Draft Report

केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN

Parts of Ranchi, Khunti and Lohardagga Districts, Jharkhand

राज्य एकक कार्यालय रांची

State Unit Office, Ranchi

CENTRAL GROUND WATER BOARD
Ministry of Water Resources, River Development & Ganga Rejuvenation
Government of India

REPORT ON
NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN FOR JHARKHAND STATE

PHASE - I

CENTRAL GROUND WATER BOARD
SUO, RANCHI
July, 2016

Central Ground Water Board
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REPORT ON
NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN FOR JHARKHAND STATE

PHASE - I

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SUO
RANCHI
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REPORT ON
NATIONAL AQUIFER MANAGEMENT PLAN IN JHARKHAND STATE
(PHASE –I)

1.0 INTRODUCTION

1.1 OBJECTIVES, SCOPE OF THE STUDY, APPROACH & METHODOLOGY

Aquifer Mapping studies were taken up in phase manner during XII plan. During first phase of Aquifer mapping studies was taken in parts of Ranchi, Lohardagga and Khunti districts covering area about 5735 sq. km. of 20 blocks (OE-1, Semi-critical-3, Safe-16) shown in (*figure.1)*. Due to rapid urbanization, domestic/ industrial draft and irrigation draft in rural areas has increase tremendously. Therefore it is urgent need for recharge deeper /shallow aquifers in those areas where ground water is under stress conditions.

Objective of the Study:-

1. To identify regional ground water scenario in the study area
2. To identify areas with quality problem.
3. To identify areas with depleting water level
4. To evolve management plan

Approach and Methodology:-

1. Demarcation of shallow water table and deeper water table areas
2. Demarcate areas with quality problem.
3. Recommend suitable methodologies for ground water recharge.
4. Finalisation of management Plan

Agriculture is the main stay of the people of Jharkhand State. Water is essential for irrigation purposes, but its indiscriminate use can lead not only to shortages, but also to the deterioration of crop yield and soils. Ground water resource of a region is one of the building blocks of balanced economic development of the area, especially in an agriculture based society. Dependence on ground water for irrigation and increasing water requirements in urban areas of phase I has necessitated judicious and planned uses of ground water resources in order to reach sustainability.

The study area has good ground water resource and at present the stage of ground water development is 49% of the available resources. There is ample scope for development of irrigation facilities using ground water provided there is planned development including measures for recharge of ground water. So besides development of surface irrigation potential, efforts are required to develop the ground water resources, though this is a replenishable resource. Over development of ground water, recurrent drought, varied monsoon etc are leading to situation in which several areas of the state experience scarcity of ground water recharging drying dug well and tube wells are drying up in peak summer seasons.

Location, Extent and Accessibility-

Study area covers parts of Survey of India, toposheet no. 73E2, 73E3, 73E6, 73E7, 73E10 and 73E11 is bounded by $23^0$19'39"-$23^0$35'20"N latitude and $85^0$07'42"-$85^0$35'41"E longitude. Total geographical area under study was **5735** sq. km. covering parts of Ranchi, Lohardegga and Khunti Districts. The study area is land locked and it is surrounded by state of West Bengal in the east, Hazaribagh and Ramgarh districts in the north, Lathehar and Gumla district in the west and West Singhbhum in the south. The area is well connected by Air, railway and road network. The district and block headquarter are well connected by state highways. The national highways no 33 and 75 pass through the Ranchi and Khunti district and airport is situated at Ranchi district. Location map is shown in *(figure.2)*

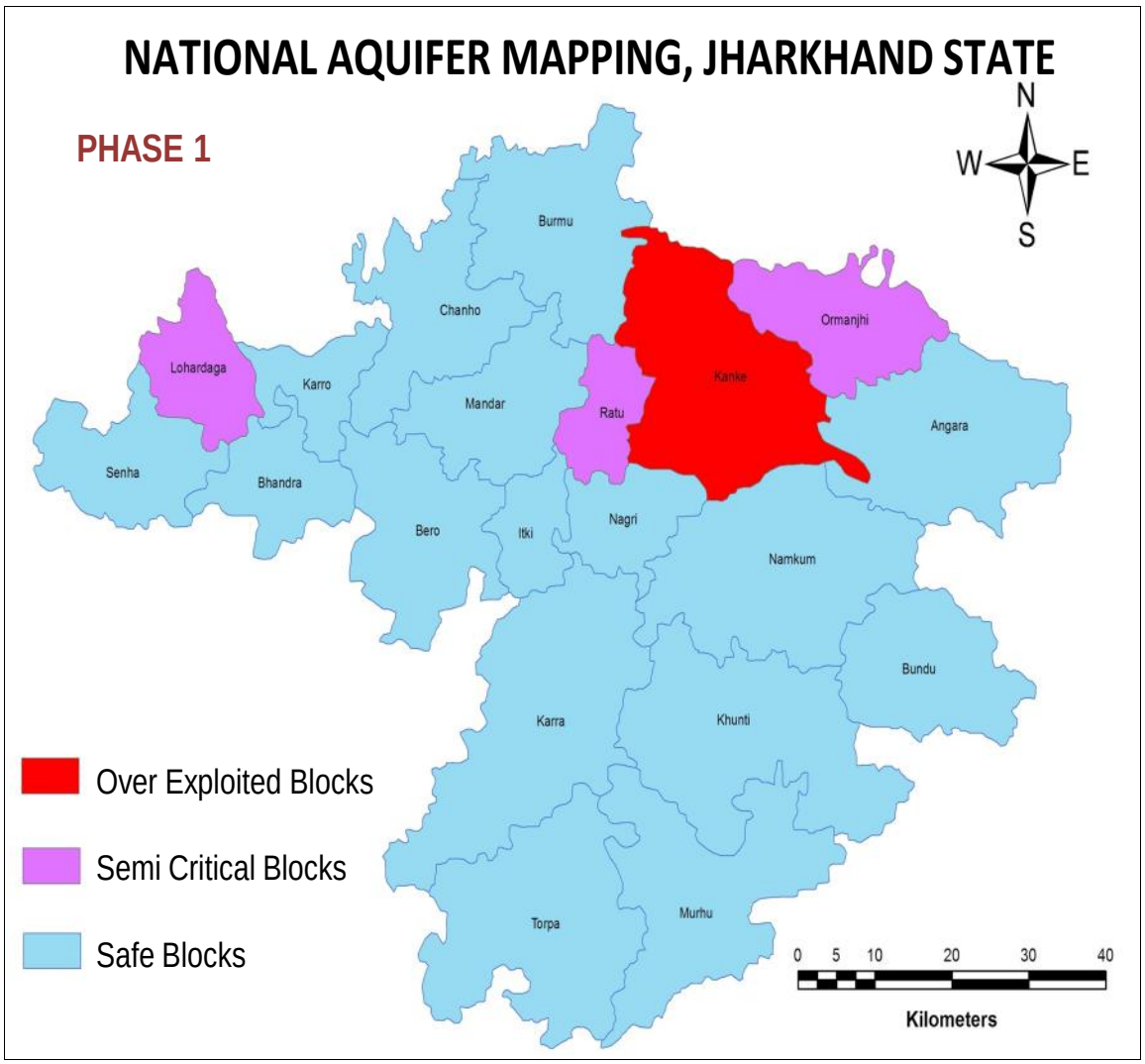

Fig-1

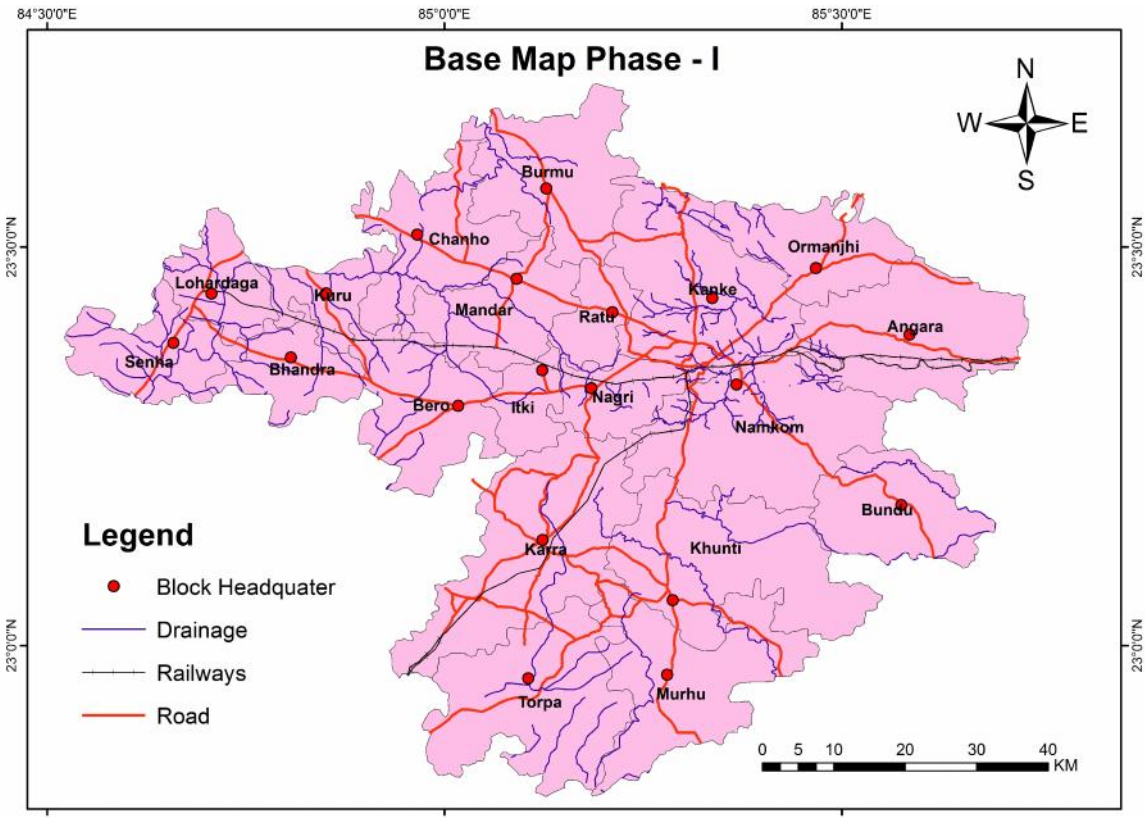

Fig.2

1.2 AREA DETAILS & DEMOGRAPHY

As per present set up there are 3 districts,20 blocks,341 Gram panchayats and the total number of villages are 1615 (as per census 2011). The district/ block wise details of administrative set up is shown in (*Table 1.)*

Table – 1 Administrative set up of Phase I area

S.No.	District Name	Geographical area (Sq. Km)	Gram Panchayats	Village	Habitants	No. of Tehsil	Name of Tehsil	No. of Blocks
South Chhotanagpur Division								
1.	Ranchi	3149	212	880	871	12	Angara, Burmu, Kanke, Itki, Mandar, Chanho, Ratu, Namkum, Ormanjhi, Bero, Nagri,Bundu	12
2.	Khunti	741	63	573	572	4	Murhu, Torpa, Karra, Khunti	4
3.	Lohardagga	1548	66	162	161	4	Bhandra, Lohardagga, Senha, Karro	4

The census report 2011 states that total population of phase I area has 1848034 whereas rural population is 1745682 and urban population is 102352. The report clearly indicates that almost 90% of the population of the total area resides in the rural areas and their main occupation is agriculture. Based on the census -2011 District/Block wise population details are given in (*Table 2)*

Table-2 Demography

Sl. No.	Distric	Block	Geographical Area (sq. kms.)	Rural Population	Urban Population	Total Population
1	Ranchi	Burmu	451.11	89889	-	89889
2		Kanke	524.09	216930	27142	244072
3		Ormanjhi	228.12	88927	5210	94137
4		Angarha	401.58	112759	-	112759
5		Namkom	415.58	118002	27839	145841
6		Ratu	97.74	54186	22379	76565
7		Nagari	126.52	65252	11190	76442
8		Mandar	238.22	128585	-	128585
9		Chanho	272.85	107503	-	107503
10		Bero	300.74	113090	-	113090
11		Itki	92.90	50058	-	50058
1	Lohardaga	Kairo	264.19	37867	-	37867
2		Lohardagga	102.28	68598	-	68598
3		Senha	161.68	69768	-	69768
4		Bhandra	212.46	57303	-	57303
1	Khunti	Karra	160.56	109082	-	109082
2		Torpa	521	84399	8592	92991
3		Murhu	456	85486	-	85486
4		Khunti	410	87998	-	87998
Total		**20**	**5438**	**1745682**	**102352**	**1848034**

1.3 DATA AVAILABILITY, DATA GAP ANALYSIS & DATA GENERATION

Data availability, data gap analysis and data generation and Targets as per EFC norms and actual achievements are given below in *Table 3*. There is no aquifer-wise data available from State or any other agencies.

Table-3 Data availability, data gap analysis and data generation

No of Blocks	20		
	Existing	As per EFC norms Required	Actual achievements
Area in sq.km	5735		
Preparation of Sub-surface Geology (area in sq.km)	5735		Existing data inadequate
Geo-morphological analysis (area in sq.km)	5735		Layer received
Land use pattern (area in sq.km)	5735		Layer yet to receive
Vertical electrical Sounding (VES) (Nos)	95	205	110
Bore Hole Logging (Nos)		Need based	Need based
2-D Imaging (Line Km)			
Ground TEM (Nos)			
Heliborne TEM & Gravity (Line km)			
Preparation of Drainage Map (area in Sq.km)	5735		Layer received
Demarcation of water bodies (area in sq.km)	5735		Layer yet to receive
Soil infiltration studies (Nos)			0
Rainfall data analysis for estimation of recharge to ground water (area in sq.km)	5735		Monthly data yet to receive
Canal flow, impact of recharge structures analysis, surface water-ground water interaction studies etc (area in sq.km)	5735		
Water level monitoring (No of stations* frequency) (No of monitoring stations)	92*4*3		1104
Exploratory Wells	32	82	23
Observation Wells	10		
Slug test (Nos)			1
Specific Yield test (Nos)			
Micro-level hydro-geological data Acquisition including Quality Monitoring			
Water Quality (sampling and Analysis) for Basic Constituent, Heavy Metals etc	210	410	200
Analysis of Ground water for Pesticides, Bacteriological contamination in Ground water (Nos)	13	10	0
Carbon dating (Nos)	1	1	0
Isotopic studies (Nos)	0		0
Core drilling (Nos)	0	Need based	

1.4 RAINFALL

The area is enjoys a healthy climate throughout the year with three distinct seasons. During the month of October to December, the average maximum temperature ranges from 27.7^0 C to 23.3^0 C while the average minimum temperature ranges from 16.96^0 C to 8.9^0 C. For the month of October to December, the average climatologically data such temperature, relative humidity, wind velocity, evaporation and rain fall data is given in *(Table -4 ,5 &6).* The average annual rainfall has been recorded to be 1377mm (2009 – 2013) where as the average rainfall ranges from 6.02 to 35 mm during October to December.

