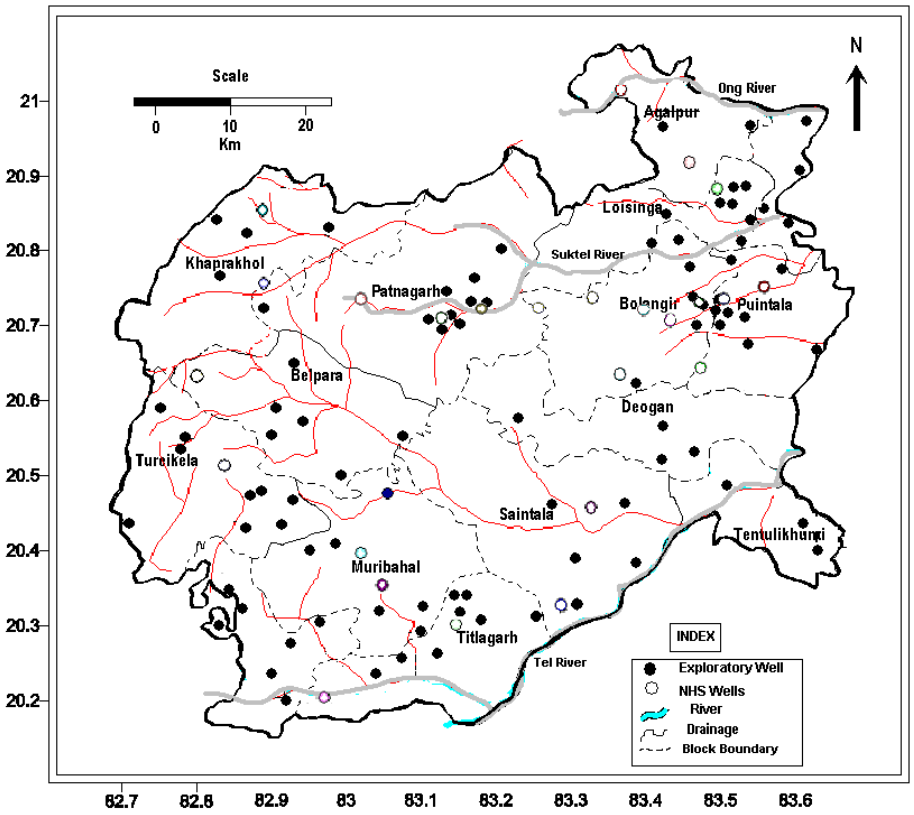
GROUND WATER INFORMATION BOOKLET

BOLANGIR DISTRICT, ORISSA



Ministry of Water Resources
Central Ground Water Board,SER
Bhubaneswar
March, 2013

GROUNDWATER BROCHURE OF BOLANGIR DISTRICT, ORISSA

C O N T E N T S

DISTRICT AT A GLANCE

Sr. No.	Items	Statistics
1	**GENERAL INFORMATION** (i) Geographical Area (Sq. km) (ii) Number of Blocks (iii) Number of Panchayat (iv) Number of Villages (v) Population as on 2001 Census (vi) Average annual rainfall (mm)	 6569 14 285 1792 13,35,760 1792
2	**GEOMORPHOLOGY** 1.Major Physiographic Units 2.Major Drainages	 (i)Undulating plains dotted with residual hills (ii)Scattered hill with high relief Ong, Tel, Suktel, Lant & Indra
3	**LAND USE (SQ KM)** a) Forest Area b) Net Area Sown	 4315.8 28052.7(Kharif)
4	**MAJOR SOIL TYPE**	Alfisol, Utisol, Vertisol
5	**AREA UNDER PRINCIPAL CROPS**	1. Autumn – 82664 Ha 2. Winter – 129221 Ha 3. Summer – 1127 Ha
6	IRRIGATION BY DIFFERENT SOURCES (Area and nos of structures) 1. Canals 2. Net Irrigated Area	 (i) Major & Minor Irrigation Project – 6077.3 Ha. (ii) Minor Irrigation Project (Flow) – 14000 Ha(Kharif); 1392 (Rabi) (iii) Lift Irrigation Project – 7628(Kharif);7628(Rabi) 27705 Ha (Kharif) 9020Ha(Rabi)

7	NUMBER OF GROUN WATER MONITORING WELLS OF CGWB (as on 31.3.2011) 1. No of BoreWells 2. Nos of Piezometers	 44 Nil
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	(i) Eastern Ghat Supergroup of Rocks (Precambrian Crystalline Rocks) (ii) Lower Gondwana Formation (iii) Quternaries
9	**HYDROGEOLOGY** • Major Water Bearing Formations • Pre-Monsoon Depth to Water Level during 2011 • Post-Monsoon Depth to Water Level during 2011 • Long Term water level trend in 10 yrs (2001-2011) in m/yr	Weathered & Fractured Crystalline Rocks 1.33 mbgl to 8.85 mbgl 0.78 mbgl to 6.85 mbgl 50% of wells show rise from 0-2m, 3.6% wells show rise from 2-4 m (Pre-monsoon). 77.8% of wells show rise in 0-2 m, 8.3% of wells show rise from 2-4 m (Post monsoon).
10	GROUND WATER EXPLORATION BY CGWB (As on 31.3.2011) No of wells drilled (EW,OW,Pz,SH,Total) Depth Range (m) Discharge (lps) Transmissivity(m ²/day)	 E/W - 52 (Departmental) O/W – 13 (do) E/W-47 (Outsourcing) Total – 112. 32 – 299.28m Negligible to 25 0.68 to 659
11	**GROUND WATER QUALITY** Presence of Chemical constituents more than permissible limit (e.g. EC ,F,AS,Fe) Type of water	 EC and F value higher in limited patches. Normal(pH 7.12 to 8.19 mg/ltr)

12	DYNAMIC GROUND WATER RESOURCES (2009 in mcm) 1. Net Ground Water Availability 2. Net Annual Ground Water Draft 3. Projected demand for domestic and industrial uses up to next 25 yrs 4. Stage of Ground Water Development	 576.56 121.21 33.8 21.02%
13	**AWARENESS AND TRAINING ACTIVITY** Mass Awareness Programmes organized Data Place No of Participiants	 Two 26.03.03 and 21.03.04 Titlagarh, Titlagarh Block Bolangir Town, Bolangir Block 200,250.
	Water Management and Training Programmes Organised Data Place No of Participiants	Two 26.03.03 and 21.03.04 Titlagarh, Titlagarh Block Bolangir Town, Bolangir Block 50,50.
14	EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING Projects compiled by CGWB (No & Amount spent) Projects under technical guidance of CGWB (numbers)	 Nil Nil
15	GROUND WATER CONTROL AND REGULATION No of OE Blocks No of Critical Blocks No of Blocks Notified	 Nil Nil Nil
16	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Groundwater pollution & depletion in parts of blocks

1.0 INTRODUCTION

Bolangir is one of the economically backward district of western Orissa with a geographical area of 6569 Sq.Km and is an integral part of Western Orissa Development Council constituted by Govt. of Orissa very often reels under severe drought condition. About 89 percent of the population of the district live in rural areas and agriculture is the main stay of the people. The agriculture is mostly rainfed and due to lack of adequate irrigation facilities and recurring severe drought conditions in the district, the agricultural production is very often curtailed. In the year 1996 the district witnessed an unprecedented drought situation. Bolangir district lies between North latitudes 21°4' and 20°9' and East longitudes 82°41' and 83°32', failing in Survey of India toposheet nos. 64O, 64P & 64L. It is bounded on the North by Bargarh district, in the East by Suvarnapur district and in the South and West by Kalahandi and Nawapara district respectively. The district is well connected by rail and roads. Two National Highways are passing through the district. The Titilagarh railway station is a junction connecting Raipur – Vizianagaram and Titilagarh – Jharsuguda broad gauge railway tracts. All the block headquarters are connected by mettalled roads. The district comprises three subdivisions namely Bolangir, Patnagarh and Titilagarh and 14 community Development blocks with the district headquarters at Bolangir (Plate-I). According to 2011 census data, the total population of the district is 1648574 constituting nearly 4 percent of the total population of Orissa. The rural and urban populations are 1182871 and 154323 respectively. The rural population constitutes 88.46 % of the total population. The density of population is 251 against the state figure of 236 persons per sq. km.

