davanagere	EW	OW	Total
		09	03	12
2	Mandya	13	04	17
3	Uttara Kannada (Normal)	09	02	11
4	Kolar-Deep drilling	04	03	07
	Total	**35**	**12**	**47**

Remote Sensing Studies for Ground Water Exploration in Davanagere & Kolar district:

Remote sensing studies were carried out in Davanagere and Kolar districts during the AAP to demarcate fracture zones for ground water exploration. During detailed interpretation of satellite data on 1:50,000 scale, it is seen that alignment of tanks in the areas are following the general trend of the lineament and also number of wells with high discharge are located in those areas. Valley fills interpreted from the satellite data are demarcated all along the drainage pattern of the area and considered to be good zones for ground water exploration. Suitable sites selected in good ground water prospects zones are recommended for Geophysical studies.

District wise findings of Ground Water Exploration

3.14.1 Davanagere District: 09 exploratory wells and 03 observation wells were drilled in Davanagere taluk, Davanegere district. Granite gneiss and schist are main geological formation exposed in the area. Six exploratory borewells were drilled in the schist formation and the yield ranged from dry to 4.00 lps. The remaining three wells drilled in Granitic gneiss formation shows the yield ranges from 1.60 to 3.00 lps. The high discharge is encountered in the schist formation however the maximum number of dry wells is also occurred in the schist formation. Total geographical area of this taluk is about 936.10 sq.km with well density of 1 well/104 sq.km. The depth of wells ranged from 126 to 200mbgl. Static water level ranged from dry to 38.2 mbgl. Specific capacity ranged from 4.54 to 36 lpm/m.d. The quality of ground water analysed for the exploratory wells are good and potable in nature.

3.14.2 Mandya: In total 13 exploratory wells and 4 observation wells were drilled in K.R.Pet, S.R.Patna, Pandavapura, Mandhya and Maddur talus of Mandhya distrct. The depth of exploratory wells ranged from 143-200 m.bgl. The area where the exploration programme was taken up is mainly underlain by granite and gneissic formations of Archaean age. Yield of exploratory wells ranged from 0.731 lps at Mahadevpura to 16.4 lps at Akkihebbalu. The deep-seated fractures are encountered at the depth of 150 to 200 mbgl. The chemical quality of ground water is good and potable for domestic and irrigation purposes. In the district an area of 1759 Sq km is covered under the present exploration.

3.14.3 Uttara Kannada district: Ground water exploration studies were carried out at nine sites in Sirsi, Siddapur and Ankola taluks of Uttar Kannada district and the salient data of each bore well is presented in Annexure-I.Studies have indicated that the fractures/ /porosity in the hard rocks is generally not uniform neither laterally nor with depth and appears to be negligible beyond 139.5m.

Ground water prospective zone having a yield of 4.16 lps up to a depth 139.5m occur along Kengre Nadi in Sirsi taluk and yield of 6.00 lps up to a depth of 75.2m occur in fractured metagraywacke along Arendur Nadi in Siddapur taluk. Ground water prospective zones having a yield of 18.3 lpm were encountered in weathered, fractured granite gneiss in the depth range of 32.5 to 78.2m at Yadurbail-Banavai in Sirsi taluk, on the eastern bank of Varada River.

The district falls under the category of “Normal”. Depth to water level in exploratory well ranged from 2.55 to 11.69 mbgl. Transmissivity is ranging from 2.09m^2/day to 25.988 m^2/day. The chemical quality of ground water is good and potable for domestic and irrigation purposes.

In the district, an area of 5199 Sq km is covered under the present exploration. Successful exploratory wells drilled in these taluks have helped to mitigate drinking water problem in problematic villages.

3.14.4 Kolar district (Deep drilling Programme to a depth of 500m): In total 7 wells (4 EW and 3 OW) were drilled in Mulbagal taluk.. In this area, a well field was constructed to find out the specific yield of the shallow aquifer. All the bore wells are drilled in the granite gneiss formation. The depth of the bore wells drilled in the taluk ranging from 24 to 305 m bgl with the yield ranging from < 1.00 to 24.00 lps (Mulbhagal APMC site). A deep-seated aquifer zones having depth range of 251m to 270 m with yield range of 1.17 to 8.2 lps have been encountered during the exploration in this taluk.

3.15 SOUTHERN REGION (Andhra Pradesh)

Total 72 wells have been drilled in the state. The details are shown in Table-3.23 & 3.24.

Table-3.23 District-wise Targets and Achievements of Ground water Exploration

S. No	District	Achievement				
		EW	OW	SH	PZ	Total
1	Medak (D)	15	7	-	-	22
2	Guntur (N)	14	3	-	-	17
3	Warangal/ Karimnagar (N)	-	-	-	17	17
4	Visakhapatnam (T)	9	3	-	-	12
5	East Godavari (N)	4	-	-	-	4
Total		**42**	**12**	**-**	**17**	**72**

D-Drought, N-Normal, T-Tribal

Table-3.24 District wise Summarised details of Ground Water Exploration

Sl. No.	District	Depth drilled (m bgl)	Zones tapped/ Fracture encoun-Tered (m bgl)	SWL (mbgl)	Draw Down (m)	Aquifer parameter (Transmissivity) (m^2/day)	Formation
1	Visakhapatnam	130-200	20-60	5-25	2.7-16.9	-	Granites
2	Medak	41-200	26-174	2.75-39	4.1-30.9	2.20-68	Pink/grey granites
3	Guntur	102-200	20-108	1.28-21.7	1.31-24.5	1.0-105	Granites, charnockites & migmatites
4	Warangal & Karimnagar	64-70	18-50	7.05-36.4	12.0-16.0	0.9-8.6	Granites
5	East Godavari	116-150	28-113	3.34-35	2.36-74.4	1.0-104	Sandstones

Saliant Features of Ground Water Exploration in A.P

3.15.1 Visakhapatnam District: The area explored is mostly underlain by khondalite and gneissic group of rocks (migmatitic). High yielding zones were encountered at the sites viz., Totada, Kakarapalli and Rebaka, where the discharge of the wells are in the range of 3.28 lps, 5.92 lps, and 5.64 lps. with low draw down rates. This indicates there is continuity in both vertical and lateral extension of the fracture zones encountered at depths and this highly fractured formation sustain long periods of pumping in the area due to nearby recharge conditions prevailing in the area. The quality of ground water is suitable for both domestic and irrigation requirements. T value is 2.20-68 m2/day

3.15.2 Medak district: The area explored is underlain by granites, gneisses of Archaean age, which are occasionally intruded by dolerite dykes. Majority of the area is drained by Godavari river and small part of the area is drained by Krishna river. The drainage pattern is dendritic to sub-dendritic. The depth of the exploratory wells ranges from 41.30 m to 200m. The fracture zones are mostly confined upto 75 m bgl in the area. Occasional occurrence of deep fractures of more than 100m were noticed at Jagadevpur, Dandupalli and Jangapalli villages. The yields of the bore well ranges from meager to 9.0 lps (Duddeda). High discharge of more than 3 lps was noticed at Gajwel, Duddeda and Siddipet villages. The aquifer performance tests were carried out at five places and found that the transmissivity of the formation ranges from 3 to 68 sq.m/day. The static water level ranges from 2.75 to 39.02 m bgl. with drawn down ranging from 4.16 to 30.9 m for a pumping duration of 1000 minutes. The quality of the ground water in the area is mostly alkaline in nature and suitable for both domestic and irrigation purposes.

3.15.3 Guntur district: Exploration was carried out in in hard rock areas of Guntur district. Majority of the area is drained by Krishna river and is underlain by granites, gneisses and sandstones. The depth of the bore wells ranged between 18.2 m and 200m. Majority of the area is drained by Krishna River. The discharge of the bore wells was in the range of 0.125 lps at Nidamarru to 7.0 lps at Rajupalem village. The Exploratory borehole drilled at Rajupalem village, piercing the shales and granite gneisses down to a depth of 115 m has yielded a discharge of 7.0 lps. The thickness of the weathered mantle ranges from 5.50 m to 19.20 m. In case of the bore well drilled at Guntur, the contact zone at 37m bgl between sandstones and granites was encountered. The static water level ranges from 1 to 21 m bgl. The transmissivity of the formations ranges from 7 to 12 sq.m/day, whereas at Rajupalem, it is 105 sq.m/day. The quality of ground water is generally good for both domestic and irrigation purposes. However, the quality of water at Guntur town is not suitable for both drinking and irrigation purposes.

3.15.4 Warangal & Karimnagar Districts: Construction of piezometers was carried out in Warangal and Karimnagar districts to monitor phreatic and semi-confined aquifers and increase the density of ground water monitoring wells. The depth of the piezometers was in the range of 59.0 to 71.10 m bgl. The yield ranges from meager (Mutsyale) to 1 lps (Jammikunta). The slug test conducted on these wells revealed that the transmissivity of the formation is upto 1 to 8.0 sq.m/day. The quality of ground water is mostly good for drinking and irrigation purposes.

3.15.5 East Godavari district: The area explored is underlain by Recent deltaic alluvial sediments comprising thin layers of medium to fine grained sand with lenses of clay in between and also underlain by Rajahmundry Sandstone. At places, weathered basalt is also encountered. Out of the four wells drilled, sub-surface Deccan trap was encountered between 124 and 125; and 113 and 116 at Mukundapura and Subhadrampeta respectively. Similarly, the Tertiary formation (Rajahmundry Sandstone) was encountered at Marripudi and Subhadrampet and Kakinada sites between the depths of 62 and 115, 42 and 116 and 76 and 110 m bgl, respectively. In all, the 4 sites explored in the area. The granular zones are occurring between 28.00-30.00; 32-40.00; 42.00-45.00; 52-58.0; 60-63.00; 68.00-76.00; 79-82.00; 86-89.00; 92-95.00; 104-115.00 and 130-133.00 m bgl respectively. The discharge from these wells varied from 0.92 to 1.7 lps with a draw down of 5.0 to 8.0 m. for a pumping duration of 1000 minutes. The quality of the formation waters in these aquifers are within the prescribed standards of domestic and irrigation needs of the area.

3.16 SOUTH EASTERN COASTAL REGION (Tamil Nadu)

Total 66 wells have been drilled in the state. The details are shown in Table-3.25 & 3.26.

Table-3.25 District-wise targets and achievements

Sl. No	District	Achievement		
		EW	OW	Total
1	**Erode (N)**	**9**	**4**	**13**
2	**Dharmapuri (D)**	**6**	**1**	**7**
3	**Krishnagiri (D)**	**3**	**2**	**5**
4	**Trichy (N)**	**-**	**2**	**2**
5	**Pudukkottai (N)**	**12**	**3**	**15**
6	**Perambalur (N)**	**8**	**-**	**8**
7	**Nagapattinam (N)**	**1**	**-**	**1**
8	**Tiruvarur (N)**	**-**	**2**	**2**
9	**Thanjavur (N)**	**2**	**2**	**4**
10	**Cuddalore**	**4**	**2**	**6**
11	**Villupuram**	**2**	**1**	**3**
	Total	47	19	66

Table-3.26: District wise Summarized Details of Ground Water Exploration in the State based on both contractual & departmental drilling

Sl No	**District**	**Depth Drilled**	**Zones tapped/ Fracture encountered**	**SWL (mbgl)**	**Discharge M^3/hr**	**Drawdown (m)**	**Aquifer parameter (T&S)**	**Formation**
1	Erode	25 - 29	10.5 - 189	1.7 – 35.75	2.6- 90	1.34 – 19.2		Charnockite &Gneiss
3	Pudukkottai	135-200	18 - 165	2.62 – 14.75	0.76 - 36.43	3 -12	T=1.03 - 117	Bio. Gn, Gr, Qtzite
4	Perambalur	200	7 - 15	0.5 – 2.78	0- 7.2	5 - 15	T=0 - 54	Bio. Gn, Garnet Bio Gn Gr, charnockite
5	Nagapattinam	350	264 - 338	5	64.8	0.15		Sandstone
6	Tiruvarur	100-215	71-210	8 - 19	16	2 - 10		
7	Thanjavur	54 - 450	42 - 419	5.33 - 11	16 - 90	1.2 – 4.3	9-48	
8	Cuddalore	300	100 - 285	16.5-60.15	5 - 20	0.7 - >40	30-680	
9	Villupuram	254 - 290	103 - 277	50 - 60	0.5 - 10	15.5		Sanddstone/ Limestone

Salient features of Ground Water Exploration in Tamil Nadu

Forty-three exploratory wells were drilled against the annual target of 24 by deploying departmental rigs under normal exploratory drilling programme. The target was exceeded by 79 %. The exploration has established the presence of potential fractures down to a depth of 189 m bgl. Out of 43 exploratory wells drilled, 14 wells yielded more than 2 lps. The highest yield of 27 lps during drilling was recorded in the exploratory well at Nichchampalayam, Erode district in hard rock terrain, whereas in the sedimentary formations, the highest yield of 18 lps was recorded at Vadakalattur, Nagapattinam district (constructed for Tsunami relief work). Cement sealing techniques were effectively adopted to seal the aquifers having poor quality in sedimentary area to facilitate selective screening of fresh water horizons.

High Yielding Well(Discharge- 23 LPS) at PANDARBHARANIA, Angul district, Orissa

3.17 KERALA REGION(Kerala)

Total 39 wells have been drilled in the state. The details are shown in Table-3.27.

Table-3.27 District Wise Achievements of Ground Water Exploration in Kerala

Sl. No	District	EW	OW	PZ	TOTAL
1.	Palakkad	-	-	22	22
2.	Trivendram	13	4	-	17
Total		13	4	22	39

District wise Saliant features of Ground Water Exploration in Kerala are as under:-

3.17.1 Palakkad district:- The various types of aquifers encountered during piezometer construction during FSP 2005-06 are fractured hornblende biotite gneiss, granitic gneiss and charnockite. The yield is up to 848lpm. The chemical analysis data of water samples of Piezometers at Chulliarmedu (2.2 mg/l), Annamthodu (2.3 mg/l), Chittoor (2 mg/l), Pallassana (2.1 mg/l), Thachankode (2.2 mg/l) and Vadavannoor (2mg/l) are with fluoride contamination and the level of contamination is slightly above permissible limit. The depth to water level in piezometers ranges between 1.25 and 23.5 mbgl. The drawdown ranged between 1.16m and 15.96m for 60 minute during Preliminary Yield test (PYT) done using compressor. The transmissivity value based on PYT ranged between 1.42 and 291 m^2/day.

3.17.2 Trivendram:- The EWs were drilled to a depth varying from 68.30m to 200 mbgl. At two sites the well could not be drilled to the target depth of 200m because of drilling problems and in three sites due to high discharge. The yield of EW ranges from 0.2 lps (0.72m^3/hr) to 7.0 lps (25.20m^3/hr). The DTW ranges from 0.65m to 11.85 mbgl. The fracture zones encountered are generally within 75 mbgl but potential fracture zones encountered at 163m and 172 metres at Malayadi and 192 m at Palayam. Many of the fracture zones are found to be unsaturated because of the thick clay formation as over burden. The quality of water is generally good. All the water samples show EC less than 500µs and fluoride less than 0.5mg/l.

3.18 NORH HIMALAYAN REGION (Dharamshala)

Total 12 wells including 5 wells in J&K have been drilled in the state. The details are shown in Table-3.28.

Table-3.28 Achievements of Ground Water Exoploration in HP

Sl. No	District	EW	OW	SH	PZ	TOTAL
1	Kangra	1	--	--	--	1
2	Una	4	--	--	--	4
3	Mandi	2	--	--	--	2
4	Leh(J&K)	5	--	--	--	5

Saliant features of Ground Water Exploration in H.P

3.18.1 Kangra District: District Kangra that come under Beas drainage Basin has it regional geology as Alluvium, Glacial moraines, Siwalik and the basement comprising of older metamorphics. During the AAP 2005-2006 an attempt has been made to find out the sub surface geology and the aquifer parameters of the alluvium and Valley Fills of the Kangra district. CGWB had been drilled 1 exploratory wells in the depth of 70.0 m bgl. It is found that the well drilled in alluvium of valley fills. The main water yielding aquifers are of sand, gravel, pebbles and boulders.

The static water level of these drilled wells is 12.17 m bgl and the discharge of these well ranges from 1105 lpm, Drawdown is 7.10 m . The Transmissivity of this well is 216.09 m^2/day.

The quality of the ground water in these areas is good and having the average EC < 750 µmhos/cm at 25°C and is suitable for drinking and irrigational use.

3.18.2 Una District: District Una that come under Soan drainage Basin has it regional geology as Alluvium and Siwalik. Central Ground Water Board had been drilled five tube wells 4 exploratory wells in the depth range of 79-205 m bgl. It is found that the well drilled in valley fill area has shallow to deep aquifers and are mainly of unconfined to semi-confined in nature. The main water yielding aquifers are comprising of sand, gravel, pebbles and boulders. The static water level of these drilled wells has the range of 11.90 m to 26.26 m bgl and the discharge of these well ranges 776-1360 lpm, Drawdown ranges from 5.8 m to 11.78 m and the Transmissivity of these well range from 364.77 to 374.77 m^2/day. The quality of the ground water in these areas is good and all the chemical parameters are under permissible limit.

3.18.3 Mandi District: District Mandi that come under Beas and Satluj drainage Basin has it Regional Geology as Alluvium, Siwalik, and Metamorphic. CGWB had been drilled five tube wells 2 Exploratory wells in the depth range of 54 – 140.98m bgl. It is found that the well drilled in valley fill area has shallow to medium aquifers and well tapping the hard rock has shallow to deep aquifers and are mainly of unconfined to semi-confined in nature. The main water yielding aquifers comprise of sand, gravel, pebbles and boulders in valley fills and fractures in hard rock area, which follows regional trend of the NNW-SSE direction.

The static water level of these drilled wells are very shallow i.e. 12.33 to 15.11 m bgl and the discharge of these well ranges 96 to 310 lpm m^3/hrs, Drawdown is 15.30 to 23.78 m and the Transmissivity of these well range from 10.11 to 28.149 m^2/day. Comparatively the well drilled in the valley fills has more yield than the hard rock area. The quality of the ground water in these areas is good and having the average EC < 750 µmhos/cm at 25°C and all the chemical parameters are under permissible limit for drinking and irrigational use.

3.19 State Unit Office(Delhi)

Ground Water Exploration is undertaken in Delhi and 25 wells have benn constructed out of which 10 EW, 5 OW, 8 PZ and 2 DW. The details are given in Table-3.29

Table-3.29 Details of Ground Water Exploration in Delhi State

Sl. No.	District	Depth Drilled	Zones Tapped/Fr Encountered	SWL mbgl	Discharge m3/hr	Draw down	Aquifer Parameters T & S	Formation
1	East Delhi-Kalan puri_EW-1	***64.00***	**23-32**	**9.05**	**42**	**5.03**	**T= 450-515**	**Alluvium**
2	Akshardham-EW-2	**120.00**	**17-23,25-31**	**6.28**	**78**	**4.6**	**T= 1250**	**Alluvium**
3	Akshardham-EW-3	**102.00**	**20-24,26-31**	**6.57**	**54**	**7.78**	**T= 2200**	**Alluvium**
4	Akshardham-EW-4	**118.00**	**17-23,25-31**	**6.45**	**78**	**7.84**	**T=900- 1575**	**Alluvium**
5	Akshardham-EW-5	**74.00**	**14-18,22-26,36-44.**	**5.83**	**60**	**9.13**	**T=1975**	**Alluvium**
6	Akshardham-EW-6	**86.00**	**21-29,36-44.**	**25**			**T=1222**	**Alluvium**
7	Akshardham-EW-7	111.00	21-30	38				Alluvium
8	Jagatpur-EW-8	94.00	15-17,20-22	2.80	42	2.69		Alluvium
9	Jagatpur-EW-9	75.00	13-17,22-25,32-36	3.25	66	3.15		Alluvium
10	Jagatpur-EW-10	80		3.90	24	6.75		Alluvium

Drilling of Exploratory well at Neyyattinkara in Trivandrum District with a discharge of 6 lps.(Formation- Khondalite)

Drilling of Exploratory well at Malayadi, Trivandrum District with a discharge of 7.0 lps. Rock type: Garnetiferous gneiss

4. DEVELOPMENTS AND TESTING OF WELLS

A tube well, is developed the construction to increase its specific capacity to prevent sand rushing into the well and to obtain maximum well life. Thereafter, pumping tests are conducted for evaluating aquifer characteristics i.e. transmitivity, storage co-efficient and well characteristics viz. specific capacity and well efficiency, with a view to evolve efficient design for tube wells, assessment of yield capabilities and spacing criteria for tube wells. The Board has got capacity of conducting 175 to 200 pumping tests per annum with the existing infrastructure facilities. With the increasing drilling activities, the Board is constructing on an average above 400 pumping wells every year, which have resulted in backlog of pumping tests. Procurement action has been initiated in the Board to equip the each rig unit with adequate pumping test unit. However, in spite of constraints faced by the Board in this aspect, a total of 245 wells were developed and tested during the year 2005-2006. Region wise achievement has been presented in Table 4.1

Table 4.1: REGIONWISE/STATEWISE PUMPING TESTS CONDUCTED IN THE YEAR 2005 – 2006

Sr. No.	Regions	State/ Union Territories	No of tests Upto March,2006 in wells		
			constructed during 2005-06	constructed in earlier Year	Total wells tested
1	NWHR, Jammu	Jammu & Kashmir	5	3	8
2	NWR,Chandigarh	Haryana	-	1	1
		Punjab	2	3	5
		Delhi	4 (DW-2)	3	7 (DW-2)
3	WR, Jaipur	Rajasthan	6	13	19
4	WCR, Ahmedabad	Gujrat	2	10	12
5	NCR, Bhopal	Madhya Pradesh	9	6	15
6	NCCR, Raipur	Chhattisgarh	17	-	17
7	CR, Nagpur	Maharashtra	31 (PT-4)	-	31* (PT-4)
8	NR, Lucknow	Uttar Pradesh	7	13	20
9	MER, Patna	Bihar	-	5	5
		Jharkhand	3	-	3
10	ER,Kolkata	West Bengal	8	6	14
11	NER, Guwahati	Assam	1	11	12
		Meghalaya	1	4	5
		Tripura	1	-	1
12	SER ,Bhubneswar	Orissa	7	13	20
13	SR, Hyderabad	Andhra Pradesh	8	5	13
14	SWR, Bangalore	Karnataka	7	1	8
15	SECR, Chennai	Tamilnadu	9	4	13
16	KR, Kerala	Kerala	4	3	7
17	NHR, Dharamshala	Himachal Pradesh	5	2	7
18	UR, Dehradun	Uttaranchal	-	2	2
TOTAL			**137**	**108**	**245**

* 27 Exploratory Wells tested on the basis of Compressor Test.

5. TAKING OVER OF WELLS BY STATES

5.1 Exploratory Wells

The exploratory drilling sites are selected in consultation with the State Government Departments considering that, successful exploratory wells would be converted into production wells once taken over by States. Till March 2006, total 11581 wells have been drilled, out of which 8886 successful exploratory wells have been constructed and only 8386 wells have so far been accepted /taken over by State Governments while 500 successful wells are yet to be accepted/ taken over by them. The status of handing over of exploratory wells drilled by Central Ground Water Board to the State Government as on 31-3-2006 is presented in table 5.1

Table 5.1: **HANDING OVER OF WELLS DRILLED BY CGWB**
(As on 31.03.2006)

Sl. No.	State/ Union Territories	Total wells drilled	Total successful Wells	No. of wells Handed over	No. of wells to be Handed over
A. STATES					
1	Andhra Pradesh	1113	796	765	31
2	Arunachal Pradesh	28	25	16	9
3	Assam	276	227	180	47
4	Bihar	236	189	175	14
5	Chhattishgarh	458	414	408	6
6	Goa	58	49	49	-
7	Gujarat	838	522	467	55
8	Haryana	361	192	192	-
9	Himachal Pradesh	144	131	114	17
10	Jammu& Kashmir	258	207	187	20
11	Jharkhand	261	214	202	12
12	Karnataka	1034	875	852	23
13	Kerala	338	237	235	2
14	Madhya Pradesh	720	444	430	14
15	Maharashtra	927	789	773	16
16	Manipur	25	15	14	1
17	Meghalaya	73	62	13	49
18	Mizoram	3	3	3	-
19	Nagaland	11	7	6	1
20	Orissa	1029	938	919	19
21	Panjab	154	130	124	6
22	Rajasthan	1005	711	705	6
23	Sikkim	31	10	6	4
24	Tamilnadu	842	619	598	21
25	Tripura	56	50	42	8
26	Uttaranchal	50	40	32	8
27	Uttar Pradesh	704	564	501	63
28	West Bangal	329	280	260	20
	Total	**11362**	**8740**	**8268**	**472**
B. UNION TERRITARIES					
1	Andaman & Nicobar	46	12	10	2
2	Chandigarh	7	7	6	1

Sl. No.	State/ Union Territories	Total wells drilled	Total successful Wells	No. of wells Handed over	No. of wells to be Handed over
3	Dadara & Nagar Haveli	12	8	8	-
4	Delhi	124	106	81	25
5	Pondicherry	30	13	13	-
TOTAL		**219**	**146**	**118**	**28**
GRAND TOTAL		**11581**	**8886**	**8386**	**500**

5.2 Deposit Wells

In addition to its exploratory drilling programme, the Board also undertakes construction of production wells on specific requests for Defence and other Govt. agencies to meet their immediate water supply requirements. During 2005-2006, 2 deposit wells was constructed by the Board for National Open School at Delhi given in table 5.2.

Table 5.2: CONSTRUCTION OF DEPOSIT WELL DURING 2005-2006

Sl. No.	State	District	No. of Deposit Wells Constructed
1	Delhi	Delhi	2
Total			**2**

6. WATER SUPPLY INVESTIGATIONS

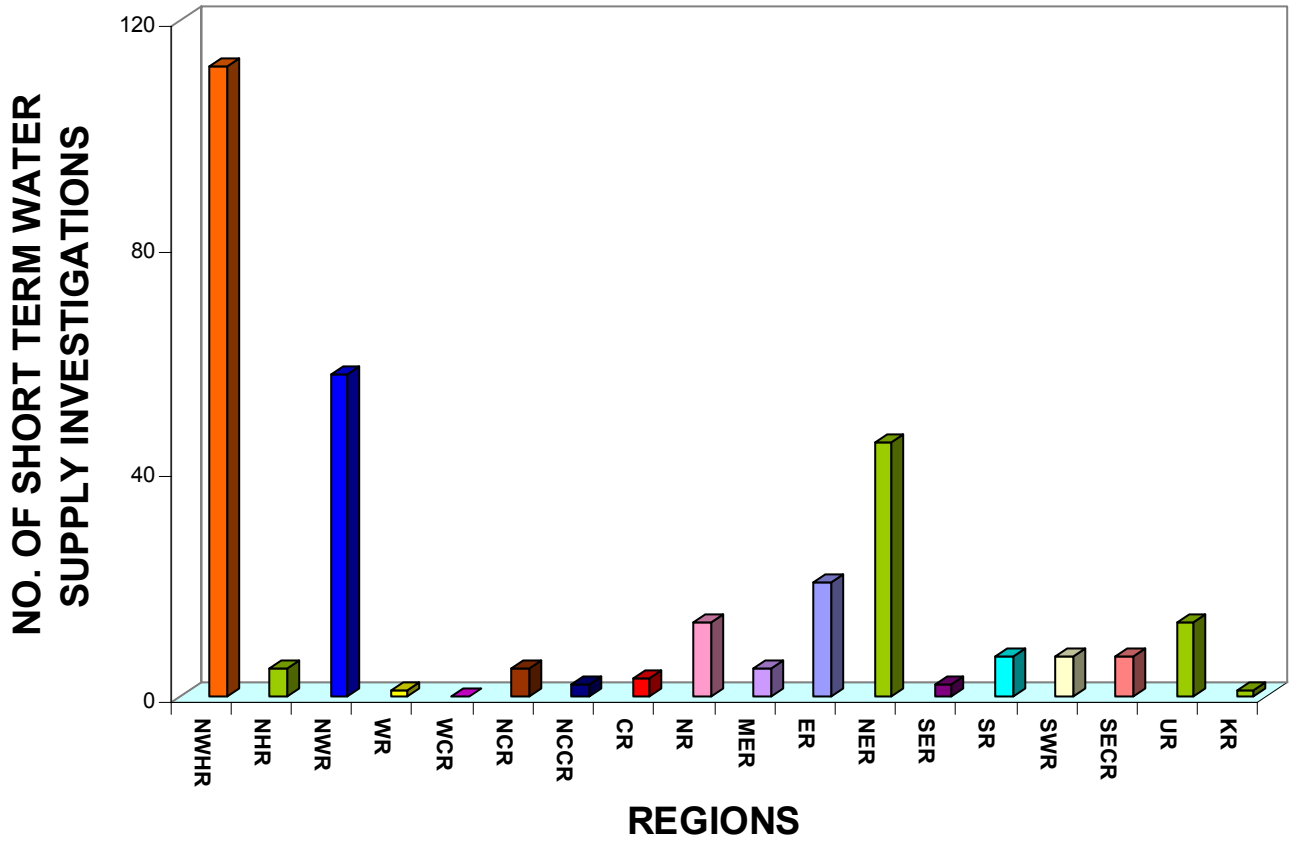
The Board provides assistance to various urban, defence and public sector establishments to solve their immediate water supply problems by selecting suitable sites for construction of ground water abstraction structures. During 2005-06, 305 Water Supply Investigations were carried out and region wise/state wise status is given in table 6.1 and fig. 6.1

Table 6.1 : REGION/STATEWISE WATER SUPPLY INVESTIGATIONS TAKEN UP DURING 2005-2006

Sl. No.	Regions	States	Number of Water Supply Investigations
1	**NORTHERN WESTERN HIMALAYAN REGION**	Jammu & Kashmir	112
2	**NORTHERN HIMALAYAN REGION**	Himachal Pradesh	5
3	**NORTH WESTERN REGION**	Punjab	14
		Chandigarh	02
		Haryana	07
		Delhi	34
4	**WESTERN REGION**	Rajasthan	1
5	**WEST CENTRAL REGION**	Gujarat	0
6	**CENTRAL REGION**	Maharashtra	3
7	**NORTHERN REGION**	Uttar Pradesh	13
8	**UTTARANCHAL REGION**	Uttaranchal	13
9	**EASTERN REGION**	West Bengal	**20**
10	**NORTH CENTRAL REGION**	Madhya Pradesh	**5**
11	**NORTH CENTRAL CHATTISGARH REGION**	Chhattisgarh	**2**
12	**MID EASTERN REGION**	Bihar & Jharkhand	**5**
13	**NORTH EASTERN REGION**	Assam	**22**
		Meghalaya	**21**
		Nagaland	**2**
14	**SOUTH EASTERN REGION**	Orissa	**2**
15	**SOUTERN REGION**	Andhra Pradesh	**7**
16	**SOUTH WESTERN REGION**	Karnataka	**7**
17	**SOUTH EASTERN COASTAL REGION**	Chennai	**7**
18	**KERALA REGION**	Kerala	**1**
Total			**305**

REGION WISE STATUS OF SHORT TERM WATER SUPPLY INVESTIGATIONS (DURING 2005-2006)

Fig 6.1



7. HYDROLOGICAL AND HYDROMETEROLOGICAL STUDIES

Hydrological and hydrometeorological studies play an important role in the assessment and management of ground water resources of an area. Hydrological and hydrometeorological data collected during the course of various hydrologeological surveys & investigation, exploration, hydrograph network monitoring etc are being entered into the computerized and analysed following standard techniques. The results are incorporated suitably in different reports.

7.1 Hydrological Studies :- Hydrological studies are carried out as a part of ground water management studies, artificial recharge studies as well as conjunctive use studies.

1. Detailed hydrological studies have been carried out as a part of Conjunctive use studies in the following irrigation command areas

   (i) Rushikulya Command Area, Orissa.
   (ii) Western Yamuna Canal Command Area, Haryana.
   (iii) Sri Ramsagar Canal Command Area, Andhra Pradesh.

The hydrological studies carried out in the Canal Command Areas included.

- Preparation of Drainage map and morphometer analysis for determination of catchment characteristics, the data has been utilised in arrking of optimal Conjunctive use plan.
- Estimation of Canal seepage in the irrigation command and adopting various techniques and the data has been suitably utilised in assessment of total availability of water in the command as well as in ground water simulation studies.
- Rain gauge data has been collected from various aquifer and analysed for estimation of surface water availability.
- Infiltration test has been carried out at selected places in the irrigation command to establish the parameter related for infiltration factor.

2. Hydrological Study as aid in ground water management study: Various hydrological data related to basin characteristics and rain gage data has been collected, computerized and analyzed used in overall planning and management of ground water. The data has been suitably interpreted in ground water management study report/ state report/ district report/brochure etc.

3. Detailed hydrological study carried out as aid in Artificial Recharge Studies for estimating the runoff from the catchment and availability of water for artificial recharge to ground water.

.4. Preparation of Watershed Atlas of India :- One of the major activity during the year was preparation of basin wise watershed map of the entire Country. The drainage map of 1:250,000 scale was used as a base map for demarcation of watershed. The compilation work has been taken up at CHQ, Faridabad, pooling the officers from Regional offices. In the first step paper maps have been prepared by demarcating the watershed boundaries on the drainage map for all the 34 major basins, in the second step all the paper maps will be digitized and finally converted into digital watershed map in GIS plat form. The preparation of paper maps of basin wise watershed on 1:250,000 scale was completed during the year.

7.1.1 SOUTH EASTERN COASTAL REGION (Tamil Nadu)

Like several states in India, the state of Tamil Nadu comes under the grip of drought conditions frequently, which hit a crippling blow to the economy of the state as well as that of the country. Study of the variability of rainfall over the districts of Krishnagiri, Coimbatore and Madurai, Tamil Nadu, was taken up. Under this, it was undertaken to analyse long-term rainfall data (1901-2000 and beyond) with a view to study the variability of annual

rainfall and seasonal rainfall (SW monsoon and NE monsoon), incidence, intensity and periodicity of droughts over Coimbatore district, Tamil Nadu. For this purpose, annual/seasonal rainfall data for available rain gauge stations spread over the respective districts have been statistically analysed and the results are presented in the form of various maps and tables. For each station, the 100-year normal annual/seasonal rainfall has been computed and the probability of occurrence of normal rainfall has been studied. The departure of each year's annual/seasonal rainfall from the normal has been computed. Based on this departure, the category of drought, if any, has been determined and "drought areas" have been demarcated. The frequency of occurrence of drought at each station has also been estimated in terms of number of years per drought. The trend of annual rainfall at each rain gauge station over the study period has been determined. The variation in long-term normals of rainfall (50 years Vs 100 years) at each station has also been studied.

Hydrological studies in Tamirabarani River basin- study includes collection and analysis of data of river discharge, canal release, command area under different canal system for different periods, calculation of water requirement details for different uses, collection of statistical details on land uses, crops, cropping pattern and intensity of irrigation, calculation of crop water requirements, soil infiltration tests for different soil groups etc. 28 infiltration tests were conducted within the basin area. Collection of statistical data such as rainfall, land use, availability of surface water harvesting structure and their capacity, water spread area and agricultural data of the river basin, was also carried out.

Calculated surplus runoff of Cuddalore, Tiruvannamalai, Nagapattinam and Villupuram districts for preparation of Artificial Recharge Projects.

7.2 Hydrometeorological Studies:- Hydrometeorological Studies forms a part of ground water management study, conjunctive use study as well as Artificial Recharge studies. It provides the various climatological data which helps in estimation of ground water resources as well as planning the development and management of ground water. The data being generated various studies through out the country entered into the database and analysed using standard techniques. Specific modal has been added into the GEMS Software for statistical analyze of rainfall and other meteorological data. The various hydrometeorological studies carried out during the year in different Regional Offices is summarized below

7.2.1 NORTH WESTERN REGION (Punjab and Haryana)

- The yearly rainfall data has been collected for 17 districts of Punjab and 19 districts of Haryana for the year 2005-06 and the same has been computerized and analysed to district wise to estimate the mean monthly rainfall, seasonal and annually rainfall.
- The monthly rainfall data has been utilised for computerization of annual departure from the normal as well as with previous year.
- The percent deviation of rainfall has been compared with the quarterly monitoring especially for the month of May, August, November 2005 and January 2006. The analysis and results have been incorporated in the quarterly ground water monitoring report.
- The results of the analysis of rainfall data along with the graphical presentation for the entire water year forms a part of the Ground Water Year 2005-06 which is one of the important publication of the Region.
- The Block wise rain fall of monsoon / non-monsoon data has been compiled and being used for ground water resource estimation as per the GEC 1997.
- Hydrometeorological studies involving collection and compilation of various climatological data has provided important input in preparation of various reports given as
  - Punjab State Report
  - Gurgao, Jind, Panipat district reports.

The various analysis carried out are as given below

- Probability analysiis of rainfall
- Drought analysis
- Preparation of various maps / graphs including isohytal maps
- Climatic classification using

7.2.2 CENTRAL REGION (Maharashtra)

7.2.2.1 Climatological input for District & RHS Reports:-

Climatological input for the district reports were provided for Yavatmal and Satara and also for Reappraisal reports of Solapur and Yavatmal districts. These climatological chapters include detailed analysis of rainfall of all raingauges in the district with isohytal maps, temperature, relative humidity and wind speed and direction and plates showing:

a) Normal annual rainfall and probability of occurrence of normal annual rainfall.
b) Co-efficient of variation of rainfall and demarcation of drought area.
c) Rainfall trend.

Apart from the above, analysed rainfall data for all the District Head Quarters of Maharashtra. Prepared hydrometeorological write up of Nanded district for Mass Awareness Programme and preparation of write up for Rainfall Analysis of Nagpur city.

7.2.2.2 Development of Hydrometeorological Database:-

Updated and maintained hydrometeorological database of Maharashtra, which includes:

a) Compilation of rainfall data of 42 IMD Observatories from daily weather reports of Nagpur and Mumbai.
b) Data received from district Collectorates .
c) Statistical data received from socio-economic Reviews of Maharashtra.

7.2.2.3 Hydrometeorological Data Analysis for Ground Water Year Book:

The hydrometeorological data for Ground Water Year Book for 2005-2006 was analysed and maps were prepared for inclusion in the Year Book.

7.2.2.4 Hydrometeorological Data Analysis for HS Reports:

Hydrometeorological data are analysed and correlated with ground Water levels after monsoon hydrograph monitoring for the preparation of status report on ground water levels during August 2005 and November 2005. These are supported by plates and detailed analysis in the form of tables.

7.2.3 WESTERN REGION (Rajasthan)

- Tabulated monthly rainfall data (2004) of all the seven Rain Gauge Stations of Sikar district .
- Completed compilation of notes on the hydro-meteorological conditions prevailing in Alwar urban area and Govindgarh block of Jodhpur district.
- Analysed rainfall data of Jaisalmer district.
- Climatology of Bikaner observatory.