Table -4 Last five years rain fall data of Lohardegga district Rainfall in millimeters (source IMD)

YEAR	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct.	Nov.	Dec.
2009	-	-	-	-	-		111.9	167.4	295.6	86.6	-	-
2010	-	-	-	-	-	104.7	147.5	228.5	116.6	52.4	-	54.4
2011	-	-	-	-	-	484.5	255.5	450.6	368.5	15.0	-	-
2012	-	-	-	-	-	160.0	256.5	195.5	117.9	12.6	-	7.6
2013	-	-	-	-	-	203.3	276.5	346.4	148.1	254.0	-	

Table-5 Last five years monthly rain fall data of Ranchi District

YEAR	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct.	Nov.	Dec.
2009	10	-	35.6	3.4	150.3	128.5	277.2	324.2	320.4	63.6	24.9	5
2010	-	-	-	8.5	28.7	55.9	152.2	152.0	221.7	69.8	8.7	37.1
2011	6	0.5	1.8	7.6	46.9	485.7	166.9	507.8	329.6	31.5	-	-
2012	71	26	5.3	15.0	13.7	91.4	253.2	359.9	277.9	49.5	71.4	7.5
2013	0.1	27	5.7	19.0	32.7	22.6	184.9	189.2	114.2	300.1	-	-

Table -6 Last five years monthly rain fall data of Khunti District

YEAR	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct.	Nov.	Dec.
2009												
2010	-	-	-	-	-	22.9	198.5	254.7	132.5	106.5	-	-
2011	-	-	-	-	-	340.0	240.9	326.7	-	-	-	-
2012	-	-	-	-	-	276.5	120.1	305.1	168.9	4.6	23.5	6.8
2013	-	-	-	-	-	205.7	229.3	340.8	208.5	291.5	-	-

1.5 GEOMORHOLOGY

The area consists of mainly three types of geomorphologic units - Plateau weathered moderate, plateau-weathered shallow and Plateau dissected. Isenberg, residual hillocks are found within the area and Ranchi hill, Tagore hill and Bariatu hill are the three major hillocks. The topography of the area is relict type, controlled by the hard and resistant rocks, which forms a part of the Chhotanagpur plateau. The middle portion of the region have a very prominent physiographical features marked by magnificent hills and hillocks. Some hills are covered by luxuriant plantation. Major drainage originated from north central part of the study area and it form the Swarnrekha river. Geomorphological map are shown in *(figure. 3).*

1.6 LAND USE

The total geographical area of phase I is 5735 sqkm. In the year 2004-2005, the total forest was 2035 sqkm of the total area. Out of the total area, net sown area is 233.87 sq.km and gross cropped area is 241.76 sq.km. Details of land use pattern given below in *(Table 7)*

Table 7 – Details of Land use

Land use classification	Area (sqkm)	% of total geographical area
Total geographical area	5735	100
Forest	2035	35.48
Not available for cultivation	1777.38	31
Fallow land	1440.99	25.10
Net sown area	233.87	.04
Gross cropped area	241.76	.04

(source: Agriculture census data base 2011)

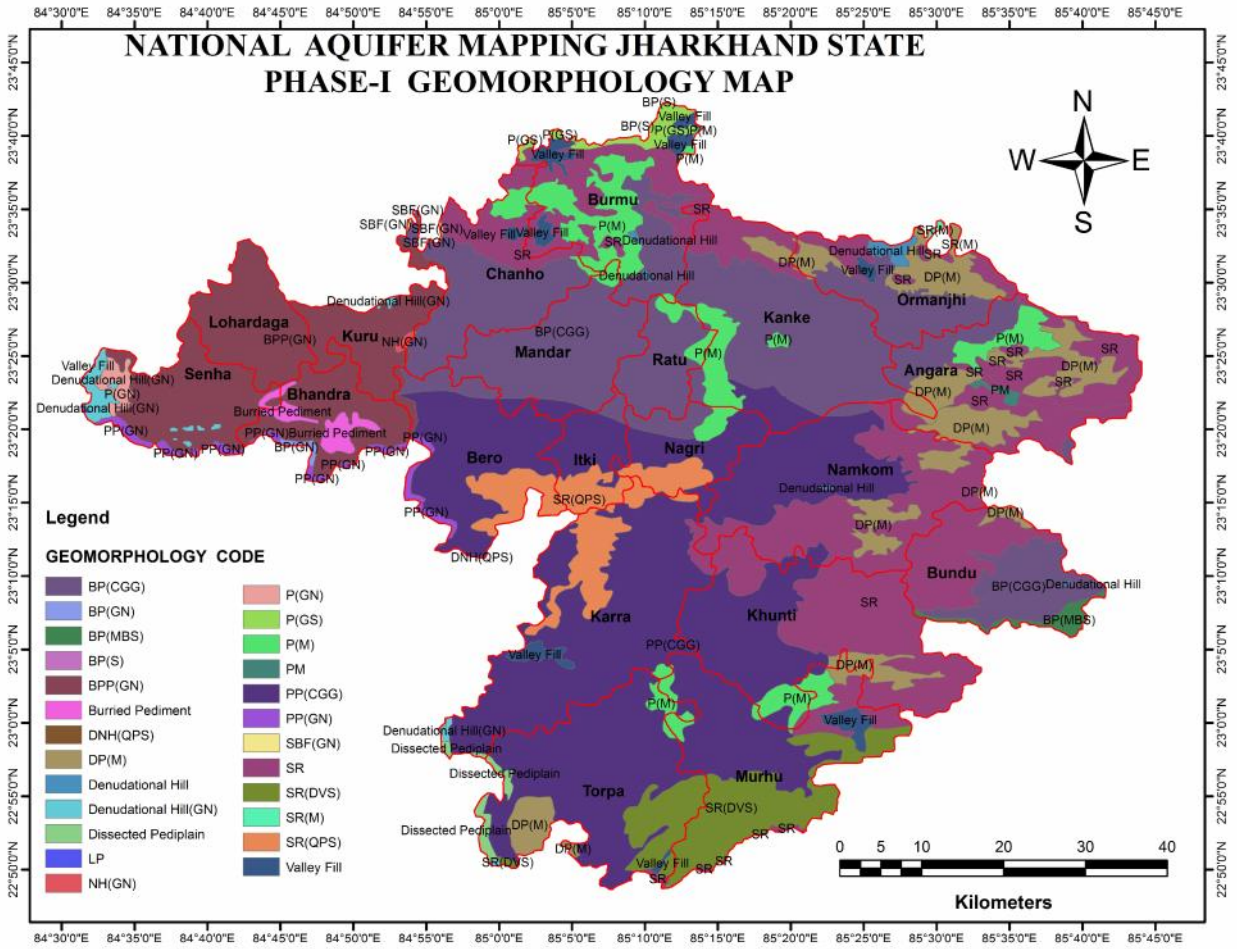

Fig-3

1.7 SOIL

The soils of the district are mostly of the residual type. High temperature and high rainfall have led to the formation of lateritic type of soils from rocks of Archean metamorphic complex. Texturally the soils have been classified into four classes-

1. Stony and gravelly soils: -These are low grade soils having a large admixture of cobbles, pebbles and gravels generally found at the base of the hills.

2. Red and yellow soils: - This soil is formed by the decomposition of crystalline metamorphic rocks like granite- gneiss etc. These rocks contain mineral particles like biotite, hornblende and iron. Higher areas have soils with light red color but the lower areas have relatively dark color. It lacks nitrogen, Phosphorus acid and humus. Potash and lime are sufficiently found.

3. Lateritic soils: - This type of soil is found in Ratu, Bero and parts of Mandar Blocks. The soil has dark red or brown colour, It has high iron content and has been formed by the process of lateralization of the weathered material in the favorable climate and topography.

4. Alluvial soils: - River channels in the district are covered with alluvial soils consisting mainly of coarse sand and gravel mixed with silt and clay. Soil thickness depends upon the topographical control.

1.8 HYDROOLOGY

The basic objective of the hydrological studies is to evaluate the interrelationship between precipitations, surface water and ground water in order to understand the process of recharge of ground water and thereby determination of ground water potential of the area. The hydrological condition of the area is governed by two major river basin/sub-basins of Phase I area

S. no.	Name of River Basin/Sub Basin
1.	Subernarekha River Basin
2.	South Koel River Basin

Subernarekha River Basin:

Subarnarekha River is also referred as the Swarnarekha River. After it originates from the Nagri/Piska and near Ranchi, it traverses long distances via Ranchi as well as eastern Singhbhum. Further, it flows for a few short distances via Paschim Medinipur, West Bengal for 80 kms via Odisha Balasore district. From there, it flows for the next 75 kms and joins the Bay of Bengal near Talsari. The Subarnarekha Basin is extremely small amongst multi-state basins. It covers a drainage area of 1.92 million hectares. The Prime Tributaries of this river includes- Roro, Kharkai, Karakari, Singaduba, Damra, Dulunga, Kanchi, Gurma, Chinguru, Karru, Kodia, Khaijori and Garra.

South Koel river basin- The South Koel originates from Piska near Ranchi

1.9 DRAINAGE

The study area is highly dissected by rivers of varying magnitude. The major water divides in the area runs north to south direction through the Ratu and Lodhma. The area in the eastern part of the water divide is drained by Subarnrekha and the western part of the divide is drained by South Koel and Karo. The important

river basins are the Subarnrekha, the South Koel, the Damodar and the Karkari. The Kanchi and Raru are the tributaries of river Subarnrekha. The South Koel originates from Piska near Ranchi. The Karkari river drains the southeastern part of the district. In the southern part of the area the drainage is mainly controlled by the Major rivers Tajna, Banai, Chata and Karo. (*Figure-4)*

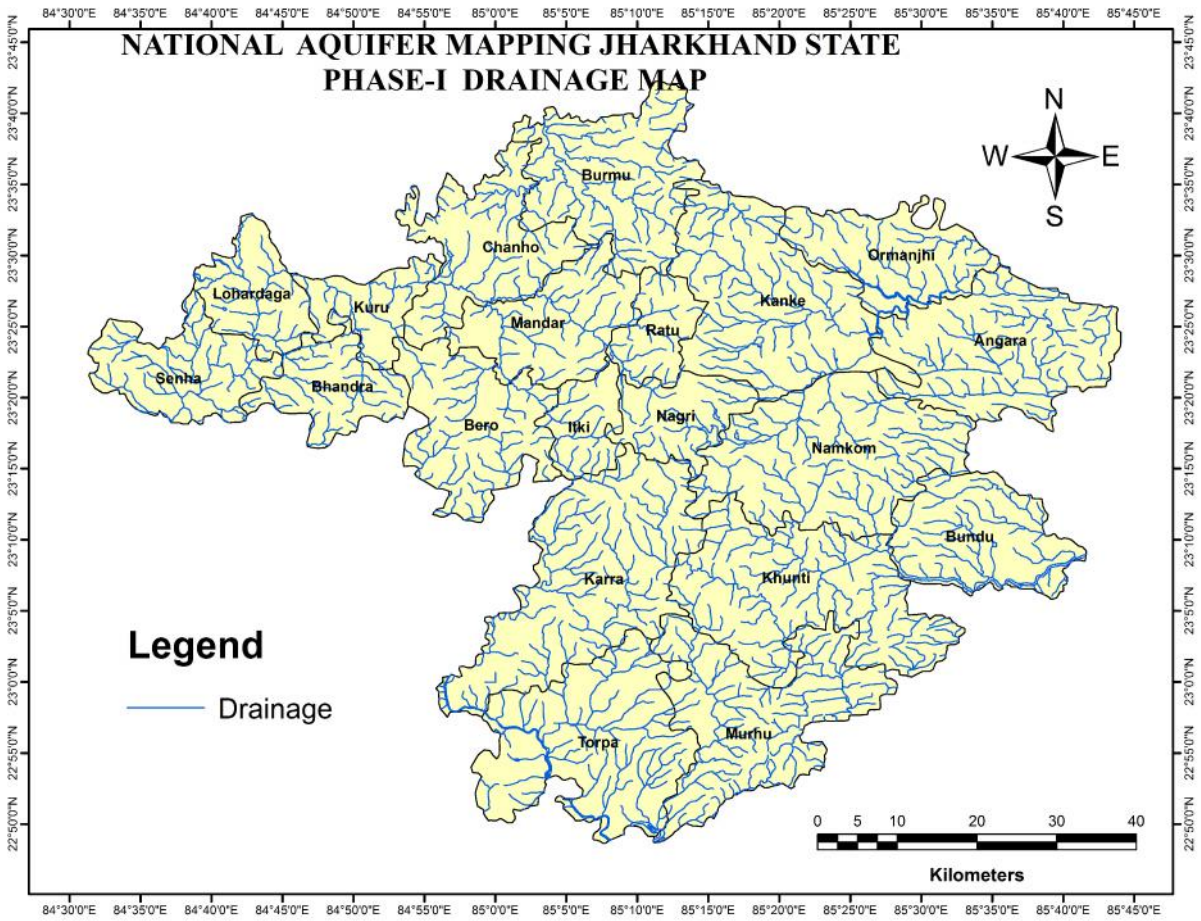

Fig-4

1.10 IRRIGATION

The area has poorly developed irrigation facilities. According to the fourth minor irrigation census data total 6244 ha are irrigated by minor irrigation schemes whereas 5909 ha irrigated by ground water schemes and 335 ha are irrigated through surface water schemes. The details of total numbers of sources and area irrigated by different schemes are shown in *(Table 8 ,9,10 and 11)*

Table 8 Details of irrigation sources

Total Number of Sources							
Ground Water				Surface Water			Grand Total
Dug well	Shallow Tube well	Deep Tube well	Total	S. Flow Scheme	S. Lift Scheme	Total	
3511	12	2	3525	102	19	121	3646

Table 9 Details of area irrigated by minor irrigation schemes

Area Irrigated by Ground Water Schemes (Ha)					Area Irrigated by Surface Water Schemes (Ha)				
Kharif	Rabi	Perennial	Others	Total	Kharif	Rabi	Perennial	Others	Total
4689	1035	134	52	5909	238	91	7	0	335

Table-10 Details of the Major &medium irrigation scheme

Sl no.	Name of project	District/Block	Ultimate irrigation potential	Physical progress		
				Head works	Main canal	Distributaries
1	Tajna reservoir scheme	Khunti/Khunti	5670	NIL	NIL	NIL
2	Raisa Resrvoir scheme	Ranchi/Bundu	3145	65%	NIL	NIL

Table-11 Details of the Renovation of Sanctioned minor irrigation Scheme

Sl no.	Name of project	District	Block	Latitude	Longitude
1	Renovation of Kochbag Medium irrigation scheme	Khunti	Namkom	23016'24.24''	85021'34.74''
2	Malar medium irrigation scheme	Ranchi	Nagri	23019'50.42''	85057'08.07''
3	Rajbandh mandari medium irrigation scheme	Ranchi	berro	23019'24.24''	85057'08.07''
4	Pelloal medium irrigation scheme	Khunti	Murhu	23002'31.7''	85014'20.3''
5	Renovation of hanhat irrigation scheme	Lohardagga	Kairron	23024'16''	85045'46''
6	Renovation of Bhakson scheme	Lohardagga	Lohardagga	23024'16''	85045'46''

1.11 CROPPING PATTERN

Agriculture is the main occupation of the people. With the growing season and with varied soils and different climate conditions influence the cropping pattern. Principal Crops of the area is Paddy, Maize, pea, Green gram, Groundnut, Urd, Wheat, Chickpea and Arhar. The horticulture crops are Cauliflower, cabbage, tomato, Brinjal, L. finger, cucumber etc.

2.0 DATA COLLECTION & GENERATION

2.1 HYDROGEOLOGICAL STUDIES

In the study area having two types of aquifers such as first aquifer (weathered) and second aquifers (fractured). Thickness of first aquifer varies between 5.50 m to 52 mbgl. In weathered zone, ground water occurs near surface under water table or phreatic aquifers in unconfined condition and in fractured zone ground water occur in semi confined to confined condition. The details of aquifer parameter is given in *(Table 12)*

2.2 Depth to water levels:

Ground water regime monitors about 119 ground water monitoring wells that includes 96 dug wells and 23 purposes built Piezometers established in the study area. With the field data, maps were prepared for visual interpretation of the behaviors of the ground water levels. Depth to ground water level were demarcated into various zones in the ranges of less than 2 m, 2-5 m, 5-10 m, 10-20 m, 20-40 m, and more than 40 m. The description of the depth to water levels during pre-monsoon and post monsoon is as follows:

2.2.a Depth to Water level May 2015:

Depth to ground water level during May 2015 ranges from 1.52 mbgl to16.2 mbgl. Minimum 1.52 mbgl recorded at Patrahatu in Ranchi and maximum 16.2 mbgl recorded at Daily market in Ranchi district. The depth of water level map of phase I area shown in (*figure 5)*

2.2.b Depth to Water level November 2015:

During month of November 2015 (post-monsoon) depth to water level varied from 1.30 m bgl to 11.0 m bgl. Minimum 1.30 mbgl recorded at chutiya, ranchi and maximum 11.00 mbgl recorded at Kisko I in Lohardegga district. Depth to water level map November 2015 of phase I area shown in (*figure 6*)

