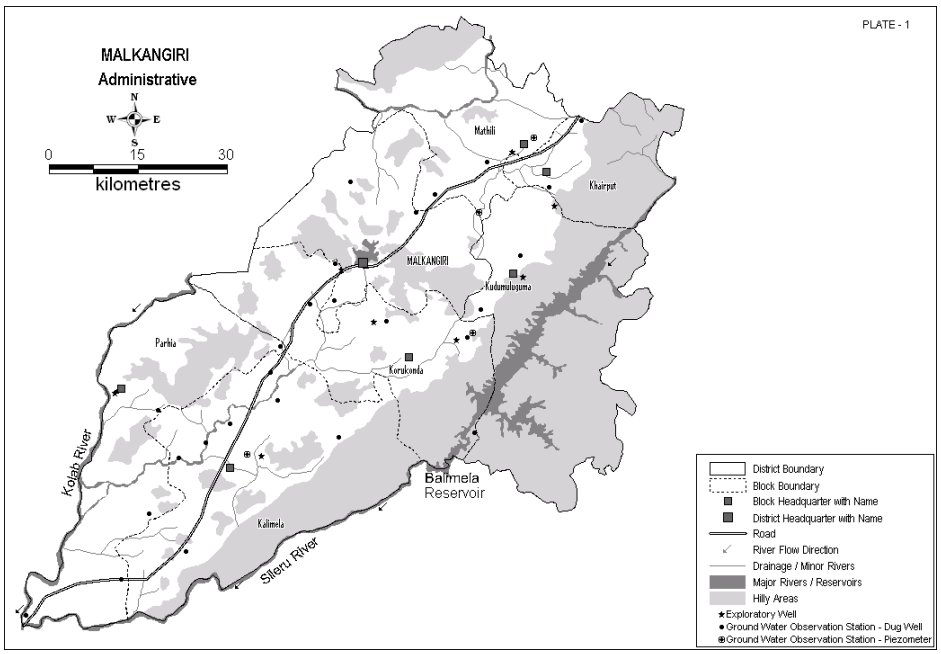
Govt. of India

MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET

MALKANGIRI DISTRICT, ORISSA



South Eastern Region

Bhubaneswar

March, 2013

MALKANGIRI DISTRICT AT A GLANCE

Sl No	ITEMS	Statistics
1.	**GENERAL INFORMATION**	
	i. Geographical Area (Sq. Km.)	5791
	ii. Administrative Divisions as on 31.03.2007	
	Number of Tehsil / Block	3 Tehsils, 7 Blocks
	Number of Panchayat / Villages	108 Panchayats 928 Villages
	iii Population (As on 2011 Census)	612,727
	iv Average Annual Rainfall (mm)	1437.47
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Hills, Intermontane Valleys, Pediment - Inselberg complex and Bazada
	Major Drainages	Kolab, Potteru, Sileru
3.	**LAND USE (Sq. Km.)**	
	a) Forest Area	1,430.02
	b) Net Sown Area	1,158.86
	c) Cultivable Area	1,311.71
4.	**MAJOR SOIL TYPES**	Ultisols, Alfisols
5.	**AREA UNDER PRINCIPAL CROP**	Pulses etc. : 91,871 Ha
6.	**IRRIGATION BY DIFFERENT SOURCES (Areas and Number of Structures)**	
	Dugwells	2,033 Ha
	Tube wells / Borewells	
	Tanks / ponds	1,310 Ha
	Canals	71,150 Ha
	Other sources	-
	Net irrigated area	74,493 Ha
	Gross irrigated area	74,493 Ha
7.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB(As on 31-3-2011)**	
	No of Dugwells	29
	No of Piezometers	4
10.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Granites, Granite Gneiss, Granulites & its variants, Basic intrusives
11.	**HYDROGEOLOGY**	
	Major Water bearing formation **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**	Granites, Granite Gneiss 2.37 – 9.02 0.45 – 4.64 Mostly rise: 0.034 – 0.304(59%) Some Fall : 0.010 – 0.193(41%)
12.	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2011)**	
	No of wells drilled(EW, OW, PZ, SH, Total)	**14 ;** EW:8,OW:2,PZ:4,SH:0
	Depth Range(m)	38.50 - 200
	Discharge(litres per second)	0.2 – 10.60
	Storativity(S)	-
	Transmissivity(m^2/day)	2.6 – 27.50
13.	**GROUND WATER QUALITY**	

Sl No	ITEMS	Statistics
	Presence of Chemical constituents more than permissible limit(e.g. EC, F, As, Fe)	Nothing significant reported
	Type of Water	Mostly Calcium Bicarbonate, C_2S_1 Irrigation Class
14.	**DYNAMIC GROUND WATER RESOURCES(2009) – in mcm**	
	Net Ground Water Resources Availability	335.98
	Net Annual Ground Water Draft	29.42
	Projected Demand for Domestic and Industrial Uses upto 2025	1.806
	Stage of Ground Water Development	8.76 %
15.	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness Programmes organized	Nil
	Date	-
	Place	-
	No of Participants	-
	Water Management Training Programmes organized	Nil
	Date	-
	Place	-
	No of Participants	-
16.	**EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING**	
	Projects completed by CGWB(No & Amount spent)	Nil
	Projects under technical guidance of CGWB(Numbers)	Nil
17.	**GROUND WATER CONTROL AND REGULATION**	
	Number of OE Blocks	Nil
	No of Critical Blocks	Nil
	No of Blocks notified	Nil
18.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Nothing significant

1.0 Introduction

Malkangiri is the southern most district of Orissa. It was awarded the status of the district in October 1992, when the erstwhile Koraput district was divided into four new districts. The district is bordered in the North and West by Bastar district of Chhatishgarh and in the south by Khammam and East Godavari districts of Andhra Pradesh, in the east by Koraput district, Orissa. The district lies between north latitudes 17º47'58" and 18º44'18" and East longitudes 81º23'23" and 82º27'05" falling in Survey of India Degree sheet Nos. 65 F,G,J. The district covers an area of 5791 Sq.Km and is divided into 7 Community Development Blocks – Kalimela, Khairput, Korukonda, Kudumulguma, Malkangiri, Mathili and Podia. The Malkangiri town, the district headquarter is approachable from adjacent districts through State Highways. The important towns of the district are well connected by road. It is one of the most economically backward tribal district of Orissa.

The general drainage pattern in the district is dendritic to sub-parallel. The Kolab river along with its tributaries, the Potteru and Sileru rivers is the most prominent river of the region. The Kolab river issues from the Sinkaram hills and follows a south westerly course after passing over Malkangiri district. The river joins the Godavari river in Khammam district of Andhra Pradesh.

The hills and forests cover almost seventy six percent of the total geographical area of the district as per the classification of the forest area by legal status in Malkangiri district as on 2005, which includes reserve forests, demarcated-protected forests, un-demarcated forests, unclassified forests and other forests. Only limited areas are utilized for agricultural purposes. The net area under cultivation is only twenty six percent of the total geographical area.

Agriculture is the main occupations of the vast majority of the population. However because of forest cover and rugged terrain conditions of the district agriculture is by and large confined to Kharif Season. Rabi cultivation is practiced at places, where irrigation facilities are available. No uniform cropping pattern seems to be followed in the district. Shifting or 'Podu' cultivation is practiced on high hill slopes. Paddy is the main crop sown during the Kharif seasons. Apart from paddy, other important Kharif crops are Maize, Ragi, millet and different type of pulses. In higher altitudes above 600 m potato is cultivated during Kharif season. During Rabi oil seeds are the main crops. Pulses and wheat are also grown substantially.

