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CONSERVE WATER – SAVE LIFE

भारत सरकार

GOVERNMENT OF INDIA

जल संसाधन मंत्रालय

MINISTRY OF WATER RESOURCES

केंद्रीय भूजल बोर्ड

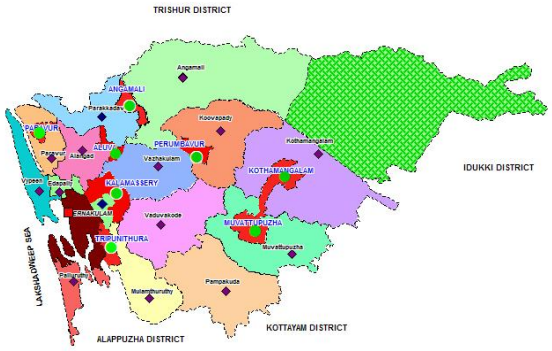
CENTRAL GROUND WATER BOARD

केरल क्षेत्र

KERALA REGION

भूजल सूचना पुस्तिका, एर्णाकुलम जिल्ला, केरल राज्य

GROUND WATER INFORMATION BOOKLET OF ERNAKULAM DISTRICT, KERALA STATE



तिरुवनंतपुरम

Thiruvananthapuram

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GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
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GROUND WATER INFORMATION BOOKLET OF ERNAKULAM DISTRICT, KERALA STATE

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DISTRICT AT A GLANCE

Sl No	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical area, sq km	3068.
	ii) Administrative Divisions (As on 31-03-2011) Number of Taluks Number of Blocks Number of Municipalities Number of Gram Panchayats Population (as per 2011 census)	 7 14 11 88 32, 79,860
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Coastal Plain , Midland and High land
	Major Drainages	Periyar and Muvattupuzha rivers and their tributaries
3.	**LAND USE**	
	a) Forest area (ha)	70619
	b) Total cropped area(ha) 2009-10	175552
4.	**MAJOR SOIL TYPES** Parur, Kochi and Kunnathunad taluks Parts of Aluva and Kunnathunad taluks Muvattupuzha, Kothamangalam and parts of Aluva and Kunnathunad taluks	 Coastal Alluvium Riverine alluvium Brown hypdromorphic soil Lateritic soil
5.	**AREA UNDER PRINCIPAL CROPS, ha (2009-10)**	Paddy : 10787 Coconut : 44475 Fruits : 25891 Spices : 17303 Rubber : 58729
6.	**IRRIGATION BY DIFFERENT SOURCES, Area in ha(2009-10)**	
	Wells	6936
	Tanks	1967
	Canals	11250
	Tube well	461
	Minor Irrigation	3592
	Other Sources	2233
	Net Irrigated area	26825
7.	**NUMBER OF GROUNDWATER MONITORING WELLS OF CGWB (AS ON 31-3-2011)** No. of Dug wells No. of Piezometers	 44 19

8	PREDOMINANT GEOLOGICAL FORMATIONS	Archaean Crystalline formation (Charnockite group& migmatite group), Tertiary sedimentary formation, Sub-Recent laterite and Recent alluvium.
9.	**HYDROGEOLOGY** Major Water bearing formation Average depth to water level (Pre-monsoon, 2002-11) Average depth to water level (Post-monsoon, 2002-11) Long term water level trend in 10 years cm/yr	Weathered, fractured crystalline formations; semi consolidated Tertiary formations, laterites and Recent alluvium. 0.75 to 12.05 mbgl. 0.54 to 10.42 mbgl. No conspicuous trend except vytilla block showing declining trend of 23.72 cm/yr in pre-monsoon and 17.52 in post-monsoon
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2011)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW – 34 OW-3, PZ –21, Total – 58
	Depth Range (m)	54 – 295.6
	Discharge (litres per minute)	6 – 1320
	Transmissivity (m^2/day)	4.72 -818
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits	Quality is good in general. Major chemical constituents lie within the permissible limits..
12.	**DYNAMIC GROUNDWATER RESOURCES (2009) – in ha.m**	
	Annual Replenishable Ground Water Resources	61572.06
	Gross Annual Groundwater Draft	23975.68
	Projected demand for Domestic and Industrial Uses up to 2025	15254.34
	Stage of Ground Water Development,%	43.02
13.	**AWARENESS AND TRAINING ACTIVITY** Mass awareness programme organised place Water Management Training Programmes organized Date Place No. of Participants	 2002 Ernakulam 2005 Ernakulam 100
14.	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over Exploited blocks	Nil
	Number of blocks notified	Nil

15.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	◆ Saline water ingress is observed in the shallow alluvial aquifer in the western part of the district which is in hydraulic connection with the back water. ◆ Water logging along the western border of the district bordering the back water lagoons during the rainy season. ◆ Brackish quality of groundwater along tidal inlets. ◆ Anthropogenic pollution.

GROUND WATER INFORMATION BOOKLET OF ERNAKULAM DISTRICT, KERALA STATE

1.0 INTRODUCTION

Ernakulam district occupies the Central part of Kerala state and is bound by Trichur district on the north, Idukki on the east and south east, Kottayam and Alappuzha districts on the south and the Lakshadweep Sea on the west. The district is spread over an area of 3068 Sq. km. earlier the district covered an area of only 2408 sq. km. But, later on Kuttampuzha panchayat of the Nedumkandam block, Idukki district was also attached to it and the district attained the present area. Ernakulam district lies between North latitudes 09^0 47' 13" and $10^0$10'44" and East longitudes 76^0 10' 05" and 77^0 05' 24. Kochi known as the Queen of Arabian Sea is the headquarters of Ernakulam district. It is a major port city on the west coast of India. The district is well connected with a good network of roads and railways. The Nedumbassery International airport is located in the district.

1.1Administation

For administrative purposes, the district is divided into two revenue divisions and seven taluks. Muvattupuzha revenue division with Muvattupuzha as its headquarters comprises of 43 villages belonging to Kunnathunadu, Muvattupuzha and Kothamangalam taluks, while Kochi division with its headquarters at Kochi consists of 71 villages of Aluva, Paravur, Kochi and Kanayanur taluks. There are 14 community development blocks, 88 gram panchayats, eleven municipalities and one corporation in the district. The district has a population of 32, 79,860 persons with 16, 17,602 males and 16, 62,258 as per 2011 census. The index map is given in **Figure 1.**

1.2 Drainage and Irrigation

The district is drained by the Periyar and its tributaries in the north and Muvattupuzha River in the south. Periyar, the longest river in the state with a total length of 244 km originates from the cardamom hills of the Western Ghats flows in a Northerly direction initially and then in North-west direction as it flows through Idukki district before entering Ernakulam district at Neriamangalam. In the district the river takes almost a straight line course roughly in a North Western direction and at near Bhuthathankettu dam, it is joined by major tributaries Cheruthoni and Idamalayar. Further downstream at Aluva, the river bifurcates into two: the Marthandavarma and the Mangalapuzha branches. The Mangalapuzha branch joins Chalakkudy river and empties into the Lakshadweep sea at Munambam, and the Marthandavarma branch flows southwards, through the Udhyogamandal area and joins the Cochin backwater system (part of Vembanad Lake) at Varapuzha. The Periyar is a perennial river and is source of drinking water for several major towns. The Idukki dam across the Periyar generates a significant proportion of Kerala's electrical power.