- Processed rainfall data (1971-2004) of all the Rain Gauge Stations of Jodhpur, Barmer and Jaisalmer districts.
- Tabulation of monthly rainfall data of the year 2004 of various Rain Gauge Stations of the State .
- Compilation of hydrometeorological chapter of Jodhpur district report. Compilation of rainfall data (1994-2004) of 65 overexploited blocks was completed.
- Analysed rainfall data of Jaisalmer and prepared a short note on the climatological conditions of the district.
- Analysed of rainfall data of Jaisalmer district.
- Analysed 30 years rainfall data (1974-2003) of Tapukrah and Tizara block of Alwar district. Compiled a detailed note describing hydrometeorological conditions prevailing in these blocks.
- Computed district-wise average annual rainfall (June-May) for a period of 10 years i.e. from 1994-95 to 2003-04 and tabulated district – wise rainfall for the period June, 2004 – May, 2005 and percentage departures from average annual rainfall. Co-related rainfall with fluctuations in National Hydrograph Stations.
- Computed year-wise average annual rainfall in the state during the period 1971-2000. Calculated percentage departures of each years rainfall from the mean annual rainfall. Constructed Bar-Diagram of annual rainfall along with departure curve. Prepared a note describing rainfall pattern and occurrence of various types of drought during this period.
- Compiled monthly monsoon rainfall data for the year 2005 of the State.
- Computed 10 years average annual rainfall of the State for the year 1995 to 2004.
- Analysed annual rainfall data for the period 1974-2003 and completed hydro-meteorological chapter for inclusion in the district report of Tonk district.
- Completed analysed of annual rainfall data of various Rain Gauge Stations of Ajmer for the period 1975-2004.
- Compilation of hydro-meteorological chapter for inclusion in the reappraisal report of Ajmer district was completed.
- Computed district wise average annual rainfall (June – October) for a period of 10 years i.e. from 1995 to 2004. Prepared a table displaying these values along with district wise rainfall for he period 6June,2005 to October , 2005 and percentage departures from average annual rainfall. Co-related rainfall with fluctuations in National Hydrograph stations.
- Compilation of hydrometeorological report of Rajasthan State, explaining rainfall distribution and pattern during the last 30 years completed.
- Compilation of hydrometeorological chapter of Nagaur district is completed.
- Tabulation of monthly rainfall data of the year 2005 of various Rain Gauge Stations of the State completed.
- Compilation of hydrometeorological chapter of Jalore district was completed.
- Compilation of hydrometeorological chapter of Ground Water Year Book 2004-05 was completed.

7.2.4 NORTH CENTRAL REGION (Madhya Pradesh)

Monsoon rainfall is the main source of recharge to ground water and rainfall pattern has an important impact on groundwater levels in the phreatic aquifer. Rainfall in the State occurs during south west monsoon season (mid June to September) and sometimes during winter (November to February). Most of the rainfall (more than 90%) occurs during the south west monsoon season, August being the rainiest month.

The rainfall data for the period June 2005 to September 2005 (monsoon period) of 48 IMD rain gauge stations located in Madhya Pradesh was collected from land record office, Gwalior. The Isohyetal map for monsoon rainfall 2005 shows that the normal southeastern parts of Madhya Pradesh receive more rainfall as compared to western parts

of the State. The monsoon rainfall varied from 454 mm in Badwani in the south-western corner of the State to 2145.6 mm. in Katni in the west central part of the State. Also, during the year 2005 west central part of Madhya Pradesh received higher rainfall as compared to rest of the State, except Sheopur, which lies in the northern part of the State. The average monsoon rainfall in the State during the monsoon 2005 was 974 mm., which is almost equal to average normal monsoon rainfall of the State (977 mm). In 2005, monsoon rainfall, more than 1250 mm. occurred in Katni, Jabalpur, Panna, Satna, Damoh, Chhindwara, Balaghat, Dindori, Mandla, Umaria, Narsimhapur, Sagar, Vidisha and Sheopur districts and rainfall less than 600 mm. was recorded in Gwalior, Datia, Shivpuri, Bhind, Morena, Mandsaur, Ujjain, Rajgarh, Dewas, Badwani and Burhanpur Stations.

The departure of the monsoon rainfall from normal was computed as per IMD norms. Departure of rainfall for the year 2005 for the normal has also been calculated. During the year 2005, out of 48 stations, 22 stations received normal rainfall, 16 stations received deficit rainfall and 10 stations received excess of normal rainfall. The western parts of MP has received less than normal rainfall varies from 0 to 53% The minimum rainfall received at Dewas is 47% of the normal rainfall. Katni recorded double of the normal rainfall (201.56% of the normal rainfall)

7.2.5 NORTHEN REGION (Uttar Pradesh)

7.2.5.1 Hydrometerological studies .

a)Written the Hydrometeorological chapter including ploting of Normal rainfall and climatical factor and Isohyetal Map for Khderi, Siddharthnagar, Basti, Aligarh, Maharajganj and Agra.
b) Compiled the station wise monthly and yearly rainfall for year 2004 and calculated Normal Rainfall for Sonebhadra, Allahabad and Jalaun. Also plotted the station wise variation (monthly) of Normal Rainfall.
c) Collected and compiled the stationwise monthly and yearly rainfall for year 2001 to 2004 for all the available Raingauge stations of U.P. from Board of Revenue.
d) Collected daily rainfall data of 15 IMD stations for Jan to March 2005 from Amousi IMD office.
e) Demonstrated the Measurement of climatic factor to trainees (CGWB) at Allahabad IMD observatory onSept.2005
f) Daily rainfall data at Bhujal Bhawan for 1.4.05 to 31.3.06 collected for Artificial Recharge

It is observed that the average Annual Rainfall for 2001 to 2004 is decreasing sharply in respect of Normal Annual Rainfall of 1901 to 1970 in U.P. This will effect the ground water recharge.

7.2.6 SOUTH EASTERN REGION (Orissa)

Block wise monthly rainfall data for all the 30 districts were collected and and the same is being computerised for various users. Rain fall data of IMD stations from IMD office, Bhubaneswar were collected.

7.2.7 SOUTH WESTERN REGION (Karnataka)

Planning and execution of hydrological and hydrometeorological work is basically undertaken. The work involved collection, compilation, analysis and interpretation of all relevant data. During this year rainfall, data pertaining to the year 2005 was collected from various central and state departments. The same is compiled and computerised with a view to efficient management and retrieval. Presently rainfall data is available from 1901 to 2005.

A report on Rainfall Statistics based, on data for the period 1971 to 2000 was compiled and submitted. Also submitted a report on rainfall distribution during the period 2001 to 2005. Draft Guidelines on Hydrometeorology were finalised and the same are being scrutinised by the Commissioner (GW). In addition data analysis and interpretation was carried out for periodic NHS reports, Hydrogeological survey reports and resources estimation reports.

7.2.7.1 Rainfall distribution during 2005:

Pre monsoon season had been extremely bad except for Mandya district where it was normal. During the monsoon season, most parts of the state had excess rainfall. Northern dry districts, Bangalore rural, coastal and Malnad districts had normal rainfall. In the case of post monsoon season, the coastal districts, Belgaum, Bijapur, Dharwar and Gadag districts had deficit rainfall. Normal rainfall was recorded in Bagalkot, Koppal, Bellary, Davangere, Haveri, Shimoga, Chikmagalur and Kodagu districts. All other districts had excess rainfall.

The year had normal to excess rainfall, in the state. A perusal of the isohyetal map indicates that rainfall from over 3000mm in the west to less than 800mm in the east. Where as the rainfall had been excess in the east, it was normal in the west. Where as 2001 was a deficit to normal rainfall year, the years 2002 and 2003 were deficient through out the state. The year 2004 was a normal year and the year 2005 experienced normal to excess rainfall.

7.2.8 SOUTHERN REGION (Andhra Pradesh)

During the year, computerized daily meteorological data collected from IMD in Andhra Pradesh for 2004-2005. Collected rainfall data from revenue stations in Andhra Pradesh for 2005. Computerized monthly seasonal and annual potential evapotranspiration for IMD stations in Andhra Pradesh. Computerised normal monthly seasonal, annual rainfall and last decadal mean rainfall. Computed percentage deviation of the periodical rainfall from the corresponding periodical rainfall during the last year and that during the last decadal mean for the periods Jan. 05 – May 05, June 05 – Aug. 05, June – 05 – Oct. 05 and June 05-Dec.05. Computerized trend of annual rainfall based on the rainfall data for the period 1970 to 2005 for the districts of East Godavari and Adilabad districts. The analysis of rainfall data has been included in ground water monitoring reports, Ground Water Year Book 2004-2005, District reports and reports on ground water management studies. Correspondence with different firms was made for purchase of material for raingauge station to be established in Osmania University campus. Registration of revenue rainfall data from excel format to GEMS format was also done.

7.2.9 KERALA REGION (Kerala)

Analysis of monthly rainfall data pertaining to Alleppey, Ernakulam and Kottayam Districts carried out.

8. MONITORING OF GROUND WATER OBSERVATION WELLS

Monitoring of ground water regime is an effort to obtain information on ground water levels and chemical quality through representative sampling. The primary objective of the ground water monitoring is to record the response of ground water regime to the natural and artificial conditions of recharge and discharge with reference to geology, climate, physiography, land- use pattern and hydrologic characteristics. The natural conditions affecting the regime involve climatic parameters like rainfall, evapotranspiration etc and the artificial conditions include pumpage from the aquifer, recharge due to irrigation system and other manmade causes like waste disposal etc. The database generated in the formulation of ground water development and management programme. The ground water level and quality monitoring has provided valuable information in management of Coastal as well as inland saline environment to assess the changes in saline water /fresh water interface as also the gradual quality changes in the fresh ground water regime.

The objective of ground water monitoring can be broadly summarized as:

- Study of interrelationship between ground water and climatic parameters.
- Study of influence of geology, topography and land use on ground water regime
- Understanding the role of ground water in the hydrologic cycle and influence of the recharge on ground water storage changes, chemistry and temperature
- Application of ground water monitoring data for reference purposes, prediction measures, environment controls and estimation of Reserve.

As a part of the International Hydrological Decade Programme, Geological Survey of India had established a net work of observation wells in the year 1969 for monitoring of ground water level and quality in the country. Since the merger of Ground Water Wing of Geological Survey of India with Central Ground Water Board in the year 1972, the number of network observation wells has been increased to have more realistic picture of ground water regime

The majority of monitoring wells of the Board are open dug wells owned by private individuals or other organizations. A number of purpose built piezometers have also been constructed by the Board to monitor the changes in water level in phreatic as well as confined aquifers. The data generated from the monitoring wells are regularly computerized, analysed and presented in the form of maps and data sheets for use of the ground water development planners and concerned agencies. The Board is at present monitoring more than 15000 observation wells in the country, four times in a year. The ground water samples are collected once in a year during pre-monsoon (April/May) for ground water quality monitoring. During 2005-2006, the Board has undertaken monitoring of ground water regime through **15640** no. of Network Station spread over the country. The data acquisition from groundwater monitoring station has been strengthened by installing digital water level recorders in selected wells and high frequency data is being collected and analyzed for various purpose.

The Region/ Statewise distribution of Monitoring of Ground Water Observation Wells (National Hydrograph Network Station) is shown in table 8.1 and fig 8.1. The cumulative progress of monitoring of these stations is shown in fig 8.2

Table 8.1: REGION/STATEWISE DISTRIBUTION OF MONITORING OF ROUND WATER OBSERVATION WELLS (NHNS)

Regions/States	Total No of NHNS as on 31.03.2006
NORTHERN WESTERN HIMALAYAN REGION	
Jammu & Kashmir	206
NORTHERN HIMALAYAN REGION	
Himachal Pradesh	85
NORTH WESTERN REGION	
Punjab	261
Chandigarh	16
Haryana	426
Delhi	87
WESTERN REGION	
Rajasthan	1373
WEST CENTRAL REGION	
Gujarat &	966
Daman & Diu	4
CENTRAL REGION	
Maharashtra	1496
Dadra & Nagar Haveli	10
NORTHERN REGION	
Uttar Pradesh	1218
UTTARANCHAL REGION	
Uttaranchal	44
EASTERN REGION	
West Bengal &	909
Andaman & Nicobar	63
NORTH CENTRAL REGION	
Madhya Pradesh	1325
NORTH CENTRAL CHATTISGARH REGION	
Chhattisgarh	516
MID EASTERN REGION	
Bihar	373
Jharkhand	208
NORTH EASTERN REGION	
Assam	381
Arunachal Pradesh	19
Manipur	25
Meghalaya	38

Regions/States	Total No of NHNS as on 31.03.2006
Nagaland	17
Tripura	42
SOUTH EASTERN REGION	
Orissa	1214
SOUTHERN REGION	
Andhra Pradesh	981
SOUTH WESTERN REGION	
Karnataka	1499
Goa	53
SOUTH EASTERN COASTAL REGION	
Tamil Nadu &	906
UT of Pondicherry	15
KERALA REGION	
Kerala	864
Total	**15640**

8.1 Ground Water Level Scenario in May, 2005

A perusal of depth to water level map of India during Pre-monsoon (May, 2005) is given in fig 8.3 reveals the following. In Sub-Himalayan area, North of river Ganga, generally the depth to water ranges from 2 – 10 meter below ground level (mbgl). In the Eastern part of the country in the Brahmaputra Valley water level generally ranges from 2 – 5 m bgl, except in isolated pockets where depth to water level is less than 2 m bgl. However, in upper Assam, isolated pocket of deeper water level, 5 – 10 m bgl has been observed. In major parts of Indus basin, depth to water level generally ranges from 10 – 20 m bgl. In the Western part of the Country covering states of Gujrat and Rajasthan deeper water level is recorded in the range of 10 – 20 m.bgl. Depth to water level more than 40m has also been observed in Jodhpur, Churu, Jalore, Nagpur, Jhunjhunu and Jaipur district of Rajasthan. In the West Coast, water level generally ranges from 5 – 10 m. Western part of Maharashtra recorded water level less than 5m. In the East Coast i.e. Coastal Andhra Pradesh and Orissa, generally the water level ranges between 2 – 5m. However, isolated pockets of water level less than 2m has also been recorded. Eastern most part of west Bengal recorded water level in the range of 5 – 10 m bgl. In Central India water level generally varies between 5 – 20 m bgl, except in isolated pockets where water level is more than 20 m bgl. The peninsular part of the Country generally water level ranges between 5 – 20 m bgl except in pockets where water level is more than 20m bgl. Isolated patches of deeper water level in the range of 20 – 40 m and more than 40m have also been in various parts of the country.

REGIONWISE NATIONAL HYDROGRAPH NETWORK STATIONS MONITORED DURING 2005-2006

Fig. 8.1

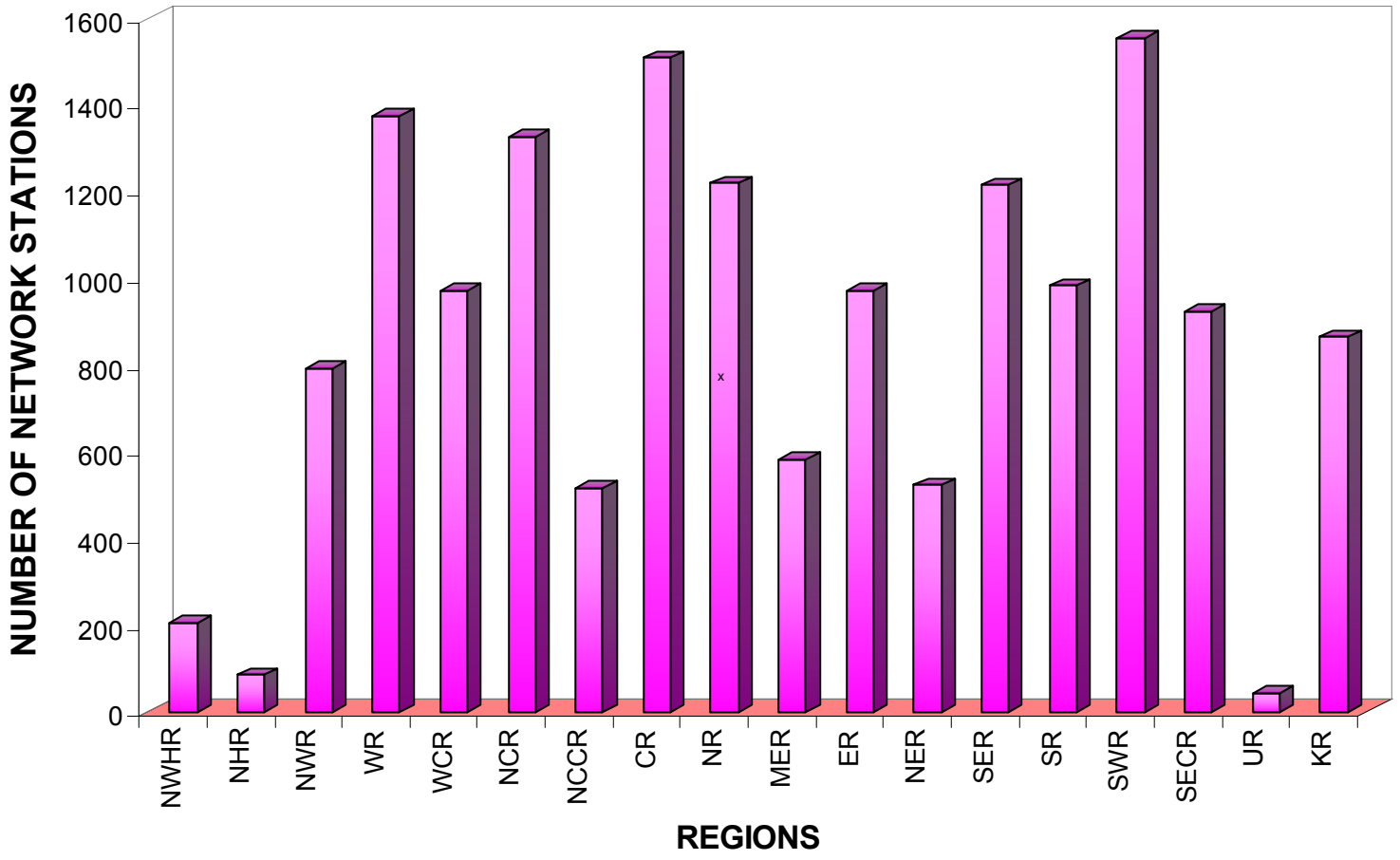


Fig. 8.2

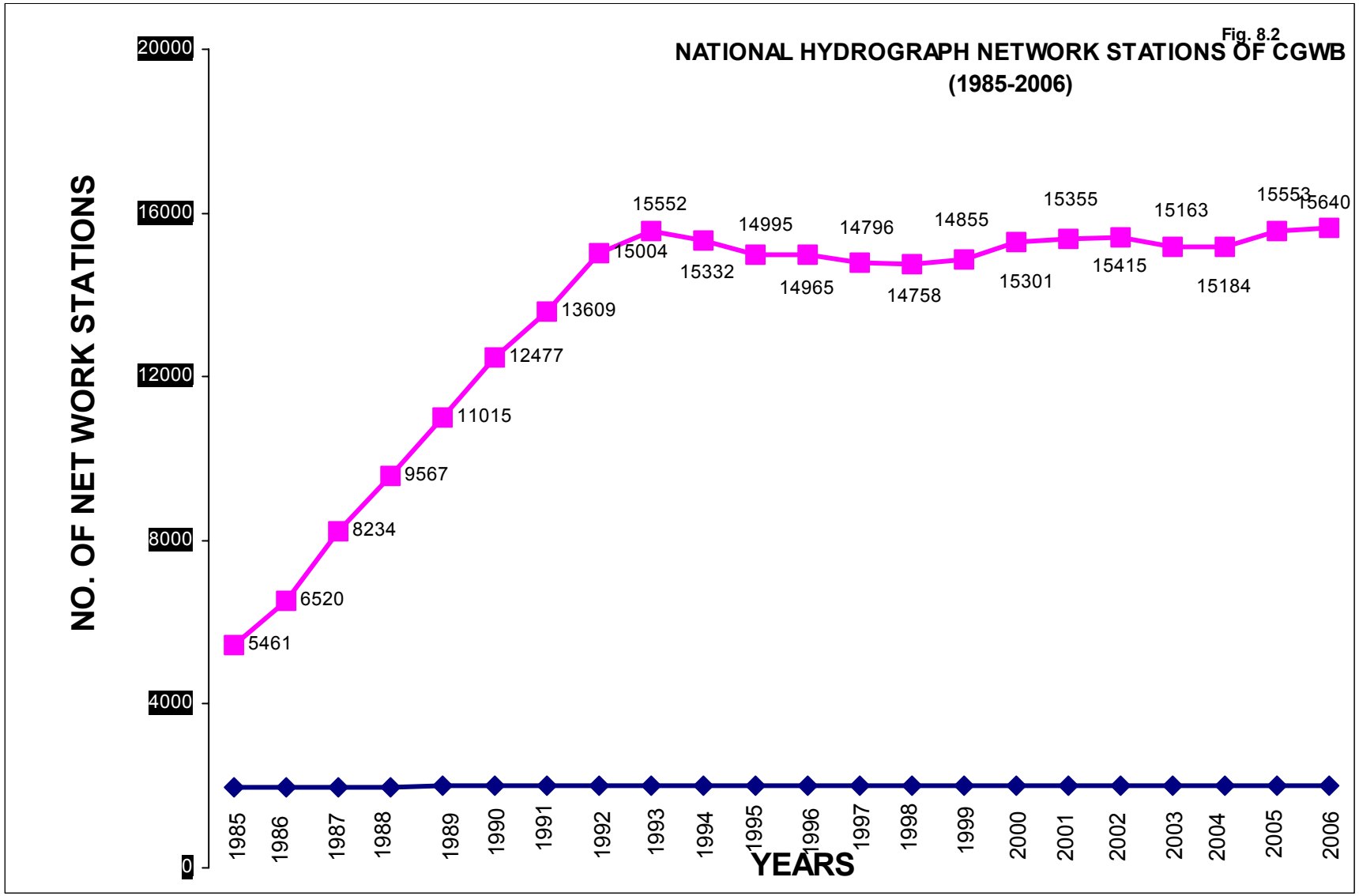
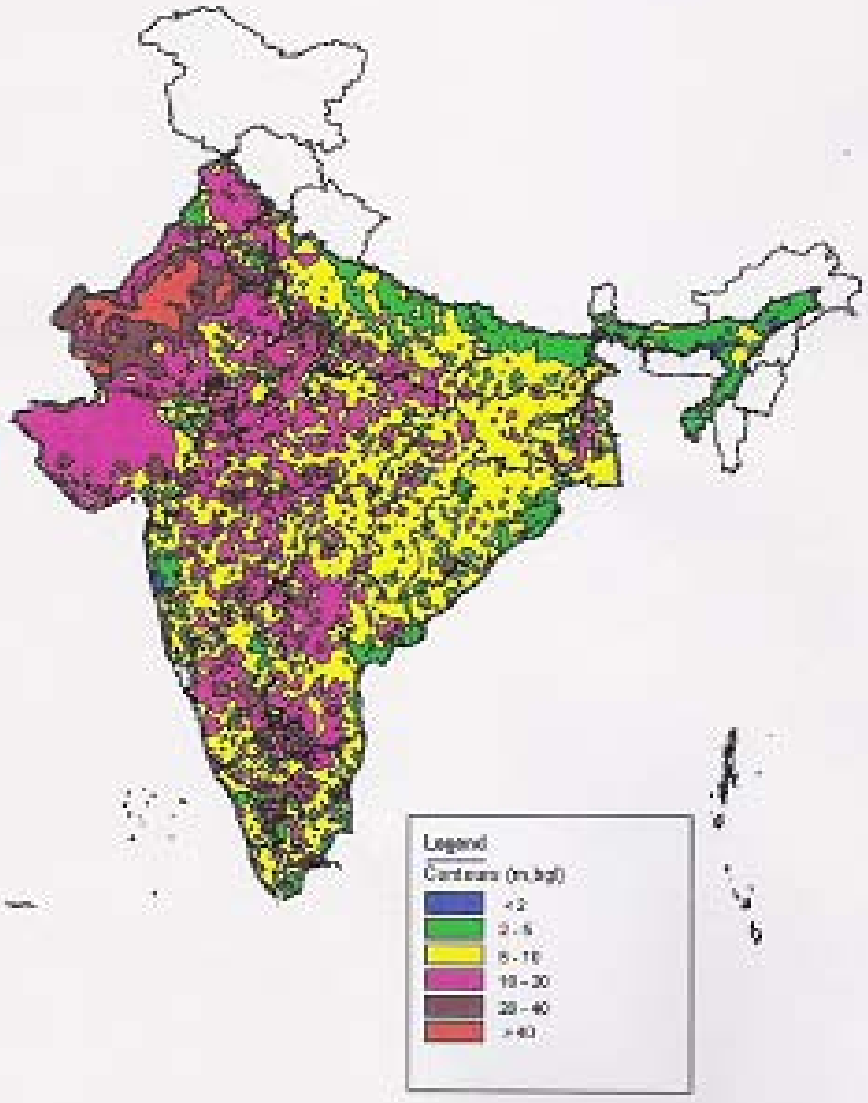

NATIONAL HYDROGRAPH NETWORK STATIONS OF CGWB
(1985-2006)
NO. OF NET WORK STATIONS
20000
16000
12000
8000
4000
0
5461
6520
8234
9567
11015
12477
13609
15004
15552
15332
14995
14965
14796
14758
14855
15301
15355
15415
15163
15184
15553
15640
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
YEARS

Fig 8.3

GROUND WATER SCENARIO OF INDIA FOR MAY'2005



9. GEOPHYSICAL STUDIES

The Board undertakes geophysical investigations to support and supplement hydrogeological surveys, ground water exploration and short-term water supply investigations as an integral part of its activities. Besides these studies, geophysical techniques were also undertaken to demarcate bedrock configuration and thickness of overburden and saline -fresh water interface.

9.1 Central Geophysical Cell

Central Geophysical cell is entrusted with planning and programming of geophysical activities in the Board, acquisition, maintenance and repair of geophysical equipment, organizing geophysical training programmes and guidance in special geophysical field surveys etc. The Central Geophysical Cell undertook the following works during year 2005-2006.

- Planning & Programming of Geophysical surveys in CGWB, Finalization of AAP of different Regions for Geophysical investigation and monitoring of progress of geophysical work.
- Acquisition of geophysical equipments, drawing of Specifications and organizing performance testing of Geophysical equipments.
- Co ordination of Geophysical Surveys and related Activities of the Regions.
- Inspection /Organization of repairs/maintenance of geophysical equipments including Loggers.
- Preparation of inventory of equipments in different Regional and Assessment of present capability of Board as regards instrumentation.
- Co-ordination of Training Activities for personnel in geophysical Survey and related items.

9.2 GEOPHYSICAL SURVEYS AT A GLANCE

Details of Geophysical surveys & geophysical borehole logging carried out in the regional offices are given in table 9.1 and 9.2

Table 9.1 : SURFACE GEOPHYSICAL STUDIES DURING 2005-2006

REGION	NO. OF VES	RESISTIVITY PROFILES (line Km)
NWHR, Jammu	32	0.520
NWR, Chandigarh	112	-
WR, Jaipur	90	-
WCR, Ahmedabad	46	-
NCR, Bhopal	110	3.52
NCCR, Raipur	125	1.55
CR, Nagpur	116	2.52
NR, Lucknow	156	2.295
MER, Patna	93	-
ER, Kolkata	103	-
NER, Guwahati	50	-
SER, Bhubneswar	100	-
SR, Hyderabad	317	12
SWR, Bangalore	304	-
SECR, Chennai	154	20.0
KR, Trivandrum	9	-
NHR, Dharamshala	-	-
UR, Utteranchal	35	0.5
TOTAL	1952	42.91

Table – 9.2 : BOREHOLE LOGGING DURING 2005-06

REGION	No. of Boreholes logged	Total meterage logged (m)
NWHR, Jammu	6	930.0
NWR, Chandigarh	34	3657.5
WR, Jaipur	19	2447.6
WCR, Ahmedabad	14	2831.0
NCR, Bhopal	3	562.0
NCCR, Raipur	-	-
CR, Nagpur	5	541.5
NR, Lucknow	13	6388.0
MER, Patna	5	1046.0
ER, Kolkata	9	1847.17
NER, Guwahati	1	200.00
SER, Bhubneswar	5	480.0
SR, Hyderabad	5	698.0
SWR, Bangalore	-	-
SECR, Chennai	7	2083.0
KR, Trivendrum	-	-
NHR, Dharamshala	-	-
UR, Utteranchal	-	-
TOTAL	**126**	**23711.77**

9.3 Region wise progress during the year 2005-2006 are given below

9.3.1 North Western Himalayan Region, Jammu

Surface geophysical surveys were mostly carried out for pinpointing the sites for groundwater exploration and to delineate the depth of potential water bearing zones. The interpreted results of the VES carried out at the exploratory sites and lithologs of the boreholes drilled were co-related to establish the resistivity ranges for different formations. Borehole drilled in Jammu &Kashmir, Punjab and Himachal Pradesh were geophysically logged for deciphering the depth &thickness of water bearing zones for recommending the well assembly.

Surface Geophysical Studies

Resistivity Surveys: A total of 32 Vertical Electrical soundings (VES) 0.520 line-Km of Wenner Resistivity Profile have been carried out in Leh (14 VES and 0.520 line-Km of Wenner Resistivity Profile) , Jammu (9VES) of J&K and Kangra district (9VES) of Himachal Pradesh.

Borehole Logging: A total of 6 boreholes drilled in parts of Jammu & Kashmir and Himachal Pradesh were geophysically logged and suitable recommendations were prepared for lowering the assembly. The district-wise details of boreholes logged is given below in the Table- 9.3

Table 9.3 : State &District-wise details of boreholes logged

S.No.	State	District	Location	Type of Borehole	Depth Drilled (m)	Depth Logged (m)
1.	**Jammu & Kashmir**	**Jammu**	**Sanghani**	**EW**	**93.00**	**92.00**
2.	**Himachal Pradesh**	**Una**	**Dhamandri**	**EW**	**200.80**	**200.00**
3.		**Una**	**Dhamandri**	**EW**	**200.80**	**200.00**
4.		**Mandi**	**Salgi**	**EW**	**137.84**	**136.00**
5.		**Una**	**Challan**	**EW**	**205.00**	**202.0**
6.		**Una**	**Takoli**	**EW**	**100.80**	**100.00**
Total						**930.00**

Compilation of Geophysical Report/Data

- A total of four reports were prepared for Kargil & Leh district of J&K and Kangra district of H.P.
- All the "Data in Log Header Form" of 117 old Electrical logs of boreholes drilled in Srinagar, Budagam, Anantnag & Kupwara districts were entered in Geophysical Logging Database in MS Access.

9.3.2 North Western Region, Chandigarh

During Annual Action Plan for the year 2005-06, Resistivity Surveys were conducted in Parts of Kaithal district (Haryana) and other areas viz. Defence area Chandi Mandir (Panchkula distt), Rajpura (Patiala Distt), NIPER (Mohali), HUDA Faridabad. In total 112 Schlumberger Vertical Electrical Soundings (VES) were conducted, out of which 85 VES were conducted in parts of Kaithal district remaining 27 VES were observed in other areas.

9.3.2.1 Resistivity Surveys in parts of Kaithal District (HARYANA) : - **Resistivity Surveys in parts of Kaithal district wee carried out with the objective of delineation of fresh and saline water interface, study of lateral and vertical variation in the quality of ground water. A total of 85 VES were conducted covering approximately 1243 Sq. Km. The entire study area is more or less affected with ground water salinity. The preliminary study of the resistivity data pertaining to Kalayat, Kaithal and Rajaund blocks of Kaithal district indicates groundwater is saline at the surface level over some parts around Rajaund and Kalayat blocks and the ground water quality slightly improves vertically in the deeper parts over few patches.**

9.3.2.2 Resistivity Surveys in other areas : - The Resistivity Surveys were conducted in Defence area Chandi Mandir (Panchkula distt), Rajpura (Patiala Distt), NIPER (Mohali), HUDA Faridabad. On the basis of the surveys, suitable sites for drilling of tubewells were recommended in all places wherever the studies were conducted except in Defence area around Chandi Mandir (Panchkula) where no favourable results were inferred. A total of 112 deep and shallow VES were conducted. The item-wise details are as follows in Table 9.4.

Table 9.4 : DISTRICT WISE DETAILS OF RESISTIVITY SURVEYS.

STATE/UT	DISTRICT	NO.OF VES
Haryana	1.Kalayat, Kaithal and Rajaund blocks of Kaithal	85
	2. Golf Course, Defence Area, Chandi Mandir Distt. Panchkula.	12
	3. HUDA area around Lalpur and Kirawali villages, District Faridabad	10
Punjab	1.E.S.I. Hospital, Rajpura, Distt.	3
	2. National Institute of Pharmaceutical Education and Research (NIPER), Mohali	2
	Total	112

9.3.2.3 Compilation of Geophysical Reports/Data

- Surface geophysical data pertaining to 95 VES in parts of Panipat and Hissar District, Haryana (where surface resistivity surveys were conducted during AAP 2005-06), were processed and detailed report has been prepared.
- Modified the detailed report on Surface Geophysical Studies in Sonepat (Haryana) and State Report on Punjab.

- Reports/findings pertaining to short-term geophysical investigations in different areas of Haryana, and Punjab were prepared.

9.3.2.4 Borehole Logging:- A total of 34 exploratory/piezeometers boreholes were geophysically logged during the AAP 2005-06 out of which ten boreholes are located in Haryana, two boreholes in Punjab. Seventeen boreholes in Delhi and remaining four boreholes in other states. The total logged depth of all the boreholes logging conducted in entire North Western Region is 3657.50 m. The instrument used for logging was UPTRON Multichannel logger. Recommendations in respect of granular zones and quality of formation water were made after each logging. Details of bore hole logging are given in Table 9.5

Table 9.5 : State & District-wise details of boreholes logged

STATE/UNIT	DISTRICT	NO. OF BOREHOLES LOGGED	TOTAL METEREGE OF BOREHOLE LOGGED
Punjab	Hoshiarpur	2	214
Haryana	Bhiwani	10	1362
Chandigarh	Chandigarh	2	361
Delhi	Delhi	17	1535
Uttranchal Region	Dehradoon	1	91
Others	Gaziabad (Noida)	2	98.50
	TOTAL	34	3657.50

9.3.3 Western Region ,Jaipur

9.3.3.1 Surface Resistivity Surveys

Total 90 Vertical Electrical Soundings were conducted during the 2005-06, finding which are follows:

1. Exploratory drilling and short term investigation

Total seven Vertical Electrical Sounding (VES) were carried out in the Suratgarh district Ganganagar and Karauli district and following were the outcome.

- Ground water quality has been inferred as saline at Suratgarh City in Army area..
- Investigation has been carried out at Mahavir ji in Karauli district for construction of suitable Rainwater harvesting structure.

2. Electrical Resistivity surveys were undertaken in Jaipur and Bharatpur districts.

a) Chaksu – Phagi section in Jaipur district:- Water scarcity is noticed in the area due to shallow depth of bedrock and saline ground water. Surface geophysical survey is proposed from Dawach to Kadera village and along the Bandi river near Dawach village with the following objectives.
   a. Mapping of Bedrock topography along Bandi River and Kitpura nala.
   b. Identification of lineaments and fractures along river and nala.
   - Delineation of saline -fresh interface

It is inferred from 21 VES carried out that depth to bedrock is comparatively deeper along the River. Weathered and fractured zones have been encountered along the Bandi river and the Titpura Nala which are good sources of fresh ground water.

b) **Alipur area at Bharatpur district:-** After the tsunami activity, vapours / gas emanations reported on the ridge near Alipura village in Bharatpur district. A

Preliminary study was done by a team of scientists of this Region for finding out reasons of such emanations. It was inferred that major fault passes along the ridge. Therefore, detail surface geophysical survey is proposed near Alipura village with following objectives:

- Study of extension of fault and secondary fractures near Alipur village
- Study of ground water quality variation in and around Alipur village.

Total 24 VES were conducted for achieving the above objectives.

(c) Investigation for delineating bedrock topography and ground water potential in Shri Madhopur blocks of Sikar district: Total 29 VES were conducted in this block.

3. Electrical Resistivity surveys for studies at to find out reason of high yielding well

Six VES were carried out for finding reasons of high yielding well near Keshwana Rajput village and following inferences have been drawn. The resistivity of saturated layer varies from 19 ohm - m to 29 ohm – m, which is indicative of comparatively coarse grained sediments and gravel with good porosity and permeability. The resistivity of bedrock varies between 50 ohm - m to 100 ohm – m, indicative of argilleceous fractured and friable formation. The coarse sediments and weathered / fractured crystalline formations have good to moderate yield potential. Total 90 Vertical Electrical Soundings were carried out in five districts in the state.

9.3.3.2 Borehole Logging : - 19 pilot boreholes measuring cumulative depth of 2447.60 meters were logged in Rajasthan. The district wise detail is given below.

1. Hanumangarh: - Total seven boreholes were logged and encountered resistivity of the order of 20 – 35 ohm – m up to depth of 60 m and below that resistivity steeply decreases down to 2 ohm – m in five boreholes and in two-boreholes high resistivity encountered up to depth of 175 m. This high resistivity indicated that formations are dominated by sand and silt with potable formation water. EC varied from 1200 to 1800 micro-mho/cm and low resistivity with high negative SP indicate saline formation water.

2. Jhunjhunu:- Total three boreholes were logged and Resistivity encountered is in the order of 10 to 20 ohm – m, indicates formations dominated by silt and sand. Electrical conductivity has been inferred as 1500 to 2000 micro-mho/cm, which indicates that formation water is potable.

3. Jaisalmer:- Total two boreholes were logged and measured parameters are S. P., N – 16", N – 64" and 6' - Lateral Resistivities Natural and Gamma. High gamma counts encountered encountered indicating argillaceous formation. However, the siltstones were also laminated which were deciphered by moderate natural gamma and recommended for well assembly.

4. Sikar:- Total five boreholes were logged and Formation inferred alluvium of mixed zones of silt and sand. The resistivity varies from 10 to 30 ohm – m. Pure sandy horizon is also identified in the borehole at Rolsabasar in depth from 90 to 97 m. Electrical conductivity of formation water varies from 2000 to 3500 micro-mho/cm at 25^{0C}.

9.3.4 West Central Region, Ahmedabad

Geophysical borehole logging were carried out on 14 boreholes drilled in alluvial area. In the case of surface investigations, total 46 VES were conducted along the coastal belt.

9.3.4.1 Surface Geophysical Studies

A total 46 Nos of VES were carried out covering an area of about 3000 sq. km. The VES were conducted in the coastal belts of Porbandar district. The purpose of the investigation is to decipher fresh/ saline water interface.

9.3.4.2 Borehole logging :- Total 14 bore holes were logged using electrical logger in Gujarat. District wise details of boreholes logged are as follows in table 9.6

Table 9.6: District wise details of boreholes logged

State/UT	Aquifer	District	Nos. of Boreholes logged	Total depth of bore holes logged(m)
Gujarat	Alluvium	Rajkot	2	315.00
	Alluvium	Patan	1	200.0
	Alluvium	Mahesana	3	852.00
	Alluvium	Banaskantha	4	514.00
	Alluvium	Surendranagar	3	500.0
	Alluvium	Gandhinagar	1	450.0
Total			14	2831.0

At 2 sites logging was done two times

9.3.5 North Central Region, Bhopal

9.3.5.1 Surface Geophysical Surveys **:- A total of 110 Vertical electrical soundings and 3.52 line-Km have been carried out unravel the subsurface hydrogeological condition in parts of Gwalior, Betul, Bhopal Satna, Mandla, Dindori and Jabalpur district to support the groundwater exploration programme and augmentation of water supply to various government agencies. Most of the VES curves have been interpreted through conventional curve matching techniques and modeled with computer software like SCHLUM and IPI2WIN. The GRP data have been interpreted qualitatively in terms of resistivity `low' with respect to the background resistivity. The Microsoft EXCEL software has also been used for plotting VES and GRP data. The district wise detail of the Resitivity survey is given below in the Table 9.7.**

Table- 9.7 : District wise detail of Resistivity survey

State/UT	District	No. of VES	Profiling line/km
Madhya Pradesh	**Gwalior**	**17**	**0.16**
	Betul	**18**	**0.64**
	Bhopal	**6**	**0.16**
	Satna	**10**	**0.32**
	Mandla	**16**	**0.80**
	Dindori	**35**	**1.28**
	Jabalpur	**8**	**0.16**
Total		**110**	**3.52**

9.3.5.2 Geophysical Logging:- **Total 3 bore hole logging conducted during the year given in table 9.8**

Table 9.8: District wise details of Geophysical Logging

State	District	Nos. of boreholes logged	Total depth of boreholes logged in meter
Madhya Pradesh	**Betul**	**2**	**358.0**
	Bhopal	**1**	**204.0**
Total		3	562.0

The geophysical logging of borehole has been conducted in at Nimpani and Athner exploratory borehole site in Betul district down to depth of 304.0 and 54.0 m respectively. A borehole drilled at RRL at Bhopal has also been logged down to 204.0 m bgl. These boreholes are in Hard rock formation. The digital Geologger 3030 (Mark-II, OYO Japan) has been used for conducting the logging. Natural gamma parameters of the boreholes were recorded.