The rivers Tel and its tributaries like Suktel, Lant, Indra etc. constitute the main drainage system in the district. The river Tel and its tributaries flow from West to East. The river Ong which is a tributary of Mahanadi is flowing in the northern part of the district following an easterly course. The rivers are generally perennial in nature with a very nominal flow during summer months. Drainage pattern is dendritic. Studies on satellite imageries and hydrogeological surveys have revealed that the drainage pattern in the district is controlled by the fracture system which is developed due to tectonic activity in the area.

The district has limited irrigation facilities as per available data. The net irrigated area from different sources is 27705 ha. The Ong dam is a Medium Irrigation Project, which caters to flow irrigation. In addition to Ong medium irrigation project the other ongoing major irrigation projects in the district are lower Lant (CCA 21444 Ha) , upper Lant (4700 Ha) upper Suktel (1350 Ha) and lower Tel (46598 Ha). Besides that other two ongoing Medium Irrigation Projects are Titilagarh and Harihar with designed ayacut of 2000 and 9950ha respectively. Block-wise and source-wise irrigation details of the district is presented in the following table. The sourcewise Irrigation potential created in the district from various sources has been tabulated in Table-1.1. The irrigation potential created from ground water resources is 23983 and 6549 Ha in Kharif and Rabi respectively.

Systematic geological mapping of the district has been completed by the officers of Geological Survey of India. The entire district has been covered by

systematic hydrogeological survey by S/Shri B.B. Basak, P.K. Das, Scientist 'B', A.D. Rao, Asst. Hydrogeologist of Central Ground Water Board during the period 1977 – 1987.The district has further been covered through reappraisal surveys by S/Shri A.Kar, S. Subburaj, K.C.Naik, Scientist 'B', G.C. Pati, Scientist 'B' & Sh. A.K.Biswal, Scientist 'B' during 1987-88, 1991-92 ,1994-95, 2006-07 respectively. The district report on hydrogeological framework and groundwater development prospects in Bolangir District, Orissa was prepared by Sh. K.C.Naik, Scientist 'D' on May, 2006.

Ground water exploration by deep drilling upto 200m has been taken up in the district and 112 nos. exploratory wells so far has been drilled to delineate the deeper potential water saturated fracture zones. The location of the wells are depicted in Plate –I Ground water monitoring is being done through 44 hydrograph network stations four times in a year.

2.0 RAINFALL & CLIMATE

The south-west monsoon is the principal source of rainfall in the district. Average annual rainfall of the district is 1229.47mm. About 80% of the total rainfall is received during the period from June-September. Droughts are quite common in the district. The rainfall is scanty in the west and west-central parts of the district i.e. in the Patnagarh subdivision, which increases in east and southern directions. Block-wise average annual rainfall varies from 946.0 mm to 1492.10-mm.

The climate of the district is tropical with hot and dry summer and pleasant winter. The summer season extends from March to middle of June followed by the rainy season from June to September. The winter season extends from November till the end of February. Humidity is high during middle of June and it's less in post-monsoon period. The relative humidity in the district varies from 26% to 84% through out the year. The mean monthly potential evapotranspiration value ranges from 45mm in December to 470 mm in May. Wind is generally light to moderate. During summer and Southwest monsoon months wind velocity increases. The mean annual wind speed is 3.3 Km/hr.

3.0 GEOMORPHOLOGY & SOIL TYPES

The district can be divided into two broad physiographic units (i) undulating plains (Pediments) dotted with residual hills and (ii) scattered hills and areas with high relief. The undulating plains occupy the central and eastern parts of the district the average elevation being 200m to 300m above mean sea level with a general slope towards east. The areas with high relief and high hills are situated in the north western, western and south eastern parts of the district (Plate-V). The hill ranges belong to the Eastern Ghats having a general trend of Northeast – Southwest. The highest peak is Gandhamardan situated 983 m above mean sea level.

The distribution of different soil types in the district depends much on its physiographic and lithologic variations. Based on the physical and chemical characteristics, mode of origin and occurrence, soils of the district may be classified into three groups namely Alfisols, Ultisols and Vertisols.

Alfisols : It includes red sandy soils and red loamy soils. The red loamy and sandy soils are occurring in major parts of the district. The characteristic features of red soils are (1) light texture, porous and friable structure, (2) absence of lime Kankar and free carbonates and (3) soluble salts in a small quantity usually not exceeding 0.05%. These are usually deficient in nitrogen, phosphate, organic matter and lime. These soils are suitable for cultivation of paddy and other crops.

Ultisols : These are lateritic soils occurring in northwestern part of the district in Khaprakhol block in a limited area. These are characterized by compact to vesicular mass in the subsoil horizons composed essentially of a mixture of the hydrated oxides of aluminum and iron. Due to peculiar granular nature, these soils can be cultivated immediately after heavy rains.

Vertisols : These are medium black soils found in the blocks of Loisinga, Bolangir and Puintala especially in the areas mostly underlain by anorthosite. The soils are highly argillaceous and contain high amount of iron, calcium and magnesium. These are poor in organic matter, nitrogen and phosphorous but rich in potash and lime. The pH varies from neutral to alkaline and texture varies from loam to clayey loam. These are quite fertile soils and the crops grown are generally cotton, wheat, tobacoo and chilly.

4.0 GROUNDWATER SCENARIO

4.1 Hydrogeology

The hydrogeological framework of the district is mainly controlled by the geological set up, rainfall distribution and the degree of secondary and primary porosities in the geological formations for storage and movement of ground water. Since major parts of the district are underlain by hard rocks of diverse lithological composition and structure, the water bearing properties of the formations also vary to a great extent. The area has undergone several phases of intense tectonic deformations which has been responsible for the development of deep seated intersecting fracture system. Hydrogeological surveys in the district reveals the lithological characteristics and the role of tectonic deformation on the occurrence and distribution of ground water reservoirs and their water bearing and water yielding properties. Lineaments formed due to tensile deformation were picked up from remote sensing studies. The structural elements mainly control the occurrence and movement of groundwater in the typical fractured crystalline basement terrain. The major hydrogeologic units in the district can be subdivided into three broad groups.

(i) Areas underlain by fractured, fissured and consolidated basement rock formations.

(ii) Areas underlain by the semi consolidated (Gondwana) formation.

(iii) Areas underlain by recent unconsolidated alluvial formations.

Water bearing properties of the Consolidated formations :

The crystalline rocks like Khondalites, granite gneisses, charnockites, quartzites and anorthosites, which are devoid of primary porosity, occupy about 95% of the area of the district. The weathered residuum and jointed & fractured portion of these consolidated rocks constitute principal water bearing horizons. The thickness of the weathered zone is generally more in the topographic lows and undulating plains than in the high land areas. Ground water occurs under phreatic condition in the weathered zone and in semi-confined to confined condition in deeper fractured zones. The water yielding capacity of fractured rocks largely depends on the extent of fracturing openness and size of fracture and nature of their inter connections. Usually two to four water bearing fractures occur down to a depth of 100m below ground level. Potential fracture zone is encountered even at depth of 178 m at Kanut (Block-Belpara).

Granites and Granite Gneisses Including Bonai granite :

These are the most predominant rock types occurring in the undulating plains and topographic lows. Depending upon the topographic set up, the depth of weathering ranges from 5.5m to 17.50m and occasionally extends up to 35.5m depth. The weathered residuum and fracture zones form principal aquifers. In deeper fracture zones ground water occurs under confined to semi-confined conditions. In general the deep bore wells in these rocks can sustain yield of 2 to 25 LPS depending upon topographic setting, proximity to the major lineaments, thickness of weathered residuum and number of saturated and interconnected fractures encountered. The granites and granite gneiss can be developed through open wells and borewells. High yielding wells are recorded in the western parts of the district where the discharge ranges from 10 to 25 LPS. Specific capacity of the dug wells tapping the weathered zone ranges from 6 to 286 LPM/M drawdown.

Khondalites : These rocks generally form steep linear ridges hence don't form potential aquifers. Well foliated nature of these rocks allows deep weathering. In the pediment areas, the thickness of weathering is varying from 5 to 32m. Ground water occurs under water table condition in the weathered zone and circulates through deeper fractures. The yield of bore wells range from 1 to 5 LPS. The specific capacity of the dug wells ranges from 2.3 to 13.3 LPM/m draw down.

Charnockite : These formations are of very much restricted occurrences in the district. Due to paucity of joints and fractures the thickness of weathering in these formations is limited up to 10m. Due to the compact nature and less weathering, ground water prospects in charnockites are not good.

Gabbro – anorthosites : The rheologic property of these rocks resembles with charnockite, Barring few locations dismal weathering and lack of fracturing renders these formation as a bad water yielder. The Sp. Capacity of dug wells in anorthosite vary from 16 to 102 LPM/M drawdown.