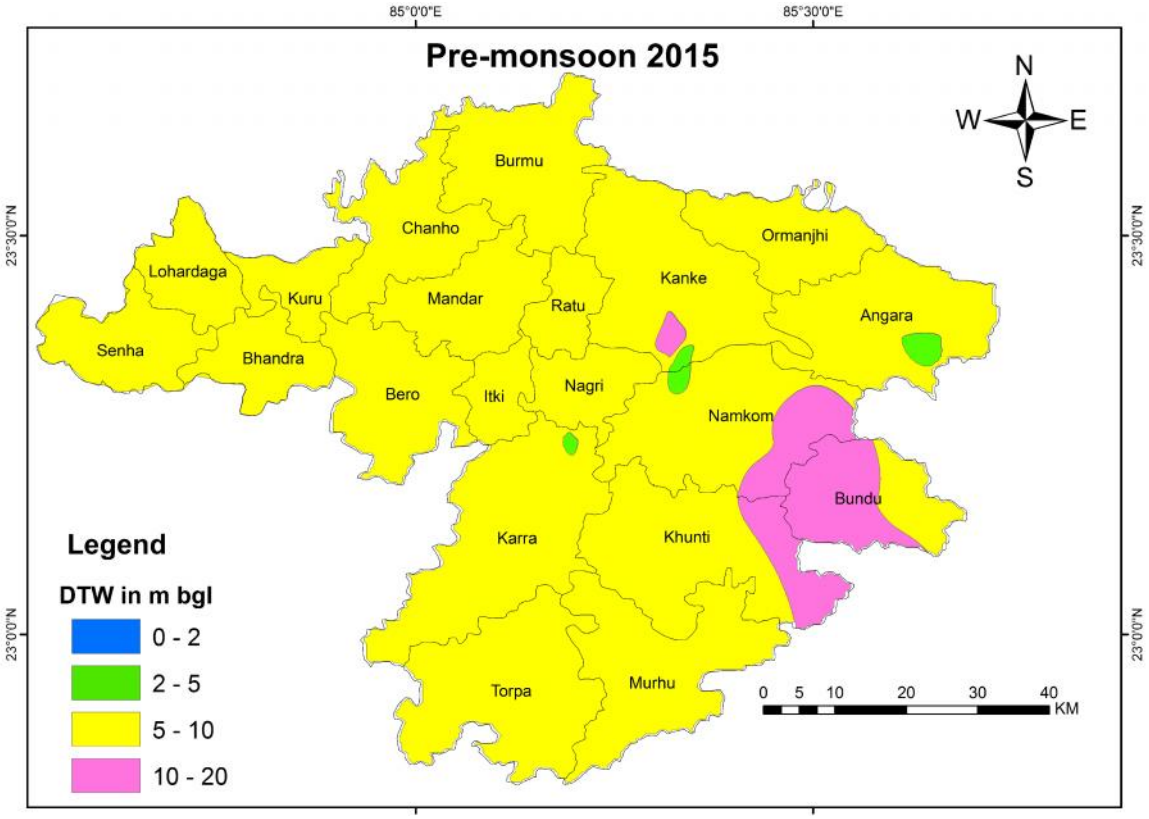
Pre-monsoon 2015
85°0'0"E
85°30'0"E
23°30'0"N
23°0'0"N
N
W
E
S
Burmu
Chanho
Ormanjhi
Lohardaga
Kuru
Mandar
Ratu
Kanke
Angara
Senha
Bhandra
Bero
Itki
Nagri
Namkom
Bundu
Karra
Khunti
Torpa
Murhu
Legend
DTW in m bgl
0 - 2
2 - 5
5 - 10
10 - 20
0 5 10 20 30 40
KM

Fig.5

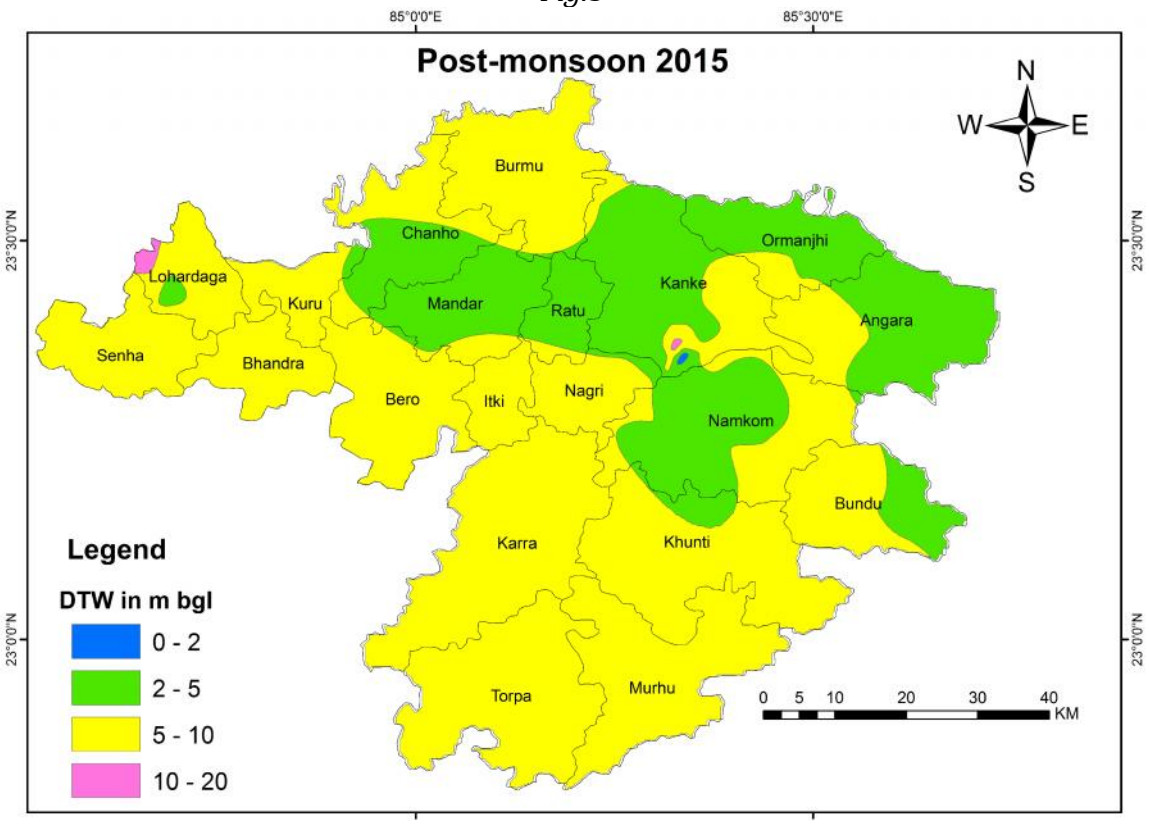
Post-monsoon 2015
85°0'0"E
85°30'0"E
23°30'0"N
23°0'0"N
N
W
E
S
Burmu
Chanho
Ormanjhi
Lohardaga
Kuru
Mandar
Ratu
Kanke
Angara
Senha
Bhandra
Bero
Itki
Nagri
Namkom
Bundu
Karra
Khunti
Torpa
Murhu
Legend
DTW in m bgl
0 - 2
2 - 5
5 - 10
10 - 20
0 5 10 20 30 40
KM

Fig.6

2.3 SLUG TEST DATA OF EXPLORATORY WELL DRILLED AT VILLAGE, KURGE, ITKI BLOCK, RANCHI DISTRICT

1. SWL (mbgl) = 7.79
2. Diameter of well = 0.190 m (7.5 inches)
3. Volume of slug injected for slug test = 30 litres
4. Actual head (Theoretical Head) i.e. 0.80 m

Time (t) since injection of slug (second)	1/t $(second)^{-1}$	DTW (mbgl)	Residual Head (H) in meter (SWL – DTW)	H/H_0
360	0.0028	7.21	0.58	1.38
600	0.0017	7.37	0.42	0.525
900	0.0011	7.51	0.28	0.35
1200	0.00083	7.555	0.235	0.29375
1500	0.00067	7.605	0.185	0.23125
1800	0.00055	7.62	0.17	0.2125
2160	0.00048	7.655	0.135	0.16875
2400	0.00042	7.66	0.13	0.1625
2700	0.00037	7.655	0.135	0.16875
3000	0.00033	7.685	0.105	0.13125
3300	0.00030	7.70	0.09	0.1125
3600	0.00028	7.71	0.08	0.1000
4200	0.00023	7.715	0.075	0.09375
4800	0.00021	7.72	0.07	0.0875
5400	0.00018	7.72	0.07	0.0875
6000	0.00017	7.73	0.06	0.075
6600	0.00015	7.73	0.06	0.075
7200	0.00014	7.72	0.07	0.0875
8400	0.00012	7.73	0.06	0.075
9600	0.00010	7.73	0.06	0.075
10800	0.00009	7.73	0.06	0.075
12000	0.00008	7.72	0.07	0.0875

Table-12 Summarized results of Aquifer parameters in Ranchi, Lohardaggga and Khunti districts

S.n	District	Discharge (m3/hr) (Q)	Transmissivity (T)	Storativity (S)	Weathered formation
1	Ranchi	1-30	2.46-80	2x10-1to 6x10-4	5-52
2	Khunti	1.8-30.96	15-28.47	1.1x10-2 to 4.9x10-4	10-36
3	Lohardagga	1.37-28.8	1-35	8.16X10-4 to 4.4X10-5	13-42

2.4 HYDROCHEMICAL STUDIES

Ground water quality monitoring is carried out by samples collected from the study area. The water samples are analyzed for Ph, Ec , CO3, Hco3 , Ca , Mg, Na, Cl, ,So4, No3, F, Total Hardness , CaCo3,Fe and K in the Regional Chemical Laboratory of CGWB, MER, Patna as per standard analytical procedure. Chemical quality of groundwater of shallow aquifer for drinking and irrigation has been worked out by analyzing 212 water samples collected from Key wells and National Monitoring wells of Phase I Aquifer Mapping area. Ground water in the study area is potable and most of the constituents are within permissible limit as per WHO standards. General ranges of chemical constituents in the study area are given in *Table13*.

Table 13: General ranges of chemical constituents in study area

Chemical Constituents and quality parameters	Dug well samples	Hand pump samples
pH	6.29 – 8.36	5.92 – 8.50
EC (micro siemens/cm at 25^0c)	95 - 1345	57.00 – 908.00
TDS (ppm)	58 - 795	36.00 – 504.00
TH as $CaCo_3$ (ppm)	35 – 330	20.00 – 315.00
Ca (ppm)	8 – 70	4.00 – 86.00
Mg (ppm)	1.20 – 45.00	1.20 – 58.30
Na (ppm)	4.10 – 111.00	1.40 – 48.50
K (ppm)	0.90 – 125.00	BDL – 58.60
HCO_3 (ppm)	24.00 – 256.00	18.00 – 238.00
Cl (ppm)	3.5 – 202.00	3.50 – 184.00
No_3 (ppm)	3.1 – 53.80	1.50 – 60
SO_4 (ppm)	BDL – 81.00	BDL – 43.00
F (ppm)	0.01 – 1.19	0.01 – 2.46

2.4.1a Electrical Conductivity

The quality of ground water in the phreatic aquifer depends on the rocks, contact time, circulation and temperature. It is also dependent on the solubility of the minerals. The list of samples having electrical conductivity more than *(EC≈1000µ/cm at 25°C)* is shown in *Table 14 and figure 7.*

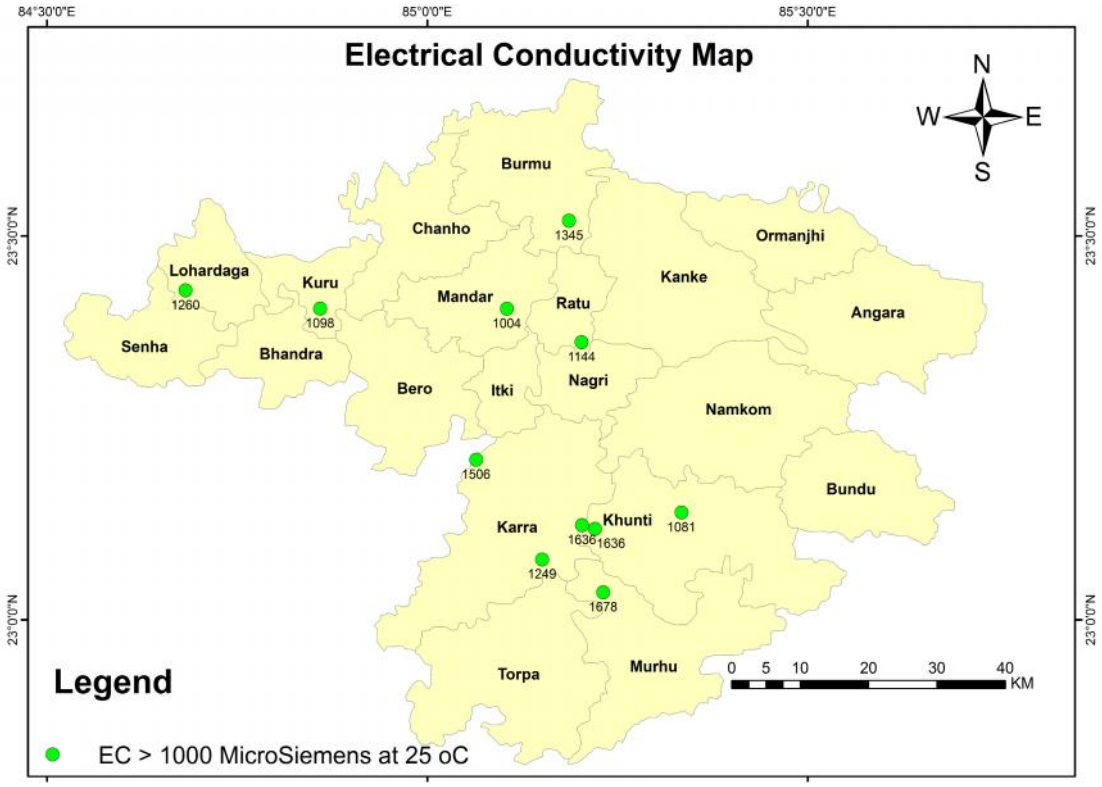

Fig.7

Table 14- Dug well Location showing electrical conductivity > 1000µ/cm at 25°C

Sr. No.	**District/Block**	**Location**	**EC in micro siemens/ cm at 25⁰c** *(EC>1000µ/cm at 25°C).*
1	Lohardaga/Lohardagga	Lohardagga	1260
2	Lohardaga/kuru	Kuru	1098
3	Khunti/Khunti	Khunti	1081
4.	Khunti/Kerra	Kakariya	1506
5.	Khunti/Kerra	Jobra	1249
6.	Khunti/Khunti	Dumardagga	1636
7.	Khunti/Murhu	Pellaul	1678
8.	Ranchi/Nagri	Kota	1144
9.	Ranchi/Mandar	Kinibhitta	1004
10.	Ranchi/Nagri	Nagri	1345
11.	Khunti/kerra	Jaltanda	1636

2.4.1b Fluoride

Fluoride enters the aquatic environment through the weathering process of igneous and sedimentary rocks. The main anthropogenic source of fluoride is discharge from phosphate and aluminum industries. Generally fluoride is present in low concentration in natural water. Fluoride are normally regarded to be beneficial in water if present in low concentration up to 1mg/1. Such water has been found to improve dental health and prevents the formation of dental caries. With level exceeding 1.0 mg/1 bone fluorosis or crippling effects are observed.

Fluoride concentration is found above permissible limit occurs in 24 location of Ranchi and Khunti districts. The spot location of fluoride in Phase I area shown in *figure 8*. Fluoride analysis reveals that there is no specific trend observed for distribution of fluoride in Ranchi and Khunti district. The occurrence of fluoride above than permissible limit is given in **Table 15 & 16.**

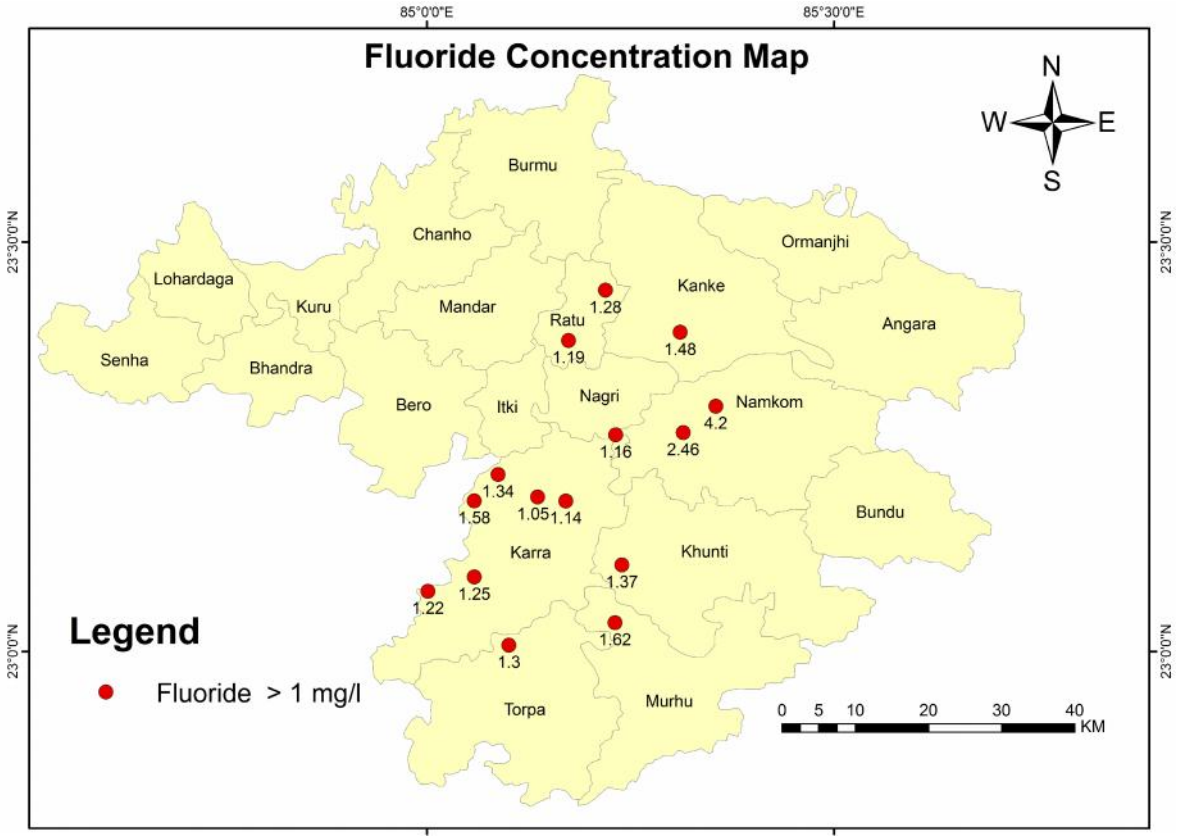

Fig 8

Table 15 Dug well Location showing fluoride above 1.0 mg/1

Sl. No.	**District/Block**	**Location**	Fluoride Conc. above permissible limits ***(1 Mg/1).***
1	Ranchi/Ormanjhi	Lapanga	1.10
2	Ranchi/Kanke	Harmu,Tongritoli	1.11
3	Ranchi/kanke	Near recreation club, Gandhinagar	1.48
4.	Ranchi/Ratu	Tigra	1.19
5.	Ranchi/Nagri	Kumbatoli	1.16