Based on the soil characteristic, cropping pattern, climatological and topographical features the district has been subdivided into two agro-climatic zones, namely South Eastern Ghat and Eastern Ghat highland. The South Eastern Ghat occupies almost the entire Malkangiri district. It is characterized by warm climate with maximum temperature of 34ºC and minimum temperature of 13ºC. The principal crop is rice. The Eastern Ghat Highland have only a very small portion in the eastern corner of the district is characterized by Eastern Ghat Highland. The climate is warm and humid. Maximum temperature is 34ºC and minimum temperature is 8ºC. The principal crops are paddy, wheat and vegetables.

The major surface water bodies are reservoirs, rivers, streams and ponds etc. The river Potteru which is a tributary of Kolab is generally perennial in nature with a sufficient flow during summer months. The Balimela reservoir is the major irrigation project and its canal command is around 61034-Ha There are substantial numbers of tanks, ponds and water harvesting structures exist in the district, which hold considerable quantity of surface water as storage which serve the purpose for irrigation, bathing, drinking and industrial purposes.

The geological mapping of the area was carried out by Sri H. Crookshank (1938). Shri F. Ahmed, Geologist of G.S.I conducted investigations on the geo-hydrological conditions in parts of the area in 1959. Parts of the area were covered by S/Sri S. K. Guha & P. N. Nag of G.S.I through systematic hydrogeological surveys (Malkangiri Zone, Dandakaranya Project) during 1966-67. The district was covered through systematic hydrogeological surveys by Sh. M. V. Rao, STA (Hydrogeology) CGWB during 1975-76. Reappraisal hydrogeological surveys were also carried out by S/Sh. G. Y. Setty

(1987-88) and S. Suresh (1990-91). Further CGWB has drilled 8 (eight) Exploratory Well and 2 (two) Observation wells in the district to delineate the potential deeper aquifers.

Ground water monitoring is being done through 29 numbers of permanent hydrograph network stations and 4 piezometers four times in a year and water samples are collected once in a year during pre-monsoon for complete chemical analysis.

2.0 Rainfall & Climate

The district has a subtropical climate. South west monsoon is the principal source of rainfall. Rainfall pattern is uneven and erratic. The average annual rainfall gradually increases from South Western to North Eastern parts of the district. The average annual rainfall varies from 994.05 mm to 1809.53 mm. The agricultural definition of drought takes into account the negative departure of seasonal rainfall from the mean seasonal rainfall. A perusal of the frequency of occurrence of drought indicates that mild to normal drought condition prevails in Malkangiri District.

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.

Maximum temperature rising up to 44^0 C during May. In the summer months of April and May, hot winds from the west are generally experienced in the afternoon. December is the coldest month with lowest temperature during Winter being 11^0C. Monsoon generally lasts from the end of May to October. Occasional showers are received in the month of April, November and December.

3.0 Geomorphology & Soil Types

The district is characterized by varied geomorphological features. Based on Landsat data interpretations and field studies, the geomorphic units of the district are broadly identified as - Structural Hills, Denundational Hills, Residual Hills, Shallow and Moderately weathered pediplain, Pediment – Inselberg complex, Inselberg, Flood plains, Structural Valley, Linear Ridge, Bazada

Structural Hills – It is characterized by a group of linear/curvilinear/folded hill ranges of large areal extent, interspersed with narrow intermontane valleys showing definite structural control. It is the most important geomorphological unit in the district adjoining the entire southern border and occupying the northern corner of the district.

Denudational Hills – It occurs in the North Eastern corner of the district in a limited patch. It is represented by a group of massive hill ranges interspersed with narrow intermontane valleys having no structural control or structures obliterated by denudation.

Residual Hills – Hill ranges of moderate dimension surrounded by plains all around, occur as isolated features along the northern boundary of the district.

Shallow and Moderately Weathered Pediplain – Next to the structural hills this forms the major geomorphological unit in the district. It presents gently undulating terrain of vast areal extent, formed as a result of coalescence of different pediments along the foot hills of the Eastern Ghats and affected by shallow to moderate weathering. The northeastern part of the district is characterized by moderately weathered pediplane with weathering prevalent down to a depth of 5-20 m. The rest of the district is covered by shallow weathered pediplain with weathering restricted to 5 m depth.

Pediment – Inselberg Complex – It is a gently undulating bed rock surface with a number of small inselbergs. This unit is widely distributed throughout the district.

Inselberg – Inselbergs are scattered all over the district. These are isolated hills of limited areal extent surrounded by plains all around.

Flood Plain – A narrow stretch of alluvium occurs along river Kolab and its tributaries in the northern part of the district.

Structural Valley – A narrow linear valley within the structural hills and formed along the structurally weak planes occurs along the south eastern boundary of the district.

Linear Ridge – A narrow linear ridge of quartz reef with steep sloped covered by debris, is found in the northern part of the district.

Bazada – A gently sloping plain is formed in the foot hill zone and consist mainly of alluvial and partly alluvial material comprising fine silt to big boulders. It occurs in the Southern part of the district.

The general drainage pattern in the district is dendritic to sub-parallel. The Kolab river alongwith its tributaries, the Potteru and Sileru rivers is the most prominent river of the region. The Kolab river issues from the Sinkaram hills and follows a south westerly course after passing over Malkangiri district. The river joins the Godavari river in Khammam district of Andhra Pradesh.

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 two groups namely Alfisols (Red Soil) and Ultisols (Lateritic soil.

Alfisols - Alfisols or red soil are the most prominent soil types in the district. There are two different varieties – red sandy soil and red loamy soil. They are red in colour and clayey in nature especially the loamy soil, poor in organic matter. Its fertility is low.

Ultisols - Ultisols or lateritic soil occurs in a narrow diagonal strip across the district trending NE-SW. They are red to brown in colour and clayey in nature. Due to low organic matter content the fertility of lateritic soil is low.

4.0 Ground Water Scenario

4.1 Geology

The area is characterized by a complex geological set up with a variety of rock types belonging mainly to the Precambrians and Archeans, except a thin alluvial patch along river Kolab. The Geological successions of the district is as follows –

↑

Recent	Alluvium	
Pre-Cambrian	~~~~~~~~~~~ *Unconformity* ~~~~~~~~~~~	
	Quartzites, Limestones, Conglomerates, Shales	
	~~ *Unconformity* ~~~~~~~~~~~	
Archeans	Younger Intrusives	Dolerite Dykes, Pegmatites, Vein Quartz
	~~ *Unconformity* ~~~~~~~~~~~	
	Andalusite Schists, Sericite Quartz Schists	
	~~ *Unconformity* ~~~~~~~~~~~	
	Charnockites Khondalites Granite Gneiss and its variants	
	~~ *Basement not known* ~~~~~~~~~~~	

The area has suffered regional metamorphism up to the granulite facies and has experienced numerous phases of magmatic intrusions, accompanied by progressive and retrogressive metamorphism, repeated folding and shearing. As a result original structures, textures and mineral compositions have been completely obliterated by new structures and mineral assemblages.

Granite Gneiss and its variants – These are medium to fine grained rocks exposed in the undulating plains and scattered hillocks. The suite of rocks comprises Hornblende Gneiss, Biotite, Gneiss and Pink Granite. Megascopically the rocks are fine to medium grained, leucocratic with well-developed foliation planes in case of gneisses. The gneisses are usually banded. The bands consist of thin layers rich in quartz and feldspar. Hornblende and mica are common occurrence while Garnet is found occasionally. The strike of the gneisses is variable, viz. N 75^0E – S75^0W with 20^0 dip to N 85^0W – S 85^0E with vertical dips. In the majority of the cases, the strike is similar to that of the Eastern Ghats. Granites occur in limited patches in the central and western parts of the district.

Khondalites – The khondalitic group of rocks consists of quartz – Garnet – Sillimanite Schist & Gneiss and Garnetiferous sillimanite quartzite. The khondalites are usually found in the South Eastern and Western parts of the district in the hilly terrains. These rocks exhibit multiple sets of joints having steep dips.