Quartzites : This unit also less fractured and weathered hence do not form good aquifers. However fractured quartzites along lineaments yield good amount of water.

Pegmatite and quartz vein : These are course grained intrusives and form good aquifers when fractured.

Semiconsolidated Formation : These are represented by rocks of lower Gondwana formations. These formations have faulted contact with the Precambrians. The friable and loosely connected sandstones form the aquifers. Ground water occurs under water table condition in the weathered zone and under semiconfined to confined condition in deeper fractured and friable sand stone beds. The yield of tube wells in these formation is meager (<1 LPS). Depth of the open wells in this formation ranges from 5 to 12 m bgl. Yield of the open wells in less then 3 LPS.

Unconsolidated Formation : Laterites and alluvium of sub-Recent to Recent age constitute the unconsolidated formations. Laterites occur as capping over the older formations are tapped through dug wells. Recent alluvium occurs as thin discontinuous patches along prominent drainage channels. The thickness of the alluvial deposit varies from 6 to 12m and form potential shallow aquifers. The specific capacity of the dug wells in alluvium vary from 336 to 466 LPM/M draw down.

Aquifer Characteristics of Crystalline: In the hard crystalline rock recharge of ground water from precipitation or seepage from surface water bodies percolate into the weathered (saprolite) zone. In case the underlying basement rocks (both weathered and fresh) are incised by open fractures, the downward movement of the water from the upper regolith zone (comprising the top soil and saprolite horizon) is facilitated. In the saprolite/regolith horizon ground water generally occurs under unconfined condition where as is the fractured bedrock aquifers it occurs under semi-confined to confined conditions. At places confined conditions give rise to the formation of auto flowing wells in the basement rocks as seen at Kantabanji (Block-Tureikela), Dokhra (Block-Belpara), Bhoipara (Block-Muribahal). The ground water potentials of various zones i.e. saprolite (tapped by dug wells), weathered basement rock and shallow fractured basement rock horizon (tapped by the hand pumps) and deeper fractured basement rock (tapped by the deep boreholes by CGWB) vary considerably depending upon their lithological and structural characteristics. A total of 34 pumping tests were conducted in dug wells tapping the saprolite horizons of various rock formations. The various aquifer parameters were derived following methods given by Slichter (1906) and Hvorslev (1951). Perusal of all result indicates that granite gneiss forms the most potential aquifer both in shallow and deeper horizons followed by Khondalite, Calc Silicate rocks and anorthosites. Anorthosites and Gondwana sediments are poor water yielder in deeper horizons where as in the weathered horizon some considerable amount of yield may be obtained from the anorthosites.

In unconsolidated alluvium the specific capacity of dug wells vary from 336-to 466- lpm/m drawdown. Although of limited extant the alluvium forms potential shallow aquifers.

Groundwater Exploration

Exploratory drilling has been taken up by the Central Ground Water Board in Bolangir district with the objective to delineate deeper water bearing fractures in the consolidated formation and their yield potentiality within a maximum depth of 200m. Till March 2011, 112 exploratory and observation wells were drilled in hard crystalline and semiconsolidated formations in the district under Normal Ground Water Exploration Programme and Accelerated Exploration Drilling Programme. The depth range of these wells varies from 32m to 299.28m below ground level. The thickness

of the overburden ranges from 5.5 to 35.5m. The yield of exploratory wells vary from negligible to 25 LPS. Formation wise yield range of the wells is given in the table 4.1.

Table 4.1 Details of Exploration (Litho unit wise)

Sl.	Lithological Unit	No. of Wells	Depth range of wells (mbgl)	No. of wells with yield (LPS)		
				<2	2-5	>5
1.	Granite and granite gneisses	81	61.5-203.3	41	16	24
2.	Anorthosite & Gabbro	12	140.5-200.3	10	2	-
3.	Khondalites, Charnokites and Calc silicate rocks	17	75.2-197.2	9	5	3
4.	Gondwana sand stone and shale	2	32.0-2.99.28	2	-	-

Depth to Water Level (Pre-monsoon and Post-monsoon, 2011)

The depth to water level is measured from the National Hydrograph Staions situated in different blocks of the Bolangir District. The Pre monsoon, 2011 water level data varies from 1.33 mbgl to 8.85 mbgl. The shallow water level was measured from Harisankar and the deepest water level was measured at Muribahahl. The depth to water level map of pre -monsoon, 2011 is displayed in Plate II.

The depth to water level data of Post-monsoon, 2011 represents 0.78 mbgl to 6.85 mbgl. The Dumerbahal shows deepest water level and Suka shows shallowest one. Plate III represents depth to water level map of post –monsoon,2011.

Seasonal Fluctuation

The fluctuation of depth to water level in 2011 shows rise in water level from 0.57 to 5.71mbgl in all the NHS wells except well in Bolangir Sadar where it represents fall of 1.65m.

Long Term Water Level Trend in Last 10 years in Ground Water Monitoring wells

The long term trend (10 years) in water level for the **pre-monsoon** shows rise of 0-2m in 50% of wells and 2-4 m rise in 3.6% of wells in Bolangir district.

The long term trend of (10 years) in water level for **post monsoon** season shows rise in water level for 0-2m in 77.8% of wells and 2-4 m rise in 8.3 % wells in the district .

Table 4.2 Litho unit wise depth to water level range in various seasons

Sl. No.	Formation	No. of wells	Depth to water level range (mbgl)	
			Pre-monsoon (April)	Post-monsoon (November)
1.	Granite gneiss	34	1.09 – 8.33	0.54 – 6.22
2.	Khondalite and Calc Silicate rocks	4	1.81 – 5.26	1.92 – 4.47
3.	Anorthosite	2	3.07 – 7.58	0.61 – 3.55
4.	Gondwana	2	3.72 – 5.22	1.24 – 2.40
5.	Alluvium	2	1.40 – 3.15	1.81 – 4.77

4.2 Ground Water Resources

The Ground Water Resources of the district has been assessed(2009) adopting the methodology recommended by the Groundwater Estimation Committee (1997), constituted by Govt. of India. The task was jointly carried out by the Central Ground Water Board and Ground water Survey & Investigation, Department of Water Resources, Govt. of Orissa. The block wise computation of ground water resources in the district has been presented in Table 4.3. The net ground water availability in the district are computed as 576.56 MCM, out of which the existing Ground Water Draft for irrigation is 909.1 MCM. The ground water draft for irrigation is through dug wells and shallow tube wells. A large number of hand pumps fitted in PHED bore wells and tube wells also cater to the rural and urban water supply needs. On the basis of the estimated ground water potentials a detailed scheme for ground water development may be launched in the district. So far ground water development in the district has been meager, and all the blocks fall under the safe category. The stage of ground water development varies from 14.68% to 32.53% in different blocks. The overall Stage of Groundwater development of the district is 21.02%. There is ample scope for stepping up ground water development in the district. The ground water budget of the district is presented in Plate No. IV.

Table 4.3 Ground Water Resource Estimation Data of Bolangir District.(2009)

Sl No	Block	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for domestic & Industrial Supply	Existing Gross Ground Water Draft for all uses	Provision for domestic & industrial requirement supply for next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	2	4	5	6	7	8	9	10
1	Agalpur	3550.00	590.00	185.23	775.00	221.00	2739.00	21.83
2	Belpara	4906.00	717.00	210.77	928.00	186.00	4003.00	18.92
3	Bolangir	4070.00	942.00	382.00	1324.00	431.00	2697.00	32.53
4	Bongamunda	3516.00	539.00	202.00	741.00	226.00	2751.00	21.08
5	Deogaon	4158.00	594.00	200.00	794.00	222.00	3342.00	19.10
6	Gudvella	2443.00	470.00	121.00	591.00	130.00	1843.00	24.19
7	Khaprakhol	4626.00	506.00	173.94	679.00	186.00	3935.00	14.68
8	Loisingha	3982.00	830.00	181.00	1011.00	215.00	2937.00	25.39
9	Muribahal	4473.00	582.00	202.00	784.00	231.00	3660.00	17.53
10	Patnagarh	5630.00	677.00	250.00	927.00	296.00	4657.00	16.47
11	Puintala	3411.00	711.00	219.00	930.00	242.00	2458.00	27.26
12	Saintala	5201.00	707.00	230.00	937.00	264.00	4230.00	18.02
13	Titilagarh	3691.00	600.00	278.00	878.00	317.00	2774.00	23.79
14	Tureikela	3999.00	633.00	189.00	822.00	213.00	3153.00	20.56
	District Total	**57656.00**	**9098.00**	**3024.00**	**12121.00**	**3380.00**	**45179.00**	**21.02**