Table 16 Hand pump/Bore well Location showing fluoride above 1.0 mg/l

Sr. No.	**District/Block**	**Location**	Fluoride Conc. above permissible limits ***(>1mg/l).***
1	Ranchi/Nagri	In front of house of Shri mangra oraon	1.06
2	Ranchi/Namkom	Screw factory of Shri chouhan	1.26
3	Ranchi/Tupudana	Near Administrative building	2.46
4.	Ranchi/namkom	Within the compound of Institute of Institute of public health	4.2
5	Khunti/Kerra	Kakariya	1.34
6	Khunti/Kerra	Barwadag	1.25
7.	Khunti/Kerra	Gobindpur	1.27
8	Khunti/Kerra	Rolaguttu	1.05
9.	Khunti/Kerra	Jamu	1.30
10.	Khunti/kerra	Bingaon	1.14
11.	Kunti/Khunti	Rewa	1.37
12.	Khunti/Murhu	Pellaul	1.62
13.	Khunti/Torpa	Dorma	1.58
14.	Ranchi/mandar	Mandar	1.26
15.	Ranchi/Ratu	Hurhuri	1.28
16.	Ranchi/mandar	Bishakhatanga	1.36
17	Ranchi/Berro	Berro	1.46

18	Ranchi/Itki	Kurgi	1.42
19	Ranchi/Nagri	Barsa	1.21
20	Ranchi/Namkom	Ladnapiri village (Near yatri shed)	1.35

2.4.1c Nitrate

Nitrate generally occurs in trace quantities in surface water but may contain high levels in some groundwater. Nitrate is non-essential constituent of groundwater and is contributed mostly by agriculture, industrial and municipal activities. Concentration of nitrate in excess of 45 mg/l in water is harmful for human consumption.

The spot location of wells in Ranchi, Khunti and Lohardegga districts, where concentration of nitrate ion was more than 45mg/l in ground water as shown in *figure 9* and nitrate concentration of dug wells are shown in *Table 17* and hand pump in *Table 18.*

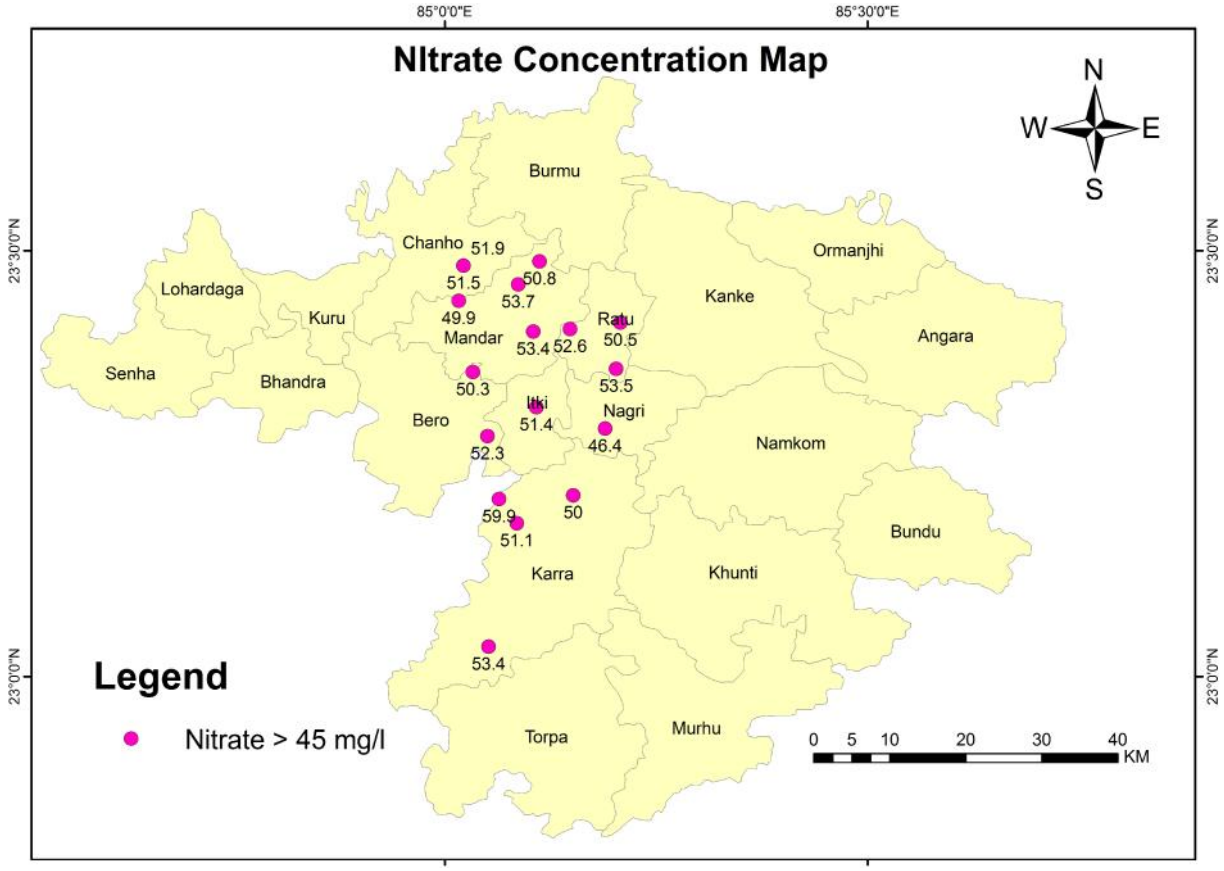

Fig.9

Table 17 dug Well Location showing Nitrate concentration above 45 mg/1

Sr. No.	**District/Block**	**Location**	Nitrate Conc. above permissible limits **(*45 mg/l).***
1	Ranchi/Chanho	Bijupara tangar	51.9
2	Ranchi/Mandar	Kaimpo	49.9
3	Ranchi/Mandar	Mandar	53.7
4.	Ranchi/Ratu	Tarup east	49.6
5.	Ranchi/Nagri	Kota	53.8
6.	Ranchi/Mandar	Kinibhitta	53.4
7.	Ranchi/Berro	Chachkapi	50.3
8.	Ranchi/Ratu	Pali	52.6
9.	Ranchi/Berro	Masu	52.3
10.	Ranchi/Nagri	Bandheratu	46.4

Table 18 Hand pump Location showing Nitrate concentration above 45 mg/1

Sl. No	**District/Block**	**Location**	Nitrate Conc. above than permissible limits **(*45 mg/l).***
1	Ranchi/Chanho	Bijupara tangar	51.5
2	Ranchi/Mandar	Karge	51.4
3	Ranchi/Nagri	Kumbatoli	50.5
4.	Ranchi/Berro	Berro	48.2
5.	Ranchi/Nagri	Dahutoli	46
6.	Khunti/Kerra	Nawatoli	51
7.	Khunti/Kerra	Kakriya	59.9
8.	Khunti/Kerra	Kasira	53.4
9.	Khunti/Kerra	Kurse	50

2.4.1d Iron

Iron is essential element in human nutrition but at levels above 0.3 mg/l it stains laundry and plumbing fixtures and causes undesirable taste. The presence of iron above 1.0 mg/l may lead to deposits in pipes and in presence of aluminum may lead to dirty water problem. The location of wells in Ranchi, Khunti and Lohardagga districts, where concentration of Iron was reported more than 0.3mg/l in ground water is shown in *Table 19***.**

Table 19 Location showing Iron concentration above 0.3 mg/1

Sr. No.	**District/Block**	**Location**	Iron Conc. above than permissible limits **(*0.3 Mg/l).***
1	Ranchi/Kanke	Dipa Toli	19.53
2	Ranchi/Kanke	Dipa Toli	5.29
3	Ranchi/Namkum	Khoja Toli	15.70
4	Ranchi/Kanke	SIRD	5.15
5	Ranchi/Kanke	Ranchi College	12.21
6	Ranchi/Kanke	Ranchi College	29.87
7	Ranchi/Kanke	Hatwar	5.21
8	Ranchi/Kanke	Harmu	16.50
9	Ranchi/Nagri	Dhurwa	12.20
10	Ranchi/Kanke	Tagore hill	1.21
11	Ranchi/Kanke	Utkramit prathmik school, Tetartoli, Bariatu	6.55
12	Ranchi/Namkom	Govt. Middle school,Gari	5.74
13	Ranchi/Namkom	Backside of Joseph Line hotel,lalganj	1.46
14	Ranchi/Namkom	Balsiring(In house of parma kacchap)	1.10

2.5 GEOPHYSICAL STUDIES

The geophysical field investigation formed an important component of the ground water exploration programme. The prime objective was to reveal the hidden sub-surface hydrogeological conditions. To support and supplement the hydrogeological surveys and groundwater exploration, Vertical Electrical Soundings (VES) is required for lithological interpretation up to a depth of 200 m in hard rock terrain. Total 112 no of Vertical Electrical Sounding were carried out in Ranchi, Khunti and Lohardagga district of Phase I aquifer mapping area which is shown in *Table 20* and *figure 10 .*

Table 20 District wise Vertical Electrical Sounding conducted in Phase I

Sr. No.	District	Toposheet no	No of VES
1	Ranchi	73 E-7	36
2	Ranchi	73 E-3	25
3	Lohardagga	73 A-11	24
4	Khunti	73 E-4	27

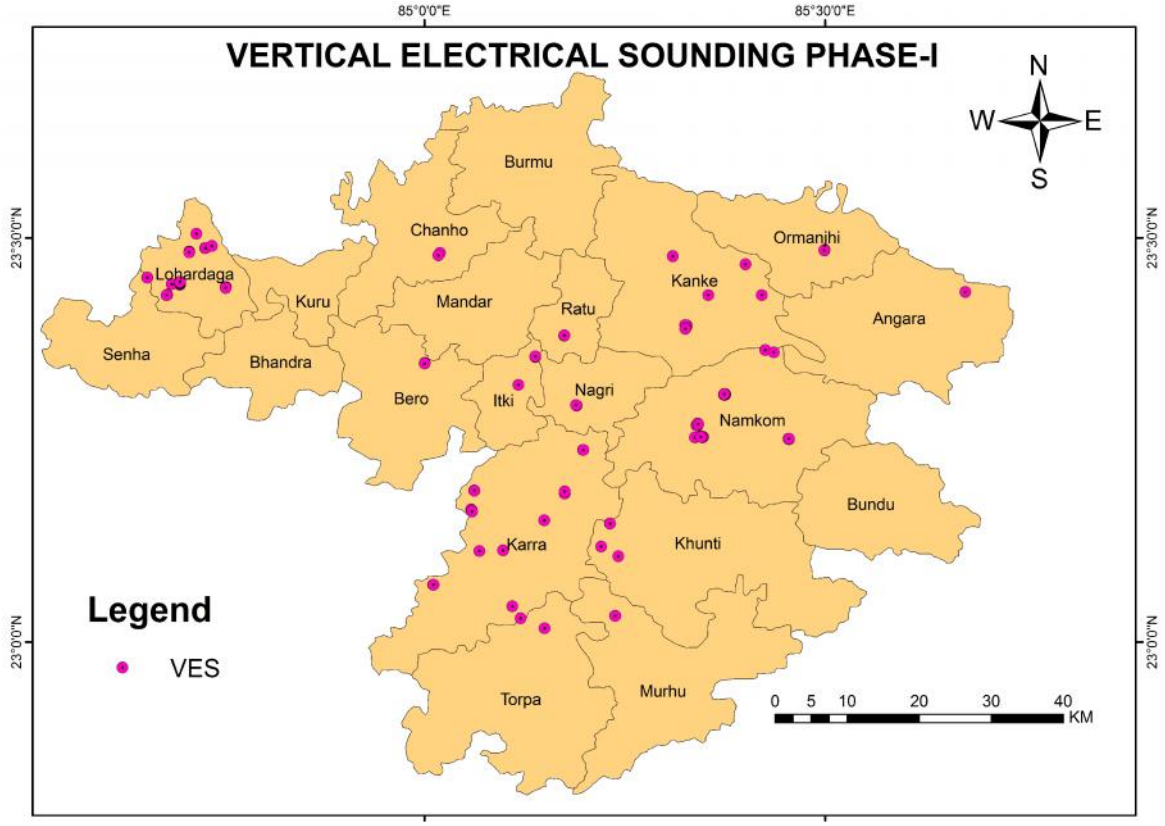

Fig-10

2.5.1 GEOPHYSICAL RESULTS:

Under aquifer mapping studies 36 VES were conducted in topo sheet No.73E/7. The interpreted VES results of toposheet No.73E/7 indicate, the top soil resistivity varies from 45.0-784ohm.m with thickness 0.75-3.3m.This is followed by highly weathered / weathered layer with resistivity 4 to 99ohm.m with thickness 0.2 to 38.0m.This is underlain by fractured rock with resistivity 106 to 782ohm.m with thickness 4.5 to 63.3m. This is followed by 1500 ohm.m to very high resistivity layer indicating massive formation and this is expected at a depth range of 1.0-70.0 m. At places within the massive rock fractures / minor fractures also expected as a

low resistivity layer expected below the very high resistivity layer. The layer resistivities and thicknesses are shown in *figure 11* .

Under aquifer mapping 52 VES were conducted out of which 25 VES in topo sheet No. 73E/3 and 27 VES in topo sheet No.73E/4. The VES results of topo sheet No. 73E/3 indicate, the top soil resistivity varies from 61-1260ohm.m with thickness 0.80-4.0m. This is followed by highly weathered layer at places with resistivity 6 to 20ohm.m with thickness 1.2-15.0m.This is followed by weathered layer with resistivity 27 to 104ohm.m with thickness 2.2 to 22.7m. This is underlain by semi weathered/fractured rock with resistivity 125 to 295ohm.m with thickness 45 to 50.8m. This is followed by minor fractured layer at places with resistivity 488-976ohm.m with thickness 2.0-65.3m.This is followed by very high resistivity layer indicating massive formation and this is expected at a depth range of 6.7-70.1m. At places within the massive rock fractures / minor fractures also expected as a low resistivity layer expected below the very high resistivity layer.

The VES results of topo sheet No. 73E/4 (*figure 12, 13 & 14)* indicate, the top soil resistivity varies from 22.0-1469ohm.m with thickness 0.60-7.1m. This is followed by highly weathered layer at places with resistivity 8 to 20ohm.m with thickness 0.5m.This is followed by weathered layer with resistivity 25 to 125ohm.m with thickness 0.9 to 27.9m.This is underlain by semi weathered/fractured rock with resistivity 142 to 262ohm.m with thickness 4.2 to 30.2m. This is followed by minor fractured layer at places with resistivity 383-679ohm.m with thickness 1.9-71.7m.This is followed by very high resistivity layer indicating massive formation and this is expected at a depth range of 3.7-78.7m. At places within the massive rock fractures / minor fractures also expected as a low resistivity layer expected below the very high resistivity layer.