The Muvattupuzha River is formed by the confluence of Thodupuzha River, Kaliyar River and Kothamangalam River at Muvattupuzha. These rivers originate from the Thodupuzha reserve forest. The Muvattupuzha River takes a rough east-west course up to Ramamangalam and thereafter it flows towards south leaving the districts south of Pazhur. In the upstream areas the drainage pattern in both Periyar and Muvattupuzha basin are trellis to sub-trellis. In the lower reaches dendritic pattern of drainage is observed.

Vembanad Lake; Ernakulam district is bordered to south-west by Vembanad Lake which is the largest lake in Kerala. Besides Ernakulam, the lake is bordered by Alappuzha and Kottayam districts. The lake is separated from the Lakshadweep Sea by a narrow barrier island and opens to the sea at Cochin. And at Munambam further north. The port of Kochi (Cochin) is located at the lake's southern outlet to the Sea. The stretch from *Kochi Azhi* to *Munambam Azhi*, is popularly known as Varapuzha. Canals link the lake to other coastal lakes to the north and south. The portion of the Vembanad Lake located in and around the Kochi mainland is known as Kochi kayal. The lake bears many an islands and in Ernakulum district itself it hosts island like Vypin, Mulavukad, Vallarpadam, Willingdon Island etc. The lake is a part of Vembanad-Kol wetland system which extends from Alappuzha in the south to Azheekkode in the north, making it by far, India's longest lake at just over 96.5 km in length. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely the Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar. The total area drained by the lake is 15,770 km², which accounts for 40% of the area of Kerala. Its annual surface runoff of 21,900 mm accounts for almost 30% of the total surface water resource of the state.

The lake has become a major tourist location due to its scenic beauty. The Vembanad Wetland system is the largest of the three Ramsar Sites in the state of Kerala. But Vembanad Lake has been heavily reclaimed over the course of the past century with the water spread area reducing from 290.85 km² in 1917 to 227 km² in 1971 and 213.28 km² in 1990. In the same period almost 63.62 km of erstwhile water spread were reclaimed primarily for formation of polders and to enlarge the extent of the Wellington island of Cochin port. The lake faces a major ecological crisis and has reduced to 37 per cent of its original area, as a result of land reclamation.

1.3 Land Use, Irrigation and cropping pattern

About 83% of the total area of the district is cultivable land, 10% is under forest cover including reserve forest and plantations; water bodies constitute 5.3% and built up area constitutes nearly 2% of the total area. The land use pattern of the district is given in **Table 1** below

Table 1: Land use pattern of Ernakulam district as on 2009-10

Sl.No.	Head of classification	Area In hectares
1	Total Geographical area	305826
2	Forests	70617
3	Land put in non agricultural use	30750
4	Barren and uncultivable land	1193
5	Permanent pastures and other grazing land	7
6	Land under miscellaneous tree crops (not included in net area sown	133
7	Cultivable waste	9938
8	Fallow land other than current fallow	7150
9	Social Forestry	10876
10	Net area sown	158763
11	Area sown more than once	16789
12	Total cropped area	175552

An area of 26,825 hectares is under irrigation (net area) in the district. Periyar valley irrigation project with a barrage at Bootathankettu which uses the tail race water of Sengulam, Panniyur and Pallivasal Hydro-electric projects and Chalakudy diversion project are source for canal irrigation in the district. Area irrigated by different source of Irrigation is given in **Table 2.**

Table 2: Area irrigated by different source of Irrigation (2009-10)

Canal	Tank	Wells	Minor Irrigation	Tube wells	other	Total
11250	1967	6936	3592	461	2233	26825

The major crops under irrigation in the district are paddy, coconut, rubber, banana and arecanut. Paddy is cultivated in more than one season. The crop wise area under irrigation is presented in **Table 3**

Table 3: Crop wise area under irrigation (2009-10)

Crop	Paddy	Coconut	Fresh Fruits	Rubber	Spices	Others	Total
Area in hectares	10787	44475	25891	58729	17303	18367	175552

(Source: Report on Agricultural Statistics by Dept of Economics and Statistics)

Rubber is the major crop in the district followed by Coconut, Paddy, and Banana. Spices, Areca nut, oil seeds and vegetables are also cultivated in the district.

1.4 Work Carried Out by CGWB

The CGWB has carried out hydrogeological studies and exploration of both sedimentary and hard rock areas. Exploration for groundwater in the district was taken up during the FSP 1965 – 66, 74 – 75, 83 – 87, 89 – 90, 98 – 2001, 02, and again in 2011-12. Systematic hydrogeological surveys were carried out in different parts of the district by S/Sh. S.V.N.S Rao (77-78, 82 – 83), GV.V.R.G.S.V. Rao (80 – 81), K.Md. Najeeb (81 – 82, 87 – 88), V. Dhinagaran (95 - 96). Detailed study of the groundwater conditions of the entire district were carried out by SIDA assisted Coastal Kerala, Ground Water Project during the period 83 – 88.

2.0 RAINFALL AND CLIMATE

2.1 Rainfall

Ernakulam district has wet monsoon type of climate. The district experiences heavy rainfall during southwest monsoon season followed by northeast monsoon. During the other months the rainfall is considerably less. March, April and May are the hottest months. December to February are the coldest months

The district receive on an average 3359.2 mm (based on 1901-99 data) of rainfall annually. The annual rainfall ranges from 3233 to 3456 mm at different places of the district.

The rainfall is less in the western part of the district and gradually increase towards the east. Maximum rainfall is received around Neriamangalam area in the eastern part where the normal annual rainfall is found to be 5883 mm. While Kochi, which is in the western part receives around 3233 mm rainfall annually. The annual average rainfall of Ernakulam district from 2007 to 2011 is given in **Table 4**

South-west monsoon season contributes nearly 67.4% of total rainfall of the year, followed by the north-east monsoon which contributes nearly 16.6% and the balance of 16% is received during the month of January to May as summer showers. The Average monthly rainfall distribution for Ernakulam district (2007 to 2011) is given in **Table 4.**

Table 4: Average Monthly Rainfall (mm) of Ernakulam District (2007 -2011)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2007	1.9	1.4	9.2	146.5	193.5	815	1133	480.1	667.3	522	66.1	9.8	2883.9
2008	3	30.8	329.6	129.1	137.7	455.1	539	326.2	555.1	304	37.4	36.9	4045.8
2009	10.4	0	45.8	89.5	315.7	615.1	839	312.2	497.4	177	290	70.1	3262.2
2010	9.8	0	30.5	233.8	239.9	849.9	691	356.5	456.9	625	517.5	63.2	4074
2011	26	98	37	201	187	896	619	593	528	161	120	34	3500

Maximum rainfall is received in the month of June or July with July 2007 recording the maximum monthly rainfall of 1133mm. Minimum rainfall is received in the month of January or February.