9.3.5.3 Compilation of Geophysical Reports: Six nos. of reports were submitted.

9.3.6 North Central Chhattisgarh Region, Raipur

9.3.6.1 Surface Geophysical Studies Geophysical studies were carried out in four tribal districts of Chhattisgarh to know the lateral and vertical variations in subsurface formations, to locate the sites for the construction of bore wells/ tube wells, and thickness of the weathered and fractured zones for exploration drillings, urban hydrology and short term investigations.

A total of 125 nos. Vertical Electrical sounding (VES), 2 nos. (0.41 line kms) Wenner Resistivity Profiling (WRP) and 11 nos. (1.14 line kms) Gradient Resistivity Profiling (GRP) were carried out . Vertical Electrical Soundings (VES) were carried out using Schlumberger configuration and Pole-Dipole configuration is used by deploying D.C. Resistivity Meter as well as Aqua meter (CRM 500). Besides these Gradient Resistivity Profiling (GRP) technique is also applied to delineate the weak zones in the subsurface for conducting electrical soundings to that particular point. Due to lack of spreading space the Pole-Dipole Resistivity Sounding technique is also applied successfully. The sounding data is interpreted by partial curve matching techniques with the help of two/three layer master curves. The interpreted results are also rechecked by SCHLUM and AIMREV software, which show the good resemblance between the above two ways of interpretation. The district wise detail is given below in the Table 9.9.

Table 9.9: Details of Resistivity Surveys

Sl. No.	Districts	Nos. of VES	Nos. of Wenner profiling (Line kms)	Nos. of Gradient profiling (Line kms)
1	Dhamtari	58	-	-
2	Durg	1	-	-
3	Janjgir-Champa	12	-	0.38
4	Korba	1	-	-
5	Kawardha	17	2 (0.41)	-
6	Raigarh	12	-	0.20
7	Raipur	18	-	0.36
8	Rajnandgaon	6	-	0.20
	Total	**125**	**2 (0.41)**	**1.14** **Total LKm.=1.55**

In special studies a total 58 nos. of Vertical Electrical Soundings (VES) were carried out in and around Dhamtari township in Dhamtari district to delineate the alluvial thickness over Charmuria limestone covering an area of about 400 square kilometers. Noticeable thickness of alluvium observed in northwest direction parallel to Mahanadi paleo-channel. Geoelectrical cross-section along east- west direction from village Basin to Bhanpuri confirmed existence of maximum thickness of alluvium in the middle of the section and minimum at extremes. The section along SE - NW has shown uniform thickness of alluvium.

Twelve VES have been carried out along Hanp River in Kawardha district to delineate the subsurface formations. The deposition of alluvium is along the river ,its measurable thickness observed near village Chhanta (40m), Larangpur (37m) and Dhogbhati (33m) whereas minimum thickness is observed near village Tenduwadih (8m). The hard and massive limestone (Pandaria formation) have resistivity range between 400 and 2000 ohm-m.

Six VES were carried out in IGKV Campus in short-term investigation, near village Pendri in Rajnandgaon district. Result of analysis showed thickness of weathered/fractured portion as 30m followed by a hard and massive formation. At 45m and 60mbgl cavernous zones were deciphered, which is a suitable site for construction of bore well.

In Raigarh district the contact of Gondwana and Archaean at a depth of 59 m is interpreted near Tejpur village. Based on these geophysical surveys Kapu in Raigarh and Amoda in Janjgir-champa districts successful exploratory wells were constructed.

9.3.6.2 Compilation of Geophysical Reports :- Three reports were prepared (Raipur Urban Area, Kawardha and Raigarh districts).

9.3.7 Central Region, Nagpur

Surface geophysical surveys and borehole geophysical logging were carried out during AAP 2005-2006. In surface surveys, electrical resistivity surveys were carried out to pinpoint sites for exploratory drilling, for Defence Establishments (Air Force) in Pune under Short Term investigation to augment its water supplies. The main objective of the survey is to delineate fracture zones/potential water bearing zones.

9.3.7.1 Resitivity Surveys:- **In total 116 Vertical Electrical Soundings (VES) in 7 districts with Schlumberger configuration were carried against the target of 100 VES. Apart from the VES 2.76 line kilometers of Gradient Resistivity Profiling were also carried out. The district wise details are given in Table 9.10 .**

Table 9.10 : District wise details of Vertical Electrical Soundings (VES)

SL. No.	District	Type of Survey	No. of VES	Profile in Lline Km
1	Aurangabad	Electrical resistivity survey	36	0.48
2	Solapur	-do-	7	0.16
3	Sangli	-do-	47	1.55
4	Raigarh	-do-	14	0.25
5	Nagpur	-do-	7	Nil
6	Amravati	-do-	2	Nil
7	Pune	-do-	3	0.32
	Total		116	2.52

9.3.7.2 Geophysical logging : - In total 5 boreholes were logged in the district Nagpur in the sedimentary area. The first logging was done using the UPTRON LOGGER and the rest three were carried out using the ABEM-SAS-200 Logging unit attached to the ABEM-SAS-300 Resistivity meter. The district-wise details are given in Table 9.11 .

Table 9.11: Ddetails of Borehole logging

S. No	Location/ District/ Taluka	Type of borehole	Depth drilled (m)	Depth logged (m)	Logging para-meters recorded	No. of bore holes logged	Cumulative since 01-04-2005	
							No. of Bore-holes logged	In meters
1.	Nagpur	Exploratory bore holes	628.15	541.50	SP, 16"/64"N Resistivities, Fluid Resistivity and Tempera-ture	5	5	541.50

9.3.7.3 Compilation of the geophysical reports :- All the surface geophysical data collected in the field was compiled and interpreted both manually and by computer aided techniques. Recommendations were given accordingly for drilling boreholes. The geophysical logs collected in the sedimentary area were interpreted and suitable recommendations were made so as to give the well assembly. Reports on Geophysical Surveys for Exploratory Drilling through out-sourcing in parts of Hingoli and Jalgaon districts and on Geophysical Surveys for Defence establishments in Pune were prepared.

9.3.8 Northern Region, Lucknow

9.3.8.1 Surface geophysical studies

Resistivity / Magnetic Surveys: **-** Geophysical surveys were carried out in the:

- Flood Plains of Gomti River around Lucknow City **– Bakshi Ka Talab block in order to delineate aquifer disposition for artificial recharge and alternative source to supplement drinking water supply – 104 VES.**
- Hard rocks for identifying fractures to pinpoint water well drilling sites**: Chandraprabha and Naugarh dam area, Naugarh block, district Chandauli and Nanaura and Basawan area, district Lalitpur - 13 soundings, 1.245Line- Km GRP and 1.050 line-Km Magnetic Profiling.**
- Electrical resistivity surveys in and around Tundla, district Firozabad: **Delineation fresh water aquifers and fresh / saline interface in the area – 39 VES**

9.3.8.2 Borehole geophysical logging **:- Borehole geophysical logging of 13 boreholes, as regular exploration program, was done for the delineation of fresh ground water zones and demarcation of thick clay zones for the purpose of cement sealing in the Arsenic affected area / districts (to prevent hydraulic continuity of contaminated formation water). Details of Geophysical Surveys are as follows in Table 9.12.**

Table 9.12: Details of Geophysical Surveys in Uttar Pradesh

District	No. of VES	Line Kms Gradient Resistivity Profiling (GRP) Magnetic Profiling (MAG)
Firozabad	39	
Lucknow	104	-
Lalitpur	05	0.590 (GRP)
Chandauli	08	0.655 (GRP) 1.050 (MAG)
	156	2.295

Total 13 wells were geophysically logged in the State. The details are given in Table 9.13

Table 9.13 **Details of Borehole logging in Uttar Pradesh**

District	No. of Boreholes logged	Total depth of boreholes logged (m)
Ballia	04	1486.00
Balrampur	03	1727.00
Gonda	04	2195.00
Sidhartha Nagar	01	475.00
Kanpur	01	505.00
TOTAL	**13**	**6388.00**

9.3.8.3 Compilation of geophysical data / reports

Reports have been prepared on the following:

i) **Electrical resistivity surveys across micro – gravity 'lows' in karstic terrain for the detection of cavities in parts of Karwi tehsil, Chitrkoot district, U.P.**
ii) **Delineation of fresh water aquifers in and around Mathura city through surface geophysical surveys .**
iii) **Delineation of shallow aquifers in Bakshi Ka Talab block, Lucknow district for Artificial Recharge site selection.**
iv) **Review of interpretation of geophysical logs of ONGC boreholes drilled in Uttar Pradesh for the delineation deep fresh water aquifers.**
v) **Demarcation of clay zones between aquifers upto 200 m from electric logs of 13 quality prone districts of U.P.**

One Scientific paper was prepared and number of expert Lectures were delivered by the Geophysicist in various parts of the Country.

9.3.8.4 Other Activities

- **Study of geophysical data on coastal tracts of West Bengal, Orissa and Gujarat.**
- **Preparation of project proposal on groundwater management studies in coastal Gujarat**
- **Preparation of an invited scientific paper on hydro geophysical studies in coastal tracts.**
- **Finalization of status of aquifer disposition in Ganga-Yamuna doab and preparation of a draft project.**
- **Preparation and submission of XI Plan proposal for geophysical studies.**
- **Computerization of 162 Vertical Electrical Sounding data of Lucknow, Banda, Baghpat and Meerut districts and entry in the GEMS software.**
- **Procurement and commissioning of Gamma Ray probe and module attachment of UPTRON logger after inspection and lab testing.**
- **Field demonstration of Ground Penetrating Radar at civil engineering department, IIT Kanpur.**

- **Field demonstration of geophysical surveys with ABEM terrameter, SYSCAL R2 resistivity meter and Proton Precession magnetometer to Induction Level trainees at new campus IIIT Allahabad.**

9.3.9 Mid-Eastern Region, Patna

9.3.9.1 Resistivity Surveys: - Total 93 Vertical Electrical Soundings (VES) were conducted during the AAP 2005-06 in Bihar and Jharkhand States. The details are given as follows in table 9.14.

Table 9.14 : District-wise details of geophysical survey in Bihar and Jharkhand Sttes

State/UT	District	No. of VES	Lines Kms	Area covered under (Km)^2
Bihar	Jammui	15	-	50
	Munger	12	-	4.5
	Patna	2	-	0.5
Jharkhand	Ranchi	33	-	5
	Gumla	15	-	3
	Hazaribagh	10	-	5
	Pakur	6	-	-
Total		**93**	-	**68**

9.3.9.2 **Geophysical logging: -** Total 5 wells were geophysically logged and details are given in Table 9.15.

Table 9.15: Details of Borehole logging in Bihar State

State/UT	District	No. of bore wells logged	Total depth of bore well logged (m)
Bihar	Patna	1	225.0
	Munger	2	87.0 & 234.0
	Bhojpur	2	250.0 & 250.0
Total		**5**	**1046 m**

9.3.9.3 Compilation of geophysical reports/data: A total of 5 short-term investigations taken up during the AAP 2005-06 in the different districts of Bihar and Jharkhand have been submitted. For exploratory drilling suitable sites were recommended. The interpretation electrical logs of exploratory well and piezometers located in the alluvial formation have been completed and zones to be tapped recommended. The results have been compiled for preparation of reports.

9.3.9.3 Salient features of the Geophysical Studies.

- In Patna, the investigation in Danapur Cantonment area was taken up to identify the depth and thickness of the clay layer for the lowering of the appropriate well assembly.
- In the campus of Central Tasar Research & Training Institute, Ranchi, surface resistivity survey was conducted to identify the different sets of fractures at various depth for the purpose of exploration and artificial recharge.
- **The geophysical study at Bharat Sevasram Sangh, Pakur, was carried out for the benefit of the tribal people, as a vocational training institute is likely to come up in the proposed site. With the help of geophysical study, probable location was pinpointed on the fracture zone for drilling.**
- In Hazaribagh district, the geophysical survey was carried out for the identification of favorable points for drilling of wells for water supply in the proposed mining area of N.T.P.C.

- o Beside these, the resistivity surveys in other districts of Bihar and Jharkhand were conducted for selection of sites for exploratory drilling through departmental rigs.

9.3.10 Eastern Region, Kolkata

9.10.1 Geophysical Studies:- A total of 103 Vertical electrical soundings were carried out in different parts of West Bengal during AAP-2006-06.The details of Surface Geophysical studies are given below in the table 9.16 .

Table 9.16 : District-wise details of geophysical survey in West Bengal

District	Location	No. of VES	Studies & Findings
Barddhaman	Radhamohanpur Area, Kanksa Block short-term water supply investigation for CRPF	3 VES	The depth range of expected occurrence of fine to medium sand is 8.0 to 150.0 mbgl.
North 24 Parganas	CBI Housing Complex, Salt Lake. short-term water supply investigation	1 VES	It is expected that the quality of groundwater is potable below 100m depth and the sand is medium to coarse grained. (up to VES penetration depth of 200.0mbgl)
Darjeeling	Khaprail short-term water supply investigation	49 VES	Topsoil and bouldery formation occur up to 16.80m depth and below it coarse to very coarse sand occurs (within the penetration depth of 150m).
Malda	Manickchak and Habibpur Resistivity survey was carried out in the tract in connection with reappraisal survey.	20 VES	For Manikchak area the interpretation of VES results indicates that medium/ coarse sands bearing aquifer occur to the depth range of about 10 to 85 mbgl. For Habibpur area the interpretation of VES results indicates that in general clay layer occur in the depth range of 30 to 40m and below it sequence of sand and clay occur. Grain size of sand increases at greater depth (up to the VES penetration depth of 200mbgl)
Bankura	Bishnupur.	20 VES	On the basis of surface geophysical investigations it is found that in the area, below the shallow aquifer (1.3 to 10.4mbgl) another aquifer is available in the depth range of 127.0 to 150.0mbgl.
Jalpaiguri	**Falakata**	6VES	On the basis of surface geophysical investigations it is found that in the area coarse sand mixed with gravel is likely to occur in the depth range of 3.0 to 110mbgl.
W. Medinipur	**Air Force Base (Kalaikunda)**	4VES	On the basis of surface geophysical investigations it is found that in the area medium to coarse sand likely to occur in the depth range of 9.0 to 137mbgl (depth of penetration).
		103 VES	

9.3.10.2 Bore hole logging: - A total of 9 nos. of borehole have been electrically logged in West Bengal. Electrical logging details and findings are as given in table 9.17.

Table 9.17 : District wise details Borehole logging in West Bengal

District	No. of borehole electrically logged	Location	Depth logged (mbgl)	Remarks
Nadia	2 nos.	i) Krishnanagar (EW), Krishnanagar -I Block	176.0	Cement sealing recommended- -81-83
		ii) Krishnanagar (EW), Krishnanagar -I Block	258	Cement sealing recommended-137-140
North 24 Parganas	3 nos.	i) CGWB Office (EW) Premises Salt Lake, Kolkata	60.0	For Testing of UPTRON Logger
		Ii) Berigopalpur, (EW) Gaighata- Block	176.0	Water is expected to be potable.
		iii) Bagdah, Bagdah block	248.1	Cement sealing recommended-137-140mbgl
Uttar Dinajpur	2 nos.	Mahaniparar, Itahar block	250.070	
		Milanpally, Islampur Municipality	214	
Barddhaman	1 No	Katwa, Katoa-I Block	225	Water is expected to be potable
Haora	1 No	Bagnan, Bagnan-I Block	240	Water is expected to be potable below 115 mbgl
	9		**1847.17m**	

9.3.10.3 Compilation of Geophysical Reports:- Eleven Nos. of reports were submitted.

9.3.11 North Eastern Region, Guwahati

Geophysical work n carried out consists of Surface Geophysical investigation (Resistivity Surveys), Sub surface geophysical investigation (Electrical logging in the borehole).

9.3.11.1 Surface Geophysical Studies :- A total of 50 VES have been conducted in different districts and States of North Eastern Region. The details of VES conducted either for short-term water supply investigation or for selecting the suitable drilling site for exploration are given in table 9.18.

Table 9.18: Details of geophysical surveys

State/UT	District	No of VES
Assam	Kamrup	05
Nagaland	Mokokchang	03
	Dimapur	04

9.3.11.2 Bore hole logging:- One borehole was logged up to a depth of 200 m in Jorhat district of Assam.

9.3.12 South Eastern Region, Bhubneshwar

9.3.12.1 Surface Geophysical Studies:- Resistivity **Surveys comprising of 100 Vertical Electrical Soundings (VES) were conducted with different objectives during AAP 2005-06.The district wise detail is given in the Table 9.19.**

Table 9.19 : District wise detail of Vertical Electrical Soundings (VES)

State	District	No. of VES	Area Covered (Sq.Km)
Orissa	Khurda	36	36.67
	Puri	57	146.67
	Ganjam	7	79.62
Total		100	262.76

The radial soundings at in Khurda have delineated the direction of the fractures to extend along north- south direction.The resistivity survey along Konark have delineated fresh/saline interface and areas suitable for construction of water supply of water wells have also been demarcated. The two sites drilled on the basis of VES results in the ADGM College Gopalpur, Ganjam were successful.

9.3.12.2Borehole Logging:- **The logging results have deciphered the granular zones and suitable zones were recommended for well assembly on the basis of log interpretations. The details are given in Table 9.20**

Table 9.20: Details of bore holes logged in Orissa

State/UT	District	No. of bore holes logged	Total depth of boreholes logged(m)
Orissa	Balasore	5	480

The borehole geophysical loggings were conducted in all the 5 exploratory boreholes drilled with Direct Rotary Rig in coastal alluvial areas of Balasore district to demarcate the saline/fresh and pervious and non pervious zones.SP,Short Normal(N16") and Long Normal(N64")resistivity logs were recorded using Uptron Multi channel Logger.The productive zones and water quality for well assembly were recommended on the basis of log interpretations.

9.3.12.3 Compilation of geophysical reports:- Three reports were submitted.

Resistivity Surveys for Fresh/Saline Ground Water interface studies: **The complex hydrogeological set up in the coastal tract of Orissa poses a serious problem for ground water exploration. There are several unexplored areas in the in the coastal tract. In this context 40 VES were conducted in Gop and Konark blocks of Puri districts to delineate fresh/saline groundwater interface and to isolate the saline areas for future planning. The preliminary study has given very interesting result. the detailed data processing & report & report preparation is under progress.**

9.3.13 Southern Region, Hyderabad

9.3.13.1 Surface geophysical studies

In all, 317 Vertical Electrical Soundings VES and 10 Line Km of resistivity, VLF and Magnetic profiling were conducted in parts of Guntur, Medak, Kurnool, Ranga Reddy and Visakhapatnam districts. These surveys are aimed to locate the shallow/deep fracture zones, litho contacts and associated structural features. Based on the interpretation of geophysical data, sites were recommended for exploratory drilling in parts of Guntur, Medak and Visakhapatnam districts and yields of the wells were found to be satisfactory. The details of VES and VLF/magnetic surveys are given in Table 9.21 and Table 9.22.

In Guntur district, a major thrust fault is deciphered in NNE-NE direction along the eastern margin of the Cuddapah basin running approximately parallel to the Meta

sedimentary/migmatites contact. Across this feature detailed VES profiling was carried out at 8 sites covering a length of maximum 1 km at each site to delineate the favorable zones for ground water development. The interpreted data revealed positive findings with encouraging results.

In order to select sites for deep boreholes in the Kadapa basin, two lineaments were selected near Panyam south of Gani-Kalava area in Kurnool district. From the interpreted data of the VES profiles, the thickness of the shales overlying the limestones has been estimated. It was also inferred that deep fractures within the limestones to depths below 200m may exist at places within the area of investigation. However, further studies are required to carry out in the area for finalization of drilling sites; which are still continuing.
The exploratory drilling results of Medak and Visakhapatnam districts reported moderate yields, for few wells, drilled on the basis of geophysical findings. From the VLF profiles conducted in Guntur and Kurnool districts, no information was drawn about the fracture location and/or shallow structural features due to presence of conductive soils and poor penetration depth. As a reconnaissance survey one magnetic profile was carried out to a length of 1 km to delineate the contact of Quartzites, limestone and shales. Since the magnetic sucesptibility contrast was poor among these formations the contact could not be inferred. Short-term investigations were taken up for suggesting the drilling sites in FCI, MES and defence areas in and around twin cities.

Table 9.21 : Details of Vertical Electrical Soundings(VES).

District	No. of VES	Area covered under (Km)^2
Guntur	179	2.5
Kurnool	71	-
Medak	49	1.0
Visakhapatnam	18	-
Total	**317**	**3.5**

Table 9.22: Details of V.L.F/Magnetic Surveys

District	Type of survey/profile	Area covered (Km)^2
Guntur	VLF	0.9
Guntur	Magnetic	1.0
Kurnool	VLF	3.6
R.R. District	VLF	0.6
Visakhapatnam	VLF	0.4
Total		**8.5**

9.3.13.2 Borehole logging:

The four wells drilled in the Alluvial/Tertiary Formations of East Godavari district and one well in the hard rock area of Guntur district were logged with ABEM Terrameter logging system measuring the parameters of Self Potential, Short/Long Normal Resistivity, Temperature and Fluid Resistivity logs. The interpreted logs inferred shallow as well as deep granular zones in the depth ranges of 30-70m and 75-135m. The T.D.S value for determining the quality of formation water has been estimated from the logs were in the range of 900-1000 ppm. Geophysical logging was also conducted in the exploratory borehole at Rajupalem (Guntur dist.) to a depth of 190m. The interpreted log indicated various litho units and shallow fractures with moderate to high yields in the inferred thrust zone. However the gamma log may indicate the shale boundaries in the quartzites/limestones formations. Details of bore hole logging are given in Table 9.23.

Table 9.23: Details of borehole logging

District	No. of boreholes logged	Total depth of bore holes logged (m.)
East Godavari	**4**	**508 m**
Guntur	**1**	**190 m**
Total	**5**	**698 m**

9.3.13.3 Compilation of Geophysical Reports/Data: Four reports were submitted.

9.3.13.4 Other Activities

The following assignments/works were attended .

- Pursued with NGRI for the repairs of OYO 24 channel Seismic equipment and handed over the unit to NGRI for repairs . Also obtained the specifications and cost of the various imported geophysical equipment .
- Conducted the training course on the Geophysical Techniques at SRO delivered the lectures during the training course.
- 10 case studies and R&D output were submitted for inserting into CGWB website., Krishna Godavari basin fill data including composite well logs of KG basin were collected for Rajahmundry.
- Procured aeromagnetic maps of Kadapa basin from AMSE GSI office. BRGM VLF equipment has been utilized for deployment with hard rock areas of AP.

9.3.14 South Western Region, Bangalore

9.3.14.1Geophysical Surveys

Under exploration programme, geophysical surveys were carried out in Kolar, Mandya, Davanagere and North Canara districts. The geophysical surveys mainly comprising of Vertical Electrical Soundings (VES) were carried out at the hydrogeologically selected sites in order to select comparatively better sites for taking up drilling. VES was conducted at 304 locations by employing Schlumberger electrode configuration up to a maximum spread length (AB/2) of 1000m. The obtained VES curves were interpreted initially by using two and three layer master curves of Orellana and Mooney (1966). The final interpretation was carried out by using iterative VES interpretation technique with the aid of a personal computer. The details of surveys carried out district wise along with the results are presented in Table 9.24.

Table 9.24: Geophysical Surveys for Ground Water Exploration

Sl.No	Location District	Type of sounding	No. VES	No. of sites recommended for drilling
1.	Kolar	VES	110	16
2.	Mandya	VES	75	21
3.	Davanagere	VES	56	10
4.	North Canara	VES	35	9
	Total		**276**	**56**

Kolar District :- **Ground water Exploration In Kolar district a total of 110 VES were carried out covering 45 sites in 26 villages Mulbagal, Bangarpet, Srinivasapur and Kolar taluks. Geologically the district forms a part of the hard rock terrain and comprises mainly gneisses, schists and younger granites. Major part of the district**

has shallow to moderate overburden, generally in the range of 6 to 18m. The VES curves obtained in the district has given rise to 3 to 4 layered geoelectric sections in which the last layer is massive formation. Based on the interpreted results a total of 16 sites were recommended in Mulbagal, Bangarpet, Srinivasapura and Kolar taluks of Kolar district for deep drilling upto 500m. At about 3 sites drilling was carried out and fracture was obtained in the range of 100-150m. and 200-300m. and drilling result indicated a discharge in the 2-16 lps.

Mandya District:- **Ground water exploration in K.R.Pet, Pandavapura, Srinrangapatna and Maddur taluks of the district, 39 sites were selected in 35 villages by Hydrogeological method and were referred for Geophysical survey. A total of 75 VES were carried out at these sites. The main rock type are granites, granitic gneisses and schists. The VES curves obtained in the district has given to 3 to 4 layered geoelectric section in which last layer was massive formation associated with fractures. At about 13 sites exploratory drilling was carried out a maximum depth of 200m. The obtained discharge are in the range of 2.5-16.4 lps.**

North Canara district:- **In Ankola, Karwar, Honnavar, Kumta and Bhatkal taluks of North Canara district 25 sites covering 16 villages were investigated by Geophysical survey. A total of 35 VES soundings were carried out covering these sites. The interpreted results at the recommended sites have given rise to 3-5 layered geoelectric section in which the last layer was the massive formation except at 2 sites where it was extended to depth. By considering the VES results a total 9 sites were recommended for drilling bore wells.**

Davanagere district:- **In Harpanahalli anhd Jagalur taluks of Davanagere district which is underlain by granitic gneisses and schistose formation. Total of 56 VES were carried out covering 12 villages with maximum currend electrode spread(AB/2) of 400m. The interpreted results given rise to 3-4 layered geoelectric section.By considering the interpreted results and nearby bore well results 3 sites were recommended in Jagalur taluk and 7 sites in Harpanahalli taluk for drilling**.

9.3.14.2Water supply investigation:

Hydrogelogical survey coupled with Geophysical survey was carried out at Seismic Array Station Authorities, Gauribidanur for identification of feasible sites for construction of 2 bore wells meeting the crisis of drinking water needs to the campus area. The investigated area is A total of 7 VES were carried out covering these sites and 2 existing bore wells.By considering the obtained VES curves and interpreted results 2 sites were recommended upto a depth of150-200m.

Bangalore district:- **In the proposed Housing Board Colony at Suryanagar, Anekal taluk, Bangalore district, total 18 sites were investigated by conducting 21 VES. The interpreted results in this area have given rise to 3-5 layered geoelectric-section in which the last layer was massive formation except at one site where it was extended with depth. By considering the VES results and type of the curve obtained a total of 10 sites were recommended for drilling borewells.**

9.3.14.3 Compilation of geophysical report ; Seven reports were submitted.

9.3.14.4Other Activities:

Two Technical papers were submitted, i) Systematic Electrical Resistivity surveys to demarcate Inland Salinity in Kundgol Taluk, Dharwar District, Karnataka state ii)

Fracture detection in hard rock terrains of erode district using apparent resistivity data – case studies.

9.3.15 South East Coastal Region, Chennai

9.3.15.1Surface geophysical studies

Surface geophysical surveys comprising electrical resistivity profiling and Vertical Electrical Sounding(VES) were conducted in locations selected on the basis of geological / hydrogeological /geomorphological studies conducted earlier as required for well siting / special studies. Schlumberger configuration with maximum current electrode separation of 600 m. was the mode of survey. The main objective of such electrical resistivity surveys was to delineate potential ground water zones to recommend most favorable sites for sinking bore wells. District-wise details / break-up of resistivity survey is given in Table- 9.25. Indian equipments with gadgets have been deployed and data analysis had been done both manually (graphically) and through computer software packages.

Table 9.25: Details of Resistivity Surveys in Tamilnadu

Sl. No	District	No. of VES	Line Km	Area Covered (Sq. Km)
1	Pudukottai	33	0.8	38
2	Dharmapurai	41	2.8	52
3	Krishnagri	9	3.6	15
4	Perambalur	25	0.4	35
5	Karur	27	11.2	33
6	Tirunelveli	3	0.4	10
7	Virudunagar	4	0.4	10
8	Chennai	12	0.4	15
Total		**154**	**20**	**208**

Items at Sl.No.1 to 5 were part of well sitting for Groundwater Exploration and items S.No. 6 to 8 were part of short term Groundwater investigation. Based on the VES results sites were recommended for exploratory drilling, keeping in view the local hydrogeological as well as favorable geoelectrical spectrum reflecting fractured rock layers at depth, which form conduits for ground water flow.

9.3.15..2 Results and Findings

Pudukottai district: - A total of 33 Vertical Electrical soundings and 0.8 km of Gradient Resistivity Profiling were conducted in the area under investigation, covering 14 sites. Most of the sounding curves are 3 to 4 layer ascending ones (H, A, HA /AA type). 12 sites were recommended for exploratory drilling. Out 12, 3 sites, Viz Kavundampatti,Chidambaramnagar,Athipallam yielding more than 3lps, remaining 9 sites yielding less than 3lps.

Dharmapuri district:- 41 Vertical Electrical soundings and 2.8 km of Gradient Resistivity Profiling were conducted in the area under investigation, covering 7 sites. 12 sites were recommended for exploratory drilling. Out of 12, 3 sites were taken up for drilling. 2 sites, Viz Oblikattur,Papparapatti yielding more than 3lps and one site (Valathottam) yielded less than 3 lps.

Perambalur district:- 25 Vertical Electrical soundings and 0.4-line km of Gradient Resistivity Profiling were conducted in the area under investigation, covering 9 sites. 7 sites were recommended for exploratory drilling. All the 7 sites yielding less than 3lps probably due to the presence of dry/clay filled fractures at depth.

9.3.15.3 Borehole Logging

Bore hole geophysical surveys comprised Electrical logging of pilot boreholes by deployment of indigenous UPTRON logging unit for recording the basic geoelectric

parameters of Spontaneous potential, Point Resistance and Normal / Lateral Resistivity of various sedimentary strata encountered in mud filled boreholes. District-wise break-up of electrical logging carried out is given in Table 9.26:

Table 9.26: District-wise break up of Logging

Sl. No.	District	No. of Boreholes Logged	Total Depth of Boreholes Logged (m)
1	**Cuddalore**	**3**	**860**
2	**Villupuram**	**2**	**538**
3	**Thanjavur**	**2**	**685**
Total		7	2083

Critical analysis of E-logs in Conjunction with drilling time and formation sample details facilitated in identification of subsurface geological formation groups, delineation of zones comprising granular / finer sediment formations and approximate assessment of quality of interstitial waters at depth. Logging played a vital role in deciding effective well assembly to be sunk for extraction of large amounts of potable quality of groundwater through selective screens / sealing techniques.

9.3.15.4Compilation of geophysical reports

Reports on surface geophysical surveys conducted in parts of Erode, Trichy, Vanur block of Villupuram districts and Thirumanimuthar basin of Salem district as well as surveys conducted in Tirunelveli, Virudungar and Chennai districts as part of Short-Term Investigations were submitted.

9.3.16 Kerala Region,Trivendrum

9.3.16.1Surface geophysical studies

9 VES were carried out in parts of Trivendrum district associated with the exploratory drilling program. The geophysical survey has enabled to locate low resistivity/fracture zone at Kummil, Tholicode, Aruvikkarakonam and CTCRI (Sreekariyam) of Trivandrum district.

9.3.16.2Compilation of geophysical reports and data

Geophysical logs were compiled and processed for preparing the coastal report. A couple of earlier geophysical logs were digitized to enter the data into GEMS software. Software programs are developed to use in this CASIO graphic programmable calculator.

9.3.17 Uttaranchal Region, Dehradun

9.3.17.1Surface geophysical studies

Thirty five (35) VES were conducted in parts of Dehradun and Uttarkashi districts. The field data collected were processed and interpretated, both manually and on computer with SCHLUM software. **District wise details are given in Table 9.27**

Table 9.27: District wise details of Geophysical Survey in Uttaranchal

District	No. of VES	Profile (LineKm)
Dehradun	31	0.5
Uttarkashi	04	-
Total	35	0.5

9.3.17.2Borehole Logging:

One exploratory well was geophysically logged with the help of UPTRON logger from NWR, Chandigarh. Electrical and Gamma ray logs were interpreted for deciphering the granular/productive zones.The recommendation report were submitted and the well assembly was finalized by the combined study of geophysical an lithologs of the boreholes.

9.3.18 North Himalayan Region,Dharamshala

The resistivity surveys for various investigations were carried out in Kangra, Una and Solan districts of Himachal Pradesh. The VES survey at 9 locations were carried out in various districts of Himachal Pradesh. The details are already discussed in NWHR, Jammu.

9.3.18.1 Borehole Logging:

The borehole logging of various exploratory wells was carried out in Una and Mandi districts of Himachal Pradesh are given in Table 9.28.

Table 9.28 : District-wise break up of Logging in H.P.

Sl. No.	District	No. Of boreholes logged	Total depth of bore holes logged (m)
1.	Una	5	716
2.	Mandi	1	122
Total		6	836

GEOPHYSICAL STUDIES

Resistivity Survey Along Water Works Road, Puri, Orissa

10. HYDROCHEMICAL REPORTS AND STUDIES

The Central Ground Water Board has 16 well-equipped Regional Chemical Laboratories to carry out chemical analysis of major and minor inorganic constituents in water samples . All Chemical Laboratories are also well equipped to carry out Basic analysis, Heavy and toxic elements analysis using sophisticated instruments like Digital and PC based Spectrophotometer, Flame Photometer, pH meter, Conductivity meter, Ion meter, Nephelometer and Atomic Absorption Spectrophotometer (AAS). All Laboratories are provided with Electronic and Top Loading Balances, Deioniser/Double Distillation Plant, Hot Air Oven, Water Bath, Magnetic Stirrers and hot plates. Regional Laboratories at Kolkata, Hyderabad, Lucknow and Raipur are equipped with Gas Chromatograph (GC) to undertake the analysis of organic pollutants (pesticides) at ng/l level and Chemical Laboratory at Hyderabad is equipped with Inductive Coupled Plasma Spectrometer (ICPS) to undertake sequential analysis of the multiple toxic elements with high accuracy. One laboratory (Kolkata) also has Total Organic Carbon analyzer (TOC). Some laboratories are equipped with equipment to carry out biological and bacteriological analysis. The Chemical Data generated by these laboratories is used for monitoring and evaluating the ground water quality in compliance with National Standards for designated use, to study the impact of anthropogenic activities on ground water quality, to demarcate critical areas where water quality deterioration has been observed and areas vulnerable to quality deterioration and to assess point and non-point sources of ground water pollution for taking necessary action for management of ground water resources.

During 2005-2006, about 17380 samples have been analyzed for Basic & specific analysis; 3541 samples for Heavy metals such as As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn and 117 samples for organic analysis. North Central Chhattisgarh Regional Chemical Laboratory has analyzed 376 samples for determination of Arsenic. Chemists from various Laboratories have participated in mass awareness programme and Trade fairs and have prepared posters, handouts and diagrams on water quality for display. They have demonstrated the testing of various chemical parameters present in water and their impact on human body. The importance of Water quality in rainwater harvesting and water quality for drinking, agricultural and industrial purposes is also explained to the visitors and students. The details of water samples analyzed by different Chemical Laboratories are given in table 10.1

Table 10.1: HYDROCHEMICAL ANALYSIS CARRIED OUT BY CGWB 2005-2006

Sl. No	Region	Basic Analysis		Specific Analysis		Heavy Metals		Organic	
		Sample	Constituents	Sample	Constituents	Sample	Constituents	Sample	Constituents
1	NR	1632	21296	-	-	689	1989	95	1302
2	ER	1245	18437	-	-	360	360	-	-
3	SR	1634	21242	-	-	179	1003	22	328
4	NCR	1160	15996	-	-	-	-	-	-
5	MER	365	3941	-	-	-	-	-	-
6	SER	1300	9056	-	-	-	-	-	-
7	NCCR	646	8398	-	-	376	376	-	-
8	SWR	713	9269	327	1635	-	-	-	-
9	CR	1558	16550	-	-	272	1360	-	-
10	SECR	1425	17802	-	-	207	669	-	-
11	NER	497	5467	01	01	407	407	-	-
12	NWR	1222	17612	-	-	139	1018	-	-
13	WCR	1221	13869	25	96	600	1176	-	-
14	NWHR	257	3194	110	1287	06	42	-	-
15	KR	486	5804	-	-	174	1098	-	-
16	WR	1555	24096	1	1	132	742	-	-
TOTAL		16916	212029	464	3020	3541	10240	117	1630

HYDROCHEMICAL REPORTS PREPARED BY THE REGIONAL OFFICES

10.1.1 NORTH EASTERN REGION (Guwahati)

1. Special study on concentration of Arsenic in Ground Water of Dhemaji district, Assam.

10.1.2 EASTERN REGION (Kolkata)

1. Hydrochemical studies in and around Howrah Municipal Corporation area.
2. Report on groundwater pollution study in Durgapur, Barddhaman District, West Bengal

10.1.3 SOUTH EASTERN COASTAL REGION (Bhubaneswar)

1. Ground Water pollution studies in and around Ambattur Industrial area.

10.1.4 NORTH WESTERN REGION (Chandigarh)

Occurrence of Arsenic in Shallow Ground Water of Haryana, Punjab & UT of Chandigarh.
Ground Water Pollution in Ludhiana city, Ludhiana district, Punjab.
Status of Ground Water Pollution in Haryana.

10.1.5 CENTRAL REGION (Nagpur)

1. Quality Maps:- Water quality maps for EC, Cl, NO_3, F and Fe (2004) of Maharashtra and Union Territory of Dadra and Nagar Haveli were prepared.

2. Ground Water Quality Data Base:- Compilation, Validation, Computarisation and Manual data entry of all ground water quality data.

3. Trend Analysis: - A trend analysis of ground water quality monitoring wells from the year 1995-2004 was carried out using GEMS software and the detailed write-up of the same was prepared.

10.1.6 SOUTHERN REGION (Hyderabad)

Pesticide residue analysis in parts of Adilabad district and around Hussainsagar lake areas. (Pesticide residues viz., Benzene Hexa Chloride (BHC) alpha, beta, gamma and delta epoxide chloridine, gamma alpha endosulphan, alpha and beta, 4-4 DDE, 4-4 DDD, 4-4 DDT, endosulphon, sulphate, methoxychlore, dialdrin and endrine were were within B.I.S. permissible limits (0.001) in Adilabad district. In Hussainsagar lake, Delta BHC & Beta & Endosulphan were beyond BIS permissible limit.)

10.1.7 NORTHERN REGION (Lucknow)

1. Preliminary Report on Residues in Gomti River, Lucknow, U.P.
2. Study on G.W. Pollution in Musafirkhana Tehsil, Sultanpur, U.P.
3. Genesis of Arsenic hazards in parts of Ballia ,Lakhimpur Kheri & Gonda districts, U.P. and its mitigation and related Geochemical studies of ground water.
4. Impact of Urban solid wastes on shallow ground water with the passage of time and its mitigation.