4.3 Ground Water Quality

The chemical quality of ground water in the district has been assessed on the basis of ground water samples collected during ground water monitoring, hydrogeological surveys and ground water exploration. The range of different chemical constituents in shallow and deeper aquifers is as follows

Table 4.4 Range of Chemical Constituents in Difference Aquifers

Sl. No.	Constituents	Shallow Aquifer Range	Deeper Aquifer Range
1.	PH	7.23 – 8.20	6.78 – 8.19
2.	Specific Conductance (μs/cm at 25°C)	107 – 1097	404 – 1423
3.	Sodium absorption ratio	0.24 – 4.17	0.76 – 5.90

4.	Calcium (mg/litre)	16 – 134	18 – 120
5.	Magnesium (mg/litre)	1.2 – 67	1.2 – 18
6.	Sodium (mg/litre)	37 – 120	20 – 147
7.	Potassium (mg/litre)	0.4 – 101	0.8 – 4.5
8.	Chloride (mg/litre)	7.1 – 202	8.9 – 213
9.	Sulphate (mg/litre)	Nil – 74	2.3 – 180
10.	Nitrate (mg/litre)	1.4 – 198	0.4 – 13
11.	Bicarbonate (mg/litre)	52 – 698	207 – 409
12.	Iron (mg/litre)	Nil – 0.46	1.01 – 0.81

The specific conductance and chloride values generated from the chemical analysis of the region are found to be comparatively higher in the Bongamunda – Muribahal – Titlagarh tract and Bolangir – Puitala – Deogaon tract. In localized patches at Khaprakhole, Deogaon and Jogimunda (Patnagarh block) the concentration of fluoride is above 1.5 mg/l otherwise everywhere it is below the permissible limit. The chemical analysis data suggests that the quality of ground water both from shallow and deeper aquifers are well within the permissible limit of utilisation for drinking purposes**.** The suitability of ground water for irrigation in the district has been assessed by use of US salinity diagram prepared on the basis of sodium absorption ratio (SAR) and specific conductance. The classification of water in the district is given in Table 4.4 below.

Table 4.5 US Salinity Classification

Classification based on Salinity diagram	Grade	No. of Samples			
		Phreatic aquifer	Deeper aquifer	Shallow aquifer (%)	Deeper aquifer (%)
C_1S_1	Good	5	-	10	-
C_1S_2	Moderately Good	-	-	-	-
C_1S_3	Unsuitable	-	-	-	-
C_1S_4	Highly Unsuitable	-	-	-	-
C_2S_1	Good	35	9	67	69
C_2S_2	Moderately Good	-	-	-	-
C_2S_3	Unsuitable	-	-	-	-

C_3S_1	Moderately Good	12	4	23	31
C_3S_2	Unsuitable	-	-	-	-
C_4S_1	Unsuitable	-	-	-	-

It may be noted that about 100% of the groundwater samples collected from the phreatic and deeper aquifers are good for irrigation purposes.

4.4 Status of Ground Water Development

Ground water development in the district is mainly through dug wells, Dug-cum-bore wells and bore wells. Ground water is mainly used for domestic and irrigation purpose and in limited scale for industrial purposes.The stage of development of Ground Water in the district is low. So far only 16.77% of its resources has been exploited. Hence a strategy for detailed ground water development is required. The hydrogeological, remote sensing studies and ground water exploration so far carried out in the district depict the tentative possibilities of ground water development through suitable ground water abstraction structures in various hydrogeological settings (Plate –VI).

Dugwells : The wells may be sited in the topographic lows and should tap the maximum saturated thickness of the weathered zone. The depth of the dugwells may vary from 9 to 12m with 4.5m to 6m diameter. The wells may be fitted with 1.5 to 2 H.P. centrifugal pumps. The wells may sustain yield maximum up to 3 lps.

Dug-cum-borewells : Dug-cum-borewells may drilled down to a depth of 25 to 30m below ground level, tapping the saturated shallow fracture below the regolith and in top portion of the hard basement. The wells should be fitted with 2 H.P. centrifugal / submersible pumps may sustain yield up to 3 lps.

Borewells : Borewells may tap the deeper saturated fractures found to occur in the depth range of 100 to 120m. The borewells should be 100 to 150mm. diameter and may be flitted with submersible pumps of 2 to 2.5H.P. capacities. The wells drilled in the vicinity of NNW-SSE and NE-SW trending lineaments are likely to be successful which has been established based on exploratory drilling by CGWB in the Western and Southern tracts of the district. The suitable sites for drilling may be selected in the district with the aid of Remote Sensing studies, Surface Geological, hydrogeological and Geophysical surveys.

Since the surface water resources are inadequate and the district often comes under the grip of drought, development of ground water resources may help in expanding irrigated agriculture in the district. An optimal utilisation of ground water in the district requires adoption of a suitable cropping pattern and energisation of the wells. The block wise ground water structures feasible as per Study Group Report (March, 2004) has been given in Table below.

5.0 Ground Water Management Strategy

5.1 Ground Water Development

The Ground Water Development of the entire Bolangir District is depicted in Plate VI. Depending on the hydrogeological condition of the area the development possibilities has been predicted.

5.2 Water Conservation & Artificial Recharge

Bolangir district is mostly traversed by Precambrian consolidated formations. The deeper water level of the order of 5-10 mbgl is observed near Bolangir, Loisignga, eastern part of Puintala block. The North Western part of Agalpur blocks and the north eastern part of Puintala block of the district show deeper water condition during pre monsoon and post monsoon periods due to rapid recessation of ground water level. The data of water level of 10 years shows fall in the Puinatala and Agalpur blocks during Post monsoon period. This is mainly due to prevailing topographic conditions and water table gradient, which facilitates flow of ground water through nalas and rivers and streams as base flows. To arrest the rapid decline of water table in these areas special studies may be taken up to pin point the areas where water scarcity problems are more pronounced during post monsoon and premonsoon period. In these pockets suitable sites are required to be pin pointed to adopt artificial recharge techniques and rain water harvesting methods based on site specific conditions. This artificial recharge will also help in increase in storage and also in improving the quality of water etc. The most feasible artificial recharge and rain water harvesting structures are percolation tanks, nala/contour bunding, small check dams/weirs, renovation of old tanks to percolation tanks, subsurface dykes, water spreading, gully plugging, gabion structures etc.

6.0 Ground Water related issues & Problems

Ground Water Problems : The ground water problems include Ground Water Pollution and Ground Water Depletion.

Ground Water Pollution : Based on the chemical analyses of water samples collected from different aquifers, it is observed that almost all chemical constituents are well with in the permissible limit for drinking as well as irrigational purposes, excepting at some localized patches where high fluoride and nitrate values have been observed. As such there is no ground water pollution in the district.

Ground Water Depletion: The stage of ground water development in different blocks varies from 12.75 % (Patnagarh) to 25.46 % (Bolangir) with the overall stage of development 16.77% in the district. From the perusal of 10 years of data it has been realized that there is a falling trend in 46.4% of water level measuring wells within the range of 0-2 m during pre monsoon and 13.5% of wells shows fall during post monsoon within range of 0-2 m. Khaprakhol, Muribahal, Patnagarh, Puintala, Saintala blocks show major fall during premonsoon period . Agalpur and Puintala blocks shows major fall during postmonsoon.

7.0 Awareness & Training Activity

7.1 Mass Awareness Programme (MAP) & Water Management Training Programme (WMTP) by CGWB

(i) Titlagarh, Titlagarh Block, Bolangir District:

The program was organized on 26-03-2003 at Titlagarh, Titlagarh block, Bolangir district. More than 250 persons including farmers, Block Development Officers, District level officers/ officials have participated in program. Project Director DRDA Bolangir, was the chief guest on the occasion. Deliberations on ground water development protection and conservation were held among the participants and CGWB scientists.

The exhibition was arranged in which the achievements of CGWB were displayed through different models, plates, photographs and instruments. Different posters were displayed for conservation of ground water, ground water pollution and its effects and slogans protecting this valuable resource. The programme have received high appreciation and were widely covered by press as well as electronic media.

(ii) Bolangir Town, Bolangir Block, Bolangir District:

The program was organised on 21-03-04 at Rajendra College, Bolangir, Bolangir District. The program was presided by the Regional Director and the Principal of College was the chief gust on the occasion. More than 200 professors, lectures, students, house wives have participated in the program. Deliberation on Ground Water development protection and conservation were held among the participants and CGWB scientists.