Charnockites – These generally occupy the hill ranges. The rock is coarse grained, dark green to grey in colour with feldspar and quartz crystals. The ferromagnesian minerals are hypersthene and pyroxene. Garnet is also present. The charnockitic rocks form massive out crops. The joints found in charnockites trend N 30^0E, N-S, & E-W with sub-vertical to vertical dips.

Schists - These include Andalusite – Schists and gneisses and quartz – sericite schists. These occupy the northern part of the district. They are essentially composed of feldspar, andalusite, sericite with inclusions of quartz.

Pegmatites and Dolerites– The pegmatites are commonly associated with the granite gneisses. These are rarely associated with the rocks of charnockites. The dolerites occur locally as dykes and small intrusions in the gneisses and charnockites. Garnet is found in the dolerite in some areas.

Quartz Reef – A prominent Quartz reef is observed in the northeastern boundary of the district. This is intrusive into the country rock and occurs as a narrow linear ridge with steep slopes covered by debris.

Conglomerate, Quartzite, Limestone, Shale – These rock types occurs near in North Eastern – South Western boundary of the district. The Quartzites are generally ferruginous in nature and are overlain by the limestones, fine grained and white to blue in colour.

Alluvium - A narrow patch of alluvium occurs along the river Kolab and its tributaries in the northern part of the district. It has only limited thickness.

The granites and its variants are most predominant rock type and occupy major parts of the district. Geological set up of the district primarily controls the Hydrogeological condition of the area.

4.2 Hydrogeology

The hydrogeology of the district varies widely depending upon the geological and geomorphic set up and soil characteristics. The major hydrgeological units may be categorized as – Consolidated formations and Unconsolidated to Semi-consolidated formations

Consolidated formations - Almost the entire district is underlain by the consolidated formations, comprising granites, granite gneiss and its variants, charnockites, Khondalites, Schists, Quartzites, Limestones etc. These formations lack primary porosity and are rendered porous and permeable only

when weathered and fractured. The weathered residuum forms the main repositories of groundwater, which occurs under water table conditions and circulates through deeper fractures and fissures.

Granites and Granite Gneisses - These are the most prominent rock types in the district occupying the undulating terrains and low lying areas. On weathering these rocks are altered to loose kaolinised sandy clay. The thickness of the weathered zone ranges from 6 to 16 m depending on the topography and foliated and joined nature of the rocks. The sheet joints and vertical joints are interconnected. These facilitate free horizontal and vertical flow of groundwater. The depth to water table ranges from 0.57 to 10.97 m bgl in the months of May – June while 0.00 to 8.19 m bgl in the months of Dec – January. The seasonal water table fluctuation is in the range of –2.37 to 10.00 m. The specific capacity Index of open wells varies from 0.017 to 17 lpm/m/m^2. The discharge of up to 6 lps has been recorded in the dugwells tapping unconfined aquifers. In exceptional cases discharge of 18 LPS has also been recorded. The borewells tapping deeper fracture zones, record discharge up to 10 Lps for moderate drawdowns. The transmissivity values of water bearing fractured zones tapped in borewells, 38 m to 200 m deep, vary from 1.3 m^2/day to 27.5 m^2/day.

Charnockites – Next to Granite Gneiss, the charnockite form the second most dominant aquifers in the area. These rocks are usually fine to medium grained, occasionally coarse grained. The weathering in these rocks is not very pronounced and restricted to 3 to 20 m depth. These rocks are jointed and fractured but the joints are not very prominent. These rocks occupy the hill ranges. The premonsoon and postmonsoon depth to water table values range from 4.93 to 9.06 m and 3.99 to 7.69 m below ground level respectively. The seasonal water table fluctuation varies from 0.50 to 6.12 m. The specific capacity Index of aquifer as computed in a representative open well was 0.134 lpm/m/m^2. Due to their hard and compact nature and occurrence in hill ranges, these rocks have poor yield prospects. The wells in this formation generally yield 1 to 2 lps.

Khondalites - The khondalites are restricted to the western parts of the district. These rocks exhibit multiple sets of joints. Most of the joints have nearly vertical to steep dips. The opening of joints range from 5-60 mm and the thickness of the weathered residuum ranges from 3.5 to 13.00 m. The weathered residuum and underlying fractured rocks constitute the aquifers. The premonsoon and post monsoon depth to water table values range from 2.2 to 14.25 m and 1.1 to 12.25 m bgl respectively. Fluctuations is in the range of 1.1 to 3.0 m.

Schists – These include Andalusite Schists, Quartz – Sericite – Schists. The highly Weathered and decomposed products consist generally of moderately sticky clay. The depth of weathering varies from 12 – 30 m.

Quartzites, Limestones – These rocks occur in small patches along the northern boundary of the district. They were not explored hydrogeologically. The depth of weathering is not known. The depth to water level in the premonsoon is 1.88 m bgl and in the postmonsoon period is 1.83 to 2.37 m bgl.

Quartz Reef - A narrow linear ridge with steep slopes covered by debris, acts as barrier to the movement of groundwater. The upstream side of the ridge is favourable for groundwater occurrence.

Unconsolidated Formations

Alluvium –Alluvium is not well developed in the area. Small and local patches occur along the Sabari river. It is generally 2-5 m in depth. Its width varies from Zero to less than a Km. Most part of the banks of Sabari, Sileru and Potteru rivers are rocky with no tendency to deposit alluvium on either side. As such these are not useful for groundwater development because of its limited areal extent and thickness.

Ground Water Occurrence: The nature of occurrence and movement of ground water were studied through periodical monitoring of ground water and well inventory conducted during the systematic and reappraisal hydrogeological surveys in the district. The phreatic zone constitute the most potential groundwater storage in the district. The depth to water table values depend upon several factors

including rainfall, topography, drainage characteristics, lithology, depth and nature of weathering, water bearing and water yielding properties of the rocks as also surface irrigation.

4.3 Ground Water Monitoring :

Ground water regime in the district is being monitored periodically through 29 network hydrograph stations. The network stations are being monitored four times in a year i.e. during January, April, August and November.

Long Term Trend - The long-term trend of ground water level has been computed based on eleven years ground water monitoring data. The water level trend analysis data of pre-monsoon period 10 years (2001-11) indicate that there is a rise in water level 54% cases and fall in rest 46% cases. The maximum rise is to the tune of 0.400 m (Maithili in Maithili block) with the majority of the values resting within 15 cm. The maximum fall is around 0.1.113 m (MV-64 in Kalimela block) with the majority of the values resting with in 10cm. Considering the small magnitude of average values of rise and fall the rise and fall values are ignored. The rise and fall values are ignored also on the plea that during pre-monsoon period ground water draft is more. The water level trends during post monsoon period indicate that 59 percent status show rise varies from 0.013 to 0.304 m. The fall of water levels are shown by 41% of the status and maximum fall is recorded to the tune of 0.193 m (Balimela in Balimela block) and in majority of the cases the magnitude of fall is restricted within 0.20 m. From the perusal of rise and fall of water level over a period of 10 years, it has been observed that there is a significant decline in the trend ground water level.

4.4 Ground Water Scenario

The aquifer parameters of various hydrogeological units were evaluated through pumping tests of representative dug wells and slug tests/compressor tests of borewells. The aquifer parameters include Transmissivity and specific capacity Index. Transmissivity indicates aquifers property to transmit water and specific capacity Index (K=C/A) of the formations is expressed in terms of flow of groundwater per meter depression of head over unit cross sectional area of inflow offered by the aquifer. Transmissivity has been calculated for borewells and specific capacity Index for open wells.