10.1.7.1 Special Studies:-

(i) Occurrence and distribution of ARSENIC in aquifer system in parts of Gonda district, Uttar Pradesh.:

An area of 3987 sq.km. in interfluve zone of the Ghaghara and the Kunao rivers (Lat. N $26^0 46^0$ to $27^0 27^0$ and Long E $81^0 31^0$ to $82^0 37^0$ was covered for Arsenic survey for assessement of

occurrence and distribution. Geomorphologically, the area can be classified into older and younger alluvial plain which are underlain by the alluvial sediments of Quaternary age. Deep drilling by (CGWB) down to maximum depth of 215 mbgl at Village Manakpur (Block Manakpur) and Gonda town indicates the occurrence of alternate bed of clay and sand horizons occasionally mixed with gravel and kankar.

The depth to water level are monitored in observation wells and it varies between 2.46 m bgl to l7.50 mbgl along the Ghaghara river. The perusal of analysis of data in table-10.2 shows that out of 257 water samples, 3.9% samples are found to have Arsenic concentration more than 50 ppb. The maximum value have been found at Binpurkatra (98 ppb), Katra (250 ppb), Tarbaganj (70) Chandrabhanpur (200), Uncheyka purwa (80), Subhagpur (60), Chakpan (200), Kalyanpur (80), Binpun Katra (60), Simrs (200) Arsenic between10-50 ppb whereas 74.70% are found to have Arsenic concentration less than 10 ppb.

Table- 10.2 : **FREQUENCY DISTRIBUTION OF ARSENIC**

Sl. No.	Arsenic range	No. of samples	% of As.
1.	As less than 10 ppb	192	74.7
2.	As 10-50 ppb	55	21.4
3.	As more than 50 ppb	10	3.9

(ii) Special studies on “Occurrence and distribution of organic pollutants (Pesticides) with quantitative identification in surface, vadoze zone in shallow aquifer in mango belt of Malihabad and Kakori blocks of Lucknow Distt. U.P.”

Sampling stations for surface & ground water samples were established at 32 locations in the Mango belt of Malihabad block and 23 stations in the Mango belt of Kakori block. The water samples were collected in the increments of 6-8 samples at a time during pre-monsoon and post-monsoon period from these stations. In total 106 samples were analysed for organic pollutants (pesticides) studies such as α β γ and δ HCH, 4-4' DDT, 2-4 DDE, 4-4' DDE, 4-4' DDD, Total DDT, Chlorpirifors, Atrazine, Alicarb and Carlofuran. The samples were collected and analysed as per “Standard Methods for Water and Waste Water Analysis (APHA.19th edition) using Gas Chromatograph (SHIMADZU GC17A) with ECD&FTD detectors.

Analysis has revealed that concentration of each of the above pesticide is much below the permissible limit of 0.1 µg/l for individual pesticide (PFA-2004) and 1 µg/l for total pesticide (BIIS-1991) for drinking water. The above studies have also revealed that at points concentration of a particulars pesticide in surface water is more in comparison to shallow ground water. It is concluded that surface and ground water of the study area is within the safe limit for drinking purpose in respect to pesticide concentration.

10.1.8 **WEST CENTRAL REGION (Ahmedabad)**

Trace element analysis was carried out for pollution studies in the Sabarmati river, Ahmedabad and along the coastal tract of Bhavnagar district. In addition to trace metals, dissolved oxygen concentration was also determined for the samples collected from the Sabarmati River.

10.1.9 **NORTH CENTRAL CHHATTISGARH REGION (Raipur)**

Arsenic contaminated free aquifers in Ground Water in Ambagarh Chowki Block, Rajnandgaon district, Chhattisgarh state were identified.

11. BASIC HYDROGEOLOGICAL RESEARCH / SPECIAL STUDIES

During X^{th} plan it is proposed by CGWB to take up Special Studies/ R&D Studies covering different areas like Ground Water Pollution & Environmental Studies, Urban Hydrogeology, Mapping of water logged areas and feasibility study for anti-water logging measures, Conjunctive Use Studies, Sea water ingress ,Remote sensing studies, Mathematical Modeling studies, Isotopic Studies, Studies in Arsenic affected areas. etc. During the studies stress has been given for evolving new methodologies for meaningful conclusions. These special studies are being taken up in collaboration(Memorandum Of Understanding) with Scientific institutions, Govt Agency, Universities, R&D organization which are engaged in research and development in Ground Water Science. During 2005 - 06, special studies in various parts of the country through regional offices of the Board has been taken up under special studies. The Region wise progress made are given below.

11.1 MID EASTERN REGION
Patna

During the AAP 2005-2006, in addition to the existing arsenic affected area of Bhojpur and Buxar districts, parts of Patna and Samastipur districts were taken up under ongoing arsenic contamination study. The objective of this study is to investigate spatial and temporal variations of Arsenic in ground water and to delineate the areas of arsenic contamination in different aquifer.
The arsenic contaminated areas are confined in the South Ganga plain, though hot spots are also being reported from the younger alluvial belt of North Ganga plain. Our study on arsenic contamination is mainly focused on the South Ganga plain. It is physiographic unit between the river Ganga in the north and Precambrian highlands in the south. The south Ganga plain can be divided into 3 units, viz.

Recent Alluvial **deposits along the course of the river Ganga**
Younger Alluvium **– Upper Pleistocene to Recent age, designated as Fatwa formation in Patna-Nalanda-Nawada section**

Older Alluvium**- Nawada/Jamui Formation, Lower to Middle Pleistocene age**
In the state of Bihar arsenic contaminated areas are located in the South Ganga Plain. The villages affected by arsenic contamination are located within the Younger alluvial deposit. By and large the villages are situated within a 10 km limit in southern part of the river Ganga. The terrain is gentle slopping towards north i.e. towards the river Ganga. The water level of the area follows the topography. The Younger alluvial deposits are made up of intercalations of sand, silt and clay, which were laid down by river Ganga over the Precambrian basement. The thickness of the Quaternary deposits ranges from 400 to more than 800 m in the study area.

In Maner block of Patna district, sampling has been carried out in and around Maner Town during the month of June 2005. Seven samples have been collected. The results indicate arsenic contamination in the aquifer confined within the 50 m.

Detailed sampling has been carried out in and around Karnamepur village, Shahpur block, Bhojpur district in the month of June 2005.Chemical analysis result of 11 wells established that the area is highly affected with arsenic contamination. The arsenic concentration range is Below Detection Limit (BDL) to 1.63 mg/l. All hand pumps in the depth rage of 10-36 m are affected with high arsenic. Iron concentration is proportionately high. Dug wells are free from arsenic.

During the month of July 2005 detailed sampling has been carried out in Gyaspur Mahazi (Bhaktiarpur Block) and Malahi Banea (Barh Block) villages of Patna District, which are situated along the bank of river Ganga. Total 20 samples were collected for arsenic analysis

and 6 samples for detailed chemical analysis. It has been observed that in all the samples collected, the arsenic concentration is BDL or below permissible limit.
Total 55 soil samples were collected in the month of December 2005 right from Maner in Patna district to Buxar along the alluvial belt of river Ganga using a 1.0 m long hand Augur. The fresh soil samples collected were dried in room temperature, powdered and then sieved in 25 mm mesh size. It was submitted to Geological Survey of India Geochemistry Laboratory Patna for total arsenic analysis and the results are waiting.

During the soil sampling work 19 detailed water samples have also been carried out from different villages coming under Buxar, Semri and Brahmpur blocks, Buxar district. The chemical result of above samples is still awaited.

Reconnaissance sampling was conducted in different villages under Mohiyuddin block of Samastipur district using Field Test Kit (FTK) (January –2006). Total 15 locations were covered using FTK and it has been found that in many shallow depth hand pumps there has been considerably high arsenic concentration. Maximum arsenic concentration of more than 110 ppb (0.11 mg/l) was observed at Peerganj village. Six samples were collected from selected locations for chemical analysis. These area required urgent attention and would be taken up for detailed study.

In order to understand the monthly variation of arsenic concentration, monthly sampling has also been carried out for the whole year 2005-06 for five wells from arsenic affected villages of Bhojpur and Patna districts. All the wells are hand pumps in the depth range of 20-40 m .The hand pumps are marked red colour by PHED as arsenic contaminated wells. The details of locations are given below in table 11.1

Table 11.1: LOCATION OF ARSENIC AFFECTED WELL FROM WHERE MONTHLY SAMPLING WAS CARRIED OUT

Sl.No	Locations	Block	District
1	Kulhariya	Koilwar	Bhojpur
2	Bibiganj	Bihiya	Bhojpur
3	Chotki Sanadiya	Ara	Bhojpur
4	Haldichapra	Maner	Patna
5	Semaria Ojhapatti	Shahpur	Bhojpur

Out of these 5 wells, Chotki Sanadiya is reported to have high Arsenic concentration during the Pre-monsoon period (April 05 to August 05) in the range of 3.74 mg/l to BDL. Same is the case of Haldichapra well, where the range is 1.808 mg/l to BDL during Pre-monsoon period (April 05 to July 05).

Status of MoU

CGWB has embarked upon a joint study with BARC, Mumbai on arsenic contamination of ground water in the State of Bihar. The objectives of the study are to

a. **Collect the baseline data on the contaminants**
b. **Delineate the areas of contamination**
c. **Age of arsenic contaminated ground water**
d. **Identify recharge areas for different aquifer systems**
e. **Identify vertical and horizontal distribution pattern of arsenic in water bearing geological formation and ground water in the study area (Bhojpur and Patna district)**

Under the study two phases of fieldwork has been completed. In the first phase, 23 samples were collected from the arsenic affected areas in the Bhojpur district of Bihar in 2004. In the second phase of fieldwork 35 samples have been collected during June 2006 from Bhojpur

and Patna district of Bihar for environmental Isotope analysis (C^{14}, O^{16}/O^{18}, $_1H^3$). The analysis is undergoing in the laboratory of BARC in Mumbai. The MOU is in the final stage and is likely to be signed soon.

11.2 NORTH CENTRAL REGION
Bhopal

11.2.1 Ravine Reclamation Studies

Hydrogeological and Remote Sensing Studies in Neemuch and Mandsaur districts (located between longitudes 75° 15' E and 75° 30' E and latitudes 23° 00' N to 24° 30' N) in Chambal river basin was taken up to study the ravines and bad land topography in the area resulting due to gully erosion of soil along Idar and Retam Nadi of Chambal sub-basin, Yamuna Basin. The area lies in Malwa Plateau and forms a part of the catchment area of Gandhi Sagar Reservoir. Geologically, the area is occupied by Vindhyan Shales (Suket Shales with intercalations of Siltstone alogwith basaltic lava flows of Deccan Trap exposed in the North- eastern part of the area around Gandhi Sagar and Rampura villages. Inter-trappean clays, overlying the basaltic lava flows are exposed along nalla beds and in valley plains. The thickness of the clays is about 15-18 m. The clays are mixed with silt and are very loose and friable in nature and thus vulnerable to erosion. In silty clay, erosion is causing gullies and ravines.

The water level in the area varies from 15 to 24 m.b.g.l. and it shows declining trend. Transmissivity of the aquifer is poor and recuperation rate is slow and nearly 18 hours takes for recuperation. There is urgent need for supplementing the recharge to the aquifer by artificial means.

Out of total irrigated land, ground water forms about 90% of total irrigation of the area. Dugwells are the main structures being used for irrigation from ground water reservoir. The crops grown in the area (mainly Opium) require heavy irrigation with water requirement of the order of 0.6 m. Ground Water is the main source of irrigation. Ground water level in this block is declining due to over exploitation of ground water.

The study of satellite imagery and field investigation reveals that the Chambal sub-basin is in the grip of the menace of soil-erosion causing the formation of ravines. The soil-erosion problem was aggravated by the construction of the Gandhi Sagar dam on the Chambal river. The removal of the forest cover naturally created and accelerated the devastating process of soil erosion. The steeply sloping plain regions, at the foot of the hills suffer from soil-erosion adjoining the rivers and nullahs. Heavy rains in the area sometimes result in flash floods during which the sudden gush of water in the streams has the capacity to carry large amount of silt and also aggravates gully/ravine formation. The worst affected areas are located mainly in Manasa Block, Neemuch district and Sitamau Block, Mandsaur, District. The head ward erosion of the gully is causing loss of fertile land, and siltation to the Gandhi Sagar Dam. The area affected by gully erosion and area prone to gully erosion has been classified and area of various classes has been demarcated and maps prepared using GIS software (Geometica, R2V and map Info).

It is proposed to reclaim the ravinous tract by construction of artificial recharge structures in Idar, Chamla, and Tilsoi watersheds of Chambal river basin. A weir is proposed be constructed across the ravine and supporting structures like gabions, retaining walls and filling the ravines behind the weir (upstream) by sand, pebbles

and boulders. While filling this material, slotted hume pipe (shaft) are to be installed in the ravines which will act as water abstraction structures after the material is filled and recharged by water. Check Dam sites have also been selected on the basis of the Satellite Imagery and Hydrogeological field investigation in the area. The upstream area in the gullies, and check dam is to be filled with boulder and coarse gravel to check the further headword erosion of soil, loss of soil, slow down runoff and also to supplement groundwater recharge in the area.

A Project Proposal has been submitted for construction of reclamation structures in the area under which the civil structures proposed for ravine reclamation at 4 sites are : weir 5 m length (7 nos.), weir 13 m length (1 no.), weir 20 m length (1 no.), Gabion 5 m (5 nos.), Gabion 10 m (13 nos.) and shaft (9 nos).

For the sustainable development of the area it is imperative that ground water resources in the area are replenished by artificial recharge. The structure being constructed during this projects will conserve water, recharge existing aquifer system of this area in addition to checking soil erosion and ravines from developing further.

11.3 NORTH EASTERN REGION

Guwahati

11.3.1 Urban Hydrological study of Greater Guwahati area;

During AAP 2005-06, Urban Hydrogeological Study of Greater Guwahati area has been undertaken. Guwahati city is the headquarter of Kamrup district of Assam. The area observes " Assam valley type tropical climate".

Geologically the area is part of the Brahmaputra basin, surrounded by hills in eastern and southern margins. Northern and western margins are open and continue as alluvial tract. Hydro geologically the subsurface lithology can be broadly grouped into two major hydrogeological units based on their hydrogeological properties and relative ground water potentialities. Fractured formations comprises of Archaear Granite gneiss, biotite gneiss, amphibolites etc. Ground water occurs in the weathered zone under water table conditions and under semi confined to confined conditions in the fractured part below. Granular formation constitutes Quaternary deposits covering the plains comprising of sand, gravel, clay and silt of various origin. Ground water occurs under water table to semi confined condition. To understand the behavior of ground water in the study area, a total 63 key observations wells were established and monitored monthly. Stage of development is computed to be 49%. Study of hydrograph reveals that neither pre monsoon water level nor post mon soon water level show any significant long term decline and maintain constancy. Hence, the area has been categorized as "SAFE".
Ground water in shallow aquifer is generally slightly acidic with pH value ranging from 5.5-7.8 (field values) and electrical conductivity, which is a function of amount of total dissolved solids in ground water, ranges from 100-1440 μ siemens/cm. However, quality of ground water is generally suitable for irrigational and domestic purposes except where iron content is high.

The area faces several problems with respect to ground water condition. They are:

1. Surface water logging
2. Ground water logging
3. Pollution from sewerage
4. Unregulated abstraction
5. High Iron content in groundwater and reported high Fluoride content in fractured formation.

In the last decade the area saw an unprecedented population growth 153.75%. Development activity for residential purpose has resulted into filling up of marshy lands and agricultural lands as well as cutting of hill slopes. This is blocking the natural flow of surface water as well as increasing the risk of slope failure. By disturbing natural flow pattern, sewage and garbage disposal have become burning problems for the city, which are also acting as sources of pollution for ground water. Moreover unregulated ground water abstraction in the area may affect the flow regime. Artificially created cone of depressions by large scale pumping may significantly change the flow patterns and resultant dewatering may lead to enhanced contamination possibility of the aquifer. Apart from anthropoid problems, geogenic problems such as high iron content and sporadic high fluoride content of ground water are also present in the area. Granitic rocks underlain the area. Weathering of these rocks under tropical humid climate resulted in to generation of thick pile of ferruginous laterites. Hence the ground water of the area generally show high iron content. However, oxidation and use of alum and sand filter can effectively reduce the iron content to permissible limits.

11.3.2. Special study on concentration of Arsenic in Ground Water of Dhemaji district, Assam.:

To detect the presence of Arsenic in ground water in Dhemaji district of Assam, 20 water samples from hand pumps located in different areas were collected. The results of chemical analysis shows that the concentration of arsenic ranges from 0.0165 to 0.5552 mg/l (ppm). To delineate the horizontal and vertical extension of Arsenic contamination in ground water in Dhemaji district, a total of 74 water samples were collected and analyzed by out sourcing. From the analysis it is observed that clear conclusion could not be made as the different organization (where from analysis were done) found wide variations of Arsenic concentration in the same well for the same month of the different year. So further detailed study is required for the same area.

11.4 NORTHERN REGION
Lucknow

The following special studies were taken up and their details are given below:-

11.4.1 Occurrence and distribution of ARSENIC in aquifer system in parts of Gonda district, Uttar Pradesh.:

The special study has been carried out in shallow aquifer in parts of Gonda district, U.P. for the assessment of occurrence and distribution of ARSENIC. An area of 3987 sq.km. area in interfluve zone of Ghaghara and Kunao rivers was covered for Arsenic survey for assessement of occurrence and distribution. The part area of district was taken for special study for "As" along Ghaghara river from Colonelganj Tehsil to Nawabganj Tehsil (Dobha – Colonelganj – Paraspur – Belsar – Nawabganj – Katra).

Geologically, the area can be classified into older and younger alluvial plain which are underlain by the alluvial sediments of Quaternary age. Deep drilling (CGWB) down to maximum depth of 215 mbgl at Village Manakpur (Block Manakpur) and Gonda town indicate the occurrence of alternate bed of clay and sand horizons occasionally mixed with gravel and kankar.
The depth to water level monitored wells distributed in the area parts of Gonda district (study area) the depth to water level varies between 2.46 m bgl to l7.50 mbgl area along Ghaghara river.

The perusal of analysis data in table-11.2 show that out of 257 water samples collected inparts of Gonda distt. 3.89% water samples are found to have Arsenic concentration more than 50 ppb. The maximum value have been found at Binpurkatra (98 ppb), Katra (250 kpb), Tarbaganj (70) Chandrabhanbpur (200), Uncheyka purwa (80), Subhagpur (60), Chakpan (200), Kalyanpur (80), Binpun Katra (60), Simrs (200) Arsenic between10-50 ppb whereas 74.71% are found to have Arsenic concentration less than 10 kppb

Table 11.2 :FREQUENCY DISTRIBUTION OF ARSENIC

Sl.No.	Arsenic range	No. of samples	% of As.
1.	As less than 10 ppb	192	74.71
2.	As 10-50 ppb	55	21.40
3.	As more than 50 ppb	10	3.89

11.4.2 Special studies on "Occurrence and distribution of organic pollutants (Pesticides) with quantitative identification in surface, vadoze zone in shallow aquifer in mango belt of Malhabad and Kakori blocks of Lucknow district Uttar Pradesh."

Under the study 32 observation stations for surface & ground water samples in mango belt of Malihabad block and 23 stations in mango belt of Kakori block were established. The water samples from the stations were collected in the increments of 6-8 samples at a time during pre-monsoon and post-monsoon period. In total 106 samples were analysed for organic pollutants (pesticides) studies such as α β γ and δ HCH, 4-4' DDT, 2-4 DDE, 4-4' DDE, 4-4' DDD, Total DDT, Chlorpirifors, Atrazine, Alicarb and Carlofuran. The samples were collected and analysed as per "Standard Methods for Water and Waste Water Analysis (APHA.19th edition) using SHIMADZU Gas Chromatograph (GC17A) on ECD&FTD detectors.

Perusal of the data thus obtained has revealed that the concentration of each of the above pesticide in much below the permissible limit defined 0.1 µg/l for individual pesticide (PFA-2004) and 1 µg/l for total pesticide (BIIS-1991) for drinking water. The above studies have also revealed that at points concentration of a particulars pesticide in surface water is more in comparison to shallow groundwater. It is concluded that surface and ground water of the study area is safe for drinking purpose in respect to pesticide concentration.

11.5 NORTH WESTERN REGION
Chandigarh

11.5.1 Mapping of Flood Plains of Ravi, Satluj , Beas & Ghaggar Rivers – Field Checks

Flood Plain of rivers in Punjab are underlain by potential sub-surface reservoir down to explored depth of 400m. Special study was takenup to check the feasibility to exploit resources, which has remained unexploited. It was proposed to dewater shallow aquifers during the pre-monsoon period and refilling these shallow aquifers during monsoon floods, so that they can provide water on sustainable basis in flood plain area especially during crisis. These aquifer has enormous potential to provide large amount of fresh water on sustainable basis owing to their hydrogeological properties provided if they were found feasible to be refilled during post-monsoon period. It could also have helped in conserving precious fresh water due to reduced evaporation losses.

Objective of the study was to map and delineate the active flood plain of above mentioned rivers, in order to ascertain the area, which has untapped ground water reserves, establish their yields and capabilities to refill the depleted aquifer during monsoon period, if any.

Keeping in mind the optimization of resource utilization and time span, it is proposed to select an area for pilot study, which could satisfy all the requisite as per objectives laid down. Help of the Remote Sensing technique may also be taken for identification of the pilot area and applying the results to other similarly placed area for project to be taken on a large scale. However, procurement of Remote Sensing (especially four band) data (July – Aug, 2005) Software/ Hardware required could not be completed in time. Non procurement of Remote Sensing data and non availability of Software/ Hardware was major limitation in the conducting the study to the tune of its full sprite.

Selection of area was based on the knowledge of hydrogeological conditions in the area. Pilot area of 205 Sq. km was selected for the study. Collection of field based relevant data of the pilot area was made during fieldwork.
Water level in proposed study area are in the depth range 5-15m. (May, 2005). In general it has been observed that phreatic aquifer system has variable thickness of 7-21 m. This aquifer system is highly productive due to occurrence of medium to fine grained sand.

During the study an attempt have been made to demarcate boundary of geologically older flood plain i.e. flood plain of the river marked by T1-terrace and a relatively newer flood plain, an area which actually gets inundated during the floods in the area on the basis of field work carried out.

River Satluj flows from east to west in pilot study area and acts as district boundary between Jalandhar and Ludhiana districts. Ropar headwork, a barrage at Ropar acts as water diverting system. Water flowing through River Satluj ex-Ropar headworks is diverted in canal network of the area and practically river Satluj has only water which comes as leakage through this reservoir. Bunding of river on both sides in form of Dhusi bund has reduced flood plain area which could otherwise be inundated during surface runoff or monsoon runoff. Due to decreased area for flooding recharge in the area has reduced. This has resulted into declining water levels in the area on both the sides. Besides, Satluj as river has very little water due to been damed at Bhakra and Ropar headwork. These structures has also resulted in decreased recurrence interval of flooding in this river.

It was found during study that it was not feasible to recharge shallow aquifer in the flood plain area of river Satluj. Though shallow aquifers in study area are highly potential of yielding water yet dewatering and refilling of these aquifers are practically not possible at least in pilot area on a viable basis. Possibility of constructing well field in active flood plain areas of rivers in study area can easily be negated. Declining water levels in the area are clear indicative of the fact that even the amount of water being withdrawn are not being replenished regularly or amount of water being withdrawn is much more that the replenished water resources.

11.6 SOUTH WESTERN REGION
Bangalore

Utilization of aero magnetic data for ground water exploration under basic research studies was taken up during AAP 2004 – 05 in collaboration with AMSE (wing), GSI through MOU singed between Deputy Director General AMSE (wing), GSI and the

Regional Director CGWB, SWR, Bangalore. It was desired to take up study in Toposheet No:57 C and D covering parts of Tumkur and Hassan Districts of Karnataka. The main objective of the study is to prepare Ground water Potential zones of the study area. The study has been carried over to AAP 2005-06 also. A meeting (23rd) was held on 19.09.2005 at AMSE wing of GSI to discuss about the utilization of Aeromagnetic data for ground water exploration. As per MOU, Interpretation and ground truth verification of high altitude aero magnetic data pertaining to Tumkur district (Covering parts of 57C &57D degree sheets) was carried out jointly by CGWB and AMSE wing (GSI) officers. Based on hydrogeological data & aero magnetic breaks sites were selected for geophysical survey. Based on geophysical survey results, drilling was carried out during outsourcing drilling programme at select sites. Even though results proved positive, high altitude aeromagnetic data could not decipher the break between shallow and deep fractures. Hence, the ambiguity in utilizing the high altitude data. Therefore, the study was wound up and the same has been conveyed to AMSE (GSI) through letter no. T-71/CGWB/SWR/2000-2017 dated 21.10.05.

11.7 SOUTH EASTERN REGION
Bhubneshwar

Special studies was taken up during 2005-06 in Puri Town, to study the urban hydrogeology with the following objectives:

a. Study the effect of withdrawal on ground water regime
b. Study of sea water ingress in the area
c. Study the status of ground water pollution
d. Project the Sweet Water Zone
e. Identifying the source (surface and ground water for meeting the domestic water demand for the projected population by 2050.

During the course of the study the following work was carried out:

a. 43 Observation wells established.
b. Pre and post monsoon water level measurement carried out.
c. 80 water samples collected during pre-monsoon & 55 water samples collected in post monsoon season.
d. Detailed studies carried out in post monsoon
e. Relevant data collected from various state govt. depts.

Puri, the Holy Town of Lord Jagannath spreads over an area of 16.84 sq.km. on a coastal sand dune. The average elevation is around 6 meters above mean sea level dotted with dune peaks; the highest one is 18.88 meters amsl. It receives a normal annual rainfall of around 1680.50 mm, 85% of which occurs during monsoonal period. However appreciable amount of rainfall occurs in late monsoon period (October & November), which is very crucial for enhancing the ground water resource.
The total population of the town is 1.75 lakhs as per 2001 census. The decadal growth of population is around 40%, which put enormous stress on the ground water resources. The top phreatic aquifer (at places semi confined) extends up to 40 meters of depth while the rest below is saline upto 180 meters below ground level. Though few fresh water bearing zones are existing between 180 to 240 meters below ground level, are not much promising from the yield and salinity hazards point of view.
Thus the huge population of the town with its floating population depends on this shallow phreatic aquifer for their daily water requirement. Only PHED is extracting

around 8.64 MCM of ground water by means of 44 numbers of tube wells and numerous shallow hand pumps. Though ground water extraction data is not available for the beach side hotels, at least 20 to 30 tube wells installed with different capacity pumps are in use, which amounts to at least 1.0 MCM. Hence the ground water withdrawal is at the tune of 9.62 MCM while the Replenishable Ground Water Resource is around 9.08 MCM. So the ground water draft is poised at 106.2%.
The impact of ground water over draft is well understood this year by the drying up of the holy temple dug wells; Ganga and Yamuna in the Lord Jagannath Temple premises during May and June 2005. Thus time has come for the Municipal, State and Central Govt. agencies to arrive at a formula for the judicious use of the precious ground water resources of the Town.

11.8 WESTERN REGION
Jaipur

11.8.1 Fresh Water Study of Thumbli Aquifer of Barmer Distt. In Association with Cairn Energy India Ltd. and RGWD.

The Thumbli formation (Tertiary) is located in the Barmer district and forms a part of hydrocarbon exploration block RJ-ON-90/1of Cairn Energy India Pvt. Ltd. (CEIL).
Fresh water studies were undertaken by Cairn Energy India Pvt. Ltd. in association with Central Ground Water Board and State Ground Water Department. The studies were planned jointly, discussed over in detail by all the participatory organizations and Water Management Consultants which were employed by the Cairn. The activities mainly include evaluation of existing data, drilling of exploratory and observation wells, conducting pumping test and data validation by hydrogeologist of WMC. Available technical information and data was shared among the participants at regular intervals, meetings were organized were to discuss the course of studies and future strategies. Conceptualization of study area model was done by WMC This model was refined during the discussions and various scenarios were generated to predict future behavior and stress on the limited freshwater reserves located in the Thumbli Formation. Field visits were made to the study area by officers of Central Ground Water Board and State Ground Water Deapartment together with WMC and Cairn representatives. Necessary study inputs were given by CGWB during these field visits as well as in the various meetings arranged during the course of study. In above meetings representation of local administration and PHED were also invited and their views were considered to assess the future water supply draft and other socio-economic aspects. The results of studies and the draft report were also discussed during the finalisation of studies and suitable suggestions were given during the detailed discussions held during the meeting.
The topography of the area is characterized by undulating sand dunes and few abruptly rising hills of rhyolites. Climate of the area is tropical desertic and hot. Rainfall in the area is scanty and erratic. The normal average rainfall in the area is 269.19 mm.

The area is covered by various geological formation of Tertiary Group. The Tertiary Group comprises of Akli formation, Thumbli formation and Dharvi Dungar formation from top to bottom respectively. Thumbly formation comprises of unconsolidated to loosely consolidated arenaceous sediments with intercalation of shales, argillaceous sediments and lignite etc. Central portion of the Thumbly formation Nagurda-Nimla- Bheemda triangle form fresh ground water area (Thumbli fresh water aquifer). The Thumbli fresh water aquifer is mostly endangered due to very thin fresh water column as compare to the total volume of aquifer water.

The thickness of Akli formation comprising of shales, lignite and semi consolidated sandstone is 0 to >1200m. The thickness of underlying Thumbli formation is above 770 m. The Thumbli formation can be further subdivided into upper predominantly sandstone named as Thumbli Sandstone (Thickness about 600 m) and lower predominantly shales called as Thumbli shales (thickness about 170m). The Thumbli shales are missing in southeastern part of the area. The Thumbli shales are underlain by Dharvi Dungar formation, which comprises of predominantly shales, locally carbonaceous with intercalation of sandstone. Its thickness ranges from about 200 m to 1200 m.

The sandstone of Akli and Thumbli formation forms the aquifer in the area. In the North Western part of the area around Bhadkha, Chokhla, sandstone of Akli formation is the principal aquifer followed by underlying Thumbli Sandstone where as in the South Eastern part around Bhimda, Khanj Ka Tala, Jogasaria, Nagana, Kau Khera, Madpura Barwala Thumbli sandstone forms the principal aquifer.
The Tertiary sandstone aquifer comprising of Thumbli sandstone formation can be divided further into two zones, the north-western-central part around villages Bhadakha, Chokhla, Bhimda, Khanji Ka Tala, Jogasaria and Nagana is represented by fresh water tertiary sandstone zone where fresh water occurs as a lens "floating" on top of more saline water at deeper levels. This fresh water zone extended down to depth of about 240 m bgl. The area of this fresh water zone is 425.59 Sq.Km. and effective potential zone area is 297.50 sq. km.

The remaining area lying in South Eastern part of the above fresh water tertiary sandstone zone is represented by saline water tertiary sand stone of Thumbli formation at all levels. The aerial extent of the saline water zone is 1727.23 sq. km.
General aquifer characteristics and sustainability in the north western part of the area, groundwater generally occurs under unconfined to semi confined conditions and depth to water level varies from 50 to 95 m bgl. Discharge of tube wells varies from 20 m^3/hr to 60 m^3/hr. In the area Akli formation sandstone and underlying Thumbli sandstone form the potential aquifer. Quality of groundwater is fresh to brackish having sp. Conductance ranging from 2000 to 4000 m. mhos/cum at 25°C.

There are evidences that ground water salinity has increased in some well fields, particularly at Bhadkha, since the start of development. At Khanji Ka Talla no such trend is identifiable. Although the proportion of fresh water reserve abstracted is small compared with estimated total reserve (2-3%), there is an indication that progressively shallower wells are being drilled at Khanji ka Tala to maintain acceptable in the produced water. This would suggest that groundwater use here may be causing thinning of the fresh water lens locally. Variability in the rate of salinity increases with depth, together with vertical variation in anisotropy and well depths, makes the differences in pumped ground water salinity both with location and time.

Facies changes within the Thumbli may also be a factor in the apparent variability of conditions at the various well fields. Based on some preliminary comparison, the proportion of <0.25mm dia sand in the aquifer at the Bhadkha well field area is greater than to the east of it.

Average discharge for a typical well has been estimated to be 22.5 m^3/hr and running time varies between well fields from 16 to 22 hours / day. Backward extrapolation of hydrograph data infers a pre-development water table at around 117 mmsl compared with current level at approximately 111 mmsl. All data present an over all receding groundwater level varying between 0.1 m/year and 0.4 m/year.

Thumbli aquifer control limited due to well completion uncertainty, well head elevation uncertainty, pumping effect. Current public and private well field abstraction in water table areas are controlling groundwater movement throughout the system. Historic ground water movement likely towards south-southwest with discharge to Akli formation.

To evaluate aquifer parameter CEIL has conducted 2 pumping tests at a constant discharge rate of 80 m^3/hr & 106.5 m^3/hr at Ma-2 and Ai- 3 sites on the tube wells constructed at respective sites, tapping Thumbli aquifer. The depth of tube wells constructed is 325.57 m bgl and 297 m bgl and saturated thickness tapped in 99.92m and 96.0 m respectively for Ma-2 & Ai-3. On the basis of pumping test the transmissivity of the aquifer at site Ma-2 was 3200 m^3/day and storage coefficient was 2.85 x 10^{-5}, whereas at site Ai-3 the transmissivity values was 1350 m^3/day and storage coefficient obtained was 2.29 x 10^{-4}. At Ma-2 this equates to a horizontal hydraulic conductivity of approximately 0.2 m/day. It is assumed that recharge into the Thumbli aquifer is (or was) balanced by natural outflow. Current model assumes that this outflow is into the overlying Akli Formation. There is support for this in that heads in the wells in the Akli (and Alluvium) are lower than those in the Thumbli. There is also evidence that the heads in the Fatehgarh Group (the main oil reservoir) are higher than in the Thumbli so it is inferred that there is flow upwards from the Fatehgarh into the Thumbli through the intervening strata.

In Eastern-southeastern part of the area, the proposed saline groundwater abstraction area falls in this zone, ground water generally occurs under confined conditions and quality of groundwater is saline having sp. conductance is more than 8000 m. mhos/cm at 25°C. CEIL has also proposed abstraction of saline groundwater from the area around villages Madpura Barwala located about 20 Km from Mangla and 9 Km from Aishwarya oil field respectively by constructing 24 deep tube wells. Total 89.4 million m^3 of aquifer water will be required for Mangla and Aishwarya oil field up to 2040.

The groundwater development in this area is meager due to highly saline groundwater. Depth to water level (i.e. piezometeric head) in confined aquifers, as interpreted by CEIL field studies, varies from 36 m to 60 m bgl, whereas depth to water level in unconfined aquifer in the area varies from 20 to 40 m bgl. Detailed study carried out by CEIL reveal that in the proposed saline groundwater abstraction area, saturated thickness of Thumbli aquifer is about 400 m.
The maximum projected water requirement is 25000 m^3/day and to meet this CEIL has proposed to construct 24 tube wells. The proposed abstraction of groundwater per tube well is 1500 m^3/day assuming 16 hours operational per day at the rate of about 62.5 m^3/hr. The proposed abstraction rate for the initial 10 years @ 25000 m^3/day maximum and @ 5000 m^3/day or less as per actual desired requirement. The results of pumping test conducted at Ma-2 and Ai-3 sites reveal that the Thumbli aquifer can sustain the proposed conservative rate of abstraction per day.

11.8.2 Hydrogeological Studies on Ground Water control measures to be adopted in Kasnau-Matasukh Mines, Nagaur district

Central Ground Water Board, Western Region, Jaipur has taken up regional hydrogeological studies of Kasnau – Matasukh Lignite Mines, Nagaur District for Rajasthan State Mines and Minerals Ltd. (RSMML) in Annual Action Plan 2005-06. The main objective of the study to understand the behaviour of the ground water regime in space and time owing to depressurization of confined aquifer for lignite mining activities. A preliminary study was carried out during the month of August' 05 and the following work plan is proposed to be undertaken under the study.

1. **Drilling of one slim hole (dia 9 $^{7}/_{9}$") of about 400 m depth. The objective of slim bore hole drilling is to collect all hydrogeological and other relevant data and to ascertain the thickness of Tertiary formation in mining leased area.**
2. **Drilling and construction of 4 nos. exploratory wells (dia 10" to 14") and 8 nos. observation wells (dia 6") of depth between 200 and 250 m. The depth of EW and OW may vary depending upon the field condition. All relevant hydrogeological and exploratory data would be collected including various logging of boreholes.**
3. **Drilling and construction of 2 recharge wells (dia 10 – 14") of depth 200 to 250 m for the purpose of recharge tests to establish the rate of recharge and consequent changes in the regime.**
4. **Collection and analysis of water samples during various tests and study.**
5. **Collection of data on land use, cropping pattern, hydrometeorological, hydrological, hydrogeological, population etc. from different departments.**
6. **Preparation of mathematical model based on regional hydrogeological studies for prediction of change in groundwater regime and depressurization of confined aquifer for lignite mining activity.**
7. **Preparation of report on "Regional hydrogeological studies in and around Kasnau – Matasukh Lignite Mines, Nagaur district, Rajasthan".**
8. **Any other work, which is not covered under item 1 to 9 and required during the studies, shall be taken up.**

11.8.2.1 Execution of work

The study is a collaborative work of CGWB and RSMML. The role of RSMML and CGWB shall be as under for execution of work to accomplish the study.

A. Role of RSMML

The Rajasthan State Mines and Mineral Ltd. will execute the following:

1. **Drilling, construction and testing of slim hole, exploration wells, observation wells, piezometers, recharge wells, Pumping test, recharge test, collection of data, mathematical modeling and preparation of report.**
2. **Collection of all existing and exploratory data and analysis.**
3. **Pumping and recharge tests and analysis of data.**
4. **Collection of water samples and analysis.**
5. **Mathematical modeling study.**
6. **Processing of analysis of data and preparation of report.**

B. Role of CGWB

1. **CGWB provide technical guidance and supervision of work of all the activities mentioned above.**

2. **Finalize the sites for EW, OW, Pz, recharge wells etc. for the studies in association with the hydrogeolotists engaged with RSMML.**
3. **Render guidance and supervision in preparation of the mathematical model and final report.**

11.8.2.2 Time frame

The entire work is to be completed within 1 years time from the date start of the investigations.

Construction	**:**	**2 month**
Test	**:**	**3 month**
Modelling study	**:**	**1 month**
Processing, analysis and report writing	**:**	**1 month**

11.8.2.3 Other requirement

a. In view of the public litigation necessary and prior approval of the concerned authority shall be required before the commencement of work.
b. The RSMML shall also make necessary provision for disposal of poor quality water to be pumped during various tests (APT, SDT). Disposal of water may be done at a safe distance so as it may not influence the test by leakage etc.
c. RSMML shall engage an experienced hydrogeologist for collection and processing of all data, conducting and analysis of test during the study and preparation of final report under the overall guidance and supervision of CGWB
d. RSMML shall also obtaine necessary permission from concerned authority for construction of EW, OW, Piezometer, recharge well etc for the sites located out side their leased area.
e. Necessary funding for execution of entire work shall be arranged by RSMML.

MoU of CGWB with RSMML signed. Strategies for lowering groundwater levels by de-watering will be finally suggested to the requesting agency.