2.2 Meteorological Parameters

Temperature

The mean monthly maximum temperature ranges from 28.1 to 31.4^{o}C and the minimum ranges from 23.2 to 26 ^{o}C. The maximum temperature occurs during March and April months and the minimum temperature occurs during December and January months.

Relative Humidity

The humidity ranges from 68 to 89% during morning hours and 64 to 87% during evening hours. The maximum humidity is observed during May to October months.

Evaporation

Evaporation is more during summer months of January to April and it is low during the rainy months May to August. The maximum rate of 4.8 mm per day is recorded in March and the lowest rate of 2.6 mm is recorded during July.

Sunshine Hours

Sunshine ranges from 4.3 to 9.7 hours/day. Maximum sunshine is during the month of February. The months of June to August record the minimum sunshine due to the cloudy sky. Generally good sunshine hours are recorded in the months of November to May.

Wind

The wind speed ranges from 6.7 to 10.9 km/hour with mean speed of 9.1 km/hour. The wind speed is high during the period from March to September.

Potential Evapotranspiration (PET)

The PET ranges from 94.5 to 159.2 mm. The maximum PET occurs during March and minimum occurs during June. The PET is less than the rainfall from May to November indicating water surplus for recharge into ground water regime.

3.0 GEOMORPHOLOGY AND SOIL

The district can be broadly divided into three physiographical units viz. (1) the Coastal plains (low lands) (2) the mid lands and (3) the high lands. The general elevation of the coast is less than 8.0m.amsl and that of the midlands is between 8.0 and 76 m.amsl. The highlands are having the general elevation above 76 m with the maximum of around 504 m.amsl. The entire taluks of Kochi and Parur and major parts of Kanayannur fall under the coastal plain. The municipalities of Paravur and Tripunithura the township of Kalamasseri and the corporation of Kochi are located in the coastal

plains. All the other taluks except the north-eastern parts of Kunnathunad taluk fall under the mid land area. The high land belt of the district is the Malayattoor reserve forest in Koovappady block, which covers about 9% of the area of the district.

The Coastal belt is dotted with a host of islands ranging from largest Vypin islands of length 27 km to, smaller islands like Mulavukad, Vallarpadam, and Willingdon Island etc. The western coast of Vypin has the longest beach in Kochi namely, the Cherai Beach. The northern tip of Vypin (Munambam) has the largest fishing harbour in Kochi namely, the Munambam Fishing Harbour. Vypin is home for harbour related industrial establishments like, the SPM project of the Kochi Refineries, and the Puthuvyp LNG Terminal.

3.1 Pedology

On the basis of morphological features and physico-chemical properties, the soils of the district are classified as Lateritic, Hydromorphic saline, Brown hydromorphic, Riverine alluvium and Coastal alluvium.

Lateritic soil is the most predominant soil type of the district. In Muvattupuzha, Kothamangalam, Kunnathunadu and parts of Aluva taluks lateritic soil is encountered. These soils are well drained, low in organic matter and plant nutrients. The major crops grown are coconut, tapioca, rubber, areacanut, pepper, cashew and spices. Small patches of hydromorphic saline soil are encountered in the coastal tracts of the district in Kanayannur and Cochin taluk. The tidal backwaters contribute to the salinity of the soil. Coconut is grown in these soils.

Brown hydromorphic soil is the second most prevalent soil type of the district and they are encountered in valley bottoms. The soil is enriched in clay content and plant nutrients. The soil is suited for paddy cultivation.

Riverine alluvium is restricted to the banks of rivers and their tributaries. They are composed of sandy to clayey loam and are enriched in plant nutrients. It is suited for a large variety of crops like coconut, paddy arecanut, pepper, vegetables etc. In Cochin taluk and the western parts of Paravur and Aluva taluk coastal alluvium is encountered and is composed of sand and clay. Coconut is the major crop in these soils.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology

Groundwater generally occurs under phreatic conditions in weathered and fractured crystalline rocks, laterites and unconsolidated coastal sediments. It occurs under semi-confined to confined conditions in the deep seated fractured aquifer of the crystallines rocks and Tertiary sediments. The weathered zone in the crystallines below acts as good storage for groundwater.

Based on nature of formation, the aquifer can be classified into hard rock aquifers and sedimentary aquifers.

4.1.1 Hard Crystalline Formation

Groundwater occurs under phreatic conditions in the shallow weathered portions whereas it occurs under semi confined to confined condition in the deep-seated fractures of the crystalline formation. The hard rock formations in general lack primary porosity. The water is stored in the secondary pores developed as a consequence of weathering in fractures, fissures and joints etc. The movement of groundwater is controlled by the extent of the interconnection of the fractures.

In the shallow phreatic zone the depth of dug wells varies from 3.4 to 14.8 mbgl. The depth to water level in the wells ranges from 1.82 to 12.05 mbgl.

The Central ground water board has drilled 7 exploratory wells in the hard rock areas of the district as a part of its exploration programme to explore the deeper confined aquifer. The depth of the wells ranged from 131 to 201 mbgl. Most of these wells were drilled in the Charnockitic area. The details of wells drilled in Hard rock area of the district is presented in Appendix – I. Fracture zones were encountered at depth ranging from 5 – 194 mbgl with yield ranging from 1 to 22 lps. The studies by CGWB have indicated that the wells located at intersections of lineaments are most potential. Among the lineaments the E-W, NNE – SSW and NE – SW lineaments are potential whereas the NNW – SSW are least potential lineaments. The deep fractured rock has transmissivity ranging from 15.64 to 319 m^2 /day.

4.1.2 Sedimentary formations

Exploratory drilling was carried out in 25 sites in sedimentary terrain. The depth of wells drilled ranged from 58 to 296 mbgl. The details of wells drilled in sedimentary area viz. the zones tapped, discharge, specific capacity, transmissivity and water quality are presented in Appendix -II **.** The sedimentary formations are confined to the coastal belt and the potential aquifers occurring at depth among are the Warkali and Vaikom beds.