Deeper Aquifers- CGWB carried out Ground Water Exploration in the district by deploying one Down The Hole Hammer (DTH) Rig. The study was aimed at identification of deeper potential fracture zones and for assessing yield potentials. In total 8 exploratory wells and 2 observation wells have been drilled in Malkangiri District. The sites for exploration were selected taking into account the hydrogeological characteristics of formations, favourable topography and tectonic features.

All the wells were drilled in Granite Gneisses except one borewell in Kalimela. The depth of drilling ranged from 38 m to 200 m below ground level. The top 8 to 20 m of the bore wells are cased with 178 mm diameter M.S pipe to prevent collapse of the loose overburden. Rest of the borewell is left uncased to tap the water bearing fractured. The discharge of the wells as tested by compressor varied widely from negligible to 10.6 lps.

Transmissivity values ranged from 2.6 m^2/day to 27.5 m^2/day. Exploratory drilling has been carried out in all the blocks of the district. At Mathili in the North East Corner of the district fracture zones were encountered in the Hornblende Mica Schist and Granite Gneiss at depths of 100 m and 13 7 m below ground level with a cumulative discharge of 2 LPS. However towards south at Khairpur, a number of fracture zones were encountered in depth range of 24 m to 107 m below ground level. The cumulative yield of the well was 2.8 LPS. The formation continues to be Granite Gneisses, at Kudumulgumma south of Khairput.

High yielding fracture zones, eleven in number were encountered within a depth of 130 m below ground level. The aquifer is Granite Gneiss with maximum discharge recorded at 10.6 lps. The high yielding fractured granite gneisses extend southwards and at Balimela the discharge of the exploratory

well was 5.16 lps. In this well also a number of fracture zones have been encountered at various depths. However the formations are compact towards west and yield of the exploratory well at Korukunda has been negligible down to 200 m depth. Similar formations continue in the adjacent block and at Malkangiri the exploratory well yielded hardly 0.88 lps, though a number of fracture zones were encountered within a depth of 144 m. In the south western part of the district at Kalimela six fracture zones were encountered in the exploratory well down to a depth of 195.3 meter below ground level during which the yield of the well was 2.54 lps. In this well charnockite was encountered in the deeper zones. At Podia in the western most corner of the district a number of fractures were encountered within a depth of 159 meter below ground level with a cumulative discharge of 3.59 lps.

4.5 Ground Water Quality

The quality of groundwater in Malkangiri district has been assessed based on chemical analysis of water samples collected during the hydrogeological surveys groundwater monitoring and exploratory drilling. The general ranges of different chemical constituents are as below –

Chemical Constituents	Shallow Aquifers	Deeper Aquifers
pH	7.17 – 8.21	6.86 – 8.18
Specific conductance (μS / cm at 25^0C)	214 - 1664	156 – 1103
Chloride (mg/L)	14 - 255	7.1 – 50
Calcium (mg/L)	18 - 110	14 – 62
Magnesium (mg/L)	36 - 54	1.8 – 47
Bicarbonates (mg/L)	79 - 409	85 – 543
Totar Hardness as $CaCO_3$ (mg/L)	75 - 495	45 – 260
Sodium (mg/L)	10 - 161	13 – 140
Potasium (mg/L)	12 - 62	1.2 – 12
Sulphate (mg/L)	-	1 – 41
Iron (mg/L)	-	0.14 – 0.53

In the U.S Salinity Diagram the suitability of groundwater for irrigation in the district, has been assessed on the basis of Sodium Absorption Ratio (SAR) and specific conductance. The classification of groundwater based on U.S Salinity Diagram in the district is given below

USSL Class	Grade	No. of Samples	%
C_1S_1	Good	2	12.50 %
C_1S_2	Moderately Good	-	-
C_1S_3	Unsuitable	-	-
C_1S_4	Highly unsuitable	-	-
C_2S_1	Good	9	56.25 %
C_2S_1	Moderately Good	-	-
C_2S_3	Unsuitable	-	-
C_2S_4			
C_3S_1	Moderately Good	5	31.15 %
C_3S_2		-	-
C_3S_3	Unsuitable	-	-
C_3S_4			

It may be seen from above that ground water samples collected from the shallow aquifers are good in quality and suitable for irrigation purposes. The water samples of deeper aquifers are well within the permissible limits of drinking water standard.

The Piper Tri-linear diagram for the type of groundwater in the district, has been assessed. The plot reveals that more than 60 % of the samples belong to the calcium–bi–carbonate(temporary hardness) type of water the rest belong to the mixed type.

4.6 Status of Ground Water Development(Blockwise)

It is basically a tribal district and occupied by hard crystalline rocks. Development of ground water is feasible through dug wells. The Net ground water resource of the district is assessed to be 33598 HM and the gross annual draft for domestic, industrial, and irrigation uses is 2942 HM. The average stage of ground water development in the district is 8.76 %. The lowest being Kudumulguma at 4.57% and highest being at Khairput at 13.38%

5.0 Ground Water Management Strategy

5.1 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 district has a net sown area of 117823 ha out of the total geographical area of 439080 ha. However only about 46000 ha area in the district is presently irrigated from both surface and groundwater sources, leaving more than 60% of the net sown area without irrigation facilities. This vast area has rainfed agriculture. For augmenting food-grains production this area has to brought under the strings of irrigation. Considering the low stage of ground water development in the district, there remains ample scope for further groundwater exploitation which will expand the irrigated agriculture.

Dug well - It is the most common groundwater abstraction structure in the district. Dugwells are feasible in pediplain areas. In hilly tracts it is feasible only in the intermontane valleys. The design of the dugwells depends upon hydro-geomorphological and hydro-geological set up, depth to water table, seasonal water table fluctuation. The dug wells should be located preferably in topographic low and should tap maximum thickness of the weathered zone. The dugwells should be of 10 m to 18 m depth and 4.5 m to 6 m in diameter. All the wells should be energized for optimal utilization of their potentials. Tentatively a total of 27189 additional wells are feasible in the district. 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-Borewell - The dug cum borewell can be constructed in the areas where the weathered zone is more than 15 m deep. The vertical bores drilled within dugwell increase the yield of the well. The bore well within the dugwell should be 25 m to 30 m in depth from ground level. The wells should be fitted with 2 H.P. centrifugal / submersible pumps may sustain yield up to 3 lps

Bore Wells - Lineaments or structurally weak zones in the hard rocks present favourable sites for borewells. Borewells have not met with success in Korukonda block. Borewells located in the vicinity of lineaments are likely to be successful. Wells drilled in Granite and Tranite Gneisses are likely to be more successful than in other formations. Borewells should be 100 m to 150 m deep and of 150 mm to 200 mm diameter. The borewells may be fitted with submersible pumpsets of 2-3 H.P depending upon the well discharge and depth to water level.

The district is predominantly inhabited by weaker section of the society and the majority of the farmers have small and marginal land holdings. In such a background sinking of groundwater structures viz. dug-wells and bore-wells which require small capital investments and less maintenance cost will be a better alternative for the poor farmers as compared to the major and medium irrigation projects. The financial institutions may provide loans on easy terms for the construction of these wells. The wells should be sunk at the hydro-geologically favorable sites. For this purpose, the expert guidance can be sought from the State Groundwater Organisation. Agricultural extension services may educate the farmers in adopting suitable cropping pattern, so as to fully utilize the newly created potentials. Energisation of the wells will ensure optimal utilization of this yield potentials. Programme may also be launched for the construction of percolation tanks, check dams, contour bounding which will conserve rain water and facilitate additional recharge to the groundwater reservoirs.

For the population of Malkangiri district particularly in the hilly areas, groundwater is the only sustainable and safe source of drinking water, particularly during summer season, when water scarcity becomes acute. As part of the Techynology Mission programme in Malkangiri district, borewell sites

were pin pointed through hydrogeological investigations aided by Remote Sensing Studies. The water scarcity in the district may be effectively mitigated through scientific management and judicious utilization of groundwater resources.