11.8.3 Govindgarh block, district Jaipur

Common people are of opinion that industrial areas having soft drinks manufacturing units withdraw more groundwater as compared to irrigation purposes. With the objectives to find out the facts, detailed scientific studies were undertaken in the Govindgarh block wherein industrial town Kaladera & Jaitpura are also located. Field studies were conducted in Govindgarh block of Jaipur district regarding impact of sectorial ground water draft i.e. for domestic, irrigation & industrial purposes. Report for the same was prepared and submitted to CHQ.

12. STUDIES ON CONJUCTIVE USE OF SURFACE AND GROUND WATER

Feasibility study for Conjunctive use of surface and ground water has been taken up by the Board in the irrigation Command areas of medium and major irrigation projects. It is essential to ascertain the hydrogeological conditions in the command areas, to identify areas affected by water logging and salinity. These study attempts to assess the availability of ground water and to formulate action plans for co-ordinated use of surface and ground water and to ensure development of the entire water resource in the commands to optimal levels. Details of the studies carried out during the year for the on going projects are as under.

12.1 Conjunctive use of ground water and surface water in Rushikulya Command Area, Orissa

Conjunctive use of surface water and ground water studies was taken up by CGWB, South Eastern Region, in the Rushikulya Canal Command Area, Ganjam district. The major irrigation canal of the system is the Rushikulya Main canal, which off takes on the right of Janivilli Anicut and covers a total length of 87.417 Km. The canal has 16 numbers of distributaries off taking from it. Distributary number 3 and 4 have been abandoned and not excavated. The total length of distributaries with their minors and sub minors is 152 Kms. The Rushikulya Main Canal integrates 88 numbers of tanks and 11 numbers of channels through its canal system and was originally designed to command an area of 33,525 Ha.

Major part of the area is underlain by the hard crystalline rocks of Archaean age. Sediments of recent to sub-recent age occur along the coastal tract and as discontinuous patches along the Rushikulya river. Laterite also occurs in the area as capping over the older formations.

The shallow aquifers comprising of the weathered residuum, vary in thickness from 5 to 15 m and offers vast scope for ground water development through open wells. The exploration carried out by the CGWB indicated that in general, the saturated fractures are within the depth range of 125 mbgl in the hard rock areas which recorded a discharge varying from 3 to 16 lps with draw down of 34 to 36 m.

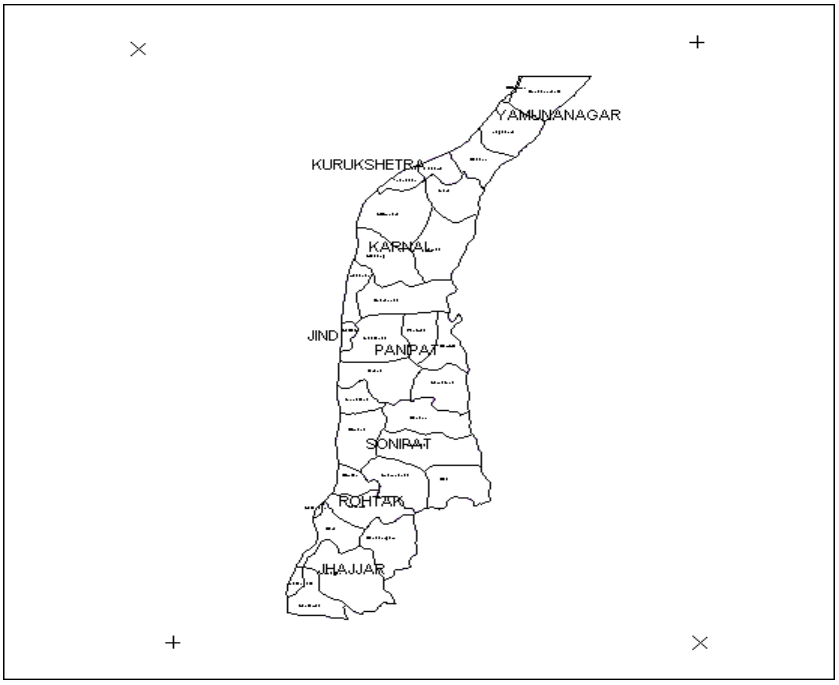
104 nos. of key wells have been established so far in the pre-monsoon season in the blocks of Rangeilunda, Chatrapur, Ganjam, Purushottampur, Hinjlicut, Dighapahandi, Sanakhemundi, Sheragada, Aska, Dharakote, Sorada, Belaguntha and Chikiti blocks and the relevant well details have been collected. Apart from the established key wells, 63 nos. of existing NHS have also been earmarked for monitoring in the canal command area.

12.2 Conjunctive use of ground water and surface water Western Yamuna Canal Command, Haryana.

Conjunctive Use studies for the whole of Western Yamuna Canal (WYC) Command area covering an area of 13500 Sq.Km. have been taken up by CGWB, NWR, Chandigarh, during Annual Action Plan (AAP) 2003-04 and 2004-05. As a follow up Mathematical modeling study has been taken up in association with National Institute of Hydrology, Roorkee on an area of around 7500 Sq.Km. during the current year with the following objectives.

c. **To simulate hydrogeological condition and ground water flow system of the area**
d. **Evaluation of the current practice of water use in the study area.**
e. **To generate alternate management scenarios and evolve planning strategies.**
f. **To develop optimal allocation plan for surface and ground water in the study area.**

The modify area extends to about 7508.11 sq.km area covering 8 districts (32 blocks) of Haryana State, located in between East Longitude 76.517^0 & 77.555^0 and North Latitude 30.318^0 & 28.437^0.



The study carried out during the year including

1. **Digitization of maps of the area digitized, imported to Modflow package, oriented parallel to North-South, East-west based on the general ground water flow in the area and river Yamuna, required spatial discritization carried out. Area divided into 105 columns and 210rows with an area of 1 sq.km. for each cell.**
2. **The Top and bottom of 2 aquifers and one confining layer, totaling to 3 layers were decided and assigned to the model. For this purpose the data of layers were compiled (from the BDR"s and Fence & Geophysical data), contoured and imported in the model.**
3. **The surface elevations compiled using data from R.L. of all observation wells, Piezometers, and RL of Exploratory Tube Wells and surface elevation map of Upper Yamuna basin Project Report. This data is then imported in the model, contoured to assign as surface elevation of the area. In both the cases the data outside the area were also utilized for contouring.**
4. **Assigned Hydraulic Conductivity and Specific Storage to layers.**
5. **Assigned Evaporation data. The Evaporation data was first compiled month-wise for the period June,2002 to May 2003 as m/day and assigned for the first layer of the entire area.**
6. **Assigned rainfall recharge for the area as m/day, month wise for Monsoon and Non-Monsoon for the period from June, 2002 to May, 2003 for all the 32 blocks. The data was assigned selecting each block and assigned two values 0-122 (Monsoon) and 123-365 (Non-Monsoon).**
7. **Discharge data was compiled from the GW ESTIMATION report of CGWB and assigned to each cell in the model area.**
8. **Assigned observation wells to the model. 22 observation wells tapping the first layer (phreatic aquifer) were selected using data from the State Ground Water Cell, Haryana and assigned to the model. 10 observation wells (piezometers of the CGWB, tapping first confined aquifer) assigned to the model**

9. **Assigned initial piezometric level to layers I and III using data of State Ground Water Cell and CGWB.**
10. **Flux computed and assigned to North and South of the Model Area.**
11. **Assigned River boundary . The river boundary from Tajewala to entry of Delhi bordering the eastern part of the model was assigned using data of CWC and Irrigation Department, Haryana.**
12. **Assigned River Boundary for canals such as MLU, MLL, WJC, Delhi Parallel, JLN Feeder and Augmentation Canal.**
13. **The model was successfully run both for steady State and Transient State.**
14. **Draft report submitted to Central HQ**

12.3 Sri Ram Sagar Conjunctive Use Project, Andhra Pradesh

Conjunctive use studies were carried out in parts of Sri Ram Sagar Canal Command area in parts of Karimnagar and Warangal districts covering an area of 1,680 sq.km. The study area lies between North latitudes 18º 00' to 18º 24' and East longitudes 79º 09' to 79º 47' and is covered by distributaries no. DBM 1 to DBM 31 on Kakatiya Main Canal form 146 KM to 234 KM starting from Lower Maanair Dam of Karimnagar district and serves the needs both for domestic and irrigation needs of Karimnagar and Warangal districts of Andhra Pradesh. The total gross command of the study area is 1,68,000 ha with localized ayacut of 90,614 ha. The area is mainly drained by Maneru river and its tributaries.

Geophysical studies in the study area reveals that the rocks in the command area are considerably permeable with weathering and fracturing. The depth of weathering ranges from 10 to 20 metres and the potential fracture zones exists within the depth range of 15 m to 50m. respectively. The surface water availability has been estimated mainly on the basis of canal water releases and has been worked out as 568 MCM. The ground water potential has been estimated on the basis of GEC 1997 methodology and is estimated as 483 MCM and thus the total water resources available in the project area has been worked out as 1051 MCM. Actual area irrigated and their demands were worked out based on the Crop Water Requirements. Based on this the demands for the entire localized area has been estimated as 742 MCM. This can be met with the available surface water resources of 568 MCM plus 174 MCM of ground water leaving a balance of 309 MCM of ground water for creating additional irrigation potential of another 31,000 ha. with the help of constructing additional no. of 20,600 bore wells and the present cropping intensity of 40 % can be increased to 90 %. The investment costs for implementing the proposed conjunctive use plan would be Rs. 80 crores and the benefits worked out will be worth of Rs. 240 crores and the Benefit-\ cost ratio works out to be 3.07.

Recommendations

To solve the water shortage problems in the canal command area, implementation of the proposed ground water development plans is recommended in conjunction with surface water. If implemented judiciously 90% of the water starving areas can be brought under ground water irrigation. The remaining 10% per cent of the area also can be brought under irrigation by modern water saving methods like sprinkler / drip irrigation.

Farmers should be educated regarding excess utilization of water in the head reaches and violation of cropping pattern. Canal water supply management needs improvement to avoid wastage of water in the head reaches and for equitable distribution of available water as per the designed discharge for the entire canal system by strictly adopting canal roistering techniques.

Modernization of canals and distribution system is recommended by lining the canals and replacement / repairs of canal regulators to minimize the conveyance losses and proper management of water distribution. The water allocations at the field head should be restricted to the crop water requirement after duly considering the percolation losses.

Since huge investments are required to implement the plan proposed farmers Cooperative Societies Programme is recommended so that loans from the financial institutions like NABARD can be sought through the formation of such societies. This will facilitate better management of agricultural activities and efficient irrigation practices and to obtain ambitious farm benefits.

Finally, it is recommended that for implementing the plan experienced ground water scientists are to be employed while selecting and pinpointing the exploratory sites. All the well sites are to be located strictly within the ground water potential zones and follow the well spacing norms meticulously on scientific basis.

13. STUDIES ON ARTIFICIAL RECHARGE OF GROUND WATER

The Central Ground Water Board under the Ministry of Water Resources is operating a Central Sector Scheme for Artificial Recharge studies to Ground Water .The objective of the scheme is to evolve effective and economic designs of artificial recharge structures for various types of hydrogeological set ups. The objective of construction of these structures is to arrest the decline in the ground water table and provide additional irrigation benefits. Besides, augmenting the recharge to ground water, this scheme is also helping in upgrading the technical competence and skills of the personnel in the State and NGOs for taking up such works at other places.

During 2005-2006, the region wise progress of work done under these studies are as follows:-

13.1 CENTRAL REGION (Nagpur)

13.1.1 CENTRAL SECTOR SCHEME OF ARP **- The new ARP schemes under Xth Plan were persued with Government of Maharashtra and UT of Dadra and Nagar Haveli and proposals have not been received from them.**

13.1.2 **TECHNICAL GUIDENCE FOR RAIN WATER HARVESTING** - Technical guidance on Rain Water Harvesting was provided to Defence and other organizations for Rainwater Harvesting schemes viz; a) Defence organization for Married Accommodation Project at Aurangabad and b) MAHGENCO M.S.E.B., Power Generation Extension Plant at Urban, Raigad district.

13.1..3 PREPARATION OF MANUAL OF ARTIFICIAL RECHARGE - **Dr. S.K. Jain, Scientist-D has attended meeting for the Preparation of "Manual of Artificial Recharge" at Central Ground Water Board, SWR, Bangalore on 13 -16th June 2005. He has attended meeting for the Preparation of "Manual of Artificial Recharge to Groundwater" for BIS at Central Ground Water Board, Bhujal Bhavan, Faridabad on 7-11th November 2005.**

13.1.4 CONDUCTION OF TRAINING PROGRAMME ON ARTIFICIAL RECHARGE:- **Dr. S.K.Jain, Scientist-D conducting a training course on "Artificial Recharge Techniques in different hydrogeological Conditions " between 21st -25th November 2005 at CGWB, Ansal Bhavan, New Delhi**

13.2 SOUTHERN REGION (Hyderabad)

Project proposal for artificial recharge studies in Kadapa received from State Government and the same has been sanctioned. Impact assessment studies of demonstrative artificial recharge structures constructed in Osmania University under Fresh Water Year was taken up and completed.

13.3 NORTH WESTERN REGION (Chandigarh)

13.3.1 PUNJAB

The following artificial recharge schemes were under taken:

Scheme for Rainwater harvesting to recharge ground water in Administrative and Judicial Complex, Fatehgarh sahib.
Scheme for rainwater harvesting to recharge ground water in D.C. Office Complex, Jalandhar City.
Scheme for Artificial Recharge of Roof Top rainwater harvesting for school buildings in Patiala district.

13.3.2 HARYANA

Work continued for the following artificial recharge schemes.

1. Pilot study for artificial recharge to escape water at Deroli village, district Mahendergarh. Pilot scheme for artificial recharge to ground water through Hassanpur distributory at Hamirpur bandh, Mahendergarh district.

13.3.3 CHANDIGARH

Monitoring was carried out the following six artificial recharge schemes.

1. **Scheme for roof top rainwater harvesting at Bhujal Bhawan Chandigarh**
2. **Artificial recharge to ground water at office of Chandigarh Housing Board in sector 9, Chandigarh**
3. **Scheme for rain water harvesting at DAV School in Sector-8, Chandigarh**
4. **Artificial recharge to ground water at TTTI, Sector-26, Chandigarh**
5. **Scheme for utilising surplus water monsoon runoff for sector 26,27,19,30,20, Chandigarh**
6. **Scheme for Artificial recharge to ground water for Government College for Girls, Sector - 11, Chandigarh.**

13.4 EASTERN REGION (Kolkata)

13.4.1 WEST BENGAL

Construction of Two Percolation tank were Completed. Re-Excavation of 1 pond recharge pit and shaft are in progress (80% work completed).

13.4.2 SIKKIM

Meeting of the Technical Coordination Committee (TCC) was held on 27.04.05, in which, maintenance of completed roof top rainwater conservation structures was discussed.

13.4.3 ANDAMAN & NICOBAR ISLANDS

Monitoring & report submission completed

13.5 MID EASTERN REGION (Patna)

There are five artificial recharge projects under monitoring for impact assessment in the states of Bihar and Jharkhand given in table 13.1. These Artificial Recharge projects have been funded by Central Ground Water Board under Central Sector Scheme except the Bhagalpur Combined Building, which has been funded under Fresh Water Year 2003.

Table13.1 : IMPACT ASSESSMENT **ARTIFICIAL RECHARGE PROJECTS** IN THE STATES OF BIHAR AND JHARKHAND

Sl No.	**Scheme**	**Executing Agency**	**Costs of project. (in lakh)**	**Status of the project**
1.	Project of Artificial Recharge to groundwater in Patna University Campus, Patna, Bihar	Geology Department, Patna University	5.84	Monitoring for impact assessment is under progress
2.	Rainwater harvesting at Combined Building of State Govt. Bhagalpur, Bihar	State Govt.	4.99	-do-
3.	Rooftop rainwater harvesting at CHES complex, Plandu, Ranchi, Jharkhand	CGWB	6.74	-do-
4.	Rooftop rainwater harvesting at Engineers' Line Cantonment area, Ranchi, Jharkhand	-do-	6.60	-do-
5.	Rooftop rainwater harvesting at Dipatoli Cantonment area, Ranchi, Jharkhand	-do-	4.61	-do-

13.6 NORTH CENTRAL REGION (Bhopal)

13.6.1 Roof top rain water harvesting, District Hospital, Dewas: - Under the Central Sector Scheme a sum of Rs 3.37 Lacs was sanctioned for construction of roof top rain water harvesting structure in Government District Hospital Dewas. The construction work was taken up during the AAP 2004-05. The impact studies are being carried out. The quality of the bore well located in the campus of the Hospital is showing improvement as the nitrate content of the well is reduced from 100 mg/liter to 65 mg/liter.

13.6.2 Roof Top Rain Water Harvesting in Dewas & Jhabua districts : - **The sanction of a Scheme costing Rs. 10Lacs to Non Government organisation Sampark in Jhabua district respectively was sanctioned vide letter No. 11/29/2004/GW dt. 24 March 2004 Ministry of Water Resources Govt. of India for construction of two numbers toilets and rainwater harvesting structures in 10 schools of Jhabua district. The Central Ground Water Board, NCR, rendered technical help for the construction of these structures. Upto the March 06 two numbers toilets and rainwater harvesting structures were constructed in 10 schools of Jhabua district.**

13.7 NORTH HIMALAYAN REGION (Dharamshala)

A centrally sponsored project of Rain Water Harvesting through construction of check dams and Roof Top Rain Water Harvesting structures has been initiated in Himachal Pradesh on similar pattern of what has been done elsewhere in the country. The aim of these schemes was to arrest the rainfall flow and store the same underground so that it can be used at the time of need. So far an amount of 81.65 Lakhs have been spent on six artificial recharge schemes. Out of the six schemes, three schemes are implemented by the construction of check dams, one scheme by construction of check dam cum ground water dam. Rest of the two schemes belongs to roof top rainwater harvesting at Irrigation and Public Health Department at Palampur and Indora both in Kangra district

These schemes are fully funded by CGWB and were executed by Irrigation & Public Health Department. All these six schemes at the cost of Rs 81.65 lakhs have already

been completed and handed over to IPH Department. However the impact assessment studies of these schemes is done by CGWB and is under progress.

13.8 NORTHERN REGION (Lucknow)

13.8.1Under Central Sector Scheme:

1. **Aligarh Nagar Nigam, Aligarh : Four Sites - 100% sanctioned funds released in the previous years to Aligarh Nagar Nigam for execution of schemes. Remaining civil work at four sites is yet to be completed. On 29th June 2006, Aligarh Nagar Nigam issued a notice to concerned contractors regarding completion of remaining works otherwise their the contract will be cancelled.**

2. **U.P. Ground Water Department : one site - Execution of scheme has been completed.**

13.8.2 Under Fresh Water Year – 2003

1. Tagore Library,Lucknow University (Old Campus), Lucknow : One site - Recharge wells and 2 trenches completed. Left over civil work near completion

The following R.W.H. schemes were prepared and designs were suggested by CGWB (NR) as per requests received.

b. Incinirator Plant, Etmadpur, Agra
c. Surface run-off harvesting at Incinirator Plant, Etmadpur, Agra.
d. Jain Temple, Mathura
e. Wrestling Hall, Sh. Kailash Prakash Sports Stadium, Meerut.
f. Gymnastic Hall.

06-11 Six schemes for CPMG Office, Lucknow.
12-18 Seven schemes for BSNL Gonda, Nanpara and Bahraic.
19-24 Six schemes for MAP, Agra Cantt. Agra.
1 Kendriya Vidhyalaya, Gomti Nagar, Lucknow.
2 Telco Plant, Chinhat – Dewa Road, Lucknow

13.9 WESTERN REGION (Jaipur)

13.9.1 Prepared rainwater-harvesting schemes for artificial recharge to ground water for most backward districts of Rajasthan identified by PMO viz. Banswara, Udaipur, Sirohi & Karauli districts.

13.9.2 Field studies carried out for rainwater harvesting for artificial recharge to ground water for different buildings of Shri Mahavirji Trust, district Karauli.

Monitoring of demonstration of Rain Water Harvesting from Roof Top in rural Government schools by Voluntary Organizations:
Rendered guidance to all departments, individual, Housing Societies & NGO etc. for rainwater harvesting schemes.

13.9.4 Impact Analysis - Artificial recharge to groundwater enhances resource availability and is reflected in the form of increase in water levels. Quantification of impact of construction of recharge structures for all the 18 Roof Top Rainwater Harvesting schemes and check dames so far completed was assessed during the Annual Action Plan under consideration. The recharge structures include Governor House, Chief Minister Residence, Secretariat, Vitta Bhawan, High Courte, Ground Water Department, Central Ground Water Board office premises, Malviya Regional Engineering College, Reserve Bank of India, Officers Training School, Sinchai Bhawan, Collectorate Building, PHED building (all in Jaipur Urban Area), CTAE (Udaipur Urban Area). Similar impact assessment was also carried out for all the 4 check dams constructed in Sikar and Jhunjhunu districts.

13.10 SOUTH EASTERN REGION (Bhubaneshwar)

13.10.1 Artificial Recharge to Ground Water for Arresting Salinity Ingress in parts of Basudevpur & Chandbali Blocks of Bhadrak District, Orissa:

In this pilot project, the fresh water pushed in to the creeks and sub creeks by tidal action of the river gets impounded in the creeks which is regulated by a regulatory structure namely sluice system. During high tide, sluice gates are kept open for entry of fresh water into the creeks and once the creek gets filled up, the sluice gates are closed. Thus, the fresh water, which was otherwise going waste, is harvested and is being utilised for irrigation. In total, 27 such creeks/sub creeks were renovated. Moreover, the excess water from Creeks is allowed to enter into the recharge wells, which tap the shallow brackish to saline aquifer system in the area for its quality improvement. Impact assessment study shows that sufficient fresh water had entered into the aquifer system. The electrical conductivity has decreased in the area.

13.10.2 Impact Assessment

1. Taking in to consideration of the Specific capacity of the recharge wells as well as the factors described above, the total intake capacity works out to be 36.16 lps for 21 number of recharge wells. The total quantity of water that can be recharged for 250 operational days comes to 716256 m3. Hence, the 75% of this quantity i.e. 537192 m3 (716256*0.75) may be taken as total quantity for recharge..
2. Generally, the river (Matei) water remains fresh up to March and gets brackish to saline during summer i.e. April to June. However, heavy late monsoon showers in 2003, which continued up to December 2003, had led to the availability of fresh water during the full summer. So as the recharge wells were made operational during April 2004, sufficient fresh water had entered into the aquifer system. Thus a floating fresh water lense is detected at the piezometer constructed at Rahimpur village. This floating fresh water has variation of quality downwards. The water sample collected from 4 m bgl on 4.6.2004 has shown EC of 760 m.mhos/cm at 25°C while that collected from 13 m bgl has given EC of 2288 m.mhos/cm at 25° C.The formation water is found out to be 36000 m.mhos /cm at 25° C.
3. The AWLR having the provision of EC measurement was lowered in the above-mentioned piezometer and was programmed for 2 hourly data acquisition. The continuous data on the fresh floating water lense for 7 days from 4.6.2004 to 10.6.2004 . The EC has improved

continuously in stepwise manner from 2288 to 1727 m.mhos/cm at 25° C. Though the ground water level is on a decline trend due to summer season, the improvement of ground water quality indicates that artificial recharge is on progress.

4. An interesting correlation is observed between the EC and the temperature of the ground water. Sudden rise of ground water temperature coincides with the steps where ground water improves its quality. This can be explained by the differences of temperature between the surface water harvested in the creeks and the ground water existing in the aquifer. During summer seasons the surface water temperature used to be around 31°C, which is more than that of the ground water. Thus when large volume of fresh surface water is recharging the aquifer, its reflection on the ground water temperature is imminent.
5. Monsoonal rain generally starts from mid June and thus creeks and canals got filled up with rainwater as well as from the fresh river water. Artificial recharge during the whole monsoonal period has improved the quality still further as the EC has reached 1500 m.mhos/cm at 25° C during October 2004.
6. To determine the utility of the fresh water lenses floating over the brackish / saline zone, the piezometer was pumped on 9.1.2004. In absence of low capacity pump, the same was pumped by a 2 HP Self-Priming Suction Pump at the rate of 5 lps. The water quality was found to be fresh up to 5 minutes of pumping with EC of around 2683 m.mhos/cm at 25° C. The water is of Na (CI + HC03) type with the concentration of Chloride is twice that of the Bicarbonate . This can be explained by the fact that the floating fresh water-bearing zone develops on the saline aquifer by replacing the saline water. Thus when the NaCI type of water is getting replaced by Ca (HC03)2 type of water, Ion exchange results in the formation of Na(CI + HC03) type of water. If the undisturbed fresh water of the floating zone could have been collected, then it could have been of Na HC03 type.
7. Once pumping was stopped, the water level start recouping by gushing of fresh water from all around. Hence EC started improving from 46000 to 8504 m.mhos/cm at 25° C between 11 days . However the improvement is not uniformed sudden jump of EC from 45290 to 16622 m.mhos/cm at 25° C within 12 hours was conspicuous.

The final report pertaining to this study has already been issued.

13.10.3 Impact Assessment of Completed Schemes:

An impact assessment report of Artificial Recharge to Ground Water in Kalajore watershed, Khallikote Block, Ganjam District, Orissa was submitted by GWS&I, Govt. of Orissa. The project area covers ten villages and i.s about 17 Sq.Km. in spatial extent. The Kalajore watershed is a micro-watershed of the Rusikulya River Basin of the State.

The ground water resource of the project area has been impacted due to augmented recharge during monsoon season. The pre-project assessment of ground water resource was made based on the rainfall infiltration factor. It was estimated to be 127 Hectare Meters (HM). During post-project period, the summer water table has been raised on an average 0.90 M, which is equivalent to additional 10.44 HM of ground water resource over and above 127 HM. Hence the present ground water resource of the project area is assed to be 137.44 HM based on the water table fluctuation.

The analyzed water quality parameters revealed that the overall water quality of the area has not been much affected by the recharge structures and the available water is suitable for both domestic and irrigation purposes.

14. MATHEMATICAL MODELLING STUDIES

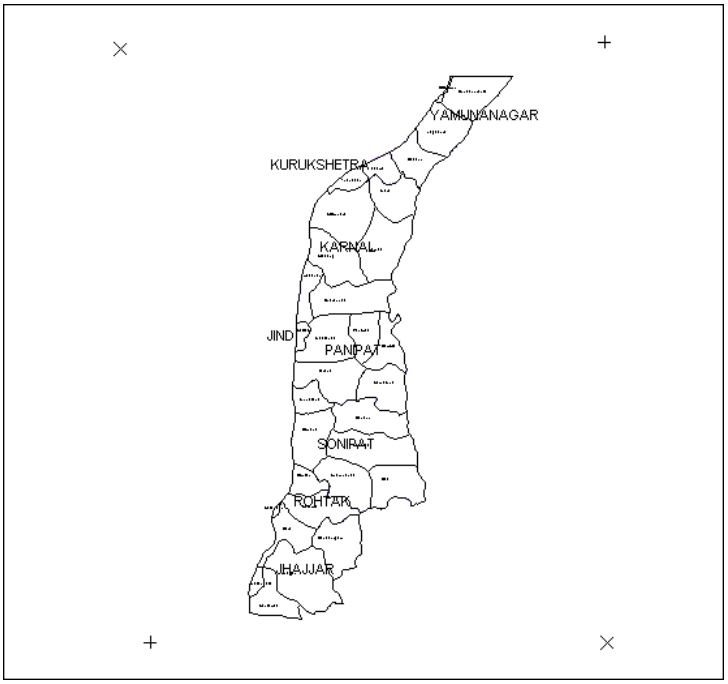
A model is any device that represents an approximation of a field situation. A ground water model can be defined as a simplified version of a real ground water system. Ground Water simulation models provide a platform to study the problems in broader perspective and resolve solutions for the optimal benefit taking into considerations the simplest and complex aspects along with economic, social and environmental aspects.

The Central Ground Water Board has undertaken various studies on ground water modeling during the year. Mathematical modeling have been taken up in irrigation commands for arriving at optimal conjunctive use plan in the Western Yamuna Canal as well as in Chennai Metropolitan Area for planning the ground water development. The brief finding of the study are described in the following paragraphs:

14.1 NORTH WESTERN REGION, Chandigarh

Feasibility study for Conjunctive Use of surface and ground water has been taken up during Annual Action Plan (AAP) 2003-04 and 2004-05 for the entire Western Yamuna Canal (WYC) Command covering an area of 13500 Sq.Km. As a follow up of this study Mathematical modeling has been carried out in a an area of about 7500 Sq km. in association with National Institute of Hydrology, Roorkee. The Study area covers 8 districts (32 blocks) of Haryana State, located in between East Longitude 76.517^0 & 77.555^0 and North Latitude 30.318^0 & 28.437^0. Study was taken up with following objectives:-

1. To simulate hydrogeological condition and ground water flow system of the area
2. Evaluation of the current practice of water use in the study area.
3. To generate alternate management scenarios and evolve planning strategies.
4. To develop optimal allocation plan for surface and ground water in the study area.



14.1.1 DATA COLLECTED

a. Daily rainfall data for different rain gauge stations for the period June, 2002 to May 2005 for the state of Haryana .
b. Other Hydrometeorological data collected for June, 2002 to May, 2005.
c. Monthly water level data of 32 piezometers and 32 Key observation Wells were collected for June, 2002 to May,2005 from State Ground Water Cell, Haryana.
d. Discharge of River Yamuna at Tajewala, discharge of canals at different head-works such as Dadupur, Yamunanagar, Munak and Khubru were collected for June,2002 to May, 2005 from Irrigation Department, Haryana.
e. Gauge data of River Yamuna at Tajewala, gauge data of WJC at Dapupur, Yamunanagar, Munak and Khubru were collected for June,2002 to May, 2005 from Irrigation Depatment, Haryana State.
g. Gauge data of River Yamuna at Kalanaur, Karnal, Panipat and Delhi collected for June,2002 to may, 2005 from CWC and Irrigation Department, Haryana.
h. Longitudinal Sections showing canal bed level, bed width, W.S.level, F.S. level, slope collected from Irrigation Department, Haryana State.
i. Monthly monitoring of 10 deep observation wells (CGWB, Piezometers), the data has been computerized.

14.1.2 MODEL CONCEPTUALIZATION AND CALIBRATIONS:

a. Model area was digitized, imported to Modlow package, oriented parallel to North-South, East-west based on the general ground water flow in the area and river Yamuna, Required spatial discritization is carried out. Area divided into 105 columns and 210rows with an area of 1 sq.km. for each cell.
b. The Top and bottom of 2 aquifers and one confining layer, totaling to 3 layers were decided and assigned to the model. For this purpose the data of layers were compiled (from the BDR"s and Fence & Geophysical data), contoured and imported in the model.
c. The surface elevations compiled using data from R.L. of all observation wells, Piezometers, and Exploratory Tube Wells and surface elevation map of Upper Yamuna Basin Project Report. This data is then imported in the model, contoured to assign as surface elevation of the area. In both the cases the data outside the area were also utilized for contouring.
d. Assigned Hydraulic Conductivity and Specific Storage to layers.
e. The Evaporation data was compiled month-wise for the period June,2002 to May 2003 as m/day and assigned for the first layer of the entire area.
f. Assigned rainfall recharge for the area as m/day, month wise for Monsoon and Non-Monsoon for the period from June, 2002 to May, 2003 for all the 32 blocks. The data was assigned selecting each block and assigned two values 0-122 (Monsoon) and 123-365 (Non-Monsoon).
g. Discharge data was compiled from the GW ESTIMATION report of CGWB and assigned to each cell in the model area.
h. 22 observation wells tapping the first layer (phreatic aquifer) were selected using data from the State Ground Water Cell, Haryana and assigned to the model. 10 observation wells (piezometers of the CGWB, tapping first confined aquifer) were assigned to the model
i. Assigned initial piezometric level to layers I and III using data of State Ground Water Cell and CGWB.
j. Flux computed and assigned to North and South of the Model Area.
k. Assigned River boundary . The river boundary from Tajewala to entry of Delhi bordering the eastern part of the model was assigned using data of CWC and Irrigation Department, Haryana.

l. Assigned River Boundary for canals such as MLU, MLL, WJC, Delhi Parallel, JLN Feeder and Augmentation Canal.
m. The model was successfully run both for steady State and Transient State.

14.2 SOUTH EAST COSTAL REGION ,Chennai

The study area comprising coastal aquifer of southern part of Chennai Metropolitan Area is located between longitudes 80°13′30″ and 80°16′30″ and Latitudes 12°48′15″ and 12°59′15″. The area is bounded by Bay of Bengal in the east and Kovalam Creek on the south while in the north Tiruvanmiyur area was taken as boundary and about 1 – 3 km west of Buckingham canal was taken as western boundary.

The Buckingham Canal, which extends through the area from north to south, parallel to the coast was used for navigation earlier and at present is used as a Channel for sewage disposal. Tiruvanmiyur, Kottivakkam, Nilangarai, Injambakkam, Uthandi, Muthukadu, Ekkatur, Sholinganallur and Mettukuppam are some of the important locations in the study area.

The rainfall data between the period 1971 – 2005 shows that the normal annual rainfall is 1449 mm of which 34% is received from SW monsoon and 59% from NE monsoon. Rainfall received during winter (January – March) and summer (April – May) months account for 3% and 4% of annual rainfall respectively.

14.2.1 Conceptualization of model

The conventional methods of hydrogeological investigations and hydrochemical analysis have been combined with isotope techniques in conceptualization of the model. The results have been summarized below. The study area can be considered in the area viz., top sandy aquifer and weathered and fractured aquifer (basement). The groundwater occurs under unconfined condition in top sandy aquifer and under semi confined condition in the underlying basement.

Aquifer Boundary

The top sandy aquifer extends through out the area underlain by weathered and fractured harnockites. The thickness of the aquifer encountered during drilling of piezometers has given the vertical extension of the aquifer. It is found that the thickness of sandy aquifer varies and the same has been interpolated to get the spatial variation within the study area.It can be inferred that the interconnection between the aquifers varies from limited to a complete interconnection. The area bounded by Bay of Bengal in the east will have a constant head boundary on the east, while on the south, west and north, as there are no conspicuous hydrogeological barrier, southern, western and northern boundaries will be a varying head boundary.

The seasonal variation in the water table elevation and the elevation of piezometric surface indicate a large contribution from precipitation. The contours in the top unconfined aquifer indicate a possible recharge from canal and the landward gradient of water table contour and piezometric elevation in the north eastern part of the area (NE of Kottivakkam) corroborate with the greater exploitation in the area. The flow patterns of the deeper aquifer indicate a possible lateral flow from the west.

Lumped Model Results:

Before proceeding to the distributed model an attempt has been made to assess the various parameters on lumped basis , this exercise has been carried out separately for two layers, the results are discussed below ;

In the lumped model, the whole study area has been taken as a single cell and water balance has been attempted with an average or cumulative values for various discharge and recharge components.

The water balance equation can be written as

$\Delta S = (R_r + R_{irr} + R_f + R_i) - (O_g + O_{et} + O_f + O_e + O_l)$ Where,

Inflow components are Rainfall recharge (R_r) Recharge from Return Flow from Irrigation (R_{irr}), Inflow Across the boundary (R_f) and Influent Seepage (R_i) and Outflow components are Groundwater Draft (O_g), Evapotranspiration (O_{et}), Outflow Across the boundary (O_f), Effluent Seepage (O_e) and Leakage from the other layer (O_l).

Layer 1

During non-monsoon period, there is a change in storage of –3.960998 M.Cu.m. Recharge components for non-monsoon period works out to be of the order of 0.966679 and discharge components works out to be the order of 4.677247 M.Cu.m. In case of monsoon period, the change in storage is of the order of 2.554059 M.Cu.m, while the recharge and discharge components works to be 6.826414 M.Cu.m and 4.388305 M.Cu.m respectively.

Layer 2

During non-monsoon period, there is a change in storage of -0.045686 M.Cu.m. Recharge components for non-monsoon period works out to be of the order of 0.108682 and discharge components works out to be the order of 0.154368 M.Cu.m. In case of monsoon period, the change in storage is of the order of 0.015149 M.Cu.m, while the recharge and discharge components works to be 0.125752 M.Cu.m and 0.110603 M.Cu.m respectively.

Validation of Lumped model results

Validation of Lumped Model Results			
Layer 1			
1	**Change in Storage Check**		
a.	**Non-Monsoon Period**		
	Based on water level Fluctuation	**-3.960998**	**M.Cu.m**
	Recharge Components	**-**	
	Discharge Components	**-3.710568**	**M.Cu.m**
	% of Variation	**7**	
b.	**Monsoon Period**		
	Based on water level Fluctuation	**2.55405923**	**M.Cu.m**
	Recharge Components	**-**	
	Discharge Components	**2.43810955**	**M.Cu.m**
	% of Variation	**5**	
2	**Checking of Parameters used by comparing Rainfall Recharge during Monsoon Period**		

Water Level Fluctuation Approach		
Rainfall Recharge (Rwtf) = (S + Og + Of + Ol) - (Rirr + Rf +Ri)	**6.32301624**	**M.Cu.m**
Infiltration Factor Method Rr = Area * Mon RF * IF	**6.20706657**	**M.Cu.m**
Percentage Departure (PD) % of Variation PD = ((Rwtf - Rif)/Rif)*100, -20 < PD < PD	**2**	

Layer 2

1 Change in Storage

Non Monsoon Period

Piezometric Surface Fluctuation	**-0.898**	**m**
Recharge -Discharge	**-0.045686**	**M.Cu.m**

Piezometric Surface Fluctuation is negative & Difference between recharge and discharge components are also negative

Monsoon Period

Piezometric Surface Fluctuation	**0.261**	**m**
Recharge -Discharge	**0.015149**	**M.Cu.m**

Piezometric Surface Fluctuation is positive & Difference between recharge and discharge components are also positive

2 Taking the Leakage from Layer 1 as recharge into Layer 2 & comparisson of Storativity computed during Monsoon & Non Monsoon Periods

Storativity computed for Non Monsoon Period	**0.000747**
Storativity computed for Monsoon Period	**0.000852**
% of Variation	**12**

Distributed Model ;

The study area has been divided into 12 columns and 43 Rows, comprising 516 cells. The column width is 483 m and Row width is 490 m. The western, Northern and Southern boundaries are taken

as Variable Head Flow Boundary, while the Eastern boundary is taken as constant Head boundary. The compiled information has been used to generate following data for each cell

a). Initial Piezometric Head for Layer 1 & 2
b)Boundary Array for Layer 1 & Layer 2
c)Top of Layer 1 & 2
d)Bottom of Layer 1 &2
e)Vertical & Horizontal Hydraulic Conductivity
f)Specific Yield
g)Effective Porosity

The month has been considered for Stress Period and simulation has been done for 11-stress periods initially (July 2000 to May 2001) and after calibration and validation, the number of stress period has been increased to 59-stress periods (July 2000 to May 2005). The water budget of distributed model are comparing well that of distributed model. However, there is a variation in the observed and computed water table elevations. The calibration and validation is in progress.

14.3 SOUTHERN REGION (Hyderabad)

Mathematical modeling studies were attempted in Sriramsagar canal command area under conjunctive use project studies. Conceptualization of model and data entry work completed. Initially the model was conceptualized as two layers system and after entering all the parameters, an attempt was made for calibration of the model. The model could not be calibrated due to lack of sufficient aquifer parameter data. In order to refine the aquifer parameters based on the results of calibration , data gaps has been identified and further exploration has been suggested. Consequently , the construction of piezometer wells has been taken up in the area under regular item of work in AAP 2005-2006 and is continuing. The work is in under progress. Once the exploration work is completed, the model calibration and simulation for generation of different scenarios will be taken up using the aquifer parameters estimated from the pumping test data.