Warkali Beds

The Warkali beds of the Tertiary formation are found to constitute aquifers of semi-confined to confined aquifers. In Ernakulam district, they are least extensive and are restricted to the southern coastal belt with thickness thinning out from South to North from 106.7m at chellanum in south to less than 13 m in north at Panangad. The Warkali aquifers are essentially composed of fine to medium grained sand. However in the district the formation water is found to be of brackish nature and not worth to be tapped except along certain pockets in and around Kumbalangi area. The central ground Water Board has constructed an exploratory well at Kumbalangi which is tapping the warkalai aquifer and also the Vaikom aquifer. The total dissolved constituents of the groundwater are found to be 1379 mg/l.

Vaikom Beds

The Vaikom beds are potential confined aquifers and are generally separated from the overlying potential Warkali formations by confining Quilon beds except in the northern portion of the district where the Vaikom beds are underlying the Coastal alluvium or Laterite. The Vaikom beds are composed of thick sequence of coarse to very coarse sand, gravel and pebble beds intercalated with ash, grey clay and carbonaceous clay. They extent North to South in the coastal belt with thickness increasing from 18 m at Panangad in north to 151 m at Chellanum in south. The wells tapping coarse sand and gravel aquifers of Vaikom formation with granular zones 6 to 14 m thick have yield ranging from 1.2 to 10.1 lps and transmissivity of aquifer ranges from 193.6 to 818 m^2/day. Some of the wells were flowing wells at the time of construction.

The beds are coarse grained in nature. The quality of groundwater from these beds is brackish in nature with EC varying from 4000 to 17,300 µ Siemens/cm at 25^0C. In small restricted pockets like Narakal, Subash Park, Naval base and Kumbalangi the water is fresh.

Laterite

The laterite are vastly occurring in the mid land areas of the district by weathering of the crystalline formation and also at depth in the sedimentary formation in the coastal belt. Along the coastal belt, they are discontinuous and are found to be eroded at places and generally they occur as a horizon between the Recent alluvium in top and Warkali beds or Vaikom beds below at depth ranging from 20 to 56 mbgl.

The laterites are highly porous and permeable. It is extensively developed by dug wells in the mid land area for domestic and to a limited extent for irrigation. The depth of wells in laterite ranges from 3.4 to 14.8 mbgl and depth to water level ranges from 1.55 to 11.06 mbgl. Wells located on slopes and elevated areas go dry or have very small water column during summer season. The yield of well ranges from 0.5 to 6 m^3/day and sustain pumping for 3 to 4 hrs a day.

Alluvial Formations

The alluvial formations occurring in the coastal belt are constituted by sand, silt, clay of the lagoonal and back water deposits, beach deposits and the river/flood plain deposits in mid land areas. The thickness ranges from less than 1m to 54 m at Kandakadavu in south. It forms potential phreatic aquifer extensively developed by dug wells and filter point wells. They are tapped to meet domestic and other needs. The dug wells range in depth from 2.14 to 13 m in general and depth to water level range from 0.35 to 7.03 mbgl. The dug wells have an average yield ranging from 15 to 20 m^3/day.

Filter point wells are common wherever the average saturated thickness of alluvial sand exceeds 5 m and have depth ranging from 5 to 15 mbgl. They have yield ranging from 12 to 18 m^3/day.

4.2 Water levels

The Central Ground Water Board is maintaining a total of 70 NHS in Ernakulam district. Of these 49 are dug wells and 21 are piezometers. They are monitored 4 times a year i.e., during January, April, August and November. Water samples are collected annually during April (pre monsoon) for analysis and analysed for major elements and other parameters.

4.2.1 Average depth to water level (2002-11)

The depth to water level in the district shows wide variation on account of the physiographical units in which the wells are located and undulating terrain in the mid land. Water level is shallower in western coastal part and is less than 2 mbgl in general although occasionally it is deeper at around 4 to 4.5 mbgl except for a small pocket in and around Chengamanad where it is more than 11 m.bgl. The average depth to water level for the different blocks in the district for the period 2002 to 2011 is given in table below.

Table 5 Block-wise decadal average depth to water level Ernakulam district (2002-11)

Sr. No	Block Name	Average Depth to Water Level (2002-11)	
		Pre-monsoon (April)	Post-monsoon (November)
1	Alangad	2.43	1.50
2	Angamaly	6.42	6.42
3	Edapally	3.87	3.40
4	Koovapady	6.63	5.46
5	Kothamangalam	4.15	3.41
6	Mulamthuruthy	6.16	4.35
7	Palluruthy	1.84	0.94
8	Pampakkuda	5.85	4.87
9	Muvattupuzha	6.58	4.45
10	Parakkadavu	6.93	5.10
11	Paravur	1.46	0.61
12	Vaduvakode	5.19	5.15
13	Vazhakulam	5.69	5.00
14	Vypeen	1.01	0.63

Figures 2 and 3 shows the average depth to water table of Ernakulam district for pre monsoon for the decade (April 2002-2011) and Post monsoon (November 2002-2011).

In the Coastal Plains the water level is shallow and restricted to less than 2mbgl.

In the eastern part of the district also it is observed that the water level is shallow and is following the riverine alluvial belt of Periyar River. In the midland region the water table is between 5 and 10 mbgl and at isolated pockets and is found to be deeper levels of more than 10 m depth.

Compared to the pre monsoon period, in the post monsoon period the water level has risen in general. In the coastal belt, the water level is very shallow and less than 2 mbgl through out. Besides in most areas of the district the water level has risen and is at depth of less than 5 mbgl. However in the isolated pockets in the northwestern segment of the district it is deeper than 10 m.

4.2.2 Long term trend analysis in water level

The long term behaviour of water level in dug wells is mainly controlled by the rainfall recharge received and also the return seepage due to canal flow and irrigation.

The pre-monsoon water level trend reflect the trend of groundwater development, the post monsoon water level trend brings out the actual rise or fall in the area. The change in water level is considered to be significant if there is a fall of more than 15 cm/year. The block-wise long term water level for pre-monsoon does not show any conspicuous change in water level except Vytila block. Six blocks show rising trend ranging from 4.99 cm/year for Palluruthy block to maximum 17.89 cm/year for Mulamthuruthy block and nine blocks show declining trend ranging from 0.98 cm/year for Vazhakulam block to 23.72 cm/year for Vytilla block. The hydrogeological map of Ernakulam district is shown in **Figure 4**.