An exhibition was organized in which the achievements of CGWB were displayed through different models, plates, photographs and instruments. Different posters were displayed for conservation of ground water, ground water pollution and its effects and slogans protecting this valuable resource. The programme have received high appreciation and were widely covered by press as well as electronic media.

8.0 Areas Notified by CGWA

The stage of Groundwater development is well within Safe Category and there is no overexploitation and major threat of Groundwater pollution and depletion. Hence no area has been notified by CGWA.

9.0 Recomendations

1. Large scale planning for Ground Water Resources development should be preceded by intensive hydrogeological and geophysical survey aided by Remote Sensing studies and ground truth data.

2. Bore wells/dug wells should be located in the vicinity of NNW-SSE and NE-SW trending lineaments which have been proved to be high yielding & productive and in thickly buried pediment areas.

3. Existing dug wells should be deepened to tap the maximum saturated thickness of the weathered mantle or vertical bores maybe drilled to enhance the yield of the well where normally the dug wells get dried up.

4. Energisation of wells should be stepped up to ensure optimal utilisation of the ground water resources to create additional irrigation potential.

5. The State Ground Water Organization should render expert guidance for siting ground water structures in favourable hydrogeological settings.

6. The farmers should be educated through agricultural extension services, Mass Awareness and water management training programme to adopt suitable cropping pattern, conservation of ground water and irrigation practices especially for drought tolerant crops for optimal utilisation of available ground water resources.

7. Programme for artificial recharge may also be taken up in areas where deeper water table condition coupled with high fluctuation is observed for augmentation of ground water resources through construction of percolation tanks, subsurface dykes, check dams, nala bunding and contour bunding and other site specific favourable artificial recharge structures.

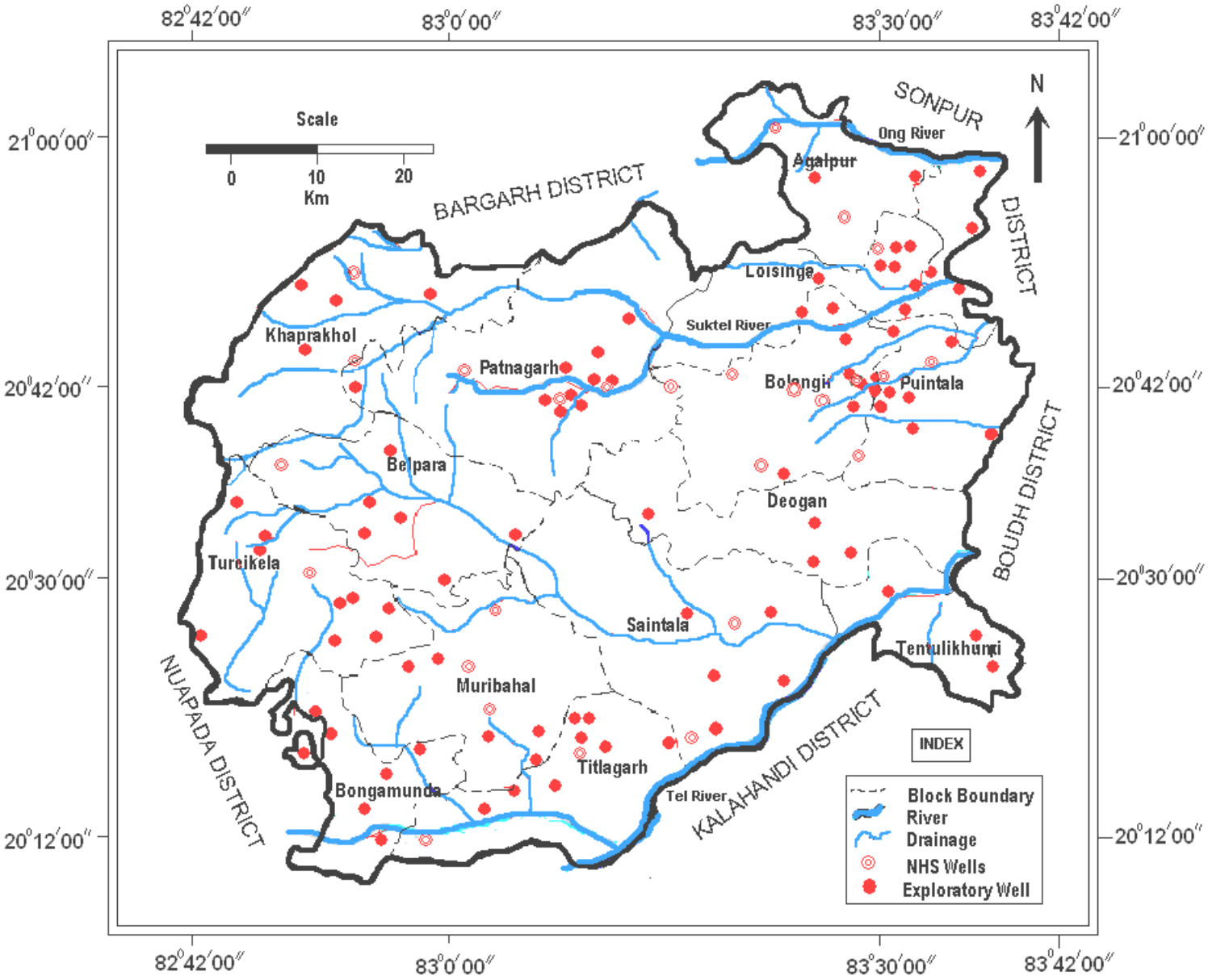
8. In areas of shallow water table lying with in 0 to 5 m bgl during post monsoon period, surface water bodies like local ponds, farm ponds and small earthen dam along small streams may be constructed to hold water for long duration and for replenishment of soil moisture.

9. For augmentation of drinking water supply to the major towns and villages near the major rivers, infiltration galleries or collector wells may be constructed in suitable locales to fruitfully harness the base flow /subsurface flow which otherwise goes as waste.

10. Growing of sugarcane and cash crops may be encouraged along the thin linear alluvial patches lying adjacent to major rivers where prolific ground water is available throughout the year.