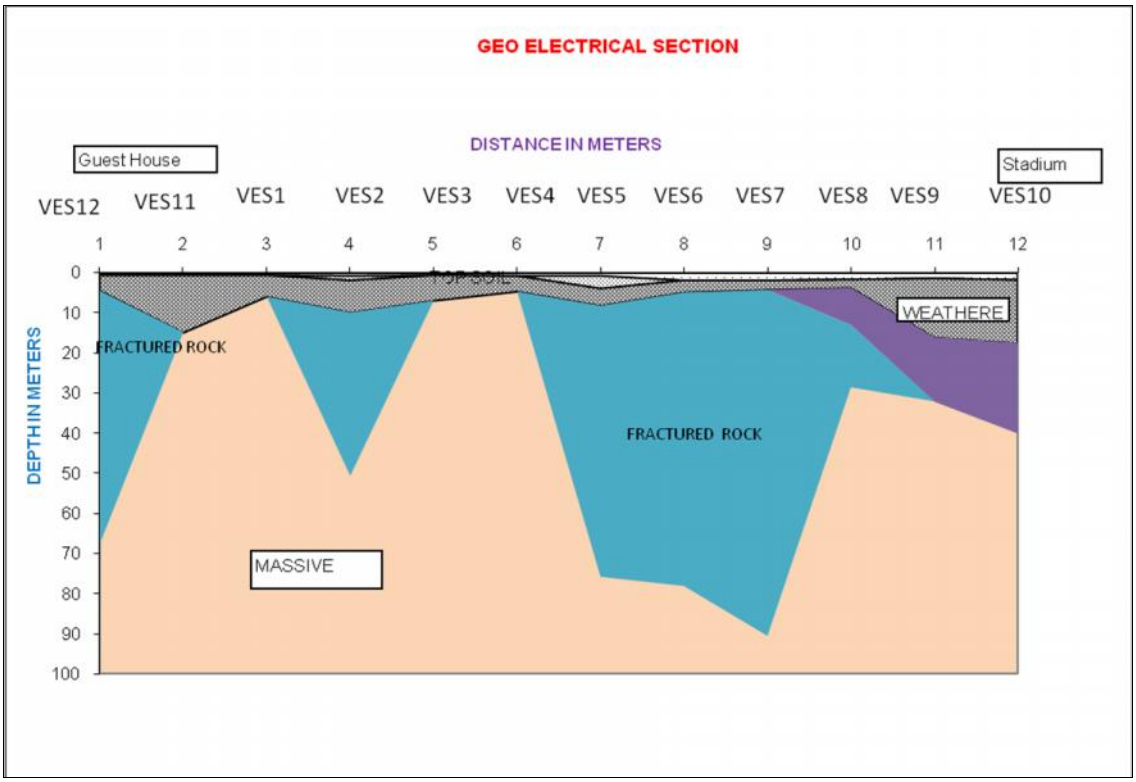

Fig-11 Geoelectric Section of morabadi midan in Toposheet 73E/7

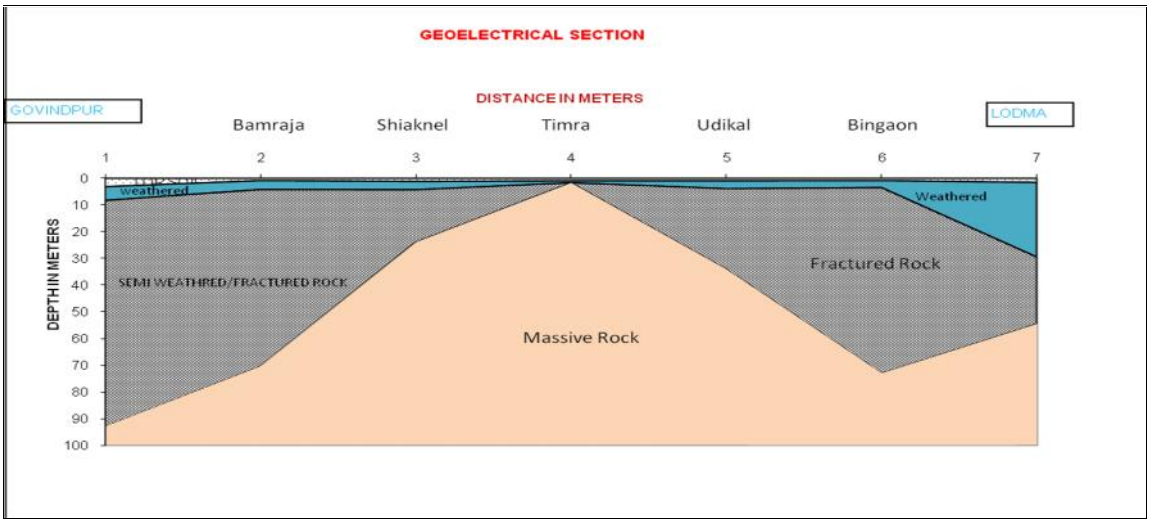

Fig. 12 Geoelectric Section of Govindpur - Lodma Section, Aquifer Mapping Area in topo sheet No. 73E/4.

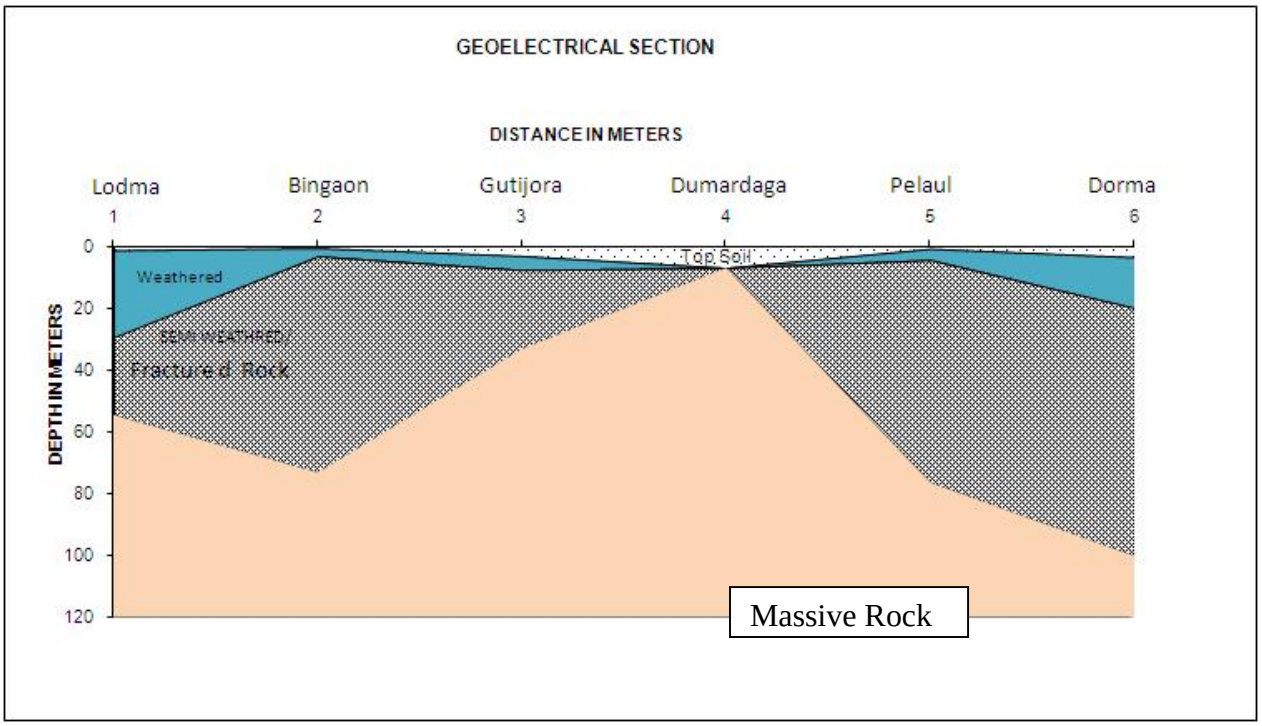

Fig. 13 Geoelectrical Section of Lodma - Dorma Section, Aquifer Mapping Area in topo sheet No. 73E/4.

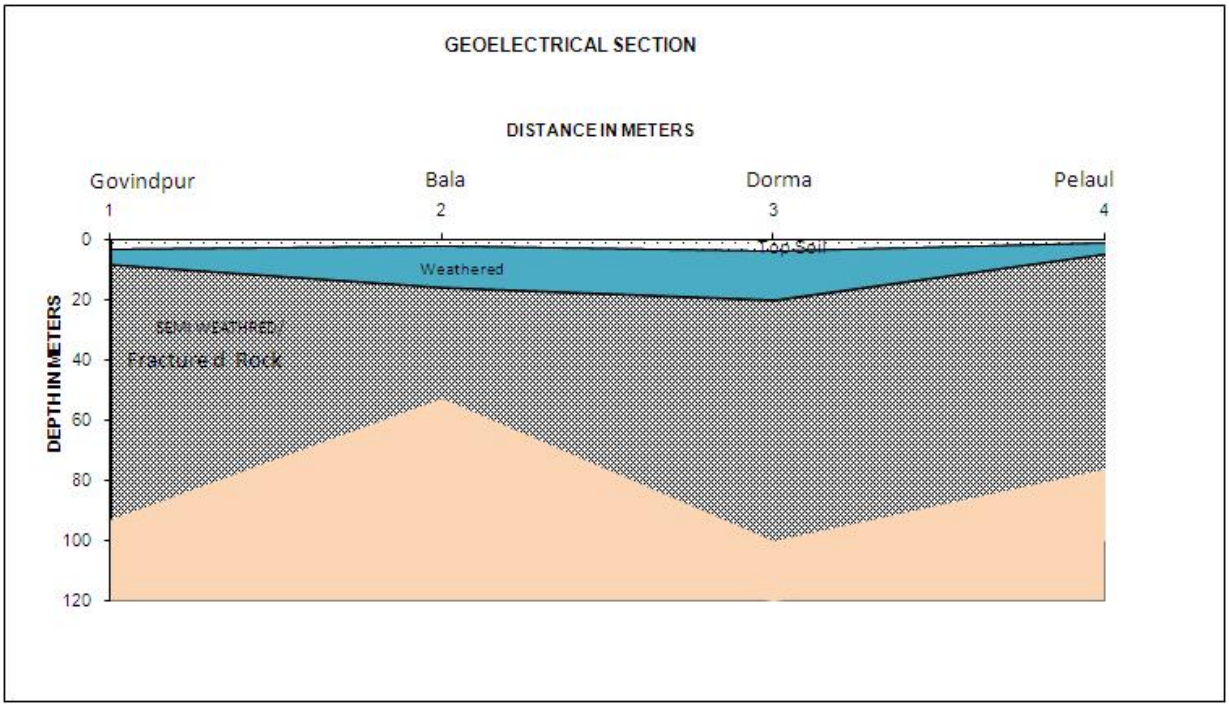

Fig14 Geoelectrical Section of Govindpur-Pelaul Section, Aquifer Mapping Area in topo sheet No. 73E/4.

2.6 GROUND WATER EXPLORATION

Central Ground Water Board (CGWB) has carried out exploratory drilling in Khunti, Ranchi and Lohardagga district. There is no aquifer-wise data available from State or any other agencies. Total 55 exploratory well drilled in the study area. Depth of drilling varies from 38 mbgl to 199 mbgl. Thickness of casing varies from 14.65 mbgl (Namkum farm) to 77 mbgl (Dipatoli 57 Eng. Line). Discharge of borewell varies between 3.6 m^3/hr. (Lac Research Namkom) to 30m^3/hr. at D.A.V. shyamli. The highest discharge at D.A.V. shyamli have aquifer disposition at depth zone 36-38m,45-46m,89-91m,120-121m.Fractures at different localities in Ranchi urban area may be summarized as follows-19-21,17-23,32-33,35-36,45-46,59-60,64-65,89-91,93-95,99-100,107-110 and 120-121mbgl.Transmissivity value varies between 2.46 m^2/day (Rajbhawan campus) to 80 m^2/day (Golf ground, Dipatoli). Storativity value at Doranda is $6.00*10^{-4}$ In phase-I Exploratory well drilled location is plotted in the map *figure15*

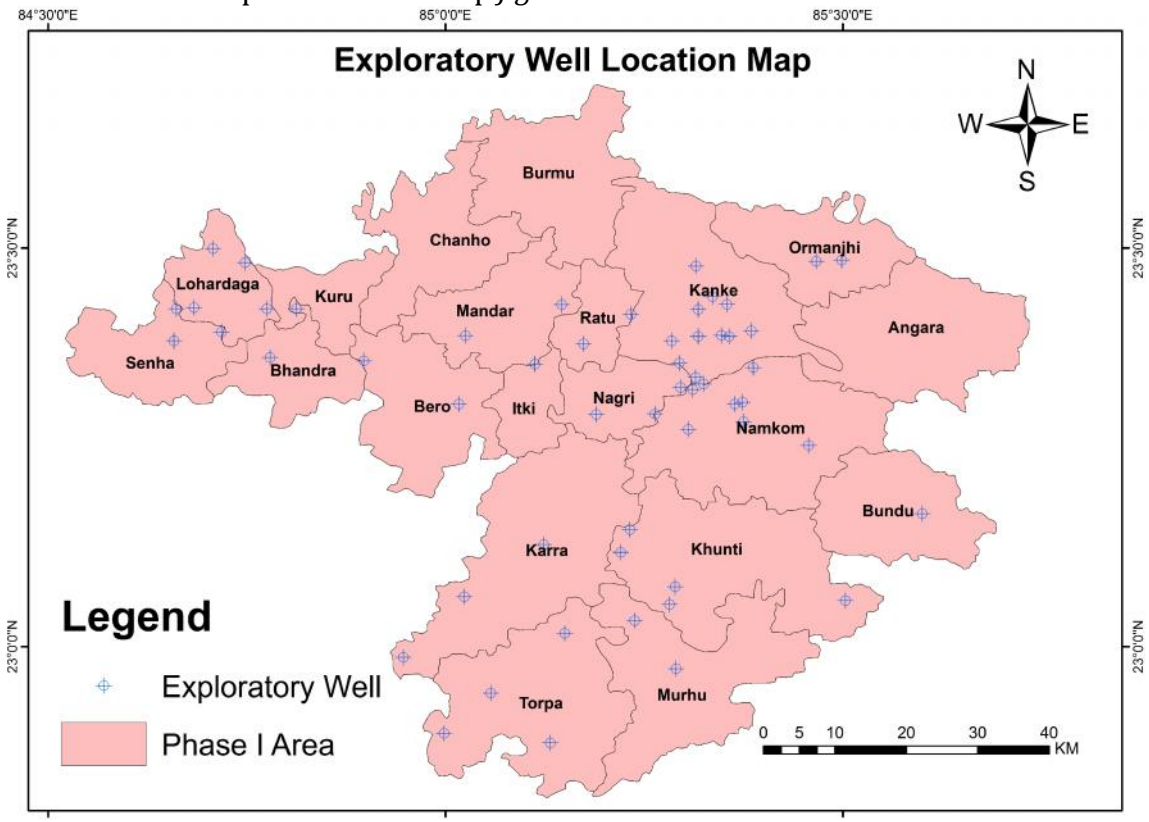

Fig. 15

3.0 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

Based on exploratory bore well, 2D & 3D litho logical map has been generated. Lithological section map of the bore wells are shown in *figure 16*. The model depicts that surface soil & weathered granite is observed of limited thickness shown in *figure 17*. The section AA' in *figure 18* indicates that Weathered Zone is having general thickness of 10-35m in the Phase-I .Maximum thickness of 52 m is observed in the Brambe locality in Ratu block. Guitjora in khunti block has weathered thickness of about 40m.In section BB' in *figure18* minimum thickness of 12 m is observed in Torpa locality of torpa block and maximum thickness of 36 m in Boreya locality of Kanke block. In (section CC') minimum thickness of 15m is observed in Chatti locality of Senha block and maximum thickness of 42 m in murpa locality of lohardagga blocks shown in *figure 19*.1-3 sets of fractures are found in the phase-I area.