4.3 Ground Water Resources

4.3.1Ground water Recharge

The groundwater resource of the district was computed jointly by CGWB and State Ground Water Department as on march 2009, as per the guidelines of the Ground water estimation Methodology 1997. The total annual recharge of groundwater has been computed block- wise using average water level fluctuation in Ground Water Monitoring Wells and Specific yield of the respective aquifers for 2 blocks and Rainfall Infiltration method for 13 blocks. The net annual groundwater availability is 557.35 MCM .The resources available varied from block to block depending on the geographical area of the block and ranges from 14.07 to 57.45 MCM. The block wise details of total recharge and the net available recharge are presented in **Table 6.**

Table 6 Net Annual Ground Water Availability (MCM) as in March 2009

Sl. No	Block	Total Annual Recharge	Net Annual GW Availability	Existing gross GW draft for irrigation	Existing gross GW draft for domestic & industrial use	Existing gross groundwater draft for all uses	Stage of GW development %	Categorization for future GW development
1	Alangadu	25.88	23.29	5.66	8.33	13.99	60.05	Safe
2	Angamaly	56.86	51.18	9.10	10.93	20.04	39.15	Safe
3	Edappali	32.36	29.12	1.81	8.28	10.10	34.67	Safe
4	Koovapady	83.50	75.14	10.61	8.24	18.85	25.09	Safe
5	Kothamangalam	62.09	55.88	9.04	10.68	19.72	35.29	Safe
6	Mulamthuruthy	22.51	20.26	4.88	7.46	12.34	60.91	Safe
7	Moovattupuzha	49.50	44.55	12.13	8.58	20.71	46.48	Safe
8	Palluruthy	34.77	31.29	0.36	19.38	19.75	63.10	Safe
9	Pampakuda	55.29	49.76	10.04	7.55	17.59	35.63	Safe
10	Parakadavu	24.39	21.95	10.48	6.52	17.00	77.47	Semi-Critical
11	Paravoor	22.26	20.04	8.84	8.42	17.25	86.10	Semi critical
12	Vaduvacode	63.83	57.45	6.44	7.19	13.63	23.73	Safe
13	Vazhakulam	53.2	47.93	11.63	9.72	21.35	45.68	Safe
14	Vypin	18.45	16.60	10.19	9.28	10.31	62.05	Safe
15	Vytilla	14.81	14.07	1.03	6.10	7.13	50.68	Semi-Critical
Total		**615.72**	**557.34**	**103.08**	**136.67**	**239.76**	**43.02**	

The withdrawal of ground water for irrigation has diminished and domestic draft has increased. The gross draft in the district was worked out to be about 239.76 MCM of which about 103.08 MCM is for irrigation. The block wise details of draft for irrigation, domestic and industrial purposes are given in **Table 6**.

As per the methodology, the blocks are categorized as safe, semi critical, critical and over exploited on the basis of the stage of development and long term groundwater trend of water level. The categorization based on stage of development and long term water level trend for the 15 blocks(old) of Ernakulam district as on march 2009 is given in **Table 6**. 12 blocks are categorised as safe and 3 as semi critical. There are no over-exploited blocks in the district. Among the three Semi-critical blocks, the long term water level trend in Parakadavu and Paravoor blocks do not show declining trend. But in Vytilla block, although the stage of development is less than 75 %, the long term trend of water level is showing significant declining trend due to which it is classified as semi-critical. As per 2004 assessment, 7 blocks are categorised as safe, 3 as semi critical and 4 as critical. The long term water level trend in these blocks are showing declining trend. Two blocks namely Koovapady and Vytilla are showing significant declining trend in water level due to which they were classified as semi-critical and critical. The categorization of blocks is represented in **Figure 5.**

4.4 Ground water Quality

4.4.1 Shallow aquifer

The ground water quality of the shallow aquifers of the district is generally very good. Samples collected during April 2009 from the groundwater monitoring stations are analysed. The range of chemical constituents (Major ions) is summarised in **Table 7**. Results of analysis are given in **Annexure – III.**

Table 7 Range of chemical constituents

Chemical constituent	Range in concentration	
	Minimum	Maximum
EC, µ Siemens / cm At 25^0C	37	5260
Total hardness, mg/l as Ca CO_3	6	675
Ca, mg/l	1.6	90
Mg, mg/l	0	109
Cl, mg/	5.7	1778
F, mg/l	0	0.39
NO_3	1.3	42

The data indicates that the ground water in the phreatic aquifers of the area is very low in mineralisation and is fit for all domestic, industrial and agricultural purposes in general. On the basis of USSL classification of groundwater, water samples from the study area have been classified into Good, Marginally saline and Saline. Majority of the samples (97.8 %) falls in the category of Good water. Marginally saline water is absent in the study area while the groundwater sample collected from Chellanum is found to be saline. The quality of formation water of phreatic aquifer is generally good. The average Electrical Conductance is ranging from 150 to 250 µs/cm.

4.4.2 Groundwater quality in deeper aquifers

In general the quality in deeper aquifers is good in most of the hard rock areas of the district. The exploratory drilling data has revealed the quality to be good. However, it has also revealed the presence of inland salinity in some areas namely Deshom and Sree Moolanagaram where the EC is found to be very high of the order of more than 17,000 micro siemens/cm at 25^0C.

In the coastal sedimentary aquifers, the quality of the water of Vaikom aquifers is saline in most part of the district except for small pockets like Narakal and Kumbalangi where it is fresh. The EC is found to range between 4000 micro siemens/cm to 17,300 micro siemens/cm at 250C. The Warkalai aquifer is completely saline in the district.

Table 7a : Range of chemical constituents

Chemical constituent	Range in concentration	
	Minimum	Maximum
EC, µ siemens / cm At 25^0C	27	9370
TDS		
Cl, mg/	5.7	3138
F, mg/l	0	0.47

5.0 GROUND WATER DEVELOPMENT AND MANAGEMENT

5.1 Ground water Development

In the district groundwater is developed for irrigation mainly by marginal farmers from wells used for both domestic and irrigation. The crops irrigated are chiefly coconut, plantain and vegetables. Groundwater is also developed for water supply schemes in rural areas by and to a limited extent in urban areas.

Though groundwater development for the district is observed to be only about 43 %, the groundwater development for two blocks viz. Parakadavu, Parur, are having a higher stage of development of above 75%. Besides the above, in the case of Vytilla block, although the stage of development is at lesser rate, the water levels are showing declining trend. Hence in this block also, further development of ground water should be done with caution and suitable conservation methods are to be resorted.

In crystalline aquifers dug wells can be constructed wherever sufficient weathered thickness of the saturated zone is available. Existing low yielding wells can be revitalized by deepening such wells to tap the entire thickness of weathered zone. Dug wells located along lineaments and fracture directions can be revitalized by converting them into dug cum bore wells. Bore-wells are feasible in crystalline areas tapping deep fractures and are site specific.

Tube wells are feasible in coastal belt in freshwater pockets of Vaikom aquifer. Tube wells may be constructed tapping 15 to 20 m of aquifer material with slot size of 3.1 mm and gravel pack. In the Laterite terrain dug wells and dug cum bore wells are feasible with depth of 10 to 16 m and diameter of 2 to 4 m and in the valley areas dug wells of 6 to 8 m depth and 1.5 to 3.0 m diameter are feasible.