INDEX MAP OF BOLANGIR DISTRICT, ORISSA

Plate I



PRE-MONSOON DEPTH TO WATER LEVEL(APRIL 2011) BOLANGIR DISTRICT, ORISSA

Plate II

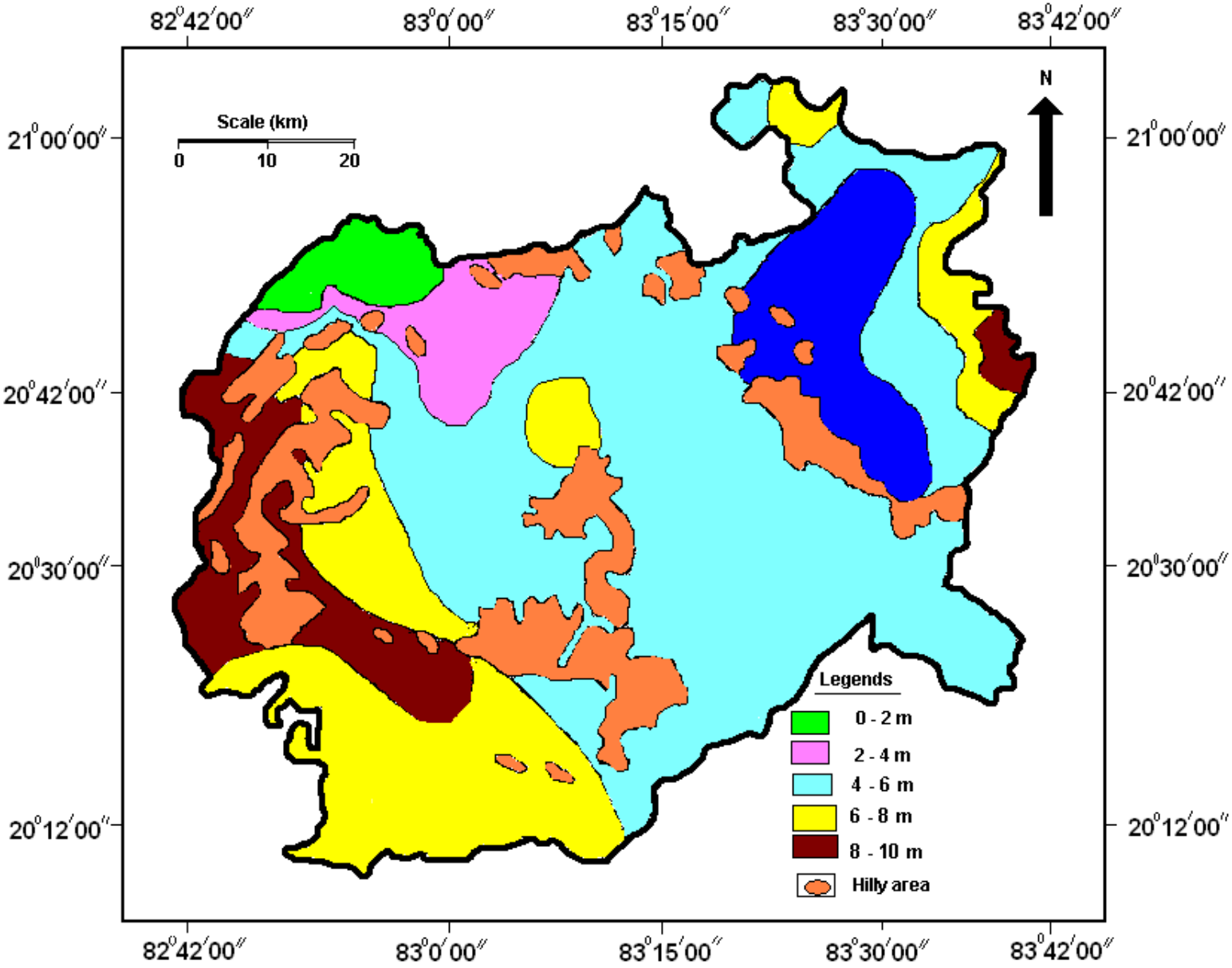
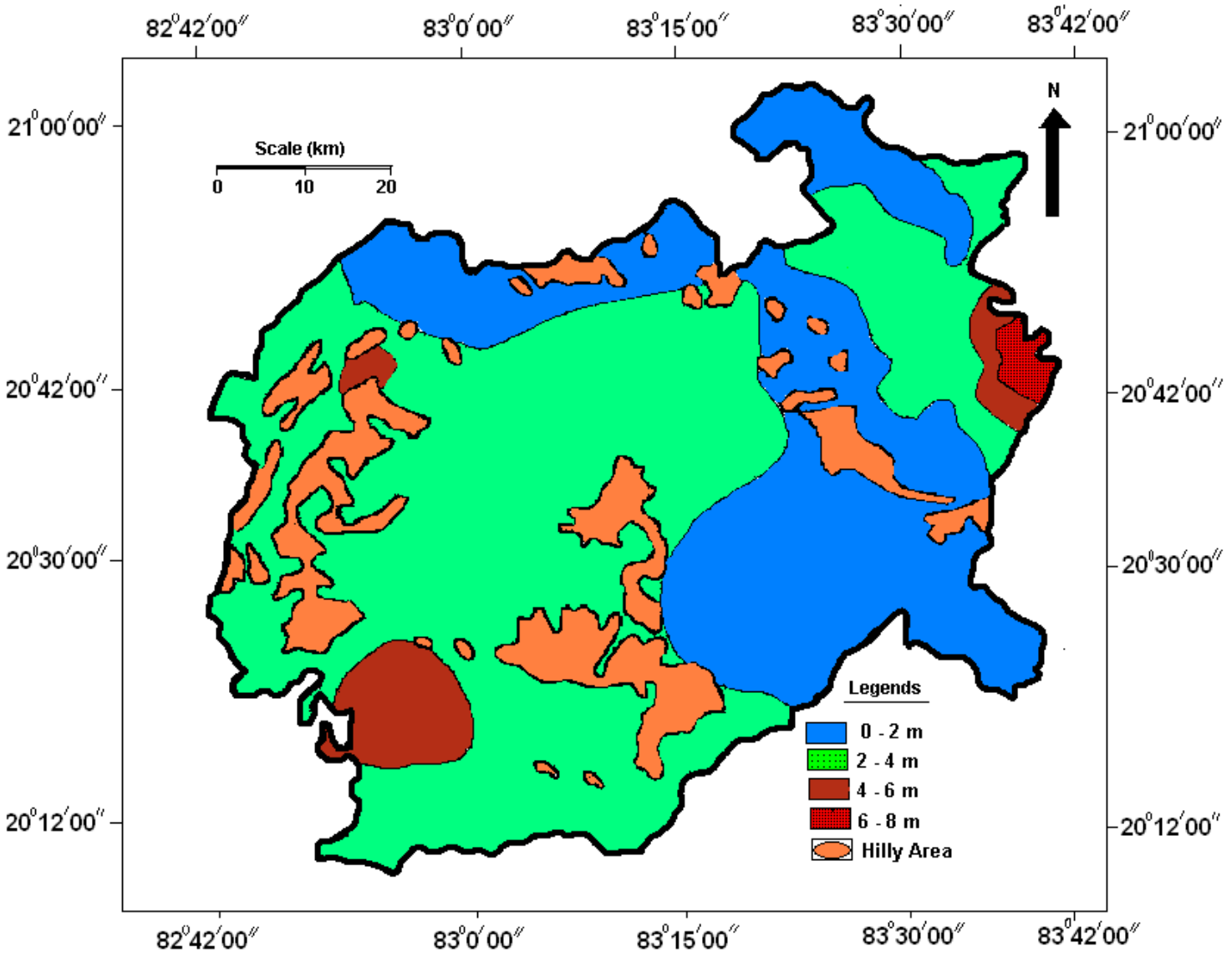