14.4 STATE UNIT OFFICE, Delhi

A mathematical modeling study has been initiated in the flood plain area , Palla , New Delhi for developing an operational model for the ground water development in collaboration with NIH, Roorkee.

15. CENTRAL GROUND WATER AUTHORITY (CGWA)

Central Ground Water Authority came in to existence under the orders of Hon'ble Supreme Court of India in I.A. No. 32 of CWP No. 4677/85, for the purpose of ground water regulation, development and management. The Central Government in the Ministry of Environment and Forest constituted the Central Ground Water Board as an Authority vide S.O. 38(E) dated 14.01.97 as amended vide S.O. 1024(E) dated 6.11.2000.

15.1 The performance of Authority during the year 2005-06 is as follows;

1. **As a result of directions issued by CGWA for regulation of ground water abstraction structures in 32 areas notified, total of 1,75,110 tube-wells have been registered as on March, 2006.**
2. **Details of Mass Awareness and training programs conducted during the period of report are given below;**

   i) **51 Mass awareness programs were organized for ground water conservation, artificial recharge, ground water protection in which around 100 persons in each program have participated.**
   ii) **49 Ground water management training programs were organized in different parts of the country for training the professionals in designing rain water harvesting structures for augmenting the water. Around 25 persons were trained in each program.**
   iii) **A specialized training course on ground water management (Regulation and Control) was conducted by CGWA from 6th to 10th March 2006 at New Delhi.**

3. **Registration of persons/ agencies engaged in the business of drilling and allied works – 57 drilling agencies were registered during the period of report.**
4. **Evaluation of proposals of industries/ projects seeking ground water clearance – Ground water clearance was accorded to 25 industries/Projects.**
5. **Public Notices : Four Public Notices were issued during the period of report. The details of public notice are as under :**

   i) **Pu**blic Notice extending the due date for adopting rainwater harvesting.
   ii) Public Notice regulating ground water development in 9 areas (3 areas in A.P. and 6 areas in Rajasthan).
   iii) Public Notice for registration of Ground Water Abstraction structures/ regulation of ground water development in 24 villages of Gurgaon block.
   iv) Public notice for registration of Ground Water Abstraction structures in 28 new areas in 9 states.

6. **Regulation of ground water development:** CGWA is regulating ground water development in 20 notified areas namely South and South-west districts and Yamuna Flood Plain area of NCT, Delhi; Municipal Corporation of Faridabad and Ballabhgarh, Faridabad district, Haryana; Ludhiana City, Punjab; Union Territory of Diu, Municipal Corporation of Gaziabad, Gaziabad District, Uttar Pradesh.; Jhotwara block, Jaipur distt., Rajasthan; Haldia Municipal area, East Medinipur Distt., West Bengal; Gandhinagar Taluka, Gujarat, Gurgoan town and adjoining industrial areas, Haryana, Midjil of Mehboobnagar District, Tirupathi (Rural) of Chittoor Distt., Vempalli of Cuddapah Distt., in the State of Andhra Pradesh; Ushkar Valley of Ajmer Distt., Chirawa and Buhana of Jhunjhunu Distt., Raniwara and Jalore of Jalore District and Mundwa of Nagaur District of Rajasthan.

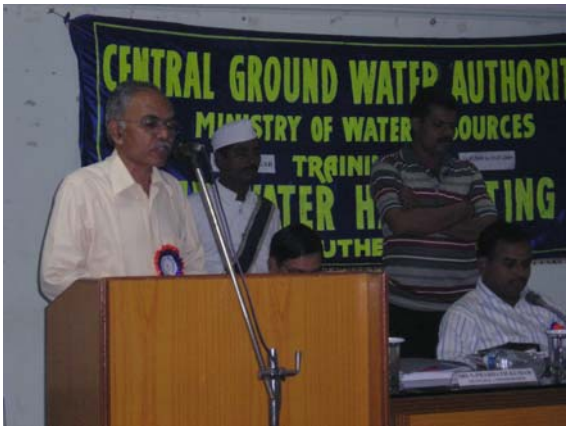
7. **129 complaints of violation of directives of the Authority have been received as on March 2006 and forwarded to the concerned Deputy Commissioners in the NCR Regions for necessary action.**
8. **Permissions granted for construction of wells for drinking and domestic purposes: During the period of report 166 permissions (Delhi – 142, Faridabad – 22 and Gurgaon – 02) have been accorded to individuals, Hospitals, Institutions, Govt. Departments etc, for the purpose of drinking and domestic.**
9. **Total numbers of 167 and 460 permissions were granted for construction of recharge wells for rain water harvesting structures with deployment of drilling rig in Gurgaon and Delhi respectively.**

Water Management Training Programme

Lecture by a Guest Faculty at Rainwater Harvesting Training held at Hosur, Krishnagiri,T.N 28th – 29th Dec' 2005.

Water management training programme at Ernakulam, Ernakulam District on 26.07. 2005.

Training Programme At NGO School, Bhopal



Training on rain water harvesting and artificial recharge Held at Mahabubnagar, Andhra Pradesh during 21-7-2005 – 23-7-2005

Training On Rain Water Harvesting And Artificial Recharge
Held At Warangal, A.P , 16-3-2006 & 17-3-2006

Water Management Training programme held at Chamarajanagar, Chamarajanagar district,Karnataka.

MASS AWARENESS PROGRAMMES CONDUCTED

Mass Awareness Programme Krishi Vigyan Kendra Rampur, District Una, Himachal Pradesh

Mass awareness programme at Chittoor, Palakkad District, Kerela on 22.07.05

Mass Awareness Programme At Goharganj, district Raisen

Mass Awareness Programme At Keesara Mandal, Ranga Reddy District, Andhra Pradesh On 30.06.05

Mass Awareness Programme At Nuzivid Mandal, Krishna District, Andhra Pradesh On 08.12.05

16. GROUND WATER MANAGEMENT STUDIES IN DROUGHT PRONE AREA

The Central Ground Water Board covered an area of 45755sq. km. categorized as drought prone in Gujarat, Rajasthan, Kerala, Orissa, Karnataka and Andhra Pradesh States of the country under ground water management studies. In addition to this, 254 bore holes (169 EW, 39 OW & 46 PZ) by departmental rigs were drilled in drought prone areas of Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Rajasthan and Uttar Pradesh.

Details of area covered under ground water management studies and status of exploration in drought prone areas are shown in Table 16.1, 16.2 & Fig 17.1 & 17.2 respectively.

Table 16.1 : AREA COVERED UNDER GROUND WATER MANAGEMENT STUDIES IN DROUGHT PRONE AREAS DURING 2005-2006

Sl. No	Regions/ State	Districts	Achievement Sq.Km.
1.	**WEST CENTRAL REGION**	Parts of Bhavnagar	3800
	Gujarat	**Total**	**3800**
2.	**WESTERN REGION**	Jaipur	6776
	Rajasthan	Jalore	3055
		Total	**9831**
3.	KERALA REGION	Kottayam & parts of Ernakulam	3072
	Kerala	Alleppey & parts of Ernakulam	2957
		Total	**6029**
4.	**SOUTH EASTERN REGION**	**Bolangir**	**3169**
	Orissa	**Kalahandi**	**6105**
		Nuapada	**3400**
		Total	**12674**
5.	**SOUTH WESTERN REGION**	**Bijapur**	**2664**
	Karnataka	**Raichur**	**3492**
		Total	**6156**
6.	**SOUTHERN REGION**	**Anantpur**	**8065**
	Andhra Pradesh	**Total**	**8065**
GRAND TOTAL			**45755**

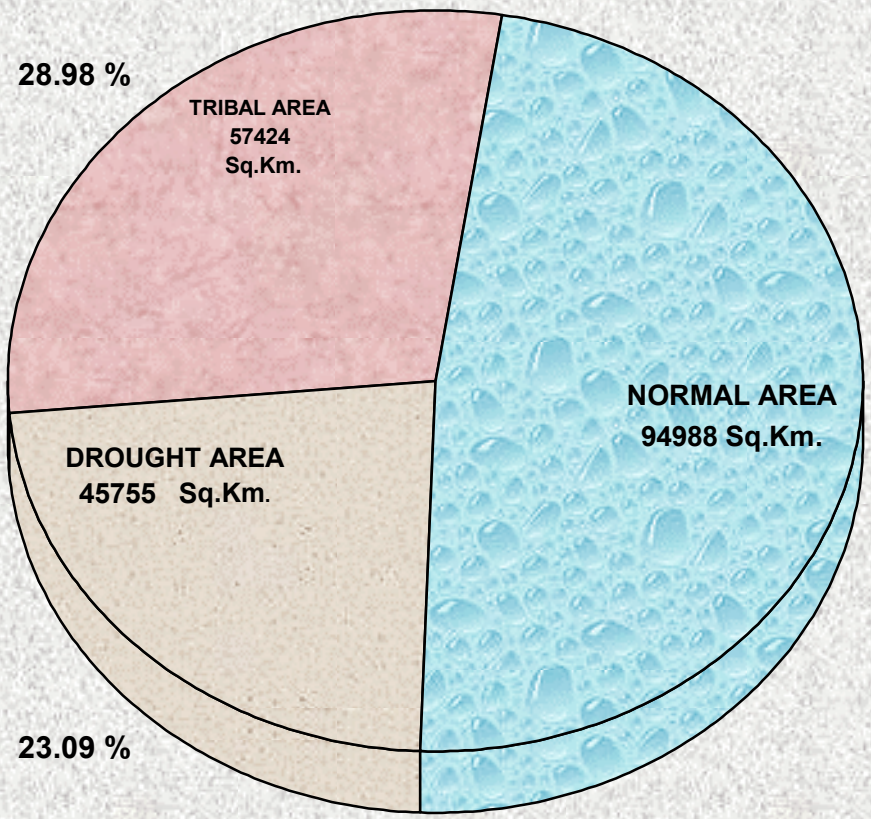
Table 16.2 : EXPLORATORY WELLS DRILLED IN "DROUGHT PRONE" AREA DURING 2005-2006
(By Departmental Rigs)

Sl. No	States	Districts	EW	OW	PZ	SH	DW	Total
1	**Andhra Pradesh**	**Karimnagar**	**-**	**-**	**06**	**-**	**-**	06
		Mahboobnagar	**-**	**01**	**-**	**-**	**-**	01
		Warangal	**-**	**-**	**11**	**-**	**-**	11
		Total	**-**	**01**	**17**	**-**	**-**	18

Sl. No	States	Districts	EW	OW	PZ	SH	DW	Total
2	Gujarat	Amreli	3	5	-	-	-	08
		Rajkot	2	-	-	-	-	02
		Surendranagar	3	-	-	-	-	03
		Total	8	5	-	-	-	13
3	Karnataka	Devanagere	9	3	-	-	-	12
		Kolar	4	3	-	-	-	07
		Total	13	6	-	-	-	19
4	Kerala	Palghat	-	-	22	-	-	22
		Kasargod	-	1	-	-	-	01
		Trivendrum	13	3	-	-	-	16
		Total	13	4	22	-	-	39
5	Maharashtra	Aurangabad	17	1	-	-	-	18
		Nagpur	1	-	-	-	-	01
		Sangli	12	1	-	-	-	13
		Solapur	2	1	-	-	-	03
		Total	32	3	-	-	-	35
6	Orissa	Angul	13	3	-	-	-	16
		Balasore	16	6	-	-	-	22
		Ganjam	10	3	-	-	-	13
		Kalahandi	12	2	-	-	-	14
		Raiarkhol	2	-	-	-	-	02
		Sambalpur	22	1	-	-	-	23
		Total	75	15	-	-	-	90
7	RAJASTHAN	Hanumangarh	6	1	2	-	-	09
		Jaisalmer	2	-	1	-	-	03
		Jhun-jhunu	3	1	4	-	-	08
		Total	11	2	7	-	-	20
8	Uttar Pradesh	Banda	1	2	-	-	-	03
		Hamirpur	6	-	-	-	-	06
		Lalitpur	10	1	-	-	-	11
		Total	17	3	-	-	-	20
GRAND TOTAL			169	39	46	-	-	254

GROUND WATER MANAGEMENT STUDIES IN TRIBAL, DROUGHT AND NORMAL AREAS

Fig. 17.1



TOTAL 198167 Sq.Km. AREA COVERED
UNDER GWM STUDIES (REAPPRAISAL)
DURING 2005-2006

17. GROUND WATER MANAGEMENT STUDIES IN TRIBAL AREAS

The Central Ground Water Board, in its 2005-2006 Annual Action Plan gave emphasis to Ground Water Management Studies and exploratory drilling programme in districts falling under tribal areas of the country. An area of 57424 sq. km. was covered in Tribal areas of the country and 158 bore holes (EW- 101, OW-52 & PZ-05) were drilled in Tribal areas to explore the possibility of tapping potential aquifers.

The status of coverage under Ground Water Management Studies and exploratory drilling in tribal areas are shown in Tables 17.1 & 17.2. and Fig 17.1 & 17.2 respectively.

Table 17.1 : AREAS COVERED UNDER GROUND WATER MANAGEMENT STUDIES IN TRIBAL AREAS DURING 2005-2006

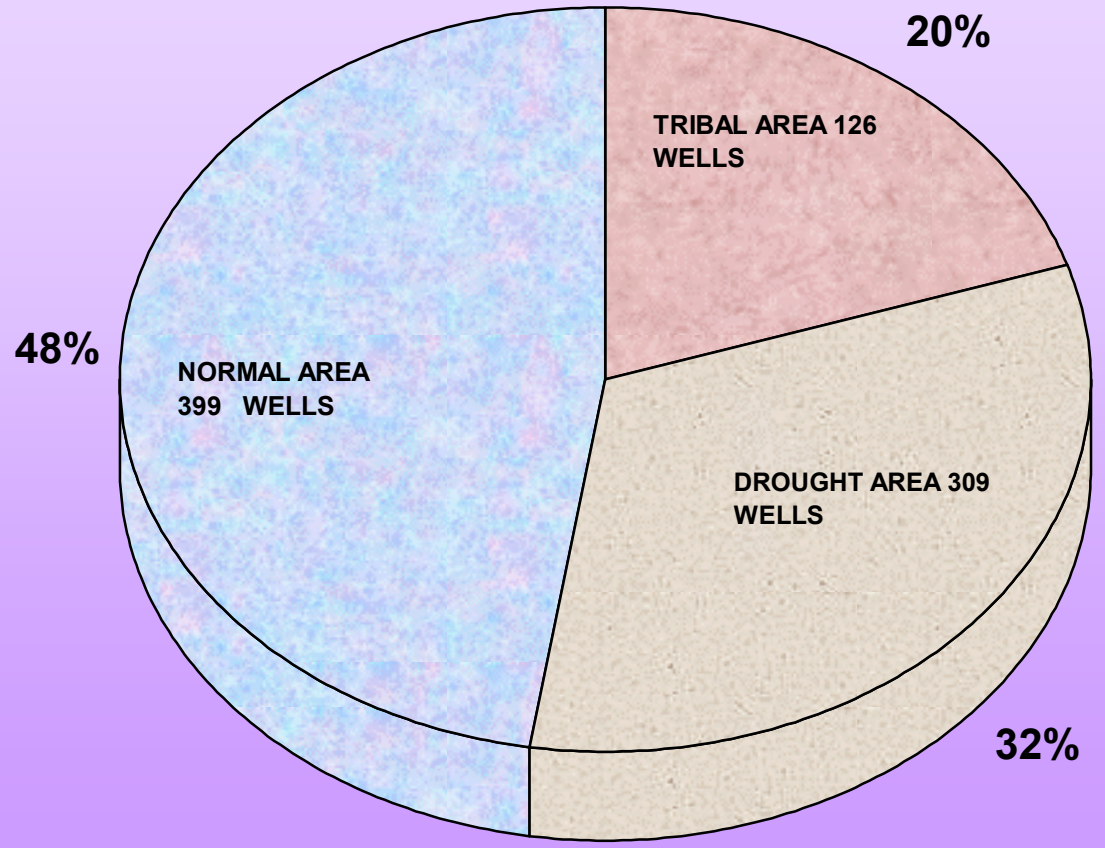
Sl. No	Regions/state	District	Achievement (Sq.Km.)
1.	NORTH REGION	**Bahraich**	**5751**
	Uttar Pradesh	**Firozabad**	**2361**
		Ghaziabad	**1956**
		Hardoi	**5986**
		Jaunpur	**4038**
		Pratapgarh	**3717**
		Total	23809
2.	NORTH CENTRAL CHHATTISGARH REGION	**Koria**	**5980**
	Chhattisgarh	Total	5980
3.	EASTERN REGION	Darjeeling	465
	West Bengal	Jalpaiguri	2540
		Malda	1350
		Murshidabad	750
		Bankura	1600
		Total	6705
4.	SOUTH EASTERN REGION	Kalahandi	6105
	Orissa	**Total**	**6105**
5.	MID EASTERN REGION	**Dhanbad and parts of Bokaro distircts 3000**	3000
	Jharkhand	Total	3000
6.	NORTH EASTERN REGION		
	Arunachal Pradesh	**Changlang**	**3000**
	Meghalaya	**East and South Garo hill**	**3000**
	Tripura	**Norh tripura**	**2150**
		Parts of Dhalai District	**850**
		Total	9000
7.	NORTH HIMALAYAN REGION	**Sirmaur**	2825
	Himachal Pradesh	Total	**2825**
GRAND TOTAL			57424

Tab**le 17.2 :** EXPLORATORY WELLS DRILLED IN "TRIBAL" AREA DURING 2005-2006
(by Departmental Rigs)

Sl. No	States	Districts	EW	OW	PZ	SH	DW	Total
1.	Andhra Pradesh	**Vishakhapatanam**	**9**	**3**	**-**	**-**	**-**	**12**
		Total	9	3	-	-	-	12
2.	Bihar	**Jammui**	**6**	**10**	**-**	**-**	**-**	**16**
		Total	6	10	-	-	-	16
3.	Chattisgarh	**Jashpur**	**01**	**-**	**-**	**-**	**-**	**01**
		Korba	**-**	**-**	**1**	**-**	**--**	**01**
		Raigarh	**16**	**1**	**4**	**-**	**-**	**21**
		Rajnandgaon	**09**	**-**	**-**	**-**	**-**	**09**
		Total	**26**	**01**	**05**	**-**	**-**	**32**
4.	Gujarat	**Vadodra**	**11**	**5**	**-**	**-**	**-**	**16**
		Total	11	5	-	-	-	16
5.	Jharkhand	**Gumla**	**3**	**1**	**-**	**-**	**-**	**04**
		Ranchi	**1**	**2**	**-**	**-**	**-**	**03**
		W. Singhbhum	**3**	**5**	**-**	**-**	**-**	**08**
		Total	**07**	**08**	**-**	**-**	**-**	**15**
6.	Madhya Pradesh	**Betul**	**11**	**5**	**-**	**-**	**-**	**16**
		Dindori	**3**	**5**	**-**	**-**	**-**	**08**
		Mandla	**13**	**11**	**-**	**-**	**-**	**24**
		Total	27	21	-	-	-	48
7.	Maharashtra	**Raigarh**	**4**	**3**	**-**	**-**	**-**	**07**
		Total	4	3	-	-	-	07
8.	Meghalaya	**Ri-Bhoi**	**7**	**-**	**-**	**-**	**-**	**07**
		Total	7	-	-	-	-	07
9.	Tripura	**West Tripura**	**2**	**1**	**-**	**-**	**-**	**03**
		Total	2	1	-	-	-	03
10.	West Bengal	**Jalpaiguri**	**1**	**-**	**-**	**-**	**-**	**01**
		Darjeeling	**1**	**-**	**-**	**-**	**-**	**01**
		Total	**02**	**-**	**-**	**-**	**-**	**02**
Grand Total			101	52	05	-	--	158

Fig. 17.2

GROUND WATER EXPLORATION IN TRIBAL , DROUGHT AND NORMAL AREA



TOTAL WELLS DRILLED DURING 2005-2006= 785

18. ESTIMATION OF GROUND WATER RESOURCE BASED ON GEC - 1997 METHODOLOGY

As per the National Water Policy 2002, the ground water resource potential need to be re-assessed periodically on scientific basis. Accordingly, the ground water resource of the entire country is being re-assessed jointly by the Central Ground Water Board and the States based on the Ground water resources estimation methodology, (GEC – 97) .

The Total Annual Replenishable Ground Water Resources of the Country have been reassessed as 433 Billion Cubic Metres (bcm) and the Net Annual Ground Water Availability is estimated as 399 bcm. Annual Ground Water Draft as on March, 2004 for all uses is 231 bcm. The Stage of Ground Water Development is 58%. The state – wise availability of ground water resources is given in Table 18.1.

The development of ground water in different areas of the Country has not been uniform. Highly intensive development of ground water in certain areas in the country has resulted in over – exploitation. As per the latest assessment of ground water resources out of 5723 assessment units (Block/Mandals/Talukas) in the country, 839 units in various States have been categorized as ' over-exploited' i.e. the annual ground water draft exceeds the annual Replenishable ground water resources and significant decline in long term ground water level trend has been observed either in pre-monsoon or post-monsoon or both. In addition 226 units are 'Critical' where the stage of ground water development is 100% of annual replenishable ground water resource and significant decline is observed in the long term water level trend in both pre-monsoon and post-monsoon periods. There are 550 semi-critical units, where the stage of ground water development is between 70 - 90% and significant decline in long term water level trend has been recorded in either Pre-monsoon or Post-monsoon. The state – wise status of over – exploited and critical and semi-critical areas is given in Table 18.2.

Table 18.1: STATE-WISE GOUND WATER RESOURCES AVAILABILITY, UTILIZATION AND STAGE OF DEVELOPMENT

Sl. No.	States/ UTs	Annual Replenish-able Ground Water Resource	Natural Discharge during non-Monsoon season	Net Annual Ground Water Availability	Annual Ground Water Draft			Stage of Ground Water Development (%)
					Irrigation	Domestic and Industrial uses	Total	
1	2	3	4	5	6	7	8	9
	States							
1	Andhra Pradesh	36.50	3.55	32.95	13.88	1.02	14.90	45
2	Arunachal Pradesh	2.56	0.26	2.30	0.0008	0	0.0008	0.04
3	Assam	27.23	2.34	24.89	4.85	0.59	5.44	22
4	Bihar	29.19	1.77	27.42	9.39	1.37	10.77	39
5	Chattisgarh	14.93	1.25	13.68	2.31	0.48	2.80	20
6	Delhi	0.30	0.02	0.28	0.20	0.28	0.48	170
7	Goa	0.28	0.02	0.27	0.04	0.03	0.07	27
8	Gujarat	15.81	0.79	15.02	10.49	0.99	11.49	76
9	Haryana	9.31	0.68	8.63	9.10	0.35	9.45	109
10	Himachal Pradesh	0.43	0.04	0.39	0.09	0.02	0.12	30
11	Jammu & Kashmir	2.70	0.27	2.43	0.10	0.24	0.33	14
12	Jharkhand	5.58	0.33	5.25	0.70	0.38	1.09	21
13	Karnataka	15.93	0.63	15.30	9.75	0.97	10.71	70
14	Kerala	6.84	0.61	6.23	1.82	1.10	2.92	47
15	Madhya Pradesh	37.19	1.86	35.33	16.08	1.04	17.12	48
16	Maharashtra	32.96	1.75	31.21	14.24	0.85	15.09	48
17	Manipur	0.38	0.04	0.34	0.002	0.0005	0.002	0.65
18	Meghalaya	1.15	0.12	1.04	0.00	0.002	0.002	0.18
19	Mizoram	0.04	0.004	0.04	0.00	0.0004	0.0004	0.90
20	Nagaland	0.36	0.04	0.32	0.00	0.009	0.009	3
21	Orissa	23.09	2.08	21.01	3.01	0.84	3.85	18
22	Punjab	23.78	2.33	21.44	30.34	0.83	31.16	145
23	Rajasthan	11.56	1.18	10.38	11.60	1.39	12.99	125
24	Sikkim	0.08	-	0.08	0.00	0.01	0.01	16
25	Tamil Nadu	23.07	2.31	20.76	16.77	0.88	17.65	85
26	Tripura	2.19	0.22	1.97	0.08	0.09	0.17	9
27	Uttar Pradesh	76.35	6.17	70.18	45.36	3.42	48.78	70
28	Uttaranchal	2.27	0.17	2.10	1.34	0.05	1.39	66
29	West Bengal	30.36	2.90	27.46	10.84	081	11.65	42
	Total States	**432.43**	**33.73**	**398.70**	**212.38**	**18.04**	**230.44**	**58**
	Union Territories							
1	Andaman & Nicobar	0.330	0.005	0.320	0.000	0.010	0.010	4
2	Chandigarh	0.023	0.002	0.020	0.000	0.000	0.000	0
3	Dadra & Nagar Haveli	0.063	0.003	0.060	0.001	0.007	0.009	14
4	Daman & Diu	0.009	0.0004	0.008	0.007	0.002	0.009	107
5	Lakshdweep	0.012	0.009	0.004	0.000	0.002	0.002	63
6	Pondicherry	0.160	0.016	0.144	0.121	0.030	0.151	105
	Total Uts	**0.597**	**0.036**	**0.556**	**0.129**	**0.051**	**0.181**	**33**
	Grand Total	**433.02**	**33.77**	**399.25**	**212.51**	**18.09**	**230.62**	**58**

Table 18.2: CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA AS ON 31st MARCH, 2004

Sl. No.	States /Union Territories	Total No. of Assessed Units	Semi-Critical		Critical		Over-exploited		Remarks
			Nos.	%	Nos.	%	Nos.	%	Nos.
	States								
1	Andhra Pradesh	1231	**175**	**14**	**77**	**6**	**219**	**18**	**-**
2	Arunachal Pradesh	13	**0**	**0**	**0**	**0**	**0**	**0**	**-**
3	Assam	23	**0**	**0**	**0**	**0**	**0**	**0**	**-**
4	Bihar	515	**0**	**0**	**0**	**0**	**0**	**0**	**-**
5	Chattisgarh	146	**8**	**5**	**0**	**0**	**0**	**0**	**-**
6	Delhi	9	**0**	**0**	**0**	**0**	**7**	**78**	**-**
7	Goa	11	**0**	**0**	**0**	**0**	**0**	**0**	**-**
8	Gujarat	223	**69**	**31**	**12**	**5**	**31**	**14**	Rest 14 talukas Saline
9	Haryana	113	**5**	**4**	**11**	**10**	**55**	**49**	**-**
10	Himachal Pradesh	5	**0**	**0**	**0**	**0**	**0**	**0**	**-**
11	Jammu & Kashmir	8	**0**	**0**	**0**	**0**	**0**	**0**	**-**
12	Jharkhand	208	**0**	**0**	**0**	**0**	**0**	**0**	**-**
13	Karnataka	175	**14**	**8**	**3**	**2**	**65**	**37**	**-**
14	Kerala	151	**30**	**20**	**15**	**10**	**5**	**3**	**-**
15	Madhya Pradesh	312	**19**	**6**	**5**	**2**	**24**	**8**	**-**
16	Maharashtra	318	**23**	**7**	**1**	**0**	**7**	**2**	**-**
17	Manipur	7	**0**	**0**	**0**	**0**	**0**	**0**	**-**
18	Meghalaya	7	**0**	**0**	**0**	**0**	**0**	**0**	**-**
19	Mizoram	22	**0**	**0**	**0**	**0**	**0**	**0**	**-**
20	Nagaland	7	**0**	**0**	**0**	**0**	**0**	**0**	**-**
21	Orissa	314	**0**	**0**	**0**	**0**	**0**	**0**	Rest 6 blocks Saline
22	Punjab	137	**4**	**3**	**5**	**4**	**103**	**75**	-
23	Rajasthan	237	**14**	**6**	**50**	**21**	**140**	**59**	Rest 1 block Saline
24	Sikkim	1	**0**	**0**	**0**	**0**	**0**	**0**	-
25	Tamil Nadu	385	**57**	**15**	**33**	**9**	**142**	**37**	Rest 8 blocks Saline
26	Tripura	38	**0**	**0**	**0**	**0**	**0**	**0**	**-**
27	Uttar Pradesh	803	**88**	**11**	**13**	**2**	**37**	**5**	**-**
28	Uttaranchal	17	**3**	**18**	**0**	**0**	**2**	**12**	**-**
29	West Bengal	269	**37**	**14**	**1**	**0**	**0**	**0**	**-**
	Total States	**5705**	**546**	**10**	**226**	**4**	**837**	**15**	**-**
	Union Territories								
1	Andaman & Nicobar	1	**0**	**0**	**0**	**0**	**0**	**0**	**-**
2	Chandigarh	1	**0**	**0**	**0**	**0**	**0**	**0**	**-**
3	Dadra & Nagar Haveli	1	**0**	**0**	**0**	**0**	**0**	**0**	**-**
4	Daman & Diu	2	**1**	**50**	**0**	**0**	**1**	**50**	**-**
5	Lakshdweep	9	**3**	**33**	**0**	**0**	**0**	**0**	**-**
6	Pondicherry	4	**0**	**0**	**0**	**0**	**1**	**25**	Rest 1 Region Saline
	Total UTs	**18**	**4**	**22**	**0**	**0**	**2**	**11**	**1**
	Grand Total	**5723**	**550**	**10**	**226**	**4**	**839**	**15**	**30**

Blocks- Bihar, Chhattisgarh, Haryana, Jharkhand, Kerala, Madhya Pradesh, Manipur, Mizoram, Orissa, Punjab, Rajasthan, Tamilnadu, Tripura, Uttar Pradesh, Uttaranchal , West Bengal
Mandals (command/ non-command) - Andhra Pradesh
Talukas - Goa, Gujarat, Karnataka, Maharashtra
Districts - Arunachal Pradesh, Assam, Delhi, Meghalaya, Nagaland
Districts (Valley) - Himachal Pradesh, Jammu & Kashmir
State – Sikkim ; **Islands** – Lakshdweep ; **UT** - Andaman & Nicobar, Chandigarh, Dadra & Nagar Haveli,Daman & Diu, Pondicherry.

19. SCRUTINY OF MAJOR/MEDIUM IRRIGATION PROJECT

The Board is scrutinizing the major and medium irrigation project reports/proposal sent by the State Government / Central Water Commission / Command Area Development & Water Management Wing of Ministry of Agriculture from the point of view of their impact on ground water regime and specific recommendations are being made to protect quality and quantity of ground water. As per the directives of Planning commission, during the year 2005-2006, twelve major irrigation projects of Central Water Commission spread over states of J & K, Assam, Rajasthan, Andhra Pradesh, Uttar Pradesh, Maharashtra, Madhya Pradesh, Himachal Pradesh and Punjab were examined and are listed below. Three irrigation projects of CADWM were also examined and area specific recommendations were made.

1. **Modernization of Nadi Canal & Mav Khul, J&K – CWC.**
2. **Champaati Irrigation Project (Major), Assam – CWC.**
3. **Pench Diversion Project, Chindwara, (M.P.) – CWC.**
4. **Narmada Canal Project (Rajasthan).**
5. **Godavari Lift Irrigation Scheme, (A.P.) (CCA – 2.62 lakh ha.) – CWC.**
6. **Arjun Sahayak Pariyojna, (U.P.) – CWC.**
7. **Lower Goi Project, Madhya Pradesh – CWC.**
8. **Bhima (Ujjani) Project, Maharashtra – CWC.**
9. **Sulwade – Jamphal – Konoli Maharashtra – CWC.**
10. **Swan River Flood Management and Irrigation Land Development Project, Phase-II, Himachal Pradesh – CWC.**
11. **Rehabilitation of 1st Patiala and Kotla Branch with 20% Enhanced Capacity and changed value of "N" Punjab – CWC.**
12. **Polavaram Multipurpose Project, Andhra pradesh (CCA – 7.2 lakh acres) – CWC.**
13. **Bhima Irrigation Project, Maharashtra – (CCA-1.26 lakh ha.) – CADWM.**
14. **Sirhind Feeder, Punjab – (CCA – 1.05 lakh ha.) – CADWM.**
15. **Malprabha Irrigation Project, Karnataka – CADWM.**

20. STORES MANAGEMENT

It is imperative that to arrange the right material at right time and at right place is the key to success for efficient drilling activity. Hence material management and physical distribution of stores play a vital role in drilling activities. The physical distribution and flow of material is mainly taken care of by divisional offices whereas arranging buffer stock, procurement of centrally controlled vital items, costly scientific equipment are managed by Material Management Cell at Headquarter. Besides this, lot of demands which are beyond the powers of Divisional / Regional offices are procured at Headquarter. The cases are examined at Headquarter and necessary approval / sanction of the competent authority is obtained and conveyed to the concerned. Inspite of poor infrastructure facility available at Headquarter the stores branch is efficiently taking care of procurement, stock taking, inspection etc. Lot of equipments which become unserviceable every year and reports of which are received at Headquarter are examined and their condemnation / write off sanction is conveyed to the concerned for their ultimate disposal. Four DTH rigs having 300 mtrs. drilling capacity have been purchased from M/s. REL Coimbatore and deployed in Division –VI, XIII and XIV after obtaining sanction from the Ministry of Water Resources.

Abstract of cases processed and finalized during the year 2005-2006 are given Table 20.1 and Table 20.2 .

Table 20.1 :STATEMENT SHOWING THE DETAILS OF PROCUREMENT ACTION TAKEN DURING 2005-2006

Sl. No	Action Taken	No of Cases	Amount involved (Rs.in Lakhs)
1	Sanction received from the Ministry of Water Resources.	2 Nos.	1102.43
2	Indent placed with DGS&D	2 Nos	75.00
3	Supply order placed on DGS&D Rate Contract	14Nos.	308.62
4	Supply order placed outside DGS&D Rate Contract	4 Nos	6.32
5	Expenditure sanction conveyed	40 Nos	55.36
6	Administrative approval conveyed	40 Nos	
7	A/T placed	2 Nos	111774

Table 20.2: STATEMENT SHOWING THE CONDEMNATION OF VEHICLES /EQUIPMENT DURING THE YEAR 2005-2006

Sl. No.	Description	Quality
1	Vehicles	28 Nos
2	Rigs	2 Nos
3	Compressors	4 Nos
4	Prime-Movers (Engines)	4 Nos
5	Geo-Logger	1 No
6	Desk Top Projector	1 No

20.1 PHYSICAL VERIFICATION OF STORES

No. of offices for which stores Physically verified = 30
No. of discrepancies settled = 514
Physical verification reports settled = 28

21. HUMAN RESOURCES DEVELOPMENT

It is the earnest endeavor of Central Ground Water Board to keep its technical personnel apprised with the latest development in all aspects related to ground water and drilling techniques. The Board also includes trainees from State Departments and candidates from abroad for different training programmes.

21.1 TRAINING ON RAINWATER HARVESTING

21.1.1 Andhra Pradesh

1. Training on "Rain Water Harvesting and Artificial Recharge" was imparted to the State Officials. NGOs and VO's etc. at Mahabubnagar District from 21st to 23rd July 2005.
2. A training programme on "Rain Water Harvesting and Artificial Recharge to Ground Water " was conducted at Jodugullapalem, Visakhapatnam district from 4.10.2005 to 6.10.2005. State Departments/NGOs/VOS etc. participated the programme. About 45 officers from Govt. agencies. NGOs/VOs etc. were given training on rainwater harvesting and artificial recharge.

21.1.2 Tamilnadu

1. A Water Management Training (TOT) was organized at Agricultural Engineering Department Training Centre at Trichirapallii. The training was imparted to 20 middle level Managers from State Government Officers, Industries, NGOs and Academic Institutions. The training modules included Ground Water Development Scenario and Water Management in Tamil Nadu, Overview of Artificial Recharge, Rainwater Harvesting in Urban rural areas and Principles and Techniques of water treatment.

2. Water management training programme was organized by CGWB, SECR during 20.9.2005 and 21.09.2005 at Hotel Aryaas, Triunelveli,. The training programme was inaugurated by Sh. P. Ponniah, Joint Director & Project Officer, DRDA, Tirunelveli and 28 officers from various state government agencies, Students of Engineering College and NOGs participated in the Training programme.

21.1.3 Maharashtra

1. **CGWB, CR, Nagpur organized a two days Water Management Training programme on "Water Management and Rainwater Harvesting" between 10-11th August 2005 at Nanded Education Society's Science College, Nanded. During the Inaugural function, Dr. D.B.Yedekar, Vice Chancellor, Nanded Univerrsity, was invited as the Chief Guest, Shri Radhesham Mopalwar, IAS, District Collector, Nanded District, was invited as the Guest of Honour. The training was imparted to 40 participants representing the College, Nanded University Research Scholars, Govt. Agencies, NGO, Consultants, Professionals, etc. The experts of CGWB with some documentaries gave the deliberations. The programme was widely covered both by the Print and Electronic media.**

2. **CGWB,CR, Nagpur has organized a two days WMTP programme on "Water Management and Rainwater Harvesting" between 22nd–23 rd at Army Postal Services Center Auditorium, Station Headquarters, Kamptee, Nagpur. Brigadier P. S. Siwach, Station Commander was invited as the Chief Guest . The Training was imparted by the export faculty of CGWB to 40 participants representing the Army Staff., Govt. Agencies, NGO, Consultants, Professionals, etc. The experts of CGWB with some documentaries gave the deliberations. The programme was covered both by the print and electronic media.**

21.1.4 West Bengal

1. **CGWB, ER, Kolkatta organised two days training programme (11th & 12th August 05) on "Water Management" at Haora, District-Haora, West Bengal. This training programme was attended by 24 No. of trainees from different departments of State Govt.**

2. **Rain Water Harvesting structure initiated by Shri Gopal Krishna Gandhi, Hon'ble Governor, Govt. of West Bengal designed by CGWB, ER for Rainwater Conservation within the premises of Governor House,Darjeeling, was inaugurated on 22.10.2005 by Shri Subhas Ghising, Administrator, Darjeeling Gorkha Hill Council. Shri Dinesh Prakash, Regional Director, &Senior officers,CGWB, ER, and other dignitaries of State Govt. attended the function. Shri Dinesh Prakash, Regional Director delivered lecture on the utility of Rainwater Conservation structures in the hilly terrain of Darjeeling as this area suffer from chronic drinking water problem.**

3. **Design for Rainwater Harvesting structure for artificial recharge to ground water within the premises of Raj Bhawan,Kolkata was prepared by CGWB, ER, Kolkata and in this regard a report on "Note on study for artificial recharge to ground water by roof top rainwater harvesting at Raj Bhawan, Kolkata, has been submitted.**

4. **Two days training programme (8th and 9th December 2005) on 'Ground Water Development and Management with special reference to Rainwater Harvesting" was organized at Kandi, District-Murshidabad, West Bengal. The trainees from different departments of State Govt. such as, Municipalities, PHED, Agriculture department, block Level Offices, etc., attended the training.**

21.1.5 Rajasthan

1. A two days Training Programme on "Rainwater Harvesting for Artificial Recharge to Groundwater" was organised by CGWB, WR, Jaipur at Jhunjhunu on 27.09.2005 & 28.09.2005. Smt. Raj Bala Ola, Jila Pramukh, Jhunjhunu was the Chief Guest. Officers from State Government departments including Ground Water Department, Irrigation, Public Health Engineering, Agriculture, Gramin Vikash, other organisations like BIT, Pilani and representatives of Non Government Organisations participated in the training. An exhibition was also organised during the training Programme. Wide press coverage was also given during the trainging programme.

2. Sh.A.D.Joseph, RD, CGWB, WR and other officers participated in Jal Abhiyan organized by the Irrigation Deptt. Govt. of Rajasthan on 10th December 2005 at Jaipur. An exhibition was also organized during the Programme, which was visited by the Chief Minister, Rajasthan and other Ministers also.