In the coastal alluvium dug-wells with depth of 4 to 7 m and diameter 1.5 to 2.0 m and filter point wells wherever saturated thickness of 5 m or more are feasible.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

6.1Vulnerable areas

Even though the district is receiving very good rainfall of about 3400 mm annually it is paradoxical that acute water scarcity is felt in certain areas. The Vypin Island along the coastal parts of the district

is one such area where the water scarcity is very acute during summer months. The Vypin Island with an area of 67 Sq.km is highly populated with total population of 197624 persons. Similar water scarcity is recorded all along the coastal parts of the district down to Chellanam. The major problem here is the limited top sand layer and at places its hydraulic continuity with tidal backwater rendering it saline during summer months. In the southern parts of the district, in the top layer sand, the quality is brackish. In these areas, rainwater harvesting with modification of the aquifer will help to improve the aquifer condition and its water quality.

In the midland areas of the district as in Mulanthuruthy, Pampakuda, Kothamangalam blocks, the dug wells dry up in summer, as the zone of weathering is very limited and the topography is sloping. In these areas to check the subsurface out flow of ground water, subsurface dams can be constructed to improve the recharge of water.

6.2 Other problems

The district being the industrial capital, the problems related to industry was studied. It is observed that the pollution due to industrial effluents is not on an alarming scale. It is mainly restricted to surface water. The pollution studies conducted by CGWB indicate that the ground water pollution is highly localized with in 80m of the dumping of industrial waste.

6.3 Water Conservation and Artificial recharge

The district is having ideal site for implementing ground water conservation structures and rainwater harvesting structures. The subsurface dam constructed at Odakkali in the premises of Aromatic and Medicinal Plant Research Station of the Kerala Agricultural University has improved the ground water conditions of the area and it ensures sustain water for irrigation for the farm area of the university. The structure was constructed during 1988 with a cost of Rs. 1.67 lakhs. The length of the dam is 80 m and the depth is about 6m.

Similar structures can be constructed along the narrow valleys of the district. In addition to this, gully plugging and check dams will also be of great use in improving the groundwater resources of the district. In the coastal area, roof top rainwater harvesting is to be given a thrust. The artificial recharge schemes recommended for different blocks are given in **Figure 6**.

7.0 AWARENESS AND TRAINING ACTIVITY

The Central Ground Water Board has carried out Mass Awareness Programme and Water Management Training Programmes in the district. Mass awareness programme was conducted in Ernakulam district during the year 2002 at Ernakulam. Water Management Training Programme was conducted in Ernakulam district during the year 2005 at Ernakulam.

8.0 AREAS NOTIFIED BY CGWA/SGWA

In the district no blocks are over-exploited and therefore there are no areas notified.

9.0 RECOMMENDATIONS

The stage of ground water development in the district is 43.02 % leaving scope for future development of ground water in the district except in the critical blocks and semi-critical blocks where groundwater development may be on a cautious scale.

In the coastal areas of the district particularly the Vypin Island where acute water scarcity is felt during summer months, rain water harvesting techniques can be carried out to solve the water problem. Tube wells are feasible in the coastal blocks where fresh water pockets have been demarcated in the deeper confined aquifer such as at Narakal and Kumbalangi. Tube wells may be constructed tapping 15 to 20m thickness aquifer with slot size of 3.1 mm and gravel pack.

The mid land areas are covered by Laterite formations and the ground water can be developed in these areas by dug wells and dug cum bore wells. The dug wells located in elevated areas/slope tend to dry up in summer. The porous nature of laterite tends to this. These areas can be developed by construction of large diameter dug wells in the valleys and dug cum bore wells in elevated areas. The sub surface dam constructed at Odakalli, in the premises of Aromatic and Medicinal plant Research station of KAV has improved the ground water conditions of area and sustain water for irrigation. In Mulanthuruthy, Pampakada and Kothamangalam blocks sub surface dams can be constructed in suitable locations for artificial recharge and improve the recharge.

In the eastern blocks with elevated hills and narrow valleys, gully plugging and contour bunding, check dam etc can be practiced to improve the recharge condition.

The ground water development may be done on water shed basis for better water management also in conjunctive with surface water management. Mass Awareness Programme can be organized to make the public aware of the importance of adopting water conservation techniques.