Plate III

POST-MONSOON DEPTH TO WATER LEVEL(APRIL 2011) BOLANGIR DISTRICT,



CATEGORIZATION OF BLOCKS FROM THE RESULT OF DYNAMIC GROUND WATER RESOURCES OF BOLANGIR DISTRICT, ORISSA

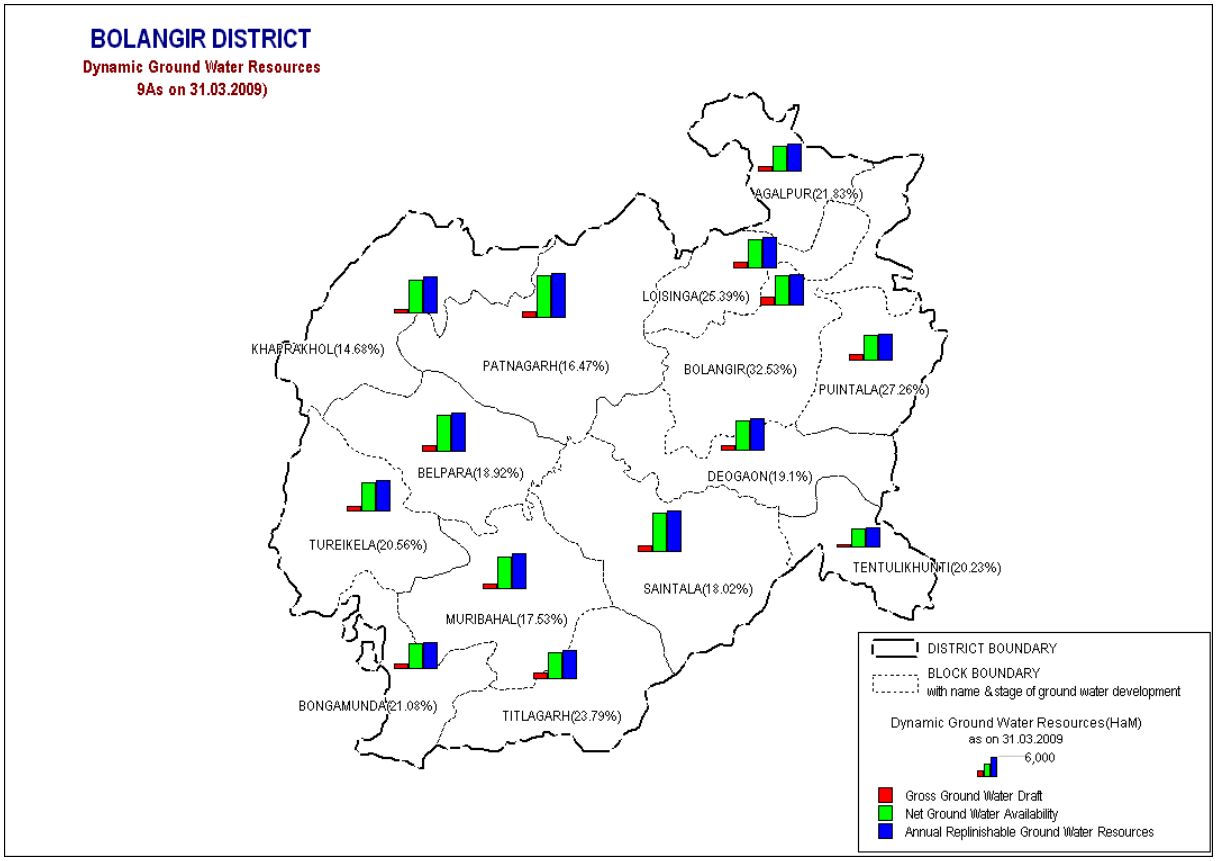
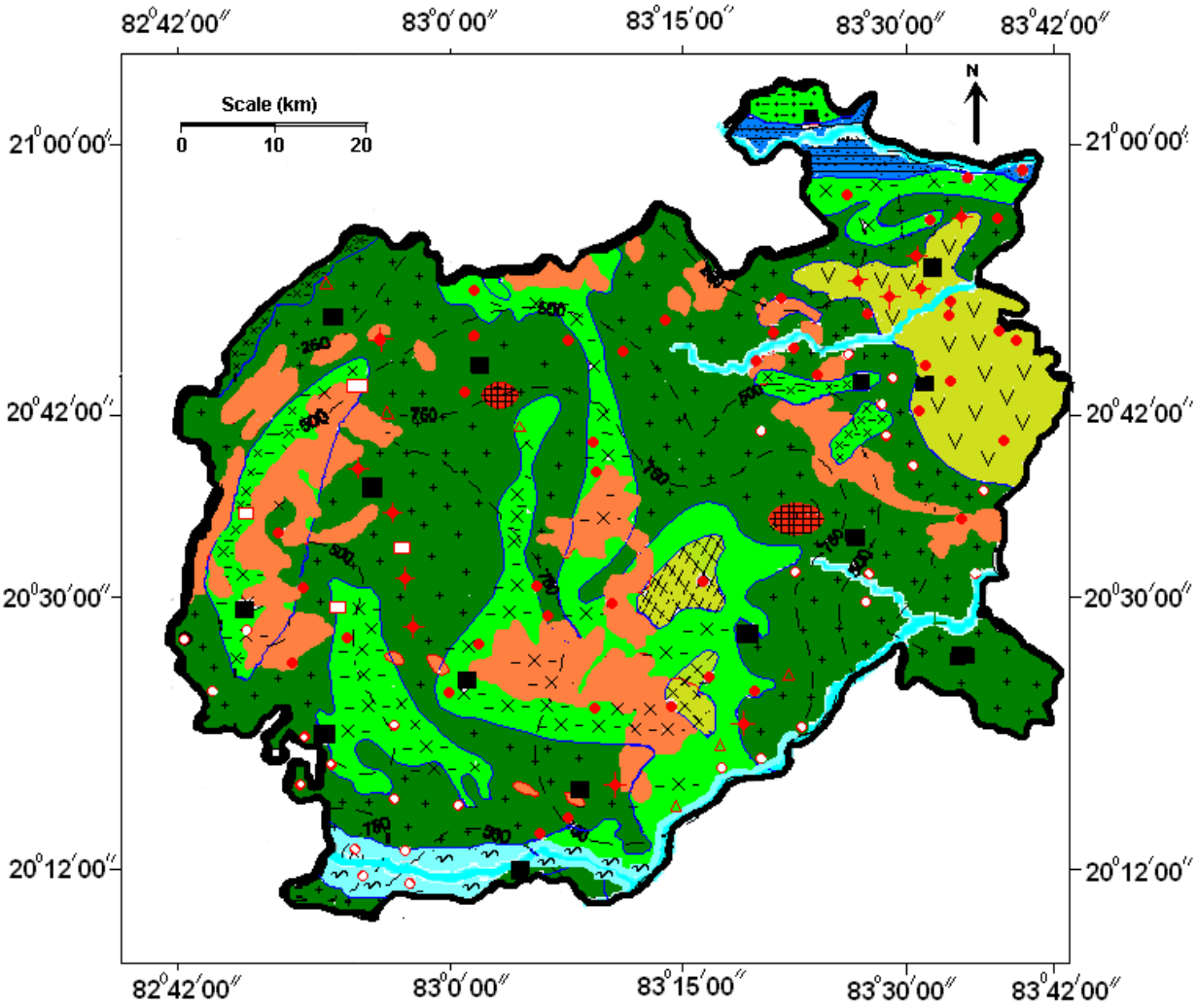


Plate V

HYDROGEOLOGICAL MAP OF BOLANGIR DISTRICT, ORISSA



LEGEND

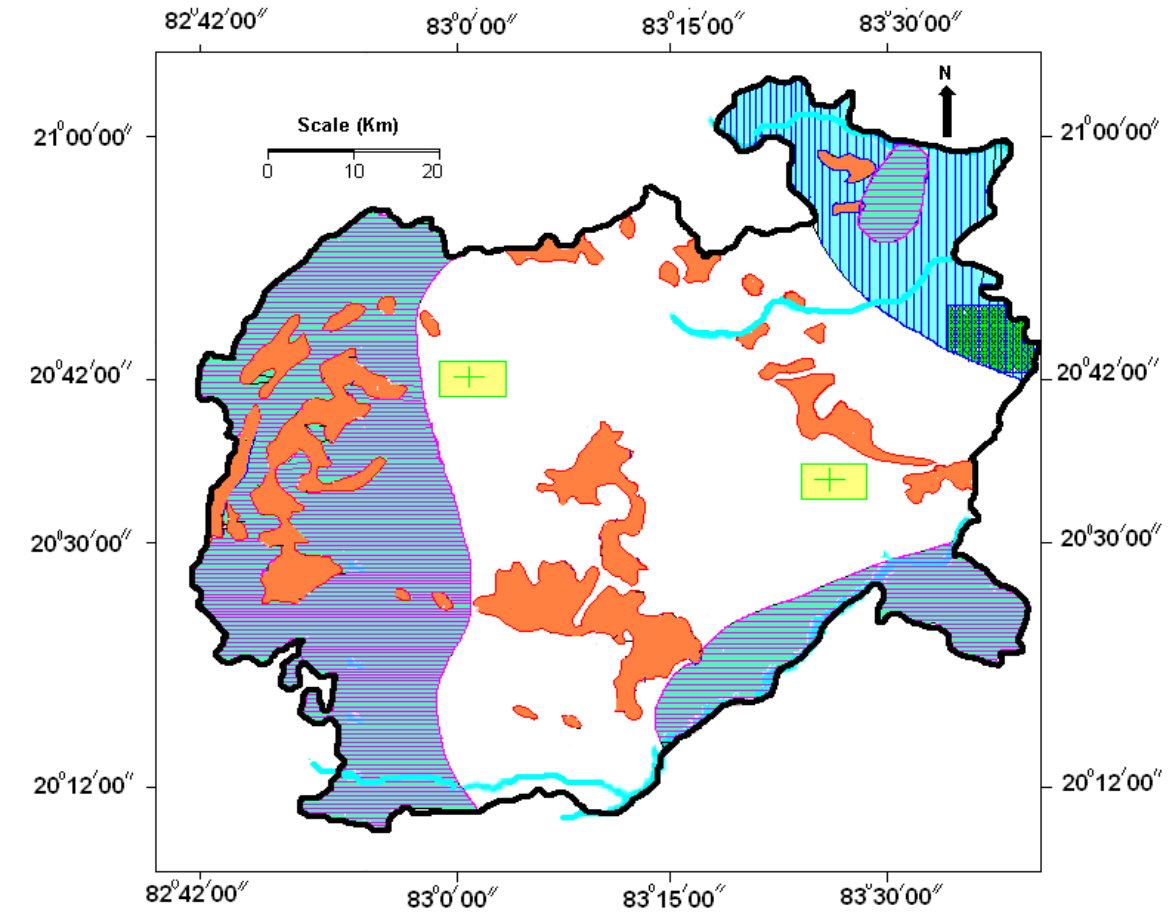
Age Group	Lithology	Index	Hydrogeological Conditions
Recent to Sub Recent	Alluvium		Flood plain, Unconfined aquifer, Yield 5 lps
Lower Gondwana	Sandstone, Shale Conglomerate		Moderately Thick, Discontinuous Confined to semi confined aquifer, Yield less than 5 lps
Pre-cambrian	Anorthosite/ Gabbro		Ground water is restricted to weathered residuum and fracture zones, low to moderate yield within 3 lps
	Charnockite		
	Bonai Granite / Quartzite		Ground water is restricted to weathered and fractured horizon. Yield upto 10 lps
	Khondalite & Calc silicate		
	Granite & Granite Gneiss		Most pervassive crystalline aquifer ground water occurs in weathered and fractured horizon. Yield upto 25 lps.
			Hilly Areas without Productive Aquifer except in pockets. Yield less than 1 lps
			Fluoride Contaminated Area
		350	EC Contour