While targeting ground water structures for irrigation use or foe heavy industrial establishment utmost care should be taken in maintaining the safe distance between ground water structures to avoid well interference. This will facilitate optimal utilization of resources without any appreciable drawdown interference. The distance between any two dug wells/ dug cum bore wells fitted with pump set should be kept at least 100m. The distance between two bore wells may be kept between 150-200m.

5.2 Water Conservation & Artificial recharge

Malkangiri district is mostly traversed by Precambrian consolidated formations. The depth to water level varies from 2 – 5 mbgl in major part of the district during post monsoon and the average depth of water table in Chitrakonda is 5.03 mbgl and that of Motu is 5.63 mbgl. In these areas special studies may be taken up to evaluate the scope for artificial recharge. Deeper water level conditions in these areas may be 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 pre monsoon 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

The ground water problems mainly is in the form of Ground Water Depletion,

6.1 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 nitrate values have been observed. As such there is no ground water pollution in the district.

6.2 Ground Water Depletion: The stage of ground water development in different blocks varies from 3.08 % (Kudmulguma) to 13.70 % (Khairput) with the overall stage of development 6.02% in the district. The fall of water levels are shown by 46% of the total and maximum fall is recorded to the tune of 0.1.113 m (MV-64 in Kalimela block) with the majority of the values resting with in 10cm. From the perusal of water level over a period of 10 years, it has been observed that there is a significant decline in the trend ground water level.

Special Studies: Special studies in the district has been taken up in the field of drinking water source finding under Rajiv Gandhi Technology Mission on Drinking Water

Technology Mission on Drinking Water : Kalimela block of Malkangiri District covered under the programme of Technology Mission on Drinking Waters. CGWB carried out scientific source finding for 14 no-source villages. A multi disciplinary approach was adopted for identification of sustainable water sources. It included a study of the remote sensing maps which depicted lineaments and geomorphic units showing favourable locates of ground water. The hydrogeological characteristics and yield potentials of formations were studied through spot hydrogeological surveys and sites for suitable groundwater structures were pin pointed for each village. In Kalimela block 14 no-source villages were

covered under source finding mission. Bore wells were recommended in 7 villages and sanitary wells in 7 others.

7.0 Awareness & Training Activity

As of March 2007, no mass awareness or water management programme have been organized in the Malkangiri district so far.

7.1 Mass Awareness programme(MAP) & Water Management Training Programme(WMTP) by CGWB. : NIL

7.2 Participation in Exhibition, Mela, Fair etc. : NIL

7.3 Presentation & Lectures delivered in public forum / Radio / T.V. / Institution of repute / Grassroots associations / NGO / Academic Institutions etc : NIL

8.0 Areas Notified by CGWA / SGWA

Since the stage of ground water development in the entire district is only 8.76 % with no significant decline in either pre-monsoon or in the post-monsoon, no notification was called for.

9.0 Recommendations

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. 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.

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

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

5. 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.

6. 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.

7. 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.

8. Proper maintenance of reservoirs, tanks and spring channel by periodical desiltation should be carried out so that the precious water resource could be judiciously utilized after monsoon.

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. Network hydrograph stations in the canal command areas should be strengthened and periodical water level measurements continued to monitor any alarming rise of water table

11. 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.

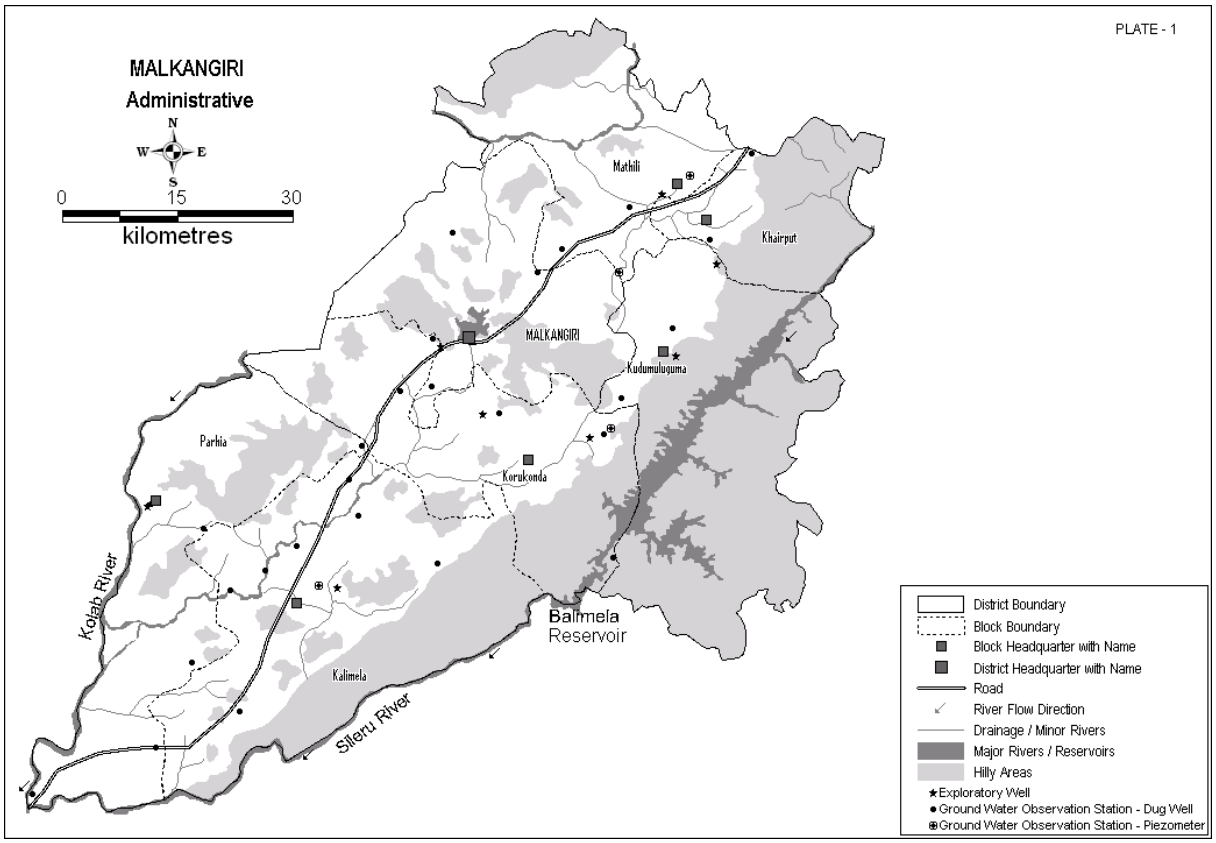


PLATE - 1
MALKANGIRI
Administrative
N
W
E
S
0
15
30
kilometres
Mathili
Khairput
MALKANGIRI
Kudumuluguma
Parhia
Korukonda
Kolab River
Balimela
Reservoir
Kalimela
Sileru River
District Boundary
Block Boundary
Block Headquarter with Name
District Headquarter with Name
Road
River Flow Direction
Drainage / Minor Rivers
Major Rivers / Reservoirs
Hilly Areas
Exploratory Well
Ground Water Observation Station - Dug Well
Ground Water Observation Station - Piezometer