Figure 1: Index map of Ernakulam district

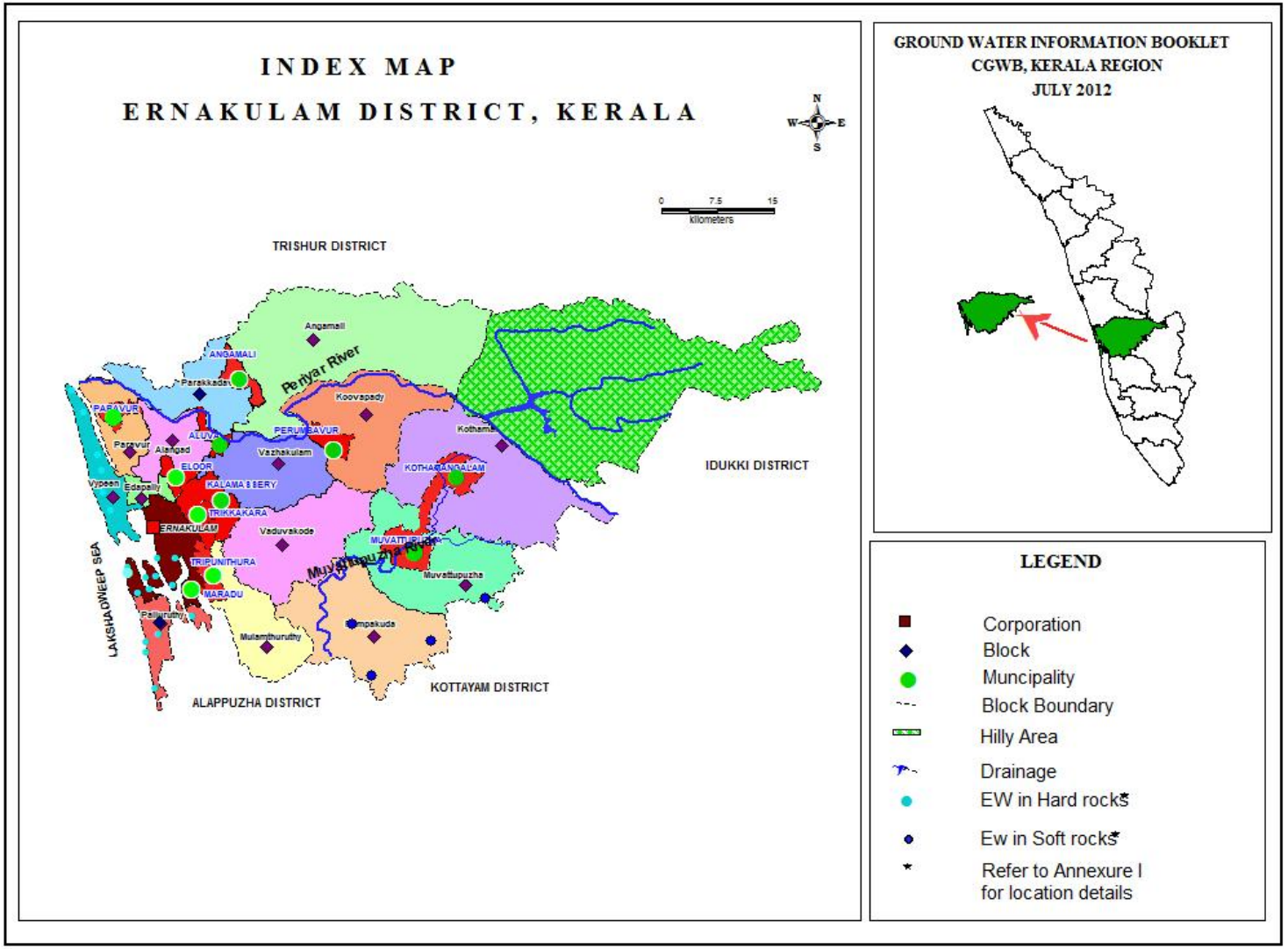


Figure 2: Pre-Monsoon average depth to water level of Ernakulam District April (2002-11)

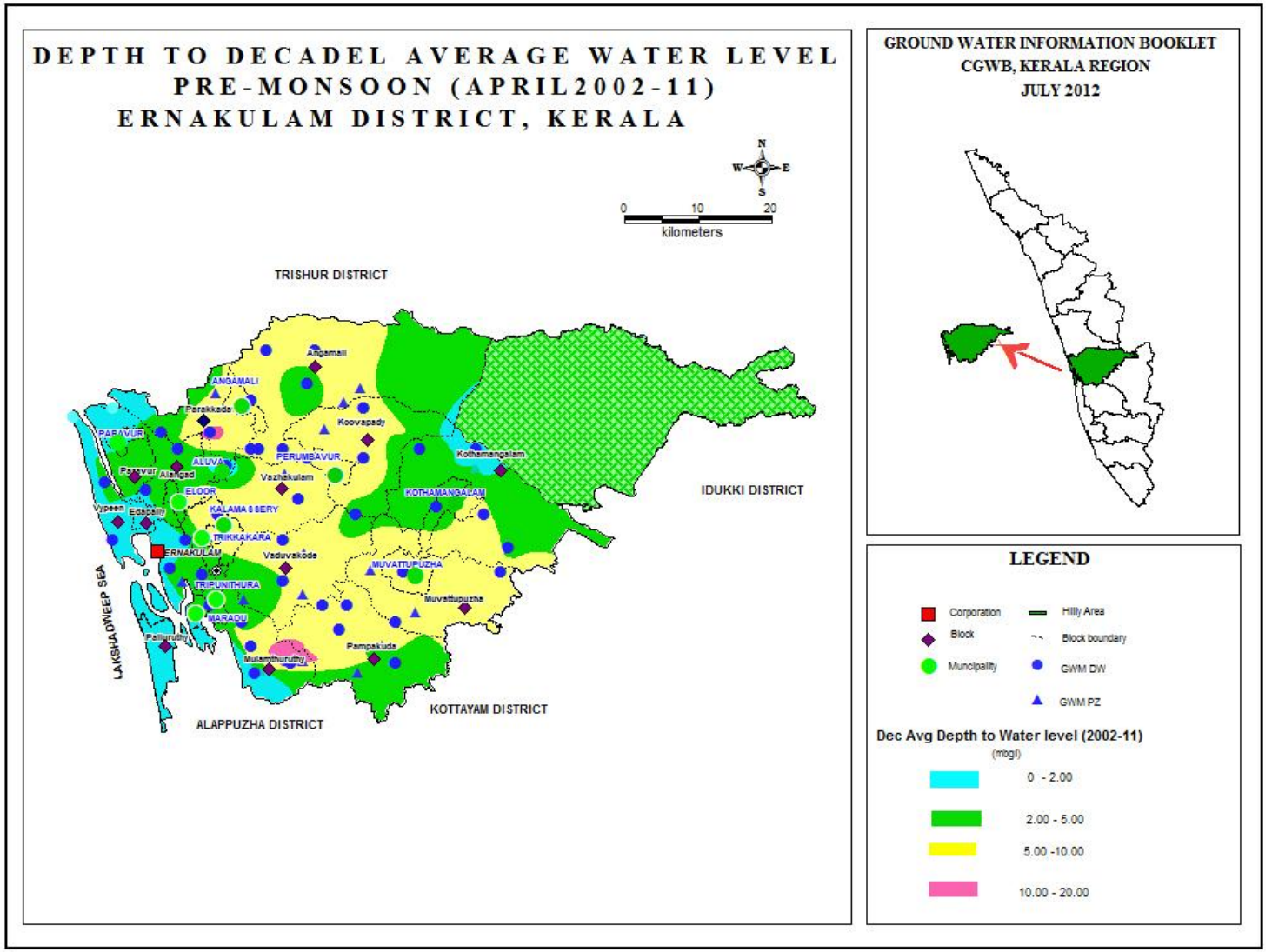


Figure 3: Post-Monsoon average depth to water level of Ernakulam District November (2002-11)