Discharge range of Bore holes

- <1 lps
- 1-3 lps
- 3-5 lps
- 5-10 lps
- >10 lps

Plate - VI

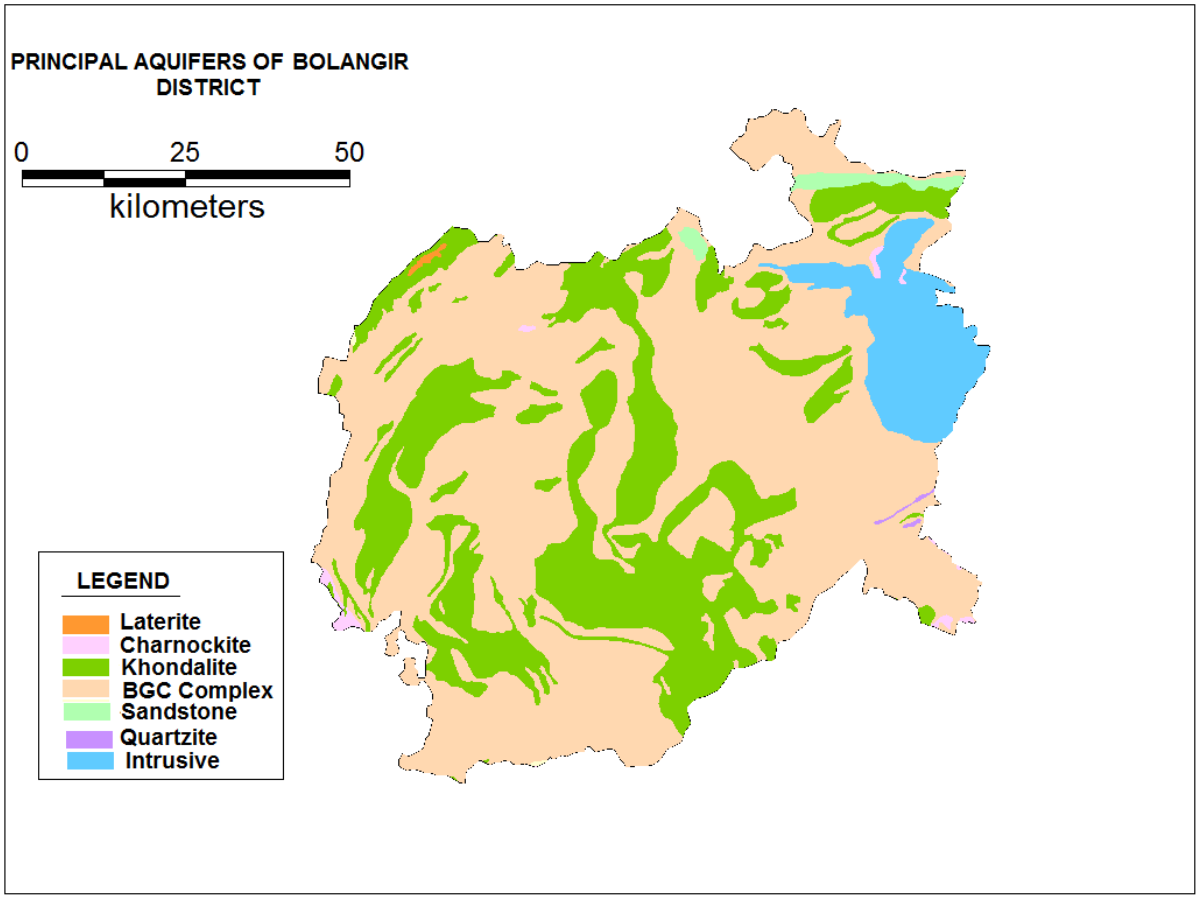
GROUND WATER DEVELOPMENT POSSIBILITIES MAP SHOWING TARGET AREAS OF ARTIFICIAL RECHARGE IN BOLANGIR DISTRICT, ORISSA.

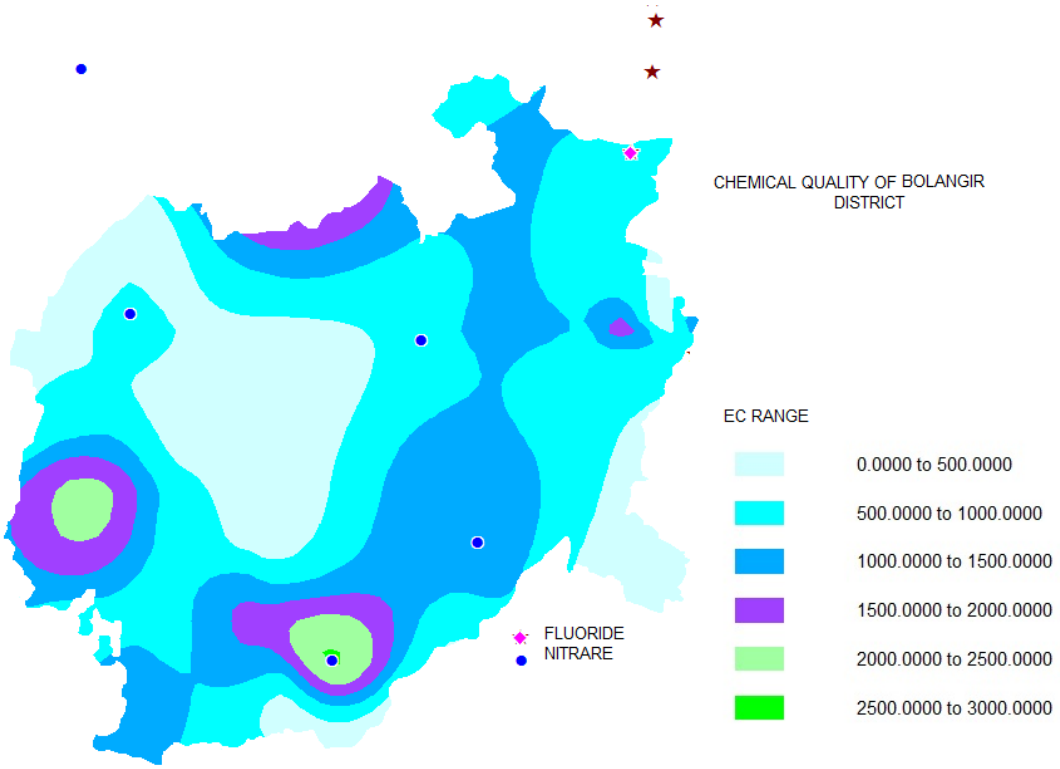


LEGENDS

Dug well 9 to 12 m deep, 4.5 to 6 m dia to be fitted with 1.5 HP Centrifugal pump, yield less than 8 lps, Dug cum Bore well, Dug well up to 12 m depth, Vertical Bore well 100 to 150 m deep, 150 mm dia, 2 H.P submersible pump, yield may go upto 25 lps	Dug well 9 to 12 m deep, 4.5 to 6 m dia to be fitted with 1.5 HP Centrifugal pump, yield less than 3 lps, Dug cum Bore well, Dug well up to 12 m depth, Vertical Bore well upto 25 to 30 m below ground level. To be fitted with Centrifugal pump, yield upto 3 lps. Bore well construction uneconomical yield upto 3 lps.	Dug well 9 to 12 m deep, 4.5 to 6 m dia to be fitted with 1.5 H.P. Centrifugal Pump uptp 2 lps.
Hilly areas ground water development restricted to intermontane valley or low laying areas. Yield of Bore well less than 1 lps.	The area where the Artificial Recharge Programme can be taken up through construction of percolation tanks, subsurface dykes, check dams, nala bunding and contour bunding for the augmentation of ground water resources.	The area where the Artificial Recharge Programme can be taken up through construction of percolation tanks, subsurface dykes, check dams, nala bunding and contour bunding for the improvement of the ground water quality of the area

AQUIFER MAP OF BOLANGIR DISTRICT, ODISHA




CHEMICAL QUALITY OF BOLANGIR DISTRICT
EC RANGE
0.0000 to 500.0000
500.0000 to 1000.0000
1000.0000 to 1500.0000
1500.0000 to 2000.0000
2000.0000 to 2500.0000
2500.0000 to 3000.0000
FLUORIDE
NITRARE