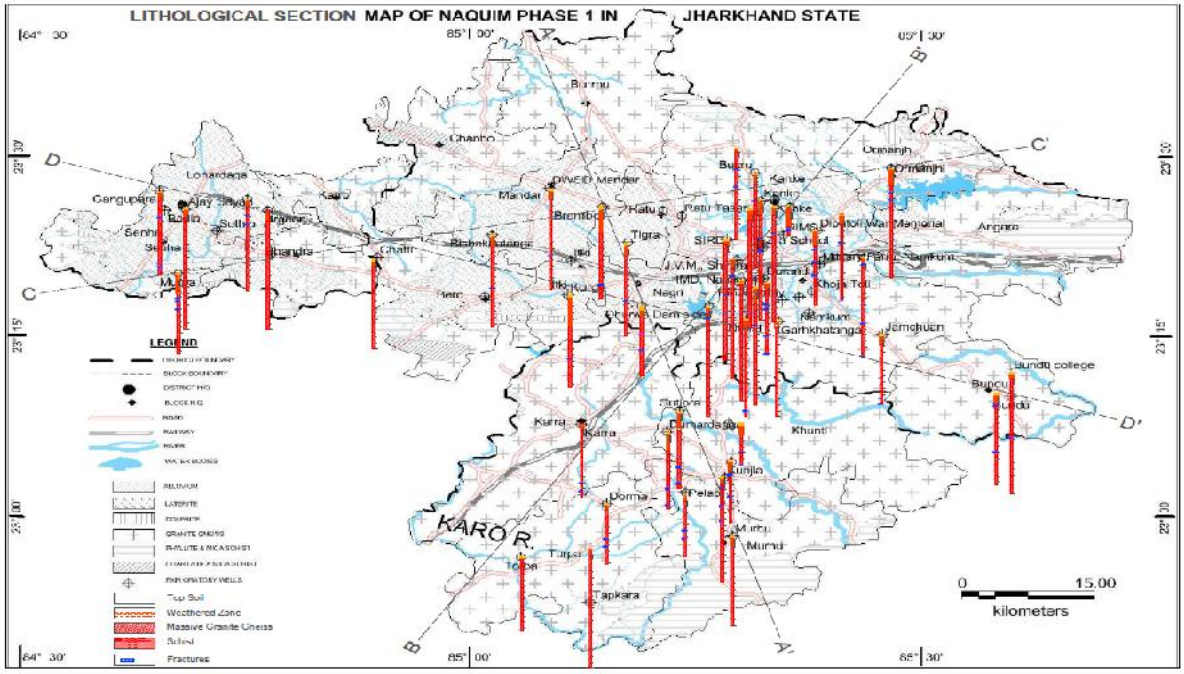

Fig-16

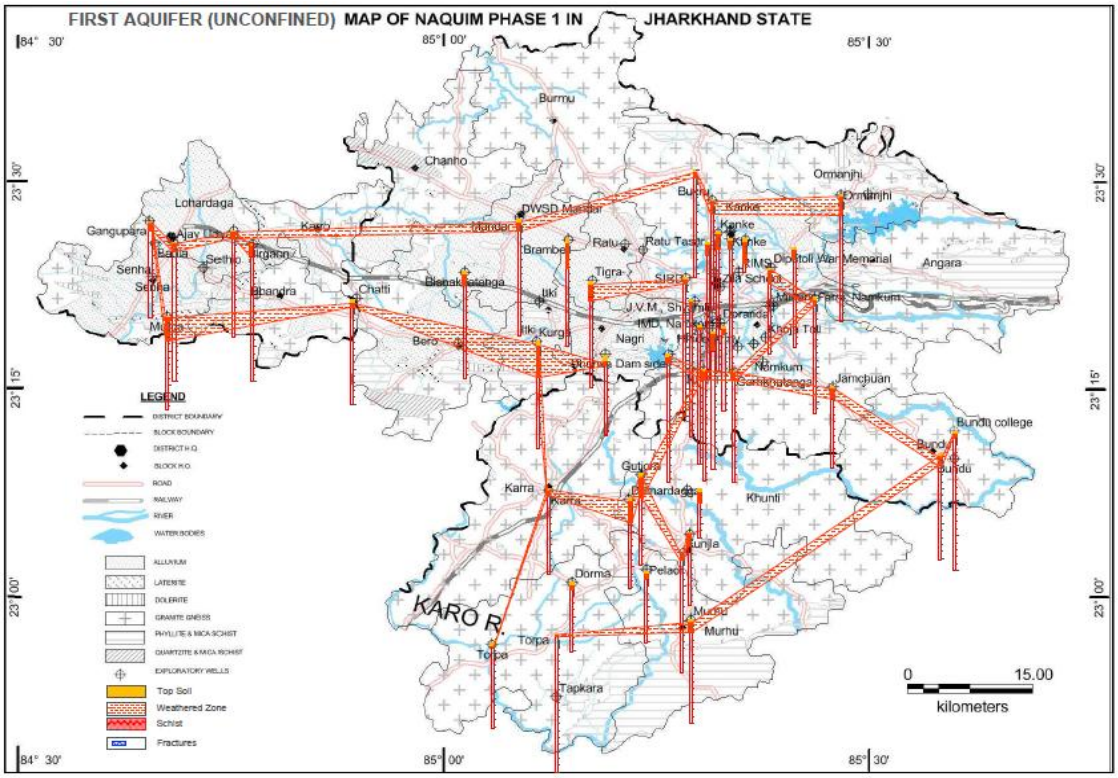
FIRST AQUIFER (UNCONFINED) MAP OF NAQUIM PHASE 1 IN JHARKHAND STATE
84° 30'
85° 00'
85° 30'
23° 30'
23° 15'
23° 00'
Burmu
Chanho
Lohardaga
Gangupara
Kairo
Senha
Chalti
Bero
Nagri
Karra
Khunti
Gutjora
Kunjla
Dorma
Pelaco
Murhu
Torpa
Tapkara
Jamchuan
Bundu college
Ormanjhi
Angara
Namkum
KARO R.
0 15.00
kilometers
LEGEND
DISTRICT BOUNDARY
BLOCK BOUNDARY
DISTRICT H.Q.
BLOCK H.Q.
ROAD
RAILWAY
RIVER
WATER BODIES
ALLUVIUM
LATERITE
DOLERITE
GRANITE GNEISS
PHYLLITE & MICA SCHIST
QUARTZITE & MICA SCHIST
EXPLORATORY WELLS
Top Soil
Weathered Zone
Schist
Fractures

Fig-17

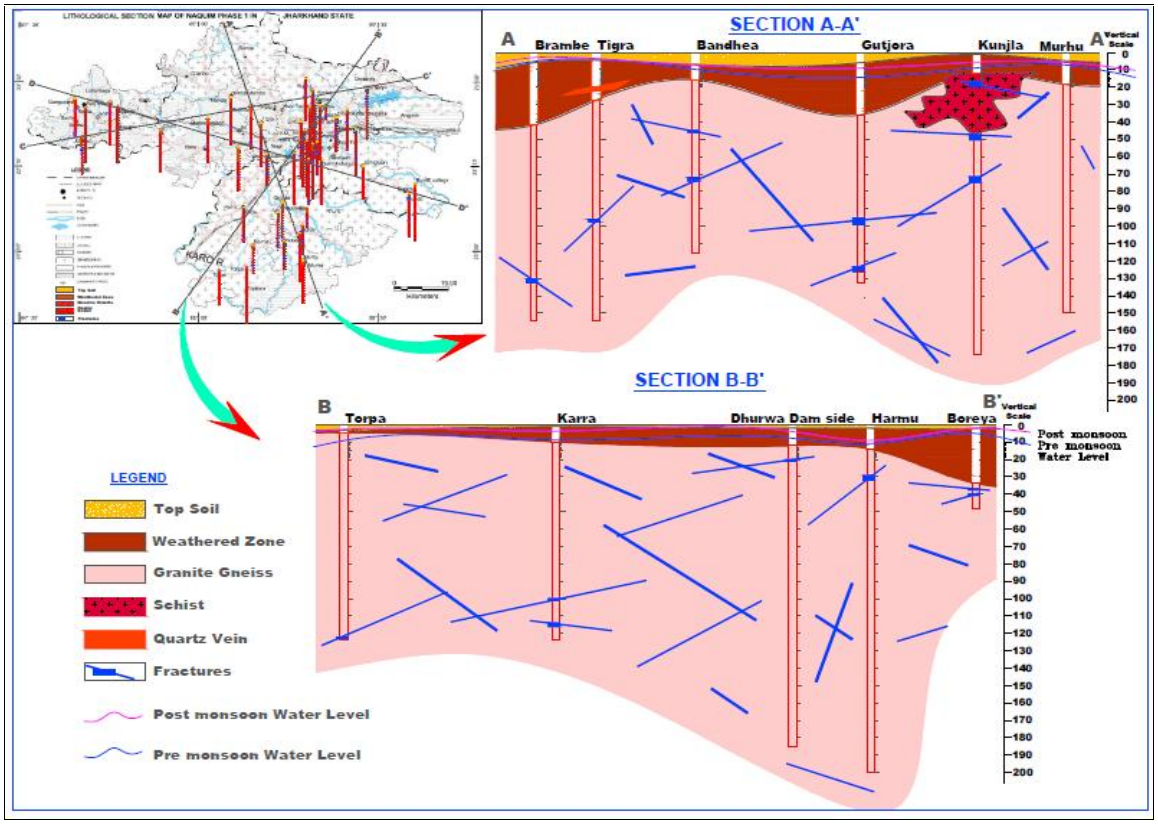
SECTION A-A'
A
Brambe
Tigra
Bandhea
Gutjora
Kunjla
Murhu
A'
Vertical Scale
SECTION B-B'
B
Torpa
Karra
Dhurwa Dam side
Harmu
Boreya
B'
Post monsoon
Pre monsoon
Water Level
LEGEND
Top Soil
Weathered Zone
Granite Gneiss
Schist
Quartz Vein
Fractures
Post monsoon Water Level
Pre monsoon Water Level

Fig-18

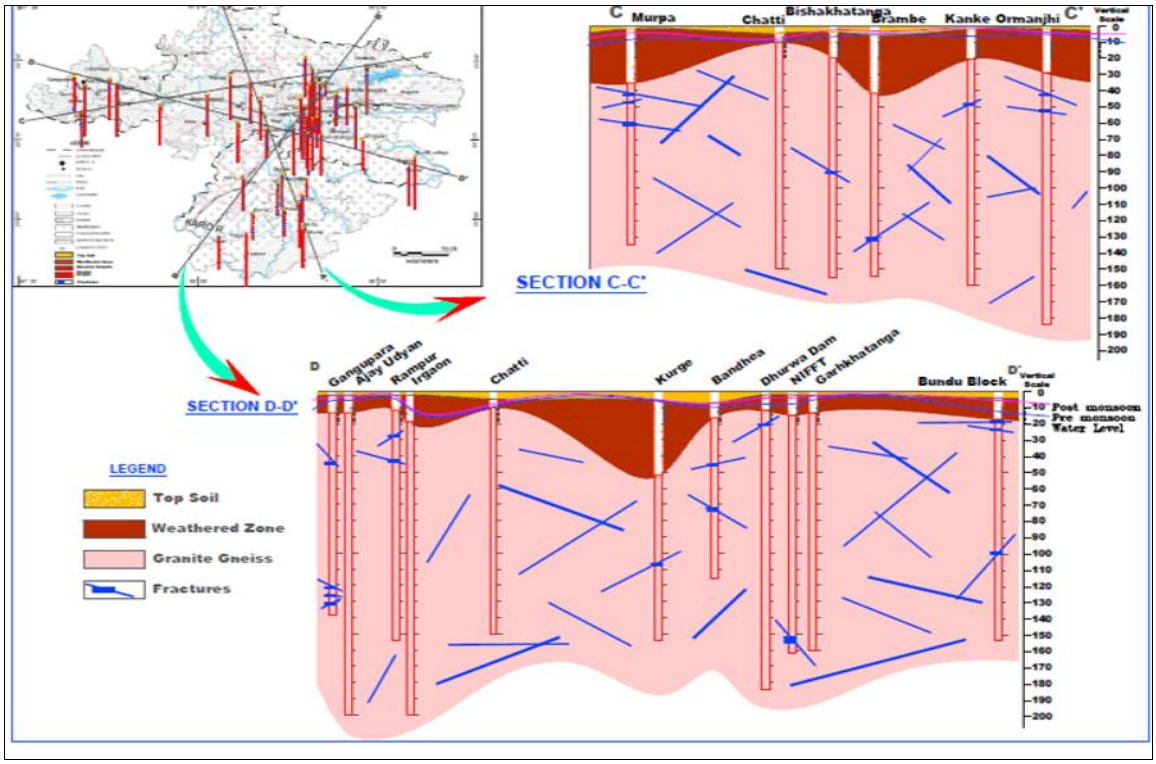
C
Murpa
Chatti
Bishakhatanga
Brambe
Kanke
Ormanjhi
C'
SECTION C-C'
D
Ganguapara
Ajay Udyan
Rampur
Irrigaon
Chatti
Kurge
Bandhea
Dhurwa Dam
NIFFT
Garkhkhatanga
Bundu Block
D'
SECTION D-D'
Post monsoon
Pre monsoon
Water Level
LEGEND
Top Soil
Weathered Zone
Granite Gneiss
Fractures

Fig-19

4.0 GROUND WATER RESOURCES

Ground Water Resource of the area has been estimated for base year-2011, on block wise basis. Out of 628828 ha of geographical area, 472189 ha is ground water recharge worthy area and 151609 ha is hilly area. There are twenty number of assessment units (block) in the study area. One block is over-exploited and three blocks comes under semi-critical and the highest stage of of ground water development is computed as 122.44 % for kanke block. The net dynamic ground water availability in the area is 45000 ham and ground water draft for all uses is 22156 ham, making stage of ground water development 49% as a whole for the phase I area. After making allocation for future domestic and industrial water supply for next 25 years, balance available ground water for future irrigation development would be 22506 ham.

The static ground water resource is 76840 ham and total ground water availability is 121840 ham in the study area of Ranchi, Khunti and Lohardegga districts. The overview of Ground Water Resource is given in *Table no.21* and graphical representation of block wise stage of development is shown in *figure 20* and the existing ground water draft for all uses and net ground water availability for future irrigation development is shown in *figure 21.*

Table 21 Ground Water Resource (As on March -2011)

S.No.	Items	Parts of Ranchi district	Parts of Khunti district	Parts of Lohardegga district
1	Area in ham	271387	114872	85930
2	Net Ground Water Availability in ham	26847	10874	7279
3	Existing Gross Ground Water Draft for Irrigation in ham	9482	3210	3116
4	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply in ham	5309	538	527
5	Existing Gross Ground Water Draft for all Uses in ham	14788	3746	3622
6	Net Ground Water Availability for future Irrigation Development in ham	12341	6777	3388
7	Stage of Ground Water Development (%)	55%	34%	49%

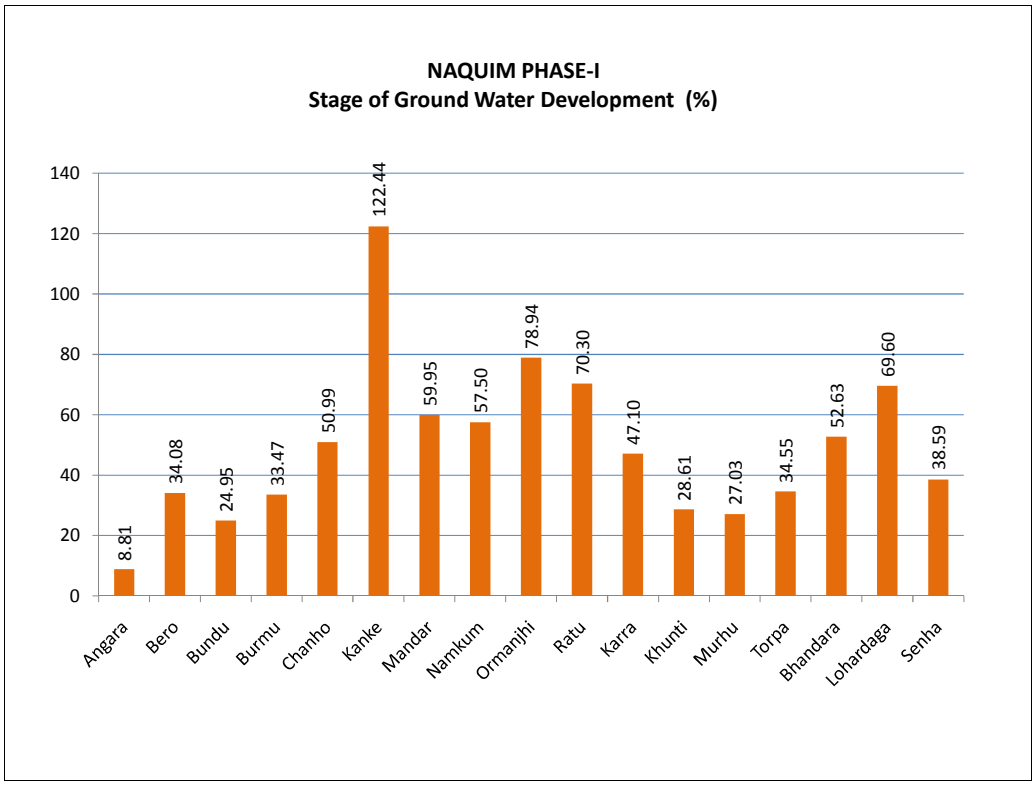

fig.-20 Block-wise stage of development(2011)