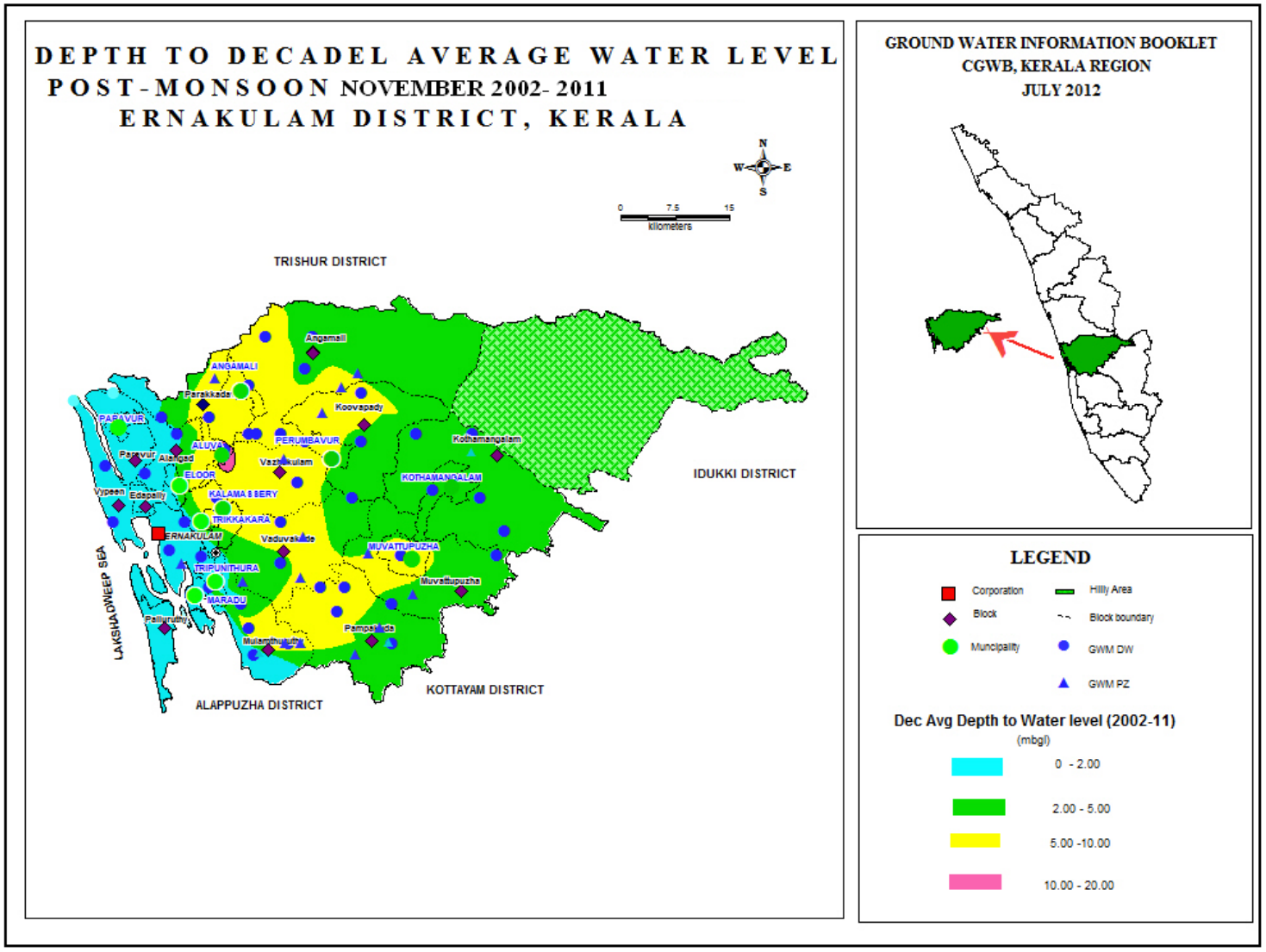


Figure 4: Hydrogeological map of Ernakulam district

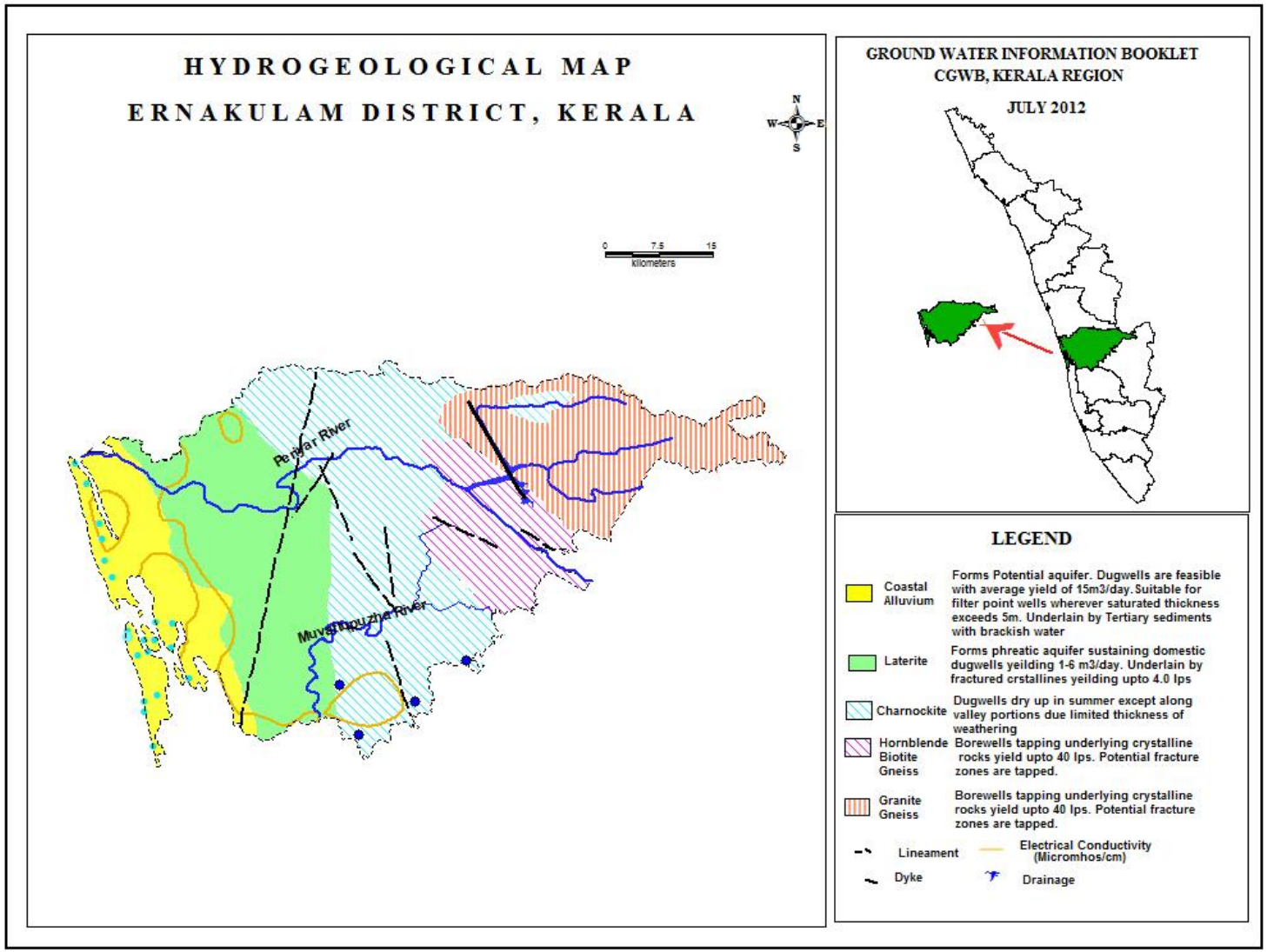


Figure 5: Groundwater Resources of Ernakulam district