3. A one day Training Programme on "Rainwater Harvesting for Artificial Recharge to Ground Water" was organized at Ajmer on 13.12.2005. Officers from various State Govt. Deptt. Including GW Deptt. , Irrigation Deptt. PHED and rep .of NGOs participated in the training. An exhibition was also organized during the training programme. Wide press coverage was also given during the training programme.

21.1.6 Madhya Pradesh

1. A Water Management Training Programme on Rain Water harvesting was organized at officers Club, Pathakheda Distt. Betul on 14.09.2005 for the officers of Western Coal India Ltd.

21.1.6 Karnataka

1. Water Management Training programme was held at Zilla Panchayat halll, Raichur during 21 – 22 September 2005. The chief guest Sh. Tushar Giri Nath, IAS Dy. Commissioner, Raichur inaugurated the programme.28 trainees from Zilla Panchayat and various state government departments attended the training programme.various topics and documentaries on the theme of water management were presented to trainees. Valedictory function was held on 22.9.2005 and certificates were distributed to trainees.

21.1.7 Orissa

1. Water Management Training Programme was organized by CGWB, SER on 22.12.2005 at DRDA Conference Hall, Koraput Town, Koraput District. About 120 officers and officials from various NGO's , State Govt. offices participated in the programme. Collector & DM Koraput was the Chief Guest and Project Director, DRDA, Koraput was the Guest of Honour.

21.2 TRAINING PROGRAMME UNDER RGNGWTRI

During the year 2005-06 sixteen training courses were conducted under Rajiv Gandhi National Ground Water Training and Research Institute, Faridabad. All the sixteen training courses were conducted successfully with the co-operation of all the Regional and Divisional offices of CGWB. In these training's a total of 305 officers / officials were trained. Out of the sixteen courses six courses were conducted at other institute like IIT Roorkee, IIRS, Dehradun, TTTI Chennai, IIPA & ISTM New Delhi etc. The following training programme were organized by CGWB under RGNGWTRI.

1. Training Course on Administrative Matters:- The training Course on Administrative Matters for Staff of CGWB Conducted at Institute of Secretarial Training & Management, New Delhi from August 22-26, 2005.

2. Water Well drilling – Techniques, Equipment and Management:-The training Course on "Water Well drilling – Techniques, Equipment and Management" was conducted during August 2005 at SECR, Chennai.

3. nduction Level Training Course - 05 on Hydrogeological Investigation, Development and Management of Ground Water Resources- Techniques, Equipments & Practices:- The Induction Level Training Course-05 (ILTC-05) on Hydrogeological Investigation, Development and Management of Ground Water Resources- Techniques, Equipments & Practices was conducted at Faridabad during August 01 to October 28, 2005. Dr Saleem Romani, Chairman, CGWB inaugurated the training course.

4. Artificial Recharge Techniques in different hydrogeological Conditions :-Training course on "Artificial Recharge Techniques in different hydrogeological Conditions " was conducted between 21st -25th November 2005 at CGWB, Ansal Bhawan, New Delhi.

5. Computer Aided Drawing and Digitization :- A Two Week training on Computer Aided Drawing and Digitization for Draftsman was organized at Central Ground Water Board Chennai from 14th to 25th November 2005. 18 Draftsman from CGWB attended the training course.

6. Management Principles and Practices :- Training course on "Management Principles and Practices" was conducted between 19 – 30th December 2005 at CGWB, Bhopal.

7. Refresher course on Surface Resistivety Surveys for Geophysicists/Hydrogeologists :- A Refresher training course on Surface Resistivety Surveys for Geophysicists/Hydrogeologist was organized at Central Ground Water Board, Hyderabad from 19th to 23rd December 2005.

8. Training Course on Material Management for Engineers : A training course on Material Management for Engineers was conducted during 3rd – 7th January, 2006 at Central Ground Water Board, Central Region, Nagpur.

9. Refresher Course for Well logging:- A Refresher Course for Well logging was conducted during 30-01-2006 to 3-02-2006 at Central Ground Water Board, Western Region, Jaipur.

10. Refresher Course for Chemists for analysis of organic constituents:- A Refresher Course for Chemists for analysis of organic constituents was conducted during 13-24th Feb 2006 at Central Ground Water Board, Southern Region, Hyderabad.

11. Mathematical Modelling of Ground Water System:- The Course on Mathematical Modelling of Ground Water System was conducted during 13-24th Feb 2006 at I.I.T Roorkee.

12. Refresher Course on Ground Water Estimation and Management Software (GEMS):- A Refresher Course on Ground Water Estimation and Management Software (GEMS) was conducted during 6-17th Feb 2006.

13. Refresher Course on GEMS Software on Statistical & Hydrograph Analysis Module:- A Refresher Course on GEMS Software on Statistical & Hydrograph Analysis Module was conducted during 27-31st March 2007 at Central Ground Water Board, HQ, Faridabad.

14. Training Course on Ground Water Management (Regulation & Control) :- A Training Course on Ground Water Management (Regulation & Control) was conducted during 6 – 10th March, 2006 at Ansal Bhawan, New Delhi.

15. Training Course on Application of Remote Sensing & GIS in Ground Water System:- A Training Course on Application of Remote Sensing & GIS in Ground Water System was conducted at IIRS, Dehradun during 13 – 24th March, 2006.

16. Administrative Training Course for Senior Officers : - A Training Course on Administrative Training for Senior Officers was conducted during 6 – 10th March, 2006.

22. TECHNICAL DOCUMENTATION AND PUBLICATION

Results of investigations carried out by The Central Ground Water Board were suitably documented in the form of reports and maps. All the field offices have been provided with report processing sections, which are responsible for the scrutiny and issuance of reports of various assignments carried out by its officers.

22.1 REPORTS

Details of various type of technical reports issued by respective regional offices of the Board were as follows:

22.1.1 State Reports

State Reports containing complete details of ground water surveys, exploration and other ground water related information are compiled and prepared for the status of ground water development in the State. Based upon reports, ground water development perspectives are worked out and future strategies are planned. During 2005-2006, six Regions undertook the assignment of preparation of State Reports of Punjab, Gujarat, Manipur, Pondicherry and Himachal Pradesh.

22.1.2 District Reports

The Central Ground Water Board is compiling and issuing district reports of each district from time to time containing all the results of ground water surveys, exploration and other related studies. Further, groundwater development perspectives are also worked out for the benefit of State and other users agencies. The reports have been found very useful for their strategies for future. During 2005-06, 38 district reports were prepared and submitted. Region wise status of preparation of District Reports are presented in Table 22.1

Table 22.1: STATUS OF DISTRICT REPORTS COMPLETED DURING 2005-2006

Sl. No	Region	District Report
1	North Himalayan Region	1
2	North Western region	2
3	Western Region	2
4	West Central Region	2
5	North Central region	3
6	North Central Chhatisgarh Region	2
7	Central Region	2
8	Northern Region	3
9	Mid Eastern Region	2
10	Eastern Region	2
11	North Eastern region	2
12	South Eastern region	3
13	Southern Region	2
14	South Western Region	3
15	South Eastern Coastal Region	2
16	Kerala Region	2
17.	Uttaranchal Region	1
18.	SUO, Delhi	2
	Total	**38**

22.1.3 Ground Water Year Book

The Central Ground Water Board is compiling ground water year books to elucidate the changes in ground water levels and water quality. The accurate monitoring of the ground water levels and its quality both in space and time are the main requisite for assessment, scientific development and planning of this vital resource. During 2005-06, 23 reports are prepared . Region wise status of preparation of ground water year books are presented in Table 22.2

Table 22..2: STATUS OF GROUND WATER YEAR BOOKS COMPLETED DURING 2005-06

Sl. No	Region	Target	
		No.	State
1	North Western Himalayan Region	1	J & K
	Western region	3	b na & digarh
	rn Region	1	than
	Central Region	1	at & Daman & Diu
	Central region	1	ya Pradesh
	Central Chhatisgarh Region	1	tisgarh
	l Region	1	rashtra
	rn Region	1	Pradesh
	stern Region	2	 hand
	n Region	1	Bengal
	Eastern region	1	
	Eastern region	1	a
	rn Region	1	ra Pradesh
	Western Region	2	taka & Goa
	Eastern Coastal Region	1	Nadu
	Region	1	la
	nchal Region	1	anchal
	Himalayan Region	1	chal Pradesh
	Delhi	1	i
		23	

22.2 BHUJAL NEWS

Ground Water has a major role in meeting the needs of irrigation, drinking water supply and industrial sector. Keeping in view the importance of ground water and scientific development in this field, the Board is issuing a journal “Bhujal News on quarterly basis. Besides a number of interesting papers, the journal contains technical notes, news items and usual columns of recent published papers, list of unpublished reports of the Board etc. The journal has more than 1300 readers all over the country amongst the Central Govt, State Govt, Undertaking and academic institutions.

During 2005-06, the issue of Bhujal news Vol. 19 , 2004 issue finalised and printed , Vol. 20 No. 1 & 2 2005 issues is under final stage of compilation.

23. RIGHT TO INFORMATION

The Govt. of India resolved that in order to ensure greater and more effective access to information, the Freedom of Information Act, 2002 must be made more progressive, participatory and meaningful. The National Advisory Council deliberated on the issue and suggested certain important changes to be incorporated in the existing Act. The government examined the suggestion and decided to make a number of changes in the law. In view of significant changes proposed in the existing law, the Government decided to repeal the Freedom of Information Act, 2002 and the, Right to Information Bill, 2005 was introduced.

Right to Information Bill, 2005 was passed by Lok Sabha on 11th May, 2005 and by Rajya Sabha on 12th May,2005 and received the assent of the President on 15th June, 2005. It came on the Status Book as THE RIGHT TO IINFORMATION ACT, 2005.

For the smooth implementation of RTI Act, 2005 in Central Ground Water Board following steps were taken

1. The Central Ground Water Board prepared and published a booklet entitled as "Information on Central Ground Water Board" containing seventeen chapters as envisaged in chapter II, Para 4 of the Act and placed them on the Website of the Board.

2. Twenty Public Information Officers and Sixteen Asstt. Public Information Officers were appointed in the Board in its different field offices spread over in the entire country.

3. Board also appointed Appellate Authority and Nodal Officer as required under the Act.

4. A system has also been developed in the Board to receive and process the request application efficiently.

5. The Board supplied the requisite material to the Ministry of Water Resources for the year ending March, 2006 as required by Central Information Commission under section 25 to enable them to prepare a report on the implementation of the various provision of the Act.

6. Up to the end of March, 2006, the Board received 16 requests seeking the information under RTI and no complaint to the Appellate Authority was received. In all the Board collected a sum of Rs.1894/- (Rupees One thousand Eight hundred Ninety four only) to supply this information.

24. MEETINGS

24.1 MEETINGS WITH HON'BLE MINISTER/VIP

i. A meeting was held with Shri Priyaranjan Dasmunsi, Hon'ble Union Minister, MOWR, Govt. of India, in his residence on 10-06-2005 regarding renovation of pond at Tarama Temple, Tarapith, Birbhum district, West Bengal. Sh D.Prakash, Regional Director, CGWB, Eastern Region attended the meeting.

ii. Chairman attended a meeting with Additional Secretary (WR) on the issue on proposal for constitution of Rain Water Harvesting and Ground Water Recharge Advisory Council under Chairmanship of MOS (WR) on 24-06-2005.

iii. Dr. Saleem Romani, Chairman, CGWB attended preparatory meeting on 10.08.2005 with Joint Rivers Commissions held at Dhaka from 29th August to 2nd Sept. 2005 with Secretary (WR) in Power Committee Room, Shram Shakti Bhawan, New Delhi.

iv. A meeting was held with Shri P.R. Das Munsi, Hon'ble Union Minister, Water Resources at Kolkata on 02.09.05 to discuss ground water condition and Arsenic contamination in ground water in parts of West Bengal was also discussed. Dr Saleem Romani, Chairman, CGWB ,the Principal Secretary, PHED, Govt. of West Bengal, PS to The Hon'ble Union Minister, Regional Director, CGWB, ER, Director, SWID, Govt. of West Bengal, and other dignitaries attended the meeting.

v. On behalf of Chairman, Sh. Abhijit Ray, Suptdg HG' attended Press Conference of Hon'ble Minister (WR) on 26-09-2005 reg. 36th Indo Bangladesh Joint River Commission meeting held in Dhaka at Conference Hall of Shastri Bhavan, New Delhi.

24.2 PARLIAMENTARY COMMITTEE MEETINGS

i. The Chairman CGWB, attended the brief meetings on Parliamentary Question taken by Hon'ble Minister (WR) in Parliament House on 1st & 2nd of May 2005.

ii. Chairman attended meeting with Hon'ble Minister (WR) on Parliamentary matter on 4.8.2005.

iii. Chairman attended the meeting on 11.08.2005 with Parliamentary delegation from South Africa with Secretary (WR) in SS Bhawan, New Delhi.

iv. Commissioner (GW) attended meeting with Secretary (WR) on 26-09-2005 regarding South Africa delegation from Parliamentary Committee on Social & Community Development.

v. Member (SAM) attended inspection meeting of Parliamentary Committee for Rajbhasha at Division-III, Varanasi on 9-11-2005.

vi. Chairman CGWB, attended briefing meeting of Parliament (Rajya Sabha) Questions taken by Minister (I&B) and Parliamentary Affairs in Parliament House on 5-12-2005 .

vii. Chairman CGWB attended briefing meeting of Parliament (Rajya Sabha) Questions taken by Minister of State (WR) on 12-13th December, 2005.

viii. Member (SML) attended Consultative Committee meeting in Parliament Annexe of MOWR during Winter Session period of Parliament 2005 on "Command Area Development & Water Management Programme" with specific emphasis on participatory Irrigation Management on 21-12-2005.

ix. Chairman CGWB attended briefing meeting with Hon'ble Minister (WR) Shram Shakti Bhavan, New Delhi on 30-01-2006.

x. Member (SAM) attended the meeting convened by the Parliamentary Standing Committee in CGWB, State Unit Office, Visakhapatnam on 8.02.06.

xi. Member (SML) and Senior. officers attended briefing with Minister (WR) regarding Parliament Question "World Bank Aid for Water Scheme in the Office Chamber of Minister (WR) on 20.02.06.

xii. Chairman attended briefing with Minister (WR) regarding 4 Starred Parliament Questions for 27.02.06 in the office chamber of Minister (WR) on 22-23 Feb 2006.

24.3 MEETING WITH A DELEGATION FROM WATER RESOURCES DEVELOPMENT DEPARTMENT, OMAN

Chairman CGWB attended a meeting with a delegation from Water Resources Development Department, Oman at Head Quarters, Faridabad on 12.05.2005. The objective of visit of delegation was to have technical cooperation in their programme in the field of Ground Water. In this regard a presentation was made regarding Data Base Management and Software developed by CGWB on Ground Water Data Processing and Management.

24.4 REGIONAL DIRECTORS MEETING OF THE CGWB

All the members of the Board , Regional Directors and Executive Engineers of all Regions attended Regional Director's meeting Chaired by Chairman, CGWB at Bhujal Bhawan, Faridabad on 9.05.2005 and 10.05.2005. Agenda items were discussed in detail and Minutes of the meetings were circulated.

24.5 CONSULTATIVE COMMITTEE OF MOWR

i. Chairman, Members and other Senior officers of CGWB, attended meeting of the Consultative Committee of MOWR held on 8.06.2005 in Parliament House Annexe regarding Development and Management of Ground Water.

ii. Chairman CGWB attended Consultative Committee meeting of the Ministry of Water Resources on 4.08.2005.

iii. Chairman CGWB attended a briefing meeting of Consultative Committee under the Chairmanship of Hon'ble Minister (WR) at MOWR on 6-11-2005

24.6. STATE LEVEL SCIENTIFIC SOURCE FINDING COMMITTEE MEETING

i. 45th meeting of State Level Scientific Source Finding Committee was held on 16.11.05 under the Chairmanship of the Principal Secretary, PHED, Govt. of West Bengal. In this meeting Technical Clearance was accorded for 12 Water Supply schemes and Source Clearance was accorded for 14 Water Supply schemes. Sh. Subhash Datta, Sc. 'D', attended this meeting.

ii. 46th meeting of State Level Scientific Source Finding Committee was held on 16.12.2005 under the Chairmanship of the Principal Secretary, PHED Govt. of West Bengal. The Regional Director is the Member Secretary of this committee in this meeting, Technical Clearance was accorded for 10 new and review of 4 Water Supply schemes, Source Clearance was accorded for 2 Water Supply schemes.

iii. Meeting of State Level Committee for Estimation of Dynamic Ground Water Resources of West Bengal based on GEC (97) , Methodology was held on 08-08-05 under the Chairmanship of the Principal Secretary, WIDD, Govt. of West Bengal. In this meeting the reconciled estimation of Block wise Stage of Development and Categorization was approved.

24.7 R&D ADVISORY COMMITTEE ON GROUND WATER

i. Chairman attended meeting taken by the Secretary (WR) to discuss the R & D proposal of Government of Kerala on 7-10-2005.

ii. Member(SML) & R.C,Jain, Suptdg HG attended the 3rd R&D Session of INCOH, held at Hyderabad during 26-29 Sept. 2005.

iii. Chairman & Member attended the R & D meeting for estimation of Ground Water Resource as per GEC-97 on 19-08-2005.

24.8 REGIONAL OFFICE LEVEL MEETING

i. Sh. A.D.Joseph, Regional Director, CGWB, Western Region, Jaipur visited Barmer with Senior Officers in connection with a VIP reference. Shri A.K.Sinha, Member (SML) CGWB and Shri K.P.S.Senger, Director, Central Water Commission also visited Barmer. A meeting was held with local Public Health Engineering Department , Rajasthan Ground Water Department officers, Ex. Member of Parliament and other Public representatives on 7.6.2005 to discuss upon problem of drinking water in areas of Barmer and Jaisalmer districts.

ii. The Principal Secretary to the Government of Maharashtra, Water supply and Sanitation Department has convened a Technical meeting in Mumbai on 21 March 2006 to discuss the issues raised by the Regional Director, CGWB, CR, Nagpur on the minutes of the meeting of Technical committee to review estimation of Ground Water in **critical** and **over exploited watersheds** on mini watershed basis. The meeting was attended by Sh.Dinesh Prakash, Regional Director & Senior officers of CR, Nagpur. The Regional Director, CGWB, CR, Nagpur suggested that detailed joint studies by CGWB and GSDA ought to be carried out in representative Critical and Overexploited watersheds for Ground Water reassessment. The Chairman of the committee has agreed to do the same and advised both the Departments to pursue the issue.

iii. Shri Goutam Deb, Hon'ble Minister in-charge, PHE & Housing, convened a meeting to discuss Water Supply Scheme for Contai, East Medinipur district, which is known for salinity problem. Detailed discussion was held on the salinity problem and also on hydrogeological condition of the area. The meeting was attended by Regional Director, CGWB, ER, and also by officers of CGCRI, BARC & PHED. The Minister desired that a Committee may be constituted to consider all issues related to drinking water problem of Contai. Accordingly, committee has been constituted. Regional Director, CGWB, ER, has been included as a member of the Committee.

iv. S/Shri R.N.Singh, Regional Director , I/C NWR, Chandigarh and A.K.Bhatia, Supdt. Hg. attended a meeting at Shram Shakti Bhawan, New Delhi on 22.12.2005 in connection with reclamation of water logged areas in Haryana State

24.9 OTHER IMPORTANT MEETINGS

i. Chairman CGWB attended a meeting held on 4.04.2005 in connection with Relaunching of Rajiv Gandhi National Ground Water Training Institute.
ii. Chairman and Member (SAM) attended a meeting with Additional Secretary (WR) regarding MOU between CGWB & CAIRN India Ltd on 12.04.2005
iii. Chairman attended a meeting with Secretary (WR) regarding specific issues indicated by MEA i.e. Water Availability in the country and water sharing agreement on 25-05-2005.
iv. Chairman attended a meeting with D.G.W., CPWD, Nirman Bhawan, regarding finalized the report of task force on Installation of Roof Top Rain Water Harvesting Structure in government buildings on 30-05-2005.
v. Meeting for finalisation of Ground Water Resource of Tamilnadu was chaired by Chairman and attended by Member (SAM), Scientist 'D' with the State Ground Water and Surface Water Data Resource Centre of Tamil Nadu at CGWB Jamanagar House, New Delhi on 1.06.2005.
vi. Member (SML) attended a meeting with JS(A) on 21-06-2005 regarding Demonstration of Rain Water Harvesting from Roof Top and Two Toilet in 100 Govt. schools in rural Areas in 13 states by community based organizations.
vii. Dr Saleem Romani, Chairman , CGWB attended meeting to review the flood situation in Gujarat & Madhya Pradesh taken by Home Secretary on 5.07.2005.
viii. Chairman attended a meeting taken by AS(WR) regarding Constitution of Expert Committee by Planning Commission to review ground water ownership in the country on 7.07.2005.
ix. Chairman attended function of 11th Annual Convention and National Seminar on Water Management in Urban Center at Vigyan Bhawan, New Delhi on 21 & 22nd July 2005.
x. Member (SAM) attended 4th meeting of Water Quality Assessment in Ministry of Environment & Forest, Paryavaran Bhawan, CGO Complex, New Delhi on 19.07.2005.
xi. Member (SML) attended meeting on 16.08.2005 with Additional Secretary (WR) to finalize format for Monitoring Report and to suggest monitoring mechanism for the Pilot Scheme "National Project for Repair, Renovation and Restoration of Water Bodies directly linked to Agriculture".
xii. Member (SML) attended meeting with JS(A) and JS(FA) regarding setting out matter to M/s Global Rain Water Harvesting, collective at the Tilonia district of Rajasthan on 4.8.2005.
xiii. 2nd Meeting of the committee to study the Arsenic contamination of water in U.P., Bihar & Chhattisgarh States was held at New Delhi on 18-08-2005, which was chaired by Member (SAM). Chairman, CGWB addressed the Members of the Committee. The representatives from UP, Bihar & Chhatisgarh presented their findings & the format for final report was decided.
xiv. Member(SAM) Chaired Bureau of Indian Standard meeting on Ground Water & Related Investigation sectional committee on WRD- 03 at Manak Bhwan, New Delhi on 28-09-2005.
xv. 3rd meeting of Committee to Study Arsenic Contamination of Water in Bihar, Uttar Pradesh and Chhattishgarh, was held under the Chairmanship of Member (SAM) in Jamangar house, New Delhi on 3-10-2005.

xvi. Chairman, Member (SML) and other senior officers attended Conference of Principal Secretaries/Secretaries (Irrigation & Water Resources) and Command Area Authorities of States held at Ashoka Hotel, New Delhi on 4.10.2005 & 5.10.2005.

xvii. Member (SAM) attended the 6th Meeting of Environment Assessment and Management of Water Resources Projects, Sectional Committee, WRD 24 in Manak Bhawan, BIS, New Delhi on 10-10-2005.

xviii. Member (SML) attended a meeting with Additional Secretary (WR) regarding finalizing India International Trade Fair Exhibition and Republic Day Parade Tabulate on 19-10-2005.

xix. Chairman attended 8th National Convention on Construction Development of Physical Infrastructure- Synergic Approach" on October 20-22, 2005 organized by CIDC on 20-10-2005

xx. Chairman & R.C. Jain, Scientist attended a meeting regarding reconstitution of Indian National Committee (INCs) and finalization of procedure for processing of Research Schemes in the Chamber of Chairman, CWC, New Delhi on 25.10.2005

xxi. Chairman attended a meeting on Finalisation of Ground Water (Regulation, Development & Management) Rules, 2005 in the office of the Secretary (WR) on 28.10.2005

xxii. Chairman, CGWB attended XIIth International Rainwater Catchment System Conference – 2005 at Hotel Inter-Continental Eros, Nehru Place, New Delhi on 15-11-2005.

xxiii. Member (SAM) attended a meeting with Scientists of National Institute of Hydrology (NIH), Roorkee in connection with Project Proposal of specification and remediation of Arsenic in the Ground Water of Bhojpur district Bihar on 16-11-2005.

xxiv. Chairman attended a workshop on Water Demand Management in areas of ground water over exploitation strategy formulation at UNICEF, New Delhi on 17-11-2005

xxv. Chairman attended a meeting of Expert Group to review the issues of ground water ownership in the country under the Chairmanship of Member, Planning Commission in Yojana Bhawan, New Delhi on 17-11-2005

xxvi. Chairman, CGWB attended meeting with representatives from Department of Water Affairs and Forestry, Republic of South Africa in the chamber of the Secretary MOWR, New Delhi on 21-11-2005

xxvii. Chairman, Members, Senior officers of the Board attended the Irrigation Minister's conference at Vigyan Bhawan, New Delhi on 30-11-2005

xxviii. Member (ED&MM) attended meeting as Chairman of the Committee for preparing specification for procurement of 2 Heavy Duty Mud Rotary Rigs of 1000 meter capacity on 16-12-2005.

xxix. Member (SML) attended meeting with Additional Secretary (WR) and Chief Secretary of Rajasthan to discuss various issues pending with the CGWA regarding State of Rajasthan on 20-12-2005

xxx. Member (SML) attended briefing meeting with Minister (WR) regarding Consultative Committee Recommendations on 22-12-2005

xxxi. Member (SML) and Member (SAM) attended a meeting regarding – Brain Storming Session- to finalize the Chapter of TOR of the Working Group of the Sub-Committee of the National Development Council (NDC) on Agriculture and related issues constituted by the Planning Commission on 31.01.2006.

xxxiiChairman & Member (SAM) attended inaugural session of International Conference of Ground Water (IGC-2006) in India International Center, New Delhi on 1.02.06.

xxxiii. Chairman attended meeting with World Bank Team regarding Ground Water Economy to Indian development Study and Technical Assistance at Jamnagar House, New Delhi on 1-02-2006.

xxxiv. Chairman and Regional Director, NWHR, Jammu attended meeting with Minister (WR) regarding Jammu & Kashmir situation in his Chamber on 10-02.06.

25. CONSTRUCTION / ACQUISITION OF OFFICE BUILDINGS

During the IXth Plan, scheme for acquisition of land and construction of various offices of CGWB was approved. Under this scheme, CGWB has completed construction of office buildings at Jaipur, Bhubaneswar, Lucknow and Kolkata. The Board has also acquired ready-built accommodation at Trivendrum, Patna and Bhopal. The construction of office building at Chandigarh, Faridabad, Guwahati has been completed during the Xth Plan. The construction of office building at Jammu , Hyderabad , Bangalore and Bhopal (Division office), is under progress. The acquisition of land for office building at Ambala, Jodhpur, Ahmedabad, Nagpur, Chennai, Dehradun and Kangra is also proposed to be taken up during Xth Plan.

The details of following construction work for own office building of Central Ground Water Board have been carried out during the year 2005-2006 is given in Table 25.1

Table 25.1 : CONSTRUCTION OF OFFICE BUILDINGS DURING 2005-2006

Sl. No.	Construction work during 2005-2006	Status
1	**Bangalore**	**The construction work of office building of CGWB in respect of SWR and Division XIV, Bangalore is under progress. The boundary wall on the land of store and workshop of Division XIV Bangalore has been constructed.**
2	**Hyderabad**	**The construction work of building of CGWB in respect of SR and Division IX, Hyderabad is under progress.**
3	**Faridabad**	**The construction work of Garage of CGWB in respect of CHQ, Head Quarter Faridabad has been completed.**

26. PARTICIPATION IN SEMINARS/ CONFERENCE/ SYMPOSIUM/ WORKSHOPS

The Central Ground Water Board successfully organized the workshops/training programme to share research & developments in the field of ground water. The Central Ground Water Board officers also actively participated in seminars/symposium/workshops/conferences organized by other organisations and presented technical papers to share its achievements in the field of ground water. The officers of the Board also gave useful suggestions/views in the various meetings and contributed immensely in committees etc on ground water development in specific areas. The important seminars and workshops among them are given below.

26.1 SEMINARS /CONFERENCE/ SYMPOSIUM/ WORKSHOPS

26.1.1 National Water Convention

Chairman, all the Members, Regional Directors and Senior Officers of CGWB attended the National Water Convention at Vigyan Bhawan, New Delhi on 11.05.2005.

26.1.2 "International Conference on Crisis Management in Water and Environment- 2005"

The International Conference on "Crisis Management in Water and Environment-2005" organized by Indian Association of Hydrology was attended by Shri D. Prakash, Regional Director, Central Region & other Senior Scientists on 15th & 16th July, 2005 at Kolkata.

26.1.3 Workshop on "Rainwater Harversting and Recycling of Water"

Scientist of CGWB, CR has delivered lecture on "Rain Water Harvesting and Artificial Recharge to Ground Water Resources" at Hotel Pride, Pune (Maharashtra) in Workshop on "Rainwater Harversting and Recycling of water" organized by Vision India, Pune on 15th July 2005.

26.1.4 Workshop on "Impacts of Bhakra Project"

Dr. Saleem Romani, Chairman CGWB, participated in a Workshop on "Impacts of Bhakra Project" at FICCI on 04-08-2005.

26.1.5 Delivered the 6th Prof. C.Karunakaran Endowment Lecture

Dr. Saleem Romani, Chairman, CGWB delivered the 6th Prof. C.Karunakaran Endowment Lecture in the Centre for Earth Science Studies (CESS), Trivandrum on 1st Aug 2005. The dignitaries earlier delivered the lecture include Dr. Kasturi Rangan, Former Chairman, ISRO, Dr. Kokodkar, Chairman, Atomic Energy Commission and so on.

26.1.6 Seminar on E - Governance

Shri K.P.Singh, Scientist-D, (Head of Office) and Shri R.P.Mathur, Suptd. Hydrogeologist, Central Ground Water Board, WR, Jaipur participated in a seminar

on E Governance organised by Hindustan Times and IBM on 24th September, 2005 at Jaipur.

26.1.7 Ground Water Modeling Workshop at Dhaka

Shri T. Talukdar, Sc-'B', participated in the Ground Water Modeling Workshop at Dhaka for the period 11th – 15th September, 2005. The Workshop was conducted by United States Geological Survey (USGS) and sponsored jointly by the Arsenic Policy Support Unit (APSU) and UNICEF, Bangladesh.

26.1.8 Seminar on Rainwater Harvesting

A seminar on Rainwater harvesting was organized by CPWD, Bangalore on 26-08-2004. Regional Director & Scientists of CGWB, SWR delivered lectures on the theme, where about 80 engineers/architects participated.

26.1.9 Workshop on "Imperative of Rain Harvesting & Reuse in Urban and Rural Areas"

Sri K.Keerthiseelan, Regional Director and Sri K.R.Sooryanarayana Sc-'D' attended one day work shop on "Imperative of Rain Harvesting & Reuse in Urban and Rural Areas" on 21st October 2005 at R.V. College of Engineering, Bangalore. They delivered technical talk on "Conservation of ground water " and "artificial recharge technique and Rainwater harvesting".

26.1.10 Conference on 12th World Water Congress of Iwra-Water for Sustainable Development

Chairman, CGWB attended the 12th World Water Congress of IWRA-Water for Sustainable Development-Towards Innovative Solutions at New Delhi on 24-11-2005. Member(SAM), CGWB attended the above conference during 22-25th, Nov 2005 and made a poster presentation on the topic- Determination of interface of freshwater and Saline Water in Island of Lakshadweep- a case study.

26.1.11 Workshop organized by National Spatial Data Base Infrastructures (Nsdi)

Shri B.M.Jha,Member(SAM) attended workshop organized by National Spatial Data Base infrastructures (NSDI) on Bharat Nirman at Hyderabad on18-21st Dec 2005

26.1.12 Seminar on "Innovation Technology for Rural Development

Shri G.D.Ojha, Regional Director chaired technical session on "Watershed Management" of the seminar on "Innovation Technology For Rural Development organized by Institution of Engineers & Regional Research Laboratory, Bhopal on 10th and 11th December 2005.

26.1.13 Workshop Sponsored by UNESCO

Shri N.Varadaraj, Supdtg. Hg. & HOO, CGWB, SECR and four officers attended State Level Workshop sponsored by UNESCO on Traditional Rainwater Harvesting Systems in Tamil Nadu (Organized by TWAD Board) during the period 8 - 9th December 2005 at Coimbatore. He has also chaired one of the Sessions titled "Towards State Water Policy Initiatives" and presented key paper.

26.1.14 National Seminar on Emergence of Geoinformatics Development

Shri K.Rajarajan, AHG, participated and presented a technical paper entitled "An integrated approach for identification of ground water potential site for development in drought affected Tiptur Taluk, Tumkur district, Karnataka – A Case Study"in National Seminar on Emergence of Geoinformatics Develoment: Trends & Opportunity", organized by BIT Mesra, Ranchi.

26.1.15 Workshop at Ministry of Environment & Forest

Member (SML) attended Workshop at Ministry of Environment & Forest regarding Environmental Governance and Mine Rehabilitation at Paryavaran Bhawan, CGO Complex, New Delhi.

26.1.16 **Seminar on "Integrated Micro Finance in Water and Agriculture**"

Sh.N.Varadaraj, Superintending Hydrogeologist & HOO along with Shri B.Umapathi, Sc.B attended and participated in the deliberation in the Policy Seminar on "Integrated Micro Finance in Water and Agriculture" organized by Dhan Foundation, on 30th January 2006 at Chennai.

26.1.17 Vidarbha Hindi Sahitya Sammelan

In the Golden jublee ceremony of " Vidarbha Hindi Sahitya Sammelan**" a lecture series was organized on "Water problems in Vidarbha" in which Regional Director, CGWB, CR, Nagpur delivered a lecture on the above subject on 27.03.06. This item has been published in the "Navbharat" News Paper (Hindi Daily).**

16.1.8 Talk on Design of Rain Water Harvesting and Artificial Recharge

Dr. S. K. Jain, Scientist-D, delivered series of Talk on Design of Rainwater Harvesting and Artificial Recharge at Area Offices of Western Coal Fields Ltd, Nagpur, Umred and Ballarpur. Officers of WCL Coal Mines attended the programme for implementation of Rainwater Harvesting in their respective areas.

26.1.19 International Workshop at Roorkee On "Impact Of Reforestation Of Degraded Land On Landscape Hydrology In The Asian Regions"

Dr P K Naik Scientist – D, has attended the International Workshop at Roorkee on "Impact of Reforestation of Degraded Land on Landscape Hydrology in the Asian Regions" co-organized by UNESCO and INCOH and hosted by National Institute of Hydrology Roorkee, between 6-10 March 2006.

26.1.20 Participation in International Ground Water Conference New Delhi

Dr P K **Naik Scientist – D, has participated in the Inter National Ground Water Conference (IGC-2006) at JNU, New Delhi from 1-4 February 2006 and presented abstract of the following:-**

a. **Ground Water Resource Development in Western Ghats/India.**
b. **Estimation of Aquifer parameters from large diameter wells.**

26.1.21 Regional Workshop on Water Quality for Western Region

Shri. Dinesh Prakash, Regional Director, CGWB, Nagpur and Dr P.K. Naik, Scientist – D, had participated in the Regional Workshop on Water Quality for Western Region on 24-25th January 2006 at National Water Academy, Pune and discussed about the ensuing seminar for Western States on Status of Water Quality. The CGWB gave a presentation on "Existing system of water quality monitoring by different agencies, gap between the present system and measure to upgrade the system".

26.1.22 Conference on Sundarban: Its Embankment and Related Issues

Sri D. Prakash, Regional Director and Sh. A. Gayen, Sc. 'B' attended the programme and participated in the Conference on Sundarban: Its Embankment and Related Issues organised by Sundarban Affairs Department, Science & Technology Deptt. and Irrigation & Water Wells Deptt., Govt. of West Bengal on **21.07.2005**.

26.1.23 T.V. Programme on Water Conservation

Shri B.M. Jha, Regional Director gave a T.V. Programme on Water Conservation, which was telecast on 1st June 2005, by Bhopal Doordarshan under "GRAM MANGAL"

26.1.24 Roof Top Rain Water Harvesting

Sh/Shri B.M. Jha, Regional Director, S.S.P. Mishra, Scientist 'D', Parvinder Singh, Scientist 'D', A.K. Budhauliya, Scientist 'D', B.P. Singh, AHG, have attended a workshop on "Roof Top Rain Water Harvesting" organised by Reliance Industries Ltd. on 23rd June 2005 at Noor-Us-Sabah Palace, Bhopal.

26.1.25 Workshop `Jalmahabhishek'

Dr S. C. Singh, Scientist `B' attended International workshop `Jalmahabhishek' organised by Ministry of Rural Development, Regional Research Laboratory, Bhopal and IIT, New Delhi.

26.1.26 Facilitating Negotiations Over Water Conflicts in Peri-Urban Catchment – with a particular focus on the Chennai city

Shri. Suresh, Scientist – D attended a workshop on the results of a project undertaken taken on " Facilitating Negotiations Over Water Conflicts in Peri-Urban Catchment – with a particular focus on the Chennai city" organized by the Madras Institute of Development Studies, Chennai on 14.09.2005 and participated in the deliberations.

26.1.27 Workshop on Environmental Aspects of Effluent Irrigation

Sh. K.Ravichandran Scientist – B attended the workshop on Environmental Aspects of Effluent Irrigation, organized by Madras School of Economics, Chennai at Coimbatore on 27.10.2005 and participated in the deliberations.

26.1.28 Workshop on Traditional Rainwater Harvesting Structures in Tamil Nadu

S/Shri G.Y.Setty, Scientist – B, J. Benjamin Vedanayagam, Assistant Hydrogeologist and C.Rajkumar, Assistant Hydrologist attended the State level workshop on Traditional Rainwater Harvesting Structures in Tamil Nadu organized by Tamil Nadu Water Supply and Drainage Board at Coimbatore 7th-9th December 2005 and participated in the deliberations.

26.1.29 Workshop on Industrial pollution control

Sh. K.Ravichandran- Scientist -B attended the workshop on Industrial pollution control on 27.12.05 at Madras School of Economics, Chennai and participated in the deliberations.

26.1.30 Seminar on Role of Groundwater in National Economy

Sh. T. Balakrishnan, Scientist – D, A. Arulprakasam, Scientist – B, K. Ramanand, Assistant Hydrogeologist, A. Rameshkumar, STA and M.T. Karuppiah, STA attended the seminar on Role of Groundwater in National Economy organized by All India Central Ground Water Board Officer's Association at Bangalore on 18.01.2006 and participated in the deliberations.

26.1.31 Policy Seminar on 'Integrating Micro Finance in Water and Agriculture

Shri N. Varadaraj, H.O.O. & Supdt. Hydrogeologist and B.Umpathi, Sceintist – B attended Policy Seminar on 'Integrating Micro Finance in Water and Agriculture" organized by DHAN Foundation, Madurai, (NGO) and participated in the deliberations, on 30.01.2006.

26.1.32 Brainstoriming Workshop for formulating a Tamil Nadu Environment Project

Shri N. Varadaraj, H.O.O. & Supdt. Hydrogeologist and Nandakumaran.P, Sceintist – D attended Brainstoriming Workshop for formulating a Tamil Nadu Environment Project organized by Department of Environment at Chennai on 20.02.2006 and participated in the deliberations.

26.1.33 Formulate a National Policy on Disaster Management

Shri N. Varadaraj, H.O.O. and Supdtg. Hydrogeologist attended the workshop, orgasnised by Dr. MCR HRD Institute of AP, Hyderabad to formulate a National Policy on Disaster Management and lay down the guidelines for preparation of plans by the Central Government Ministries/Departments, State Governments and also oversee their implementation at Hyderabad and made presentation On 24-25.03.2006.

26.1.34 Workshop on "Environmental Sustainability and Human Development in Tamil Nadu

Shri. A. Subburaj, Scientist-D attended the workshop on "Environmental Sustainability and Human Development in Tamil Nadu" organized by the Madras School of Economics on 28.03.2006 at Chennai and participated in the deliberations.