PLATE - 2

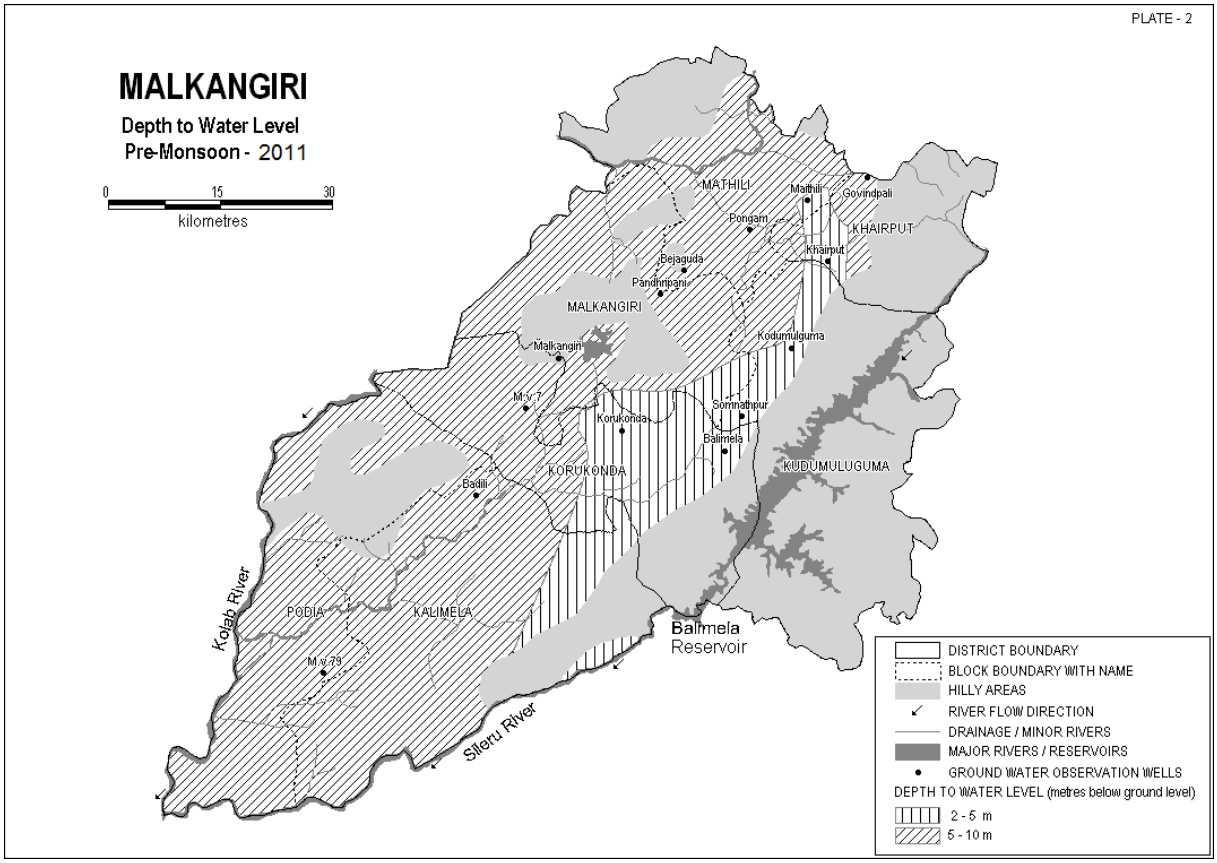
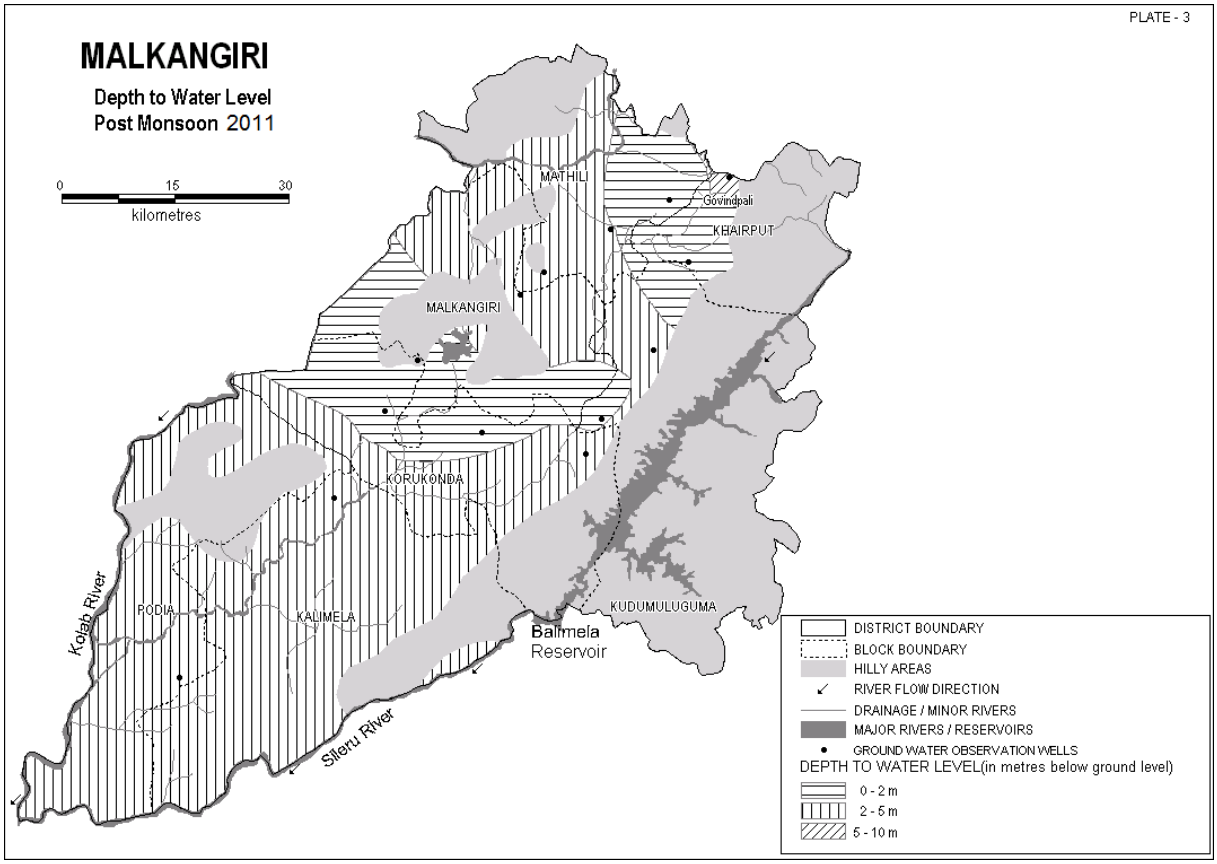

MALKANGIRI
Depth to Water Level
Pre-Monsoon - 2011
0
15
30
kilometres
MATHILI
Mathili
Govindpali
Pongam
KHAIRPUT
Khairput
Bejaguda
Pandripani
MALKANGIRI
Kodumulguma
Malkangiri
M.v.7
Korukonda
Somnathpur
Balimela
KORUKONDA
KUDUMULUGUMA
Badili
Kolab River
PODIA
KALIMELA
Balimela
Reservoir
M.v.79
Sileru River
DISTRICT BOUNDARY
BLOCK BOUNDARY WITH NAME
HILLY AREAS
RIVER FLOW DIRECTION
DRAINAGE / MINOR RIVERS
MAJOR RIVERS / RESERVOIRS
GROUND WATER OBSERVATION WELLS
DEPTH TO WATER LEVEL (metres below ground level)
2 - 5 m
5 - 10 m

PLATE - 3


MALKANGIRI
Depth to Water Level
Post Monsoon 2011
0
15
30
kilometres
MATHILI
Govindpali
KHAIRPUT
MALKANGIRI
KORUKONDA
PODIA
KALIMELA
KUDUMULUGUMA
Balimela
Reservoir
Kolab River
Sileru River
DISTRICT BOUNDARY
BLOCK BOUNDARY
HILLY AREAS
RIVER FLOW DIRECTION
DRAINAGE / MINOR RIVERS
MAJOR RIVERS / RESERVOIRS
GROUND WATER OBSERVATION WELLS
DEPTH TO WATER LEVEL(in metres below ground level)
0 - 2 m
2 - 5 m
5 - 10 m