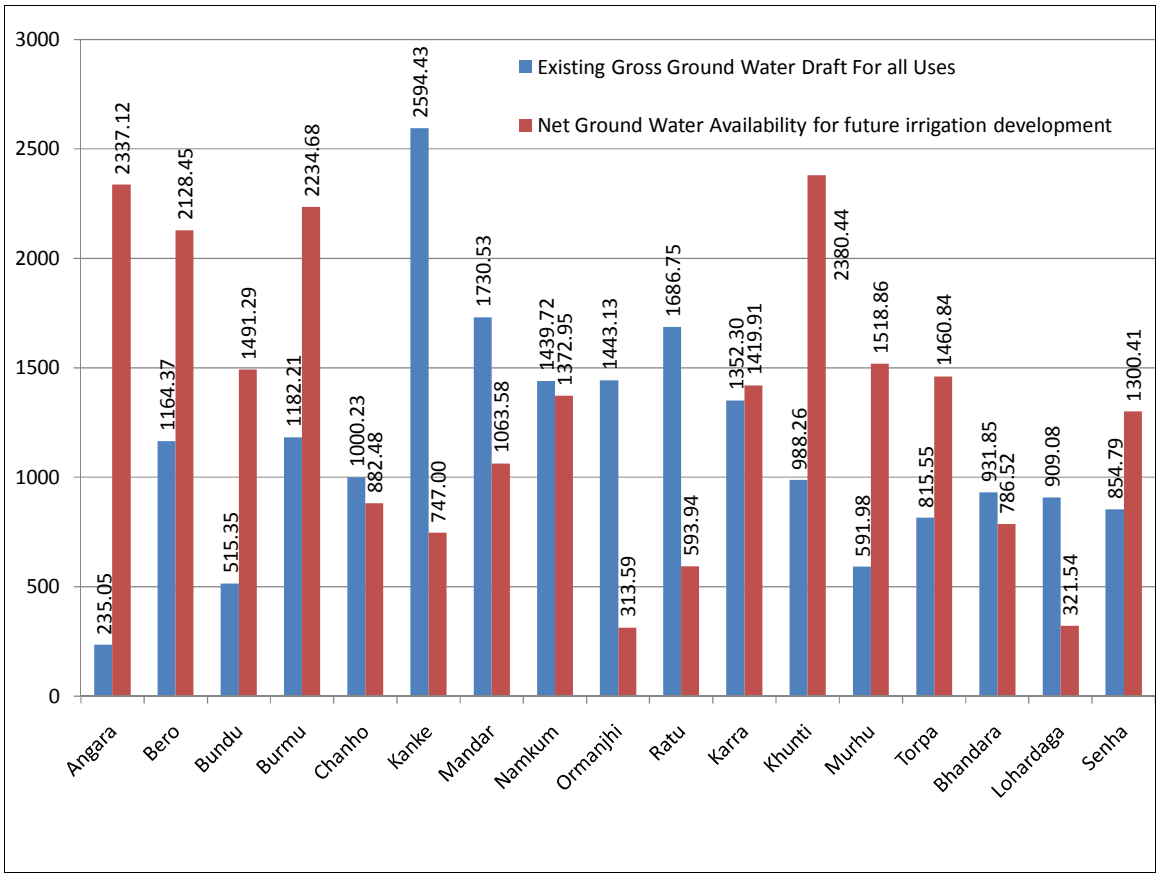

fig.-21 Gross ground water draft and Net ground water availability for future irrigation development

5.0 GROUND WATER RELATED ISSUES

5.1 Identification of Issues:

The major ground water related problems and issues of the districts are grouped into two broad categories:

a. Quantifying aspects
b. Quality aspects

A variety of nature's factors affect the quantity and quality aspects of ground water over space and time. The major quantity and quality aspects are discussed as follows;

5.1.1 Quantity Aspects:

The occurrence and movement of ground water depends in the hydrogeological characteristics of the sub surface rock formation. Ground water potential at any area mainly depends on the topography, rainfall, and geology. Because of plateau topography and Chotanagpur granitic gneiss complex of the hydrogeological condition in the study area, the ground water potential is not uniform and it changes from one area to another.

In Ranchi, Khunti and Lohardagga districts the entire area is covered by hard rock terrain i.e. Granite Gneiss Complex and the specific yield of the formation is .015% . Therefore the quantity of which can be stored in the sub surface as ground water is limited and quantity of water can be extracted from these areas which depend on the rainfall, thickness of the aquifer and specific yield of the aquifers. The salient features of ground water resources as on March-2011 is given in *Table 22.*

Table 22 Ground Water Resource (As on March -2011)

S.No.	Items	Ground water in ham
1	Total annual replenishable ground water resource	49148
2	Natural losses	4148
3	Net Dynamic Ground Water Availability	45000
	Existing Gross Ground Water Draft for irrigation	15808.38
4	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply	6375
5	Existing Gross Ground Water Draft for all Uses	22156
	Provision for domestic and industrial requirement supply to next 25 years	4212.18
6	Net Ground Water Availability for future Irrigation Development	22448
	Number of blocks	20
	Number of semi-critical blocks	3
	Number of critical blocks	0
	Number of over-exploited blocks	1
	Number of safe blocks	16
	Static/in-storage Ground water availability	76840
	Stage of development	49%
7	Total Ground Water availability (Dynamic+Static)	121840

Thus the availability of water resource is not uniformly distributed over time. This resource depletes often in summer, Therefore reduction of bore well's yield in lean period. The area is covered by Chotanagpur granite gneiss complexes where ground water potential of deeper aquifer is very less and limited thickness of fracture/joints are encountered in exploratory well drilling programme.

In Ranchi district (parts) high dependency on ground water for Industrial and Domestic as well as irrigation purposes. Existing ground water draft for Irrigation is 9482 ham and existing Domestic and industrial ground water draft is 5309 ham which constitute total existing Gross Ground Water Draft for all Uses is 14788 ham. Deeper aquifers of Ranchi Urban area is showing declining trend of water levels.

In Khunti and Lohardegga districts (parts) dependency on ground water is generally concise in Irrigation draft.. The irrigation draft is 3210 ham and 3116 ham respectively.

5.1.2 Quality Aspects:

The ground water quality of the study area is potable and is suitable for irrigation as well, however at few localities contamination in ground water due to geogenic cause. The major problems and issues related to the quality is fluoride, iron, nitrate. The concentration of fluoride in the study area having more than permissible limit i.e 1.5 mg/l encountered in deeper aquifer in Ranchi, Khunti and Lohardegga districts. In Ranchi district Fluoride contamination has been observed in parts of Wells at Ormanjhi. Dug wells & bore wells constructed in these areas must be tested for Fluoride before being used.

5.2 Future demand scenario and stress aspects of the aquifer:

Ground Water Modeling is required to estimate the different scenario and stress aspects of the aquifer response. Few of the prospective scenarios is given in *Table23.*

Table 23 Future demand scenario and stress aspects of the aquifer

S,No,	Scenario (stress applied)	Aquifer-I Response	Aquifer-II Response	Remarks
1.	Existing Draft due to pumping	decline		
2.	Ground water draft increased to 10% in next year			
3.	Draft increased 50% from the present level @ 5% annually from the present condition			
4.	Drought condition			

5.3 Participatory ground water management issues:

The most of the study area falls under tribal population, having their own traditions, culture and beliefs. Illiteracy, monetary and ignorance is one of the sections they are being failed to manage the aquifer. The electric supply has still not reached in many villages of the study areas and where it is reached the supply of electricity is erratic. The problem of low voltage and its non availability during agricultural activities are the major problem faced by cultivators/farmers.

6.0 MANAGEMENT STRATEGIES

In management part of the phase I area, we have to prepare separate plan for over-exploited blocks, semi-critical blocks and safe blocks based on the ground water resource availability and draft condition of the area .

6.1 Management objective and option:

Prime Management objective is keeping in view of stage of development 70% and Management options are ;

- Implementation of Rain Water Harvesting & Artificial Recharge Techniques.
- Adoption of advance irrigation practices & Change in cropping pattern.

6.2 Management plan for Over-Exploited block:

In the study area, Kanke block comes under over exploited block where the net dynamic ground water availability in the area is 3588 ham .Existing gross ground water draft for irrigation is 1177 ham. Existing gross ground water draft for domestic and industrial water supply is 3217 ham and ground water draft for all uses is 4394 ham, making stage of ground water development 122.44%. As per the draft condition of over-exploited block its clearly indicate that Domestic and Industrial draft is on higher side rather than irrigation draft. The area is under intensive Domestic and Industrial draft may be due to urban agglomeration.

To reduce Domestic and Industrial draft and keep stage of development at 70% we have to reduce draft upto 1882.ham or adopt recharge practices of ground water. The ground water requirement pattern of kanke block is given in *Table 24***.**

Table 24 Ground water requirement pattern in Kanke block

S.No.	Items	Volume of water (ham)
1	Net dynamic ground water availability	3588
2	Existing gross ground water draft for irrigation	1177
3	Existing gross ground water draft for domestic and industrial water supply	3217
4	Existing gross ground water draft for all uses	4394
5	Net ground water availability for future irrigation development	- 806
6	**Proposed gross ground water draft for all uses**	**2512**
7	**Reduction in ground water draft for stage of development 70%**	**1882**

6.2.a. Aquifer wise space available for recharge and proposed interventions

The computational procedure for computing the aquifer wise in-storage ground water resource comprising the following steps

- The area of the ground water assessment unit for which the static ground water resource is to be computed is obtained.
- The depth below ground level up to which the zone of water table fluctuation occurs is obtained. This can be taken as the maximum depth below ground level recorded during the pre-monsoon interval. An acceptable depth below ground level up to which ground water can be mined is obtained. This will be usually less than the maximum depth below ground level up to which the saturated aquifer formation extends.

The assessment of total availability of ground water resource has been carried out using following methodology.

In- Storage Ground Water Resource Assessment:

Thickness of Aquifer (granular/productive zone) * Sp.yield * Area below zone of fluctuation water

Parameter used : Specific Yield
Depth of Assessment of in-storage Ground Water Resources
For Alluvial Area: Upto bed rock
For Hard rock area: Depth upto which the aquifer is commonly developed

6.2.b Aquifer wise availability of Kanke block:

The over-exploited area comes under hard rock terrain (Chotanagpur granite gneiss) therefore aquifer wise ground water resource availability is given below considering specific yield 1.5%.

For Aquifer I

AQUIFER I	
Area (A) (sqkm)	416.09
Pre-monsoon (average) depth to water level (mbgl) (B)	5.71
Average depth to bed rock (mbgl) (C)	30
Specific yield (Sy)	1.5%
Saturated zone thickness (B-C) of aquifer (ST)	24.29
Resource (A * Sy * ST)	151.60 mcm

For Aquifer II

Aquifer II	
Area (A) (sqkm)	416.09
Thickness of fracture from weathered zone to the depth of 200m-(ST)	3 m
Specific yield (Sy)	1.5%
Resource (A * Sy * ST)	18.72mcm

Aquifer wise static ground water resource

Aquifer-I	151.60 mcm
Aquifer-II	18.72mcm

Total Availability = Dynamic Ground Water Resource + In- Storage Ground Water Resource

Total Availability (Mcm) *= 35.88 + 170.32 = 206 mcm*

6.2.c. Source water requirement/availability for recharge, Types and number of Recharge structure:

Based on NHS monitoring well data area suitable for artificial recharge has been segregated into 2 categories as follow:

1. Depth to water level < 3 mbgl and declining trend of .010m/year
2. Depth to water level more than > 3 and declining trend of .010 m/year.

The location map showing high decaling trend of Ranchi urban area is shown in *figure 22*

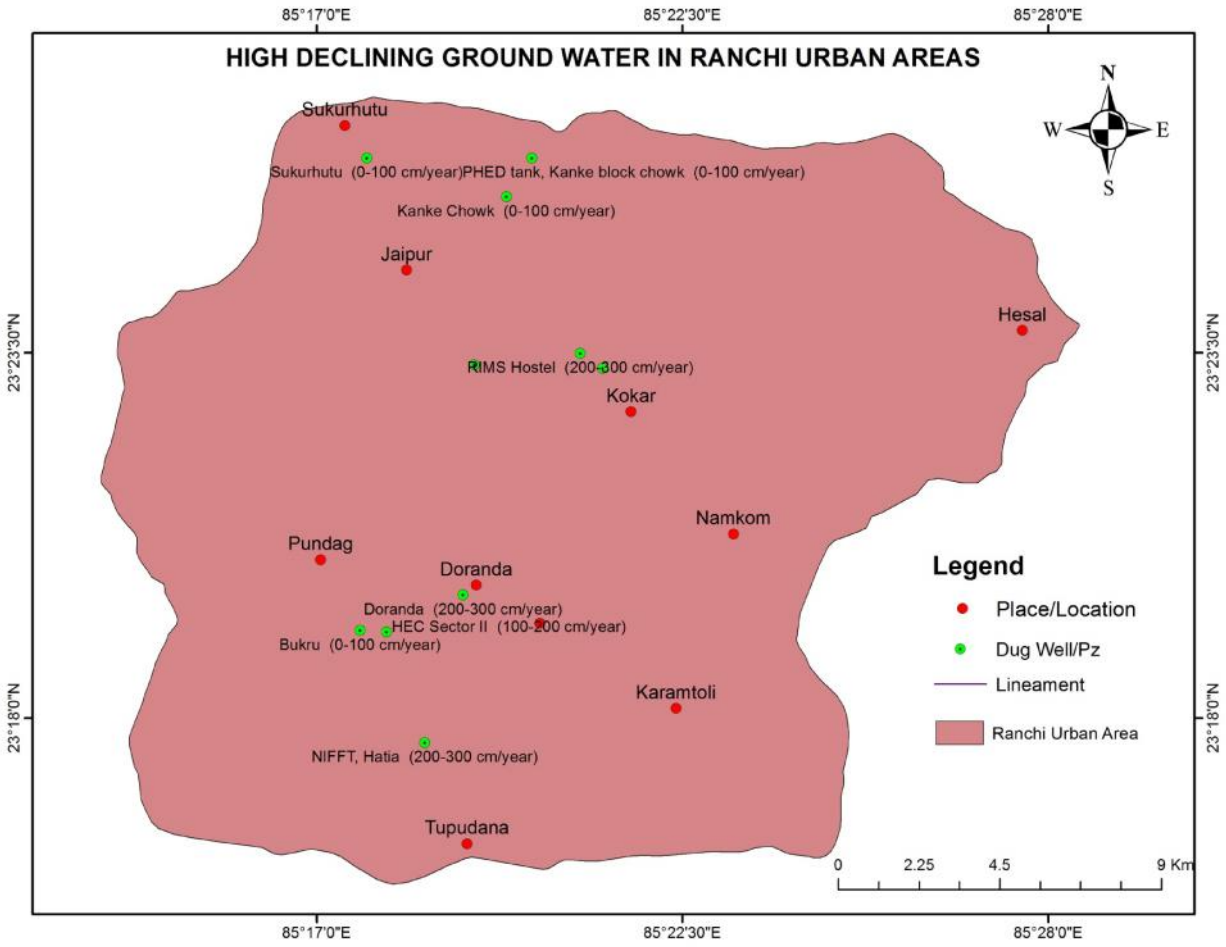

figure22

6.2.d Estimation of Available Sub Surface Storage Potential

The thickness of unsaturated zones (below 3 mbgl) of above categories is estimated by considering the different range of water level. The total volume of unsaturated zone is calculated by considering the above categories and unsaturated thickness of different ranges. This volume was multiplied by specific yield i.e. 1.5 % for hard rock or 10% for alluvial on area specific basis to arrive the net amount of water required which is to be recharge by artificial recharge to saturate the aquifer up to 3 mbgl. The details of sub surface storage potential and no of AR structures required in the study area is shown in *Table 25***.**

Table-25 details of sub surface storage potential & no of AR structures required

	Sub surface storage available (mcm	Surface water required (mcm)	Runoff available (mcm)	Non-committed Runoff available (mcm)	Number of recharge shaft/ tube well/ NB/CD/CP/ percolation tank/ponds
Kanke	**4.74**	**6.31**	**185.48**	**55.64**	recharge shaft/ tube well- **63**
					percolation tank- **6**
					NB/CD/CP- **105**
					Pond -**32**

6.2.e Projected status of Ground Water Resources & Utilization:

After interventions of AR structure the following output comes in respect of stage of development. The details of output are given in *Table.26*

Table.26 Projected status of ground water resources and its utilisation in kanke block

Block	Net Ground water availability	Additional recharge from water conservation &AR structure	Total net ground water availability after	Existing Gross Ground water Draft for all uses	Net ground water draft after intervention	Present stage of ground water development	Projected stage of ground water development after interventions
	Mcm	Mcm	Mcm	Mcm	Mcm	%	%
Kanke	35.88	4.74	**40.62**	43.94	43.94	**122.44**	**108**

The proposed suitable location of AR structures of Ranchi urban area is shown below in *figure 23*