26.1.35 Workshop on management of shallow ground water in coastal deltaic

Shri C. Paul Prabhakar, Sc-D, Sri G. Sudarshan, Sc-D, Dr. V.S.R. Krishna, A.Hg have participated in two-day workshop on management of shallow ground water in coastal deltaic region from 4.5.2005 to 5.5.2005 organised by National Institute of Hydrology, Coastal Deltaic Region, Kakinada, Andhra Pradesh.

26.1.36 Workshop on "Disaster Management

S/Sri B. Jaya Kumar, Head of Office and G. Sudarshan, Scientist-D have participated and proposed the role of CGWB in disaster management in a National Workshop on "Disaster Management – Role of Scientific and Technical Institutions" from 24th to 25th March, 2006 organized by National Disaster Management Authority at Hyderabad.

26.1.37 Water Conservation and people's participation

Prasar Bharti, Akashwani, Jaipur recorded talk with Dr. L.N.Mathur, Scientist- B, Central Ground Water Board, WR, Jaipur on 14. 07.2005 on Water Conservation and people's participation. The same was broadcast on 15.07.2005 in Krishi Darshan Prograame of Akashwani in the State of Rajasthan.

26.1.38 Shri A.D.Joseph, Regional Director. Central Ground Water Board, WR, Jaipur and other officers of Central Ground Water Board, WR, Jaipur participated in Jal Abhiyan organized by the Irrigation Department , Government of Rajasthan on 10th December, 2005 at Jaipur. An exhibition was also organized during the Programme, which was visited by the Chief Minister, Rajasthan and other Ministers

26.1.39 National seminar on " Urban lakes of India "

Shri R.P.Mathur, Suptg. Hydrogeologist attended national seminar on " Urban lakes of India" organized by NIH, Roorkee & Udaipur University at Udaipur on 20th & 21st October,2005.

26.1.40 International Seminar on Water Conflicts

Shri Saleem Romani, Chairman, Central Ground Water Board, Shri A.D.Joseph, Regional Director, CGWB (WR), Jaipur Shri O.P.Poonia, Scientist 'B', SUO, Jodhpur attended International Seminar on Water Conflicts organized by Jal Bhagirathi Foundation at Jodhpur on 29th & 30th March 2006.

26.2 Published and presented Technical Papers

i. **S/Shri. K. Keerthiseelan, Regional Director, A.N. Tiwari, Sc-B (CH), V.P. Nawale, Asstt.Chemist, B.N. Dehury, STA (CH) and J.A. Tambe, STA (CH) has submitted a scientific paper titled "Ground Water quality in India" which was published in the "National Workshop on Assessment of current and futuristic Water Quality Standards in India which was held on May 17-18, 2005" at National Environmental Engineering And Research Institute (NEERI), Nagpur.**

ii. **S/Shri J.A. Tambe, STA (CH) and P.K. Jain, Sc-D has submitted a scientific paper titled "Impact of Inland Salinity in Socio-economic development of Purna Alluvial basin, Amravati, Akola and Buldhana districts" which was published in All India Seminar on Role of Ground Water in National Economy" wahich was held on 18th January 2006.**

iii. **S/Shri. A.N. Tiwari, Sc-B (CH), V.P. Nawale, Asstt.Chemist, J.A. Tambe, STA (CH) and Y. Satyakumar, STA (CH) has prepared a technical paper on 'Ground Water Quality of the Union Territory of Dadra & Nagar Haveli', which was published in the Regional Workshop on Water Quality for Western Region held at National Water Academy, Pune during 24-28th January 2006.**

iv. **A Technical Paper written by Shri D. Prakash, Regional Director & Dr. T.L.Chakraborty, Sc. 'D' was presented in National Workshop on " Assessment of Current & Futuristic Water Quality Standards in India organized by NEERI, Govt. of India from 20.09.05 to 21.09.2005.**

v. **Shri D. Prakash, Regional Director and Shri R.K.Guha, Sc.'B' attended the Workshop on Planning for Water Security and the Technical Paper prepared by Shri D. Prakash, Regional Director; Shri S. Datta, Sc.'D' & Shri R.K.Guha, Sc.'B' was presented on21.09.2005 organized by Credia Bengal and Ion Exchange Ltd., Kolkata.**

vi. **Sh. S.K. Samanta Sc. 'D' and Sh. R.K.Guha, Scientist 'B'delivered lectures in Awareness cum Sensitization Workshop on Artificial Recharge to Ground Water and Rain Water Harvesting under National Rural Employment Guarantee Act 2005 organized by Murshidabad Zilla Parishad & DRD Cell, Murshidabad, Govt. of West Bengal at Berhampur on 02.03.06 & 03.06.2006.**

vii. **Shri D. Prakash, Regional Director and Shri R.K.Guha, Sc.'B' attended the Workshop and the Technical Paper prepared byShri D. Prakash, Regional Director; Shri S. Datta, Sc.'D' & Shri R.K.Guha, Sc.'B' was presented in Seminar on Rain Water Harvesting and Conservation organized by Association of Engineers India on 21.09.05.**

viii. **Following technical papers have been presented at National Seminar on Proterozoic System of India Evolution and Economic Potential at Indian School of Mines, Dhanbad**

1. Ground water feasibility and aquifer parameters of Chotanagpur gneissic complex around Bundu area in Ranchi, Sub-basin, Ranchi district, Jharkahnd By T.B.N. Singh and S.N.Sinha
2. Application of Electrical Resistivity Technique to Delineate Fracture zone and construction of potential recharge structures in Proterozoic terrain – A case study from CHES campus Palandu. By Subrata Das and R.S. Singh.
3. Ground water exploration in Precambrian terrain in the state of Jharkhand – An overview. By S. Upadhyaya and Bijimol Jose

ix. **Following lectured have been presented at Workshop on Artificial Recharge organized by Water Resources department, Govt. of M.P., Bhopal at State Data Center of Ground Water Survey Department at Bhopal on 11.08.05.**

a. **Artificial Recharge to Ground water In Urban & Rural Areas.**
b. **Use of Geophysical Techniques In Artificial Recharge Studies**
c. **Ground Water Quality In Madhya Pradesh**
d. **Design of Artificial Recharge Structures**
e. **Ground Water Level Behavior in Madhya Pradesh**

ix. **One paper on "Stress on Ground water Systemof Ludhiana due to Urbanisation – A Case Study" was submitted by S/Shri S. Marwaha, Scientist 'D' and Anmol Sharma, AHG for 'All India Seminar on challenging problems in Water Resources Management and Development' held at Nagpur on 12-13 Nov., 2005.**

x. **Shri. B.Umpathi, Sceintist – B delivered a lecture on "Rainwater Harvesting and Artificial Recharge" at the workshop organized by Institution of Engineers, Neyveli Chapter, on 24.09.2005 and participated in the deliberations.**

xi. **Shri N. Varadaraj, H.O.O. and Supdtg. Hydrogeologist made a presentation on "Management of Coastal Aquifers of Tamil Nadu with reference to the disaster management" at the National Conference on "Disaster Mitigation and Management using space technology (DIMMS-2006) organized by Centre For Remote Sensing, Bharathidhasan University, Tiruchirapalli and participated in the deliberations during 27th-28th March 2006.**

xii. **Shri N. Varadaraj, H.O.O. & Supdtg. Hydrogeologist presented a paper entitled "Flood Control Polices and Risk Mitigation" at the International Conference on Spatial Data Infrasturcture and its role in Disaster Management organized by Federation of Indian Chambers of Commerce and Industry, New Delhi, at Chennai on 26.10.2005.**

xiii. **Shri N. Varadaraj, H.O.O. & Supdtg. Hydrogeologist presented a paper entitled "Water policy initiatives & Drinking Water Supply" at the State level workshop on Traditional Rainwater Harvesting Structures in Tamil Nadu organized by Tamil Nadu Water Supply and Drainage Board at Coimbatore 7th-9th December 2005.**

xiv. **Shri V.Arulprakasam SC-B presented paper entitled "Delineation of surface geological formations using electrical resistivity methods in Vanur watershed Villupuram district, Tamil Nadu" at XXIV AHI Nation Seminar on Hydrology with special reference to 'Urban**

Groundwater Pollution" held at Dept. of Geology, Karnatak University, Dharwad during 27th –28th December 2005.

xv. Shri N. Varadaraj, H.O.O. & Supdtg. Hydrogeologist presented a paper entitled "Sustainable Water Resource Development and Management in Tirumanimuttar Watershed Salem and Namakkal districts, Tamil Nadu" at National conference on Geomatics for Infrastructure Development and ISG Annual convention at Chennai during 4-6th January 2006 organized by Institute of Remote Sensing, Anna University and others.

xvi. Shri. Nandakumaran.P, Sceintist – D presented a paper entitled "Constraints in the Development of Groundwater Resources in Hard Rock terrain – A case study" at National conference on Geomatics for Infrastructure Development and ISG Annual convention at Chennai during 4-6th January 2006 organized by Institute of Remote Sensing, Anna University and others.

xvii. Shri. Arul Prakasam, Scientist – B presented a paper entitled Electrical Resistivity methods as a Tool for Demarcation of Groundwater Qaulity Zones in Vanur block, Villupuram district, Tamil Nadu" at National conference on Geomatics for Infrastructure Development and ISG Annual convention at Chennai during 4-6th January 2006 organized by Institute of Remote Sensing, Anna University and others.

xviii. Shri. B. Umapathi, Scientist – B presented a paper entitled "GIS based analysis for scope of revitalization of existing percolation ponds in Virudunagar district" at the national conference on Geomatics for infrastructure development organized by Institute of Remote Sensing on 05.01.2006.

xix. Shri N. Varadaraj, H.O.O. & Supdtg. Hydrogeologist presented a paper entitled "Role of Groundwater in natural disaster management" at Seminar on Role of Groundwater in National Economy organized by All India Central Ground Water Board Officer's Association at Bangalore on 18.01.2006.

xx. Shri. A. Subburaj, Scientist-D presented a paper entitled "Development of Groundwater Resources for Agriculture and its impact on ground water levels in Tamil Nadu, India" at Seminar on Role of Groundwater in National Economy organized by All India Central Ground Water Board Officer's Association at Bangalore on 18.01.2006.

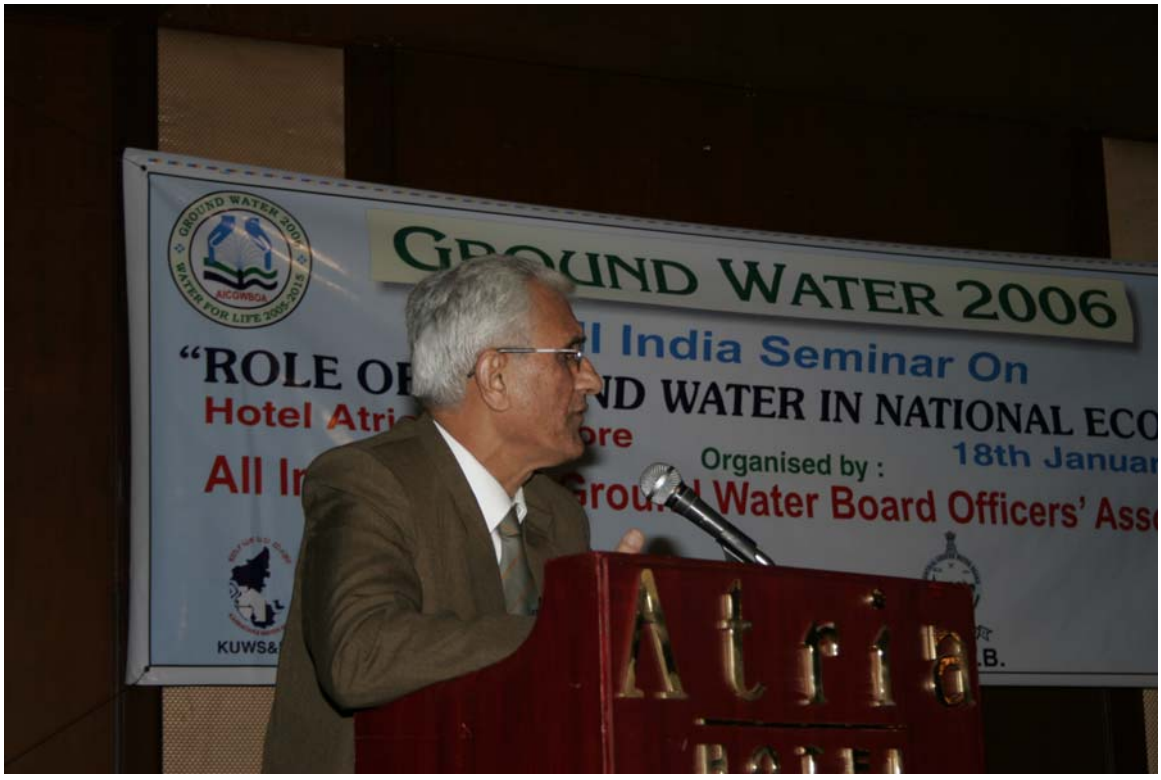
xxi. Dr. Gnanasundar Sc B delivered a scientific paper on "Sea water Intrusion" in the national seminar on "Role of Ground Water in National Economy" conducted by the CGWBGOA at Bangalore on 18th January 2006.

xxii. Shri R.P.Mathur, Suptg. Hydrogeologist presented a paper "Interlinking of rivers in West Aravali Region, Rajasthan" written by Dr. L.N.Mathur, Sc. "B" & Shri R.P.Mathur, Suptg. Hydrogeologist in a seminar on " Internal & External Rivers Linking in Rajasthan" held at MNIT, Jaipur on 15th October 2005.

xxiii. Dr. L.N.Mathur, Sc.'B' attended & contributed scientific paper on " Role of NGOs in water management" in a seminar on " Role of Ground Water in National Economy" organized by CGWBAIOA on 18th January, 2006 at Banglore.

xxiv. Management Strategies for Nitrate Pollution in Groundwater, Jaipur Urban Area, Rajasthan by Dr. L.N.Mathur, Sc.'B' and Shri A.D.Joseph, RD, WR, Jaipur. Abstract sent to BITS, Pilani for National Conference on Environmental Conservation.

Inaguration ceremony of the national Seminar on Ground water 2006 at Bangalore



Chairman, CGWB, addressing the delegates of the national Seminar on Ground water 2006

27. RESEARCH AND DEVELOPMENT SCHEMES

Central Ground Water Board under its R&D activities is assisting Ministry of Water Resources in the form of a sub-committee of Indian National Committee on Hydrology (INCOH), with a view to accelerate the development programme in ground water sector and giving due consideration to increased need of taking up research in the field of ground water. This Committee examines the project proposals received by INCOH in the field of ground water for their suitability for funding by MOWR and also monitors the research schemes funded by INCOH.

During the 2005-06 seven schemes as given in table 27.1 have been scrutinized and sent for comments to experts.

Table 27.1: R&D SCHEME PROPOSALS SCRUTINIZED AND SENT FOR COMMENTS

Sl. No.	Project Title	P.I.	Institution
1.	**Development of Models for clean up of Cr (VI) contaminated Aquifers using Bio-remediation**	**Dr. Ligy Philip**	**Department of Civil Engineering, IIT, Chennai.**
2.	**Spatio-temporal modeling of ground water quality using artificial neural network**	**Dr. K.P. Sudheer**	**Department of Civil Engineering, IIT, Chennai.**
3.	**Detailed study of saline ground water in Amravati, Akola and Buldana districts , Maharashtra with an emphasis on its cause and control.**	**Dr. Ashok Kumar Srivastava**	**Department of Geology, Amravati University , Maharashtra**
4.	**Arsenic Problem in Jharkhand and Bihar and some Remedial measure**	**Prof. V. Subramanian**	**School of Environmental Sciences, JNU, New Delhi**
5.	**Evaluation and Modeling of Rainwater Harvesting Filter Systems**	**Dr. Deepak Khare**	**Dept. of WRD&M, Indian Institute of Technology Roorkee**
6.	**Detection and Quantification of Pollutants in Najafgarh drain and the levels of contamination in ground water**	**Dr. Mrs J. Adhikari**	**Ganesh Scientific Research Foundation, New Delhi**
7.	**Flouride contamination of ground water in Nayagarh district, Orrisa: its assessment and amelioration**	**Dr. J.K.Mohanty**	**Regional Research Laboratory, Bhubaneshwar**

Based on the comments of the experts, 5 revised proposals as given in Table 27.2 have been received which will be considered in the forthcoming meeting of Research Committee on ground water. Five Proposals as given in Table 27.3 have been finally cleared for payment of installments, which will be monitored for their progress.

Table 27.2 : R&D PROPOSALS RECEIVED BASED ON HE COMMENTS

Sl. No.	Project Title	P.I.	Institution
1.	**Bacterial degradation of lignin and pentachlorophenol from pulp paper effluent and its applications for aquaculture and ferti-irrigation**	**Dr. Ram Chandra**	**Asstt. Director, Deptt. of Environmental Microbiology, Indian Toxicology Research Centre M.G. Marg Lucknow-226001**
2.	**Spatio-temporal modeling of ground water quality using artificial neural network**	**Dr. K.P. Sudheer**	**Department of Civil Engineering, IIT, Chennai.**
3.	**Arsenic Problem in Jharkhand and Bihar and some Remedial measure**	**Prof. V. Subramanian**	**School of Environmental Sciences, JNU, New Delhi**
4.	**Evaluation and Modeling of Rainwater Harvesting Filter Systems**	**Dr. Deepak Khare**	**Dept. of WRD&M, Indian Institute of Technology Roorkee**
5.	**Developing a methodology for evaluating the impact of rainwater harvesting in Urban Areas**	**Dr. G. Ravikumar**	**Centre for water Resources, Anna Univ., Chennai**

Table 27.3 : R & D PROPOSALS FINALLY SANCTIONED FOR PAYMENT OF INSTALLMENT

Sl. No.	Project Title	P.I.	Institution
1.	**Rain water Harvesting in Veeranam Catchment**	**Dr. V.Kanaka Sabai**	**Faculty of Engineering & Technolog]y, Annamalai University, Annamalai Nagar.**
2 .	**Control of Water – logging and Salinity through agroforestry Intervention**	**Shri Jeet Ram, IFS**	**Principal Chief Conservator of Forests, Haryana.**
3.	**Identification & Mapping of Palaeo channels in the eastern fringe of Thar Desert for water resources augmentation Plan**	**Dr. M.P.Punia**	**BM Birla Science & Technology Centre, Jaipur.**
4.	**Development of Models for clean up of Cr (VI) contaminated Aquifers using Bio-remediation**	**Dr. Ligy Philip**	**Department of Civil Engineering, IIT, Chennai.**
5.	**Evaluation and Modeling of Rainwater Harvesting Filter Systems**	**Dr. Deepak Khare**	**Dept. of WRD&M, Indian Institute of Technology, Roorkee**

28. PUBLICITY AND PUBLIC AWARENESS

Water is a precious resource vitally important for development as a whole for every day life. With a view to generate consciousness among the masses ' Water Resources Day" is being celebrated everywhere since 1986. Central Ground Water Board has played very active role by organizing functions jointly with Central Water Commission, other State Govt. Organizations and departments. On the occasion of Water Resources Day, emphasis has been laid to educate the rural population on various aspects of water resources in the country by organizing these functions in rural areas and by giving popular talks and bringing out technical pamphlets in regional languages.

Important technical achievements of the Board have been brought to the knowledge of the public through Radio Talks, Television interviews, telecast of a short film on ground water pollution, News Paper reports, release of district reports, Atlases at the Public functions.

Working Model of Hydrological Cycle, Conjunctive use of Surface and Ground Water, Artificial Recharge Studies carried out in JNU, New Delhi and Rotary Drilling Rig are displayed along with photos of drilling activities, panels showing activities and achievements of CGWB, Translite showing various methods of artificial Recharge, Translite on Roof Top Rain Water Harvesting Techniques, various publications released by Central Ground Water Board and various slogans on ground water are displayed to create awareness on various aspects of ground water. Knowledge on water quality and testing is provided to visitors and facility for 'on the spot analysis of water to check its suitability for drinking and domestic use is provided.

The Central Ground Water Board was successful in attracting the masses and creating awareness among the farmers, school/college students, agriculture Scientists, general public and dignitaries. During the exhibition brochures on activities and achievements of CGWB, Attributes of Ground Water, Roof Top rain Water harvesting Techniques, Ground Water and Health etc were distributed. Various publications of CGWB and Water Testing Kits developed by CGWB were in great demand by the visitors. Some of them have expressed this in the visitor book also.

28.1 EXHIBITIONS/ MELAS/ TRADE FAIRS

During the year 2005-2006 various exhibitions and trade fairs have been organized and the participation of the Board in these events are indicated below.

i. Sunderban Krishi Mela**:- CGWB, ER , participated in Sunderban Krishi Mela Lok-Utsav organised by Kultali Milan Tirtha Society, at Kultali Basanti block, south 24 Parganas district, West Bengal, during 20–29th Dec, 2005. During this occasion Models, charts, photographs and posters were displayed in the pavilion.**

ii. International Agriculture Trade Fair Exhibition :-**CGWB, CR, Nagpur participated in Krishi 2005: International Agriculture Trade Fair Exhibition at Nasik, Maharashtrsa. from 30 November to 5th December 2005. The exhibits on rain Water Harvesting as Models and CG flashes were taken to Nashik from Central region. Around 20,000 visitors visited the exhibition stall of CGWB. His Excellency Shri Sharad Pawar, Hon'ble Union Minister of agriculture also made a visit to the fair ad appreciated the exhibition.**

iii. 93rd Indian Science Congress Meet **:- The Central Region, Nagpur and Southern Region Hyderabad had participated in the exhibition organized on the occasion of 93rd Indian Science Congress Meet held at Hyderabad from 3-7th Jan, 2006. The working modelss on Artificial Recharge, exhibits on Rain Water Harvesting, posters showing effect on chemical pollutants and CD flashes etc. were exhibited. The stall of Ministry of Water Resources was selected out of 120 stalls by the organizers and has bagged the award for "Most Innovative Exhibits".**

iv. Celebration of Banga- Bhanga Anti-movement **:- In the Centenary Celebration of Banga- Bhanga Anti-movement, CGWB displayed various exhibits and live models on Rainwater harvesting, arsenic infested areas, sub surface aquifer disposition etc. The Hon'ble Minister of Water Resources Shri Priyaranajan Dasmunshi, visited the pavilion on 14.05.2005 and appreciated the displays/exhibits of the Board.**

v. India International Trade Fair-2005:- **Ministry of Water Resources participated in the 25th India International Trade Fair-2005, Pragati Maidan, New Delhi during 14th to 27th November,2005. The theme of the Pavilion was "Water Conservation". Under the theme CGWB displayed one model on Roof Top Rain Water Harvesting. Additional Secretary, Minister of Water Resources visited the pavilion and appreciated the efforts of the Scientists and Engineers towards awareness, conservation and management of water.**

vi. Celebration of Hindi Pakhwara:-**Hindi Pakhwara was celebrated at HQ &all the regional offices of CGWB during 14-28 Sept 2005. Various competitions of Hindi essay, writing ,typing, Hindi Quiz, Hindi Poem etc were held and prizes were given to the winners in each category including non-Hindi candidates.**

vii. Vigilance Awareness Week**The Central Ground Water Board, HQ, Faridabad and all the regional/ divisional offices of CGWB observed Vigilance awareness week w.e.f 7-11-2005 to 11-11-2005 and all the officers and staff has taken pledge on 7-11-2005 for eradicating corruptions in all walks of life. Posters were also displayed at prominent places for eradication of corruption.**

viii. Quomi Ekta Week **:-The Central Ground Water Board, HQ, Faridabad and all the regional / divisional offices of CGWB observed** QUOMI EKTA WEEK(National Integration Week) **w.e.f 19-11-2005 to 25-11-2005 and all the officers and staff has taken pledge to work with dedication to preserve and strengthen the freedom and integrity of the nation. Quomi Ekta Week was observed with various themes like National Integaration day, Welfare of Minorities day, Linguistic Harmony day, Weaker Section day, Cultural Unity day, Womens day, Conservation day.**

28.2 AWARENESS THROUGH PRINT & ELECTRONIC MEDIA

i. DD News producer has taken an interview of Chairman on Water Crisis on 24-06-2005.

ii. Sh.B.M.Jha, R.D., NCR, Bhopal gave a T.V. Programme on Water Conservation which was telecast on 1st June 2005, by Bhopal Doordarshan under "GRAM MANGAL".

iii. Prasar Bharati , Akashwani, Jaipur recorded talk with Dr L.N.Mathur, Scientist-B, CGWB, WR, Jaipur on 14-07-2005 on Water Conservation and Peoples participation. The same was broadcasted on 15-07-2005 in Krishi Darshan Programme of Akashwani in the state of Rajasthan.

iv. Chairman attended the Interview on 12.8.2005 by All India Radio on the talk of RWH & Artificial Recharge of Groundwater reference from MOS (WR).

v. Miss A. Bhatia, Sc. 'B' gave a talk in TV programme "Gram Mangal" on Rain Water Harvesting & Water Level Behaviour in M.P. on 6.8.2005.

29. PROPOGATION AND PROGRESSIVE USE OF HINDI

1. राजभाषा अधिनियम, 1963 की धारा 3(3) का शत-प्रतिशत अनुपालन किया जाता है ।

2. हिन्दी में प्राप्त पत्रों के उत्तर अनिवार्य रूप से हिन्दी में दिए जाते हैं ।

3. हिन्दी संबंधी तिमाही प्रगति रिपोर्ट नियमित रूप से जल संसाधन मंत्रालय, नगर राजभाषा कार्यान्वयन समिति, फरीदाबाद एवं राजभाषा विभाग (क्षेत्रीय कार्यान्वयन कार्यालय) को भेजी जाती है ।

4. विभागीय राजभाषा कार्यान्वयन समिति की तिमाही बैठक नियमित रूप से आयोजित की जाती है तथा बैठक में लिए गए निर्णयों के अनुसार यथावश्यक कार्रवाई की जाती है ।

5. प्रत्येक तिमाही में नियमित रूप से हिन्दी कार्यशाला आयोजित की गई और अधिकारियों/कर्मचारियों को हिन्दी टिप्पण आलेखन, परिभाषिक शब्दावली, वैज्ञानिक-तकनीकी शब्दावली की जानकारी दी गई । वर्ष के दौरान आयोजित की गई हिन्दी कार्यशाला में कुल 45 अधिकारियों/कर्मचारियों ने भाग लिया ।

6. दिनांक 14.9.05 से 28.9.05 तक हिन्दी पखवाड़ा का आयोजन किया गया । इस पखवाड़े के दौरान हिन्दी के प्रति रूचि जागृत करने के लिए अनेक प्रतियोगितायें आयोजित की गईं । इसमें अधिकारियों एवं कर्मचारियों ने उत्साहपूर्वक भाग लिया ।

7. मूल रूप से हिन्दी कामकाज के लिए प्रोत्साहन योजना के अन्तर्गत मुख्यालय के सात कर्मचारियों को पुरस्कार दिए गए ।

8. राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रम में निर्धारित लक्ष्यों की प्राप्ति हेतु समय-समय पर अनुदेश जारी किए जाते हैं । हिन्दी पत्राचार में वृद्धि के लिए विभिन्न प्रपत्रों के हिन्दी अनुवाद सभी अनुभागों को उपलब्ध कराए गए ।

9. मुख्यालय में वर्ष के दौरान कुल 4,15,497/- रूपये की पुस्तकें खरीदी गई । इसमें से हिन्दी पुस्तकों पर 1,34,604/- रूपये व्यय किए गए ।

10. बोर्ड मुख्यालय के सभी अनुभागों को शत-प्रतिशत हिंदी में कार्यालयीन कामकाज के लिए विनिर्दिष्ट किया गया है ।

11. बोर्ड के 'क' एवं 'ख' क्षेत्र में स्थित अधीनस्थ कार्यालयों को राजभाषा नियम 10(4) के अंतर्गत अधिसूचित करने के संबंध में कार्रवाई की जा रही है ।

12. बोर्ड हिंदी की प्रगति एवं कार्यान्वयन के लिए प्रतिबद्ध एवं राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रमों के अनुरूप हिंदी के प्रयोग एवं उत्तरोत्तर प्रगति के लिए संकल्पित है ।

30. PERSONNEL MANAGEMENT

The sanctioned strength, filled up, vacancy position, category-wise personnel deployed and highlights of the achievements of the administrative wing in the Board is presented in table 30.1, 30.2 and 30.3 respectively.

Table 30.1: PERSONNEL DEPLOYMENT IN CENTRAL GROUND WATER BOARD

of Group	Particular	Scientific/ Technical	Ministerial	Engineering	Total Strength
Group A	Sanctioned	364	6	54	424
	Filled	322	3	48	373
	Vacant	42	3	06	51
Group B (Gazetted)	Sanctioned	225	37	110	372
	Filled	197	28	91	316
	Vacant	28	9	19	56
Group B (N-Gazetted)	Sanctioned	120	58	29	207
	Filled	99	56	27	182
	Vacant	21	2	02	25
Group C	Sanctioned	91	1085	865	2041
	Filled	80	992	793	1865
	Vacant	11	93	72	176
Group D	Sanctioned	79	375	893	1347
	Filled	76	344	869	1289
	Vacant	03	31	24	58
Grand Total	Sanctioned	879	1561	1951	4391
	Filled	774	1423	1828	4025
	Vacant	105	138	123	366

Table 30.2 : CATEGORY - WISE STAFF POSITION

Groups	Category	Scientific	Ministerial	Engineering
Group A	OBC	19	-	4
	SC	28	-	7
	ST	09	-	5
	Handicapped	-	-	-
Group B (Gazitted)	OBC	15	-	6
	SC	28	4	19
	ST	08	2	4
	Handicapped	01	-	-
Group B (Non-Gazitted)	OBC	11	-	1
	SC	09	7	4
	ST	02	4	1
	Handicapped	01	1	-
Group C	OBC	02	92	9
	SC	19	178	57
	ST	05	72	13
	Handicapped	-	08	-
Group D	OBC	02	16	58
	SC	21	97	174
	ST	07	22	44
	Handicapped	02	4	-

Table 30.3 :HIGHLIGHTS OF THE ACHIEVEMENTS OF THE ADMINISTRATIVE WING DURING 2005-2006

Sl. No	ITEMS	Scintific	Ministrial	ngineering
1.	DPCs held	15	19	10
2.	Promotions, Appointments & ACPs	54 05 -	204 12 14	47
3.	EB cases cleared	-	-	-
4.	Confirmation ordered/Probation	0 Confirmation & 73 Probation	11	6
5.	Deputation	3	-	-

31. VIGILANCE

31.1 Vigilance Activities

During the year 2005-2006, 13 complaint cases were brought forward from the last year and 17 complaints have been received during 1.04.2005 to 31.03.2006. Thus total 30 complaint cases were on the record. Out of these 4 cases of complaint were closed and 6 complaint cases have been taken up as disciplinary proceedings. Therefore, 20 complaint cases have been carried forward w.e.f. 1.04.2006 to next year.

31.2 Disciplinary Proceedings

15 cases of disciplinary proceedings were brought forward from last year and 6 cases of disciplinary proceedings have been received during the year. Thus a total 21 cases of disciplinary proceedings were on the record. Out of these 6 cases of disciplinary proceedings have been finalized and 15 cases have been carried forward to next year.

32. PERSONS WITH DISABILITIES FOR THE YEAR 2005-2006

Persons with Disabilities for the year 2005-2006 are given in Table 32.1

Table 32.1 : PERSONS WITH DISABILITIES FOR THE YEAR 2005-2006

1	Schemes/Policies run by the respective Ministry/Department for the benefit of Persons with Disabilities.					Nil
2	Budget allocated and expenditure incurred under each scheme during the financial year.					Nil
3	No. of persons benefited					Nil
4	Per capita expenditure					Nil
5	Sanctioned strength, the number of vacancies filled since 1996 and the number of persons with disabilities appointed in various posts in Group – A, B, C & D against the 3% vacancies to be reserved for them under Section-33 of the PWD Act.	**Group**	**Sanction Strength**	**Number of vacancies filled since 1996**	**Number of persons with disabilities appointed against 3% reservation**	**Remarks**
		A	424	82	-	-
		B	577	95	-	-
		C	2041	145	2	Requisition for filling up 2 posts amongst physical handicapped (One for OH and One for HH) has been sent to the SSC.
		D	1347	208	3	-

33. BUDGET AND ACCOUNTING

Statement showing actual expenditure incurred by the Board during 2005-2006 has been shown in Table 33.1, Table 33.2, Table 33.3, Table 33.4, Table 33.5 and Table 33.6

Table 33.1 : STATEMENT SHOWING ACTUAL EXPENDITURE INCURRED BY THE BOARD DURING 2005-2006

Sub-Head	Plan (Rs. In Lakhs) Final Grant up to March 2006		Non-Plan (Rs. In Lakhs) Final Grant up to March 2006	
	Funds	Expenditure	Funds	Expenditure
Salary	**1187.00**	**1180.19**	**4975.00**	**4988.16**
Wages	**11.00**	**11.82**	**1.00**	**0.85**
O.T.A	**1.95**	**1.94**	**16.03**	**16.10**
T. E	**350.00**	**342.00**	**305.33**	**304.47**
F.T.E	**3.00**	**2.37**	**1.00**	**0.59**
O.E	**525.00**	**521.05**	**6.64**	**6.66**
P.S	**9.00**	**4.72**	**0.50**	**0**
R.R.T	**167.00**	**158.62**	**5.00**	**4.82**
Publications	**70.00**	**61.33**	**1.00**	**0**
Subsidies	**0.25**	**0.18**	**0**	**0**
Susp. Stock	**800.00**	**804.81**	**0**	**0**
W. O.L	**22.00**	**21.94**	**0**	**0**
M.V.	**421.00**	**416.28**	**0**	**0**
M & E	**1175.00**	**975.64**	**0**	**0**
Works	**2000.0**	**2005.75**	**0**	**0**
Medical	**50.05**	**46.09**	**134.00**	**127.76**
Other Charges	**14.00**	**10.30**	**0**	**0**
Total	6806.25	6565.03	5445.50	5449.41

Table 33.2: Rajiv Gandhi National Training & Research Institute for Ground Water

Sub-Head	**Fund Allotment**	**Expenditures**
Salaries	15.07	15.07
Wages	0.10	0.04
O.T.A	0	0
D.T.E	26.00	17.34
O.E	4.00	3.82
R.R.T	0	0
Publication	0	0
P.S	15.50	15.47
M.V	3.50	3.50
M & E	3.00	2.31
Medical treeatment	1.00	0.80
Total (RGNTR&I)	**68.17**	**58.35**

Table 33.3: Central Ground Water Authority

Sub-Head	**Fund Allotment**	**Expenditures**
Salaries	50.00	49.92
Wages	0	0
O.T.A	0.10	0.10
D.T.E	2.75	2.66
O.E	14.00	14.03
R.R.T	0	0
Publication	5.0	4.82
P.S	0.50	0.25
M.V	4.80	4.38
M & E	2.50	1.57
Medical Treatment	1.00	0.62
Other Charges	2.00	1.98
Advs. & Publicity	67.35	58.04
Total CGWA	**150.00**	**138.37**

Table 33.4 :Research and Development in Water Resources Sector

Grant-in-aid	**75.00**	**Scheme controlled by Commissioner(GW) MOWR**
Total (R&D)	**42.00**	**-**

Table 33.5 : Central Ground Water Board building for offices

Sub-Head	Fund Allotment	Expenditures
Major Works	500.00	437.23
Total	**500.00**	**437.23**
Total CGWB	7566.42	7198.98

Table 33.6 : DEDUCT RECOVERIES

lead	Fund Allotment	Expenditures
al Ground Water Board		
to works and other credits	**1100.00**	**1230.04**
ct Recoveries 01.02.70		
Suspense Stock	**100.00**	**0.00**
ct Recoveries 01.03.70		
Recoveries	1200.00	1230.04
NET CGWB	**6366.42**	**5968.94**

Annexure -1

LOCATION AND JURISDICTION OF REGIONAL AND OTHER OFFICES OF CENTRAL GROUND WATER BOARD

REGIONS	HEADQUARTERS	JURISDICTION
NORTH WESTERN HIMALAYAN REGION		
Regional Office	Jammu	J&K
Division Office	Div. VIII, Jammu	J&K
NORTH HIMALAYAN REGION		
Regional Office	Dharamshala	Himachal Pradesh
Division Office	Div. XVII, Dharamshala	Himachal Pradesh
NORTH WESTERN REGION		
Regional Office	Chandigarh	Punjab, Haryana, NCT of Delhi & UT of Chandigarh
State Unit Office	Delhi	NCT of Delhi
Division Office	Div. II, Ambala	Punjab, Haryana, NCT of Delhi & UT of Chandigarh
WESTERN REGION		
Regional Office	Jaipur	Rajasthan
State Unit Office	Jodhpur	Western Rajasthan
Division Office	Div. XI, Jodhpur	Rajasthan
WEST CENTRAL REGION		
Regional Office	Ahmedabad	Gujarat, UT of Daman & Diu
Division Office	Div.I, Ahmedabad	Gujarat, UT of Daman & Diu
NORTH CENTRAL REGION		
Regional Office	Bhopal	Madhya Pradesh
Division Office	Div.XII, Bhopal	Madhya Pradesh
NORTH CENTRAL CHATTISGARH		
Regional Office	Raipur	Chattisgarh
Division Office	Div.XIII, Raipur	Chattisgarh
CENTRAL REGION		
Regional Office	Nagpur	Maharashtra, UT of D & N. Haveli
State Unit Office	Pune	West Maharashtra
Division Office	Div. VI, Nagpur	Maharashtra, UT of D & N. Haveli
NOTHERN REGION		
Regional Office	Lucknow	Uttar Pradesh
State Unit Office	Allahabad	Uttar Pradesh
Division Office	Div.III, Varanasi	Uttar Pradesh
UTTARANCHAL REGION		
Regional Office	Dehradun	Uttaranchal
State Unit Office	Bareilly	Uttaranchal
Division Office	Div.XVI, Bareilly	Uttaranchal
MID EASTERN REGION		
Regional Office	Patna	Bihar, Jharkhand
Division Office	Div. V, Ranchi	Bihar, Jharkhand
EASTERN REGION		
Regional Office	Kolkata	West Bengal, Sikkim, UT of A & Nicobar Islands
Division Office	Div. XV, Kolkata	-do-
NORTH EASTERN REGION		
Regional Office	Guwahati	Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura
State Unit Office	Itanagar	Arunachal Pradesh
	Shillong	Meghalaya
	Agartalla	Mizoram, Tripura
Division Office	Div.VII, Guwahati	Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura
SOUTH EASTERN REGION		
Regional Office	Bhubaneshwar	Orissa
Division Office	Div. x, Bhubaneshwar	Orissa
SOUTHERN REGION		
Regional Office	Hyderabad	Andhra Pradesh
State Unit Office	Vishakhapatanam	Coastal Andhra Pradesh
Division Office	Div. ix, Hyderabad	Andhra Pradesh
SOUTH WESTERN REGION		
Regional Office	Bangalore	Karnataka & Goa
State Unit Office	Belgaum	W. Karnataka & Goa
Division Office	Div. xiv, Bangalore	Karnataka & Goa
SOUTH EASTERN COASTAL REGION		
Regional Office	Chennai	Tamil Nadu, UT of Pondicherry
Division Office	Div. iv, Chennai	Tamil Nadu, UT of Pondicherry
KERALA REGION		
Regional Office	Trivendrum	Kerala & UT of Lakshadweep
Division Office	Div. iv, Chennai	Kerala & UT of Lakshadweep