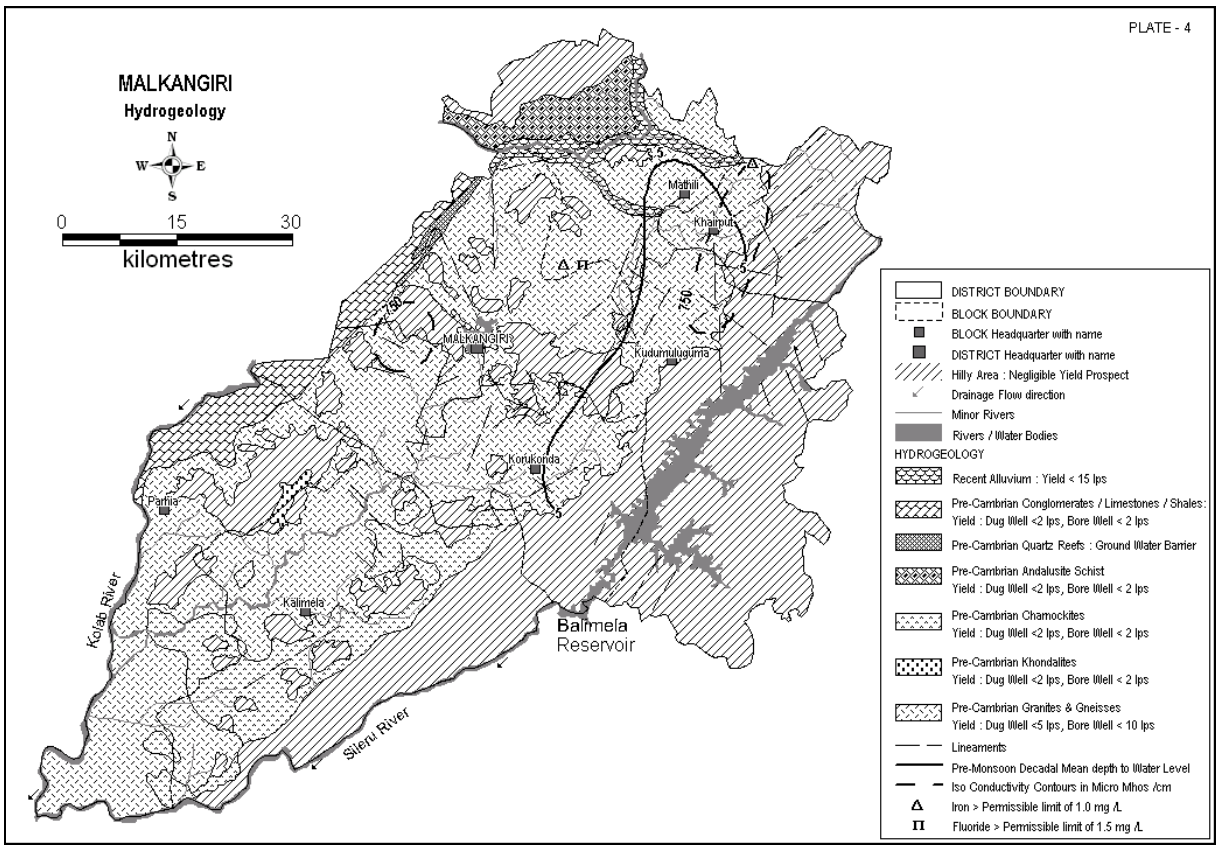
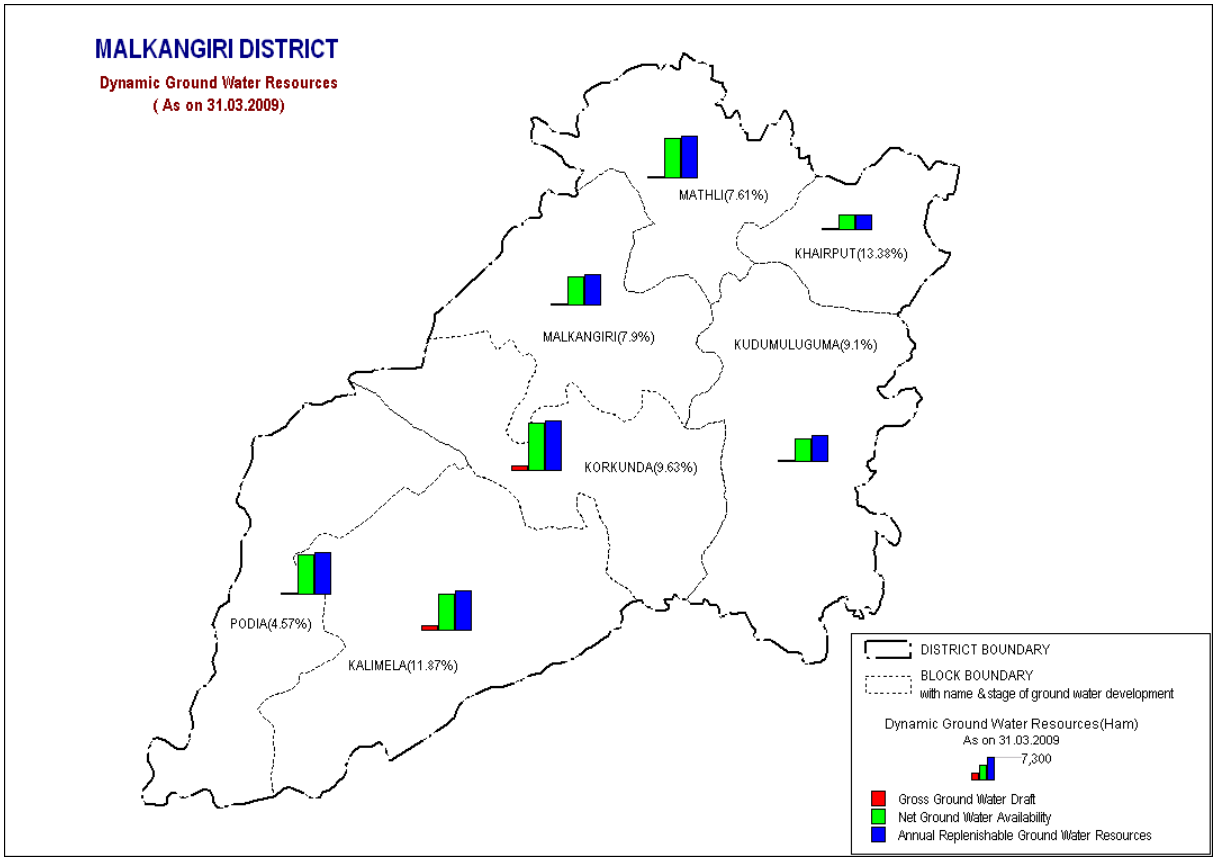