Proposed suitable location of AR structures of Ranchi urban area

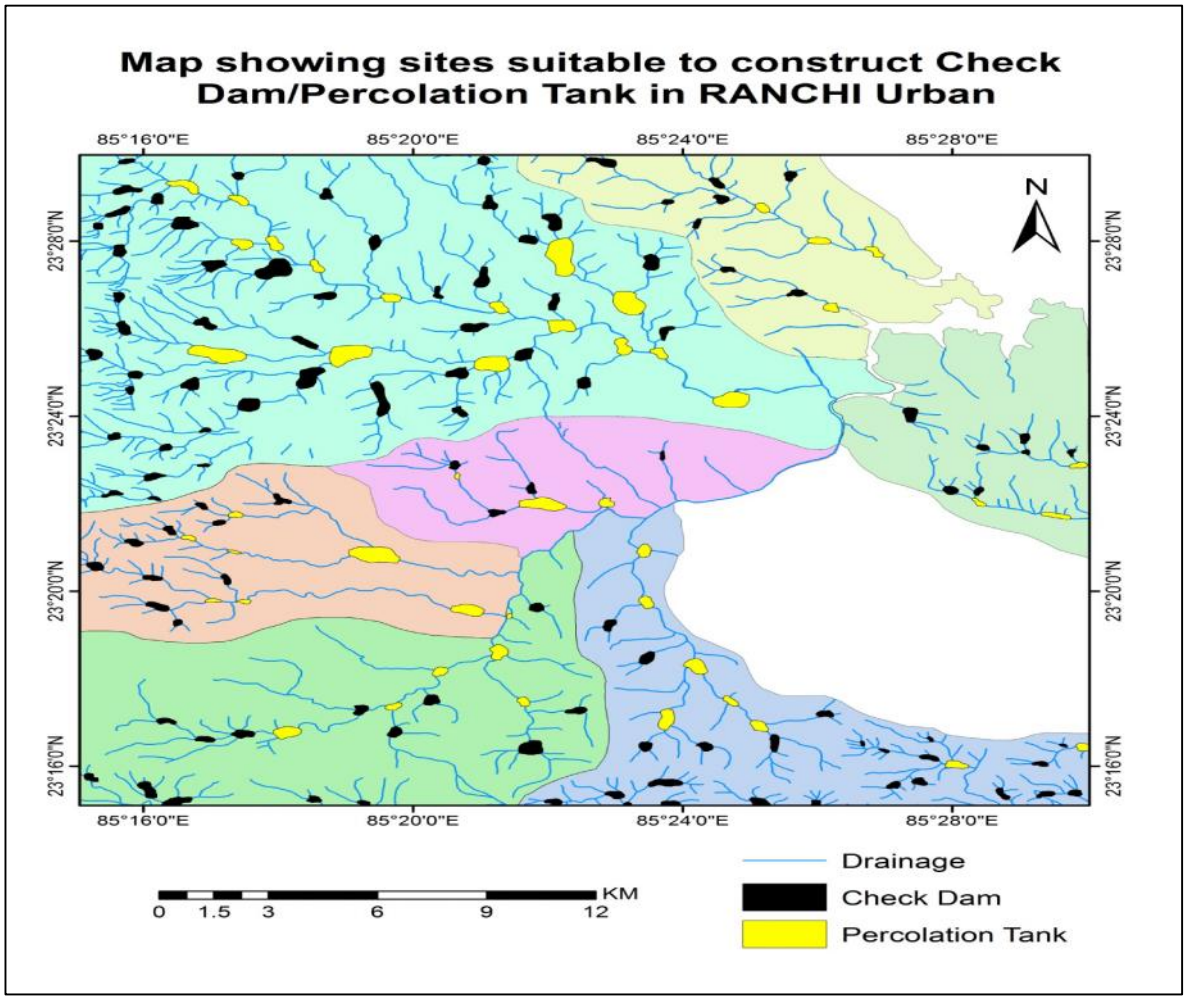

figure 23

Roof-Top Rain Water Harvesting:

Implementation of Roof top rain water harvesting we can also enhance the ground water availability. A generalized plan for roof top rain water harvesting is given below:

- One rooftop having area 500 square feet = 45 square meters
- Rainwater that can be harvested from one roof with 75% efficiency = 34 cubic meters

  Considering urban households around 1 Lac, total rainwater that can be harvested =**3.4 million cubic meters (mcm)** can be recharge by roof top rain water harvesting system

The proposed suitable location of Roof Top Rainwater Harvesting of Ranchi urban area is shown in *figure 24*

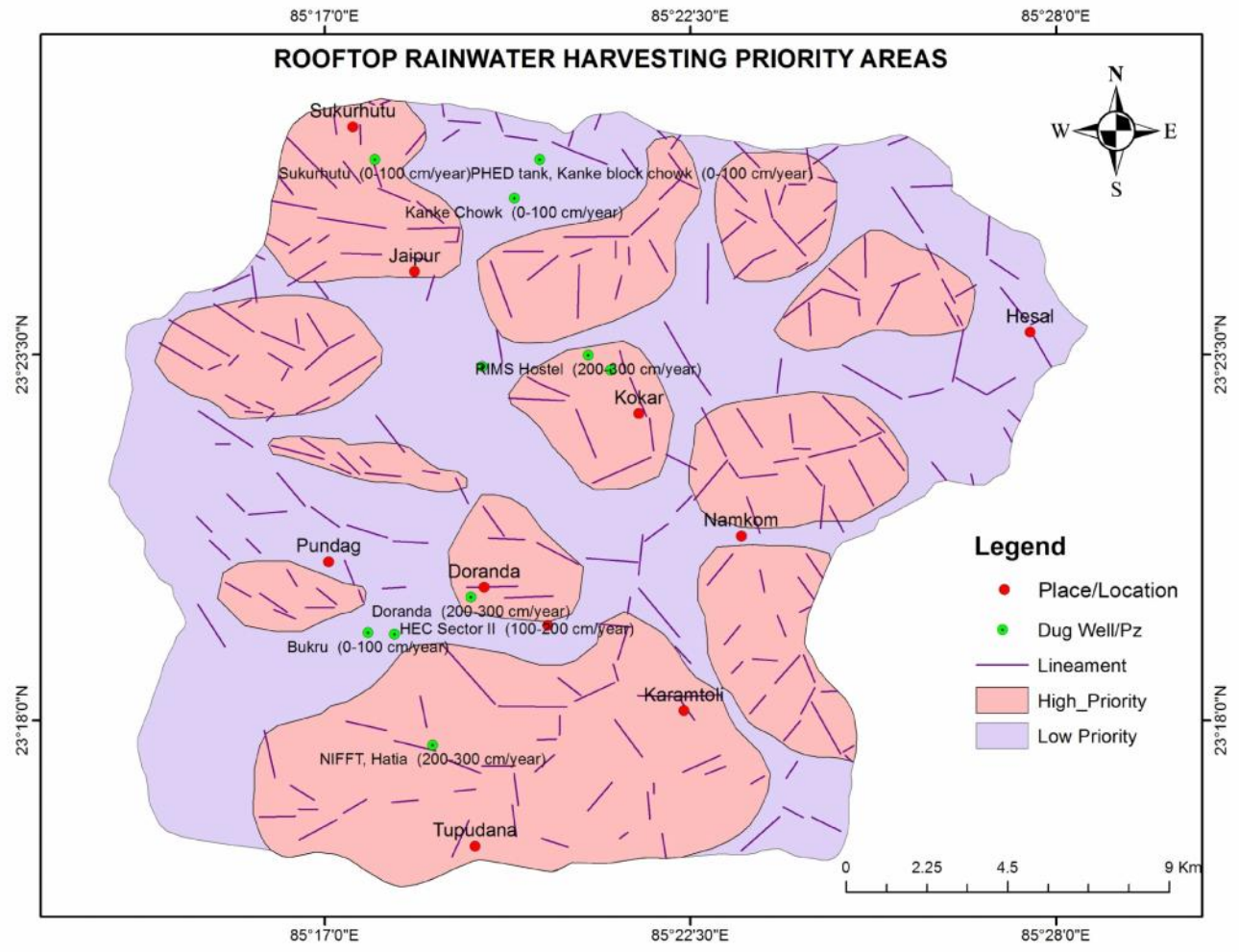

figure 24

6.3 Management Plan for Semi-Critical blocks:

The study area of phase I total three numbers of blocks namely, Ormanjhi, Ratu and Lohardegga which comes under semi-critical categories. These three blocks are intensive agricultural area where irrigation draft is more as compared to domestic and industrial draft. The ground water requirement pattern of semi-critical blocks should be managed to keep stage of development 70%. The volume of water required is given in *Table 27*

Table 27 Ground Water Management Pattern in semi-critical blocks

S.No.	Items	Ormanjhi	Ratu	Lohardegga
		Volume of water in ham		
1.	Net dynamic ground water availability	1828	2399	1306
2	Existing gross ground water draft for irrigation	1303	1454	761
3	Existing gross ground water draft for domestic and industrial water supply	140	231	147
4	Existing gross ground water draft for all uses	1443	1686	909
5	**Proposed gross ground water draft for all uses**	**1280**	**1679**	**914**
6	**Reduction in ground water draft for stage of development 70%**	**163**	Marginal reduction required to maintain SOD 70%	Marginal reduction required to maintain SOD 70%

6.3.1 Aquifer-wise availability of the semi-critical blocks;

The total availability of ground water resources (i.e. dynamic + in-storage resource) is computed block wise and the computational procedure which is already discussed above in 6.1.c. The ground water resource availability estimation for semi-critical blocks is shown in *Table 28*

Table 28-Aquifer wise availability in Lohardagga, Ormanjhi and Ratu blocks

S.No.	Block	Net dynamic ground water availability (mcm)	Aquifer I (mcm)	Aquifer II (mcm)	Total Ground water availability (mcm)
1	Ormanjhi	18.28	63.11	8.55	**89.94**
2.	Ratu	23.99	55.33	8.42	**87.84**
3.	Lohardegga	13.06	49.15	6.66	**68.87**

6.3.2 Augmentation plan of the resource through artificial recharge and water conservation

The thickness of unsaturated zones (below 3 mbgl) of above categories is estimated by considering the different range of water level. The total volume of unsaturated zone is calculated by considering the above categories and unsaturated thickness of different ranges. This volume was multiplied by specific yield i.e. 1.5 % for hard rock or 10% for alluvial on area specific basis to arrive the net amount of water required which is to be recharge by artificial recharge to saturate the aquifer up to 3 mbgl. The details of sub surface storage potential and no of AR structures required in the study area is shown in *Table-29*

Table-29 Details of sub surface storage potential and no of AR structures required

	Sub surface storage available (mcm	Surface water required (mcm)	Runoff available (mcm)	Non-committed Runoff available (mcm)	Number of recharge shaft/ tube well/ NB/CD/CP/ percolation tank/ponds
Oramanjhi	6.47	8.61	77.81	22.34	recharge shaft/tube well- **86**
					percolation tank- **9**
					NB/CD/CP- **143**
					Pond -**43**
Ratu	5.20	6.91	74.17	25.25	recharge shaft/tube well- **69**
					percolation tank- **7**
					NB/CD/CP- **115**
					Pond -**35**
Lohardagga	3.18	4.22	63.18	18.95	recharge shaft/tube well- **42**
					percolation tank- **4**
					NB/CD/CP- **70**
					Pond -**21**

6.3.3 Projected status of Ground Water Resources & Utilization:

After interventions of AR structures the following result comes out in respect of stage of development. The details of output are given in *Table30.*

Table30-Projected status of GW resources its utilisation in Semi-critical blocks

Block	Net Ground water availability	Additional recharge from water conservation &AR structure	Total net ground water availability after intervention	Existing Gross Ground water Draft for all uses	Net ground water draft after intervention	Present stage of ground water development	Projected stage of ground water development after interventions
	Mcm	Mcm	Mcm	Mcm	Mcm	%	%
Ormanjhi	18.28	6.47	**24.75**	14.43	14.43	**78.94**	**58**
Ratu	23.99	5.20	**29.19**	16.86	16.86	**70.30**	**57**
Lohardagga	13.06	3.18	**16.24**	9.09	9.09	**70**	**56**

6.4 Demand side management:

In demand side intervention, the area proposed to be taken where intensive irrigation practices is going on especially in parts of Ormanjhi, Ratu, Lohardegga and some part of kanke blocks. Principal crops of these areas are ;(Kharif)- Paddy, Maize, pea, , Green gram, Groundnut, Urd and (Rabi)- Wheat, Chickpea, Pea, Arhar. The volume of water expected to be conserved after taking 50% of the total area under advance irrigation practices is shown in *Table-31*.

Table-31 Volume of water expected to be conserved in Lohardagga,Ormanjhi and Ratu

Type	Area proposed to be covered	Crop	Volume of water consumption before adoption of Advance irrigation practices (mcm)	Volume of water expected to be conserved (mcm)
Sprinkler	2867 ha	Wheat	4000	1300
Sprinkler	2867 ha	Mustard	3000	1440
Drip	2867 ha	Arhar	3000	1080

6.5 Change in cropping pattern:

In the study area of phase I change in cropping pattern in which Kharif crops replaced by Kharif crops and Rabi replaced by Rabi crops. Total volume of water conserved after 50% change the cropping practices expected volume of water to be saved after adoption of change in cropping pattern are shown in *Table-32*

Table-32 Expected volume of water to be saved after adoption of cropping change

Area	Total water conserved after 50% change the cropping practices (mcm)
Kanke	6.13248
Ormainjhi	0.86674
Ratu	0.86674
Lohardagga	0.6298

6.6 Management plan for Safe blocks:

6.6.1Plan for Ground Water Development:

The present status of ground water development of the phase I area is only 49% . although the ground water development in central and western part is more, there are ample scope of ground water development in southern and eastern part of the area. The Net ground water availability and future irrigation development and stage of ground water development of safe blocks are given in *Table 33*

Table-33 Net GW availability for future irrigation development and SOD

District	Assessment unit	Net ground water availability for future irrigation development in ham	Stage of ground water development (%)
Ranchi	Angara	2337.12	8.81
	Bero	2128.45	34.08
	Bundu	1491.29	24.95
	Burmu	2234.68	33.47
	Chanho	882.48	50.99
	Mandar	1063.58	59.95
	Namkum	1372.95	57.50
Lohardagga	Bhandara	786.52	52.63
	Kuru	981.48	46.69
	Senha	1300.41	38.59
Khunti	Karra	1419.91	47.10
	Khunti	2380.44	28.61
	Murhu	1518.86	27.03
	Torpa	1460.84	34.55

Out of 20 blocks, the stage of development is less than 50%, there are fourteen blocks having stage of development is less than 60% are considered for the further ground water development. District wise balance ground water for future irrigation potential is determined by deducting ground water draft for irrigation and allocation for next 25 years (up to year 2033). The ground water available for future irrigation is divided by an average depth of irrigation (△), considering of 0.40m for Jharkhand, which ultimately gives irrigation potential *(Table.34).* Considering 70% of future irrigation potential as optimum utilization with .45 ha area for dug well and considering 60% for dug well, the numbers of proposed ground water abstraction structures are obtained which is shown in *Table 34*

Table 34 Future irrigation potential created and proposed number of dug wells

District	Assessment unit	Net ground water availability and future irrigation development (ham)	future irrigation potential available (ha)	70% of future irrigation potential created (ha)	Proposed number of ground water structure (Dug wells)
Ranchi	Angara	2337.12	5842.8	4089.96	5453
	Bero	2128.45	5321.125	3724.788	4966
	Bundu	1491.29	3728.225	2609.758	3480
	Burmu	2234.68	5586.7	3910.69	5214
	Chanho	882.48	2206.2	1544.34	2059
	Mandar	1063.58	2658.95	1861.265	2482
	Namkum	1372.95	3432.375	2402.663	3204
Lohardegga	Bhandara	786.52	1966.3	1376.41	1835
	Kuru	981.48	2453.7	1717.59	2290
	Senha	1300.41	3251.025	2275.718	3034
Khunti	Karra	1419.91	3549.775	2484.843	3313
	Khunti	2380.44	5951.1	4165.77	5554
	Murhu	1518.86	3797.15	2658.005	3544
	Torpa	1460.84	3652.1	2556.47	3409

Development of ground water for the safe blocks in phase I area requires thorough understanding of the heterogeneity of the formations, non-uniformity in the degree and nature of weathered and fractured zones based on the aquifer and its disposition. The feasibility of different ground water structures together with yield prospects for the balance ground water resources for future irrigation use may be computed as in **(***Table 35).*

Dug wells are feasible ground water structures for the study area. The construction of 49838 additional ground water abstraction structures would bring an additional area of 22426 ha under assured irrigation. This would involve a total expenditure of Rs 423 crore *(Table 36)*

Table 35.Proposed feasible GW abstraction structures based on balance potential

GW Balance to be utilized for irrigation (ham)	Type of structure	Depth range (m)	Diameter (m)	Probable yield range (lps)	Command/ Non Command area (ham)	No of GW abstraction structure to be constructed
22426	Dug well	12 to 20	3 to 5.5	2 to 5	.45	49838

Table 36.Proposed cost estimation for feasible GW abstraction structures

S.No.	Description	No of GW abstraction structure	Unit cost Rs	Construction Cost in Crore Rs
1	Construction of dug wells fitted with pump set	49838	80000	398
	Total			398
2	Annual maintenance cost	---	5000	25
3	**Grand Total**			**423**

Management Strategies:

The following management strategies proposed to be adopted for safe blocks of phase I area.

- Ground water draft for irrigation may continue with same pace.
- No change in Industrial and Domestic water draft.
- Ground water development and irrigation potential creation.
- No change in cropping pattern