PLATE - 4
MALKANGIRI
Hydrogeology
N
W
E
S
0
15
30
kilometres
Mathili
Khairput
MALKANGIRI
Kudumulugumma
Korukonda
Partlia
Kalimela
Kolab River
Balimela
Reservoir
Sileru River
DISTRICT BOUNDARY
BLOCK BOUNDARY
BLOCK Headquarter with name
DISTRICT Headquarter with name
Hilly Area : Negligible Yield Prospect
Drainage Flow direction
Minor Rivers
Rivers / Water Bodies
HYDROGEOLOGY
Recent Alluvium : Yield < 15 lps
Pre-Cambrian Conglomerates / Limestones / Shales:
Yield : Dug Well <2 lps, Bore Well < 2 lps
Pre-Cambrian Quartz Reefs : Ground Water Barrier
Pre-Cambrian Andalusite Schist
Yield : Dug Well <2 lps, Bore Well < 2 lps
Pre-Cambrian Charnockites
Yield : Dug Well <2 lps, Bore Well < 2 lps
Pre-Cambrian Khondalites
Yield : Dug Well <2 lps, Bore Well < 2 lps
Pre-Cambrian Granites & Gneisses
Yield : Dug Well <5 lps, Bore Well < 10 lps
Lineaments
Pre-Monsoon Decadal Mean depth to Water Level
Iso Conductivity Contours in Micro Mhos /cm
Δ Iron > Permissible limit of 1.0 mg /L
Π Fluoride > Permissible limit of 1.5 mg /L


MALKANGIRI DISTRICT
Dynamic Ground Water Resources
(As on 31.03.2009)
MATHLI(7.61%)
KHAIRPUT(13.38%)
MALKANGIRI(7.9%)
KUDUMULUGUMA(9.1%)
KORKUNDA(9.63%)
PODIA(4.57%)
KALIMELA(11.87%)
DISTRICT BOUNDARY
BLOCK BOUNDARY
with name & stage of ground water development
Dynamic Ground Water Resources(Ham)
As on 31.03.2009
7,300
Gross Ground Water Draft
Net Ground Water Availability
Annual Replenishable Ground Water Resources

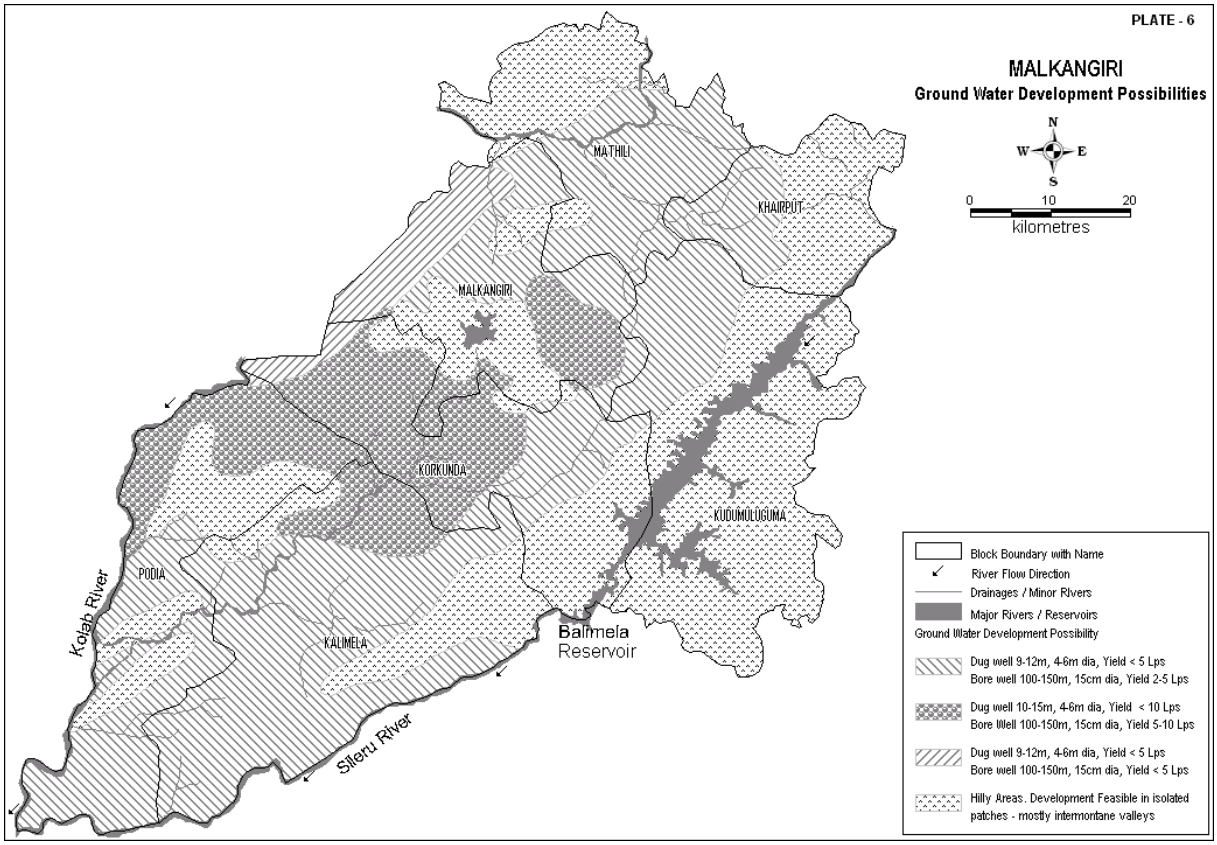
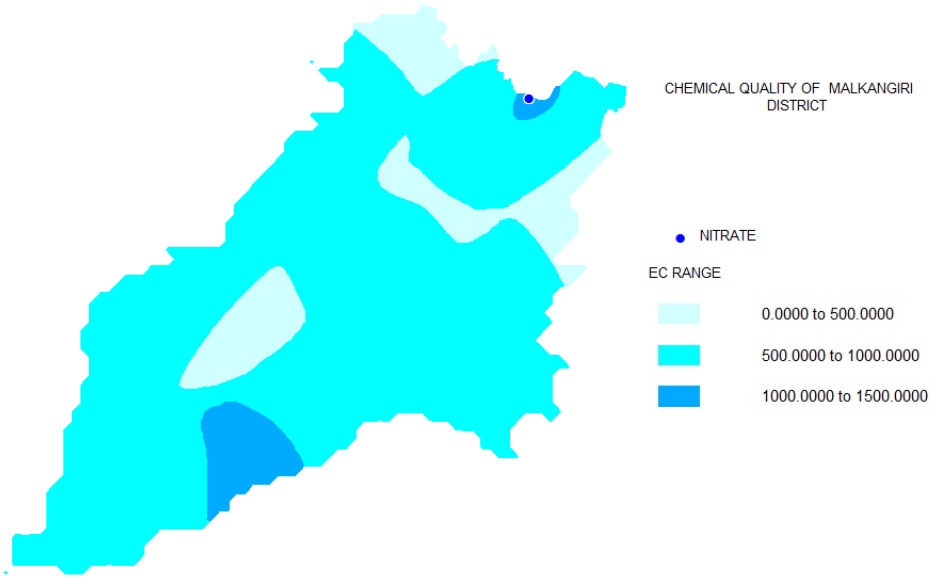


PLATE - 6
MALKANGIRI
Ground Water Development Possibilities
N
W
E
S
0
10
20
kilometres
MATHILI
KHAIRPUT
MALKANGIRI
KORKUNDA
KUDUMULUGUMA
PODIA
KALIMELA
Kolab River
Balimela
Reservoir
Sileru River
Block Boundary with Name
River Flow Direction
Drainages / Minor Rivers
Major Rivers / Reservoirs
Ground Water Development Possibility
Dug well 9-12m, 4-6m dia, Yield < 5 Lps
Bore well 100-150m, 15cm dia, Yield 2-5 Lps
Dug well 10-15m, 4-6m dia, Yield < 10 Lps
Bore Well 100-150m, 15cm dia, Yield 5-10 Lps
Dug well 9-12m, 4-6m dia, Yield < 5 Lps
Bore well 100-150m, 15cm dia, Yield < 5 Lps
Hilly Areas. Development Feasible in isolated patches - mostly intermontane valleys


CHEMICAL QUALITY OF MALKANGIRI DISTRICT
NITRATE
EC RANGE
0.0000 to 500.0000
500.0000 to 1000.0000
1000.0000 to 1500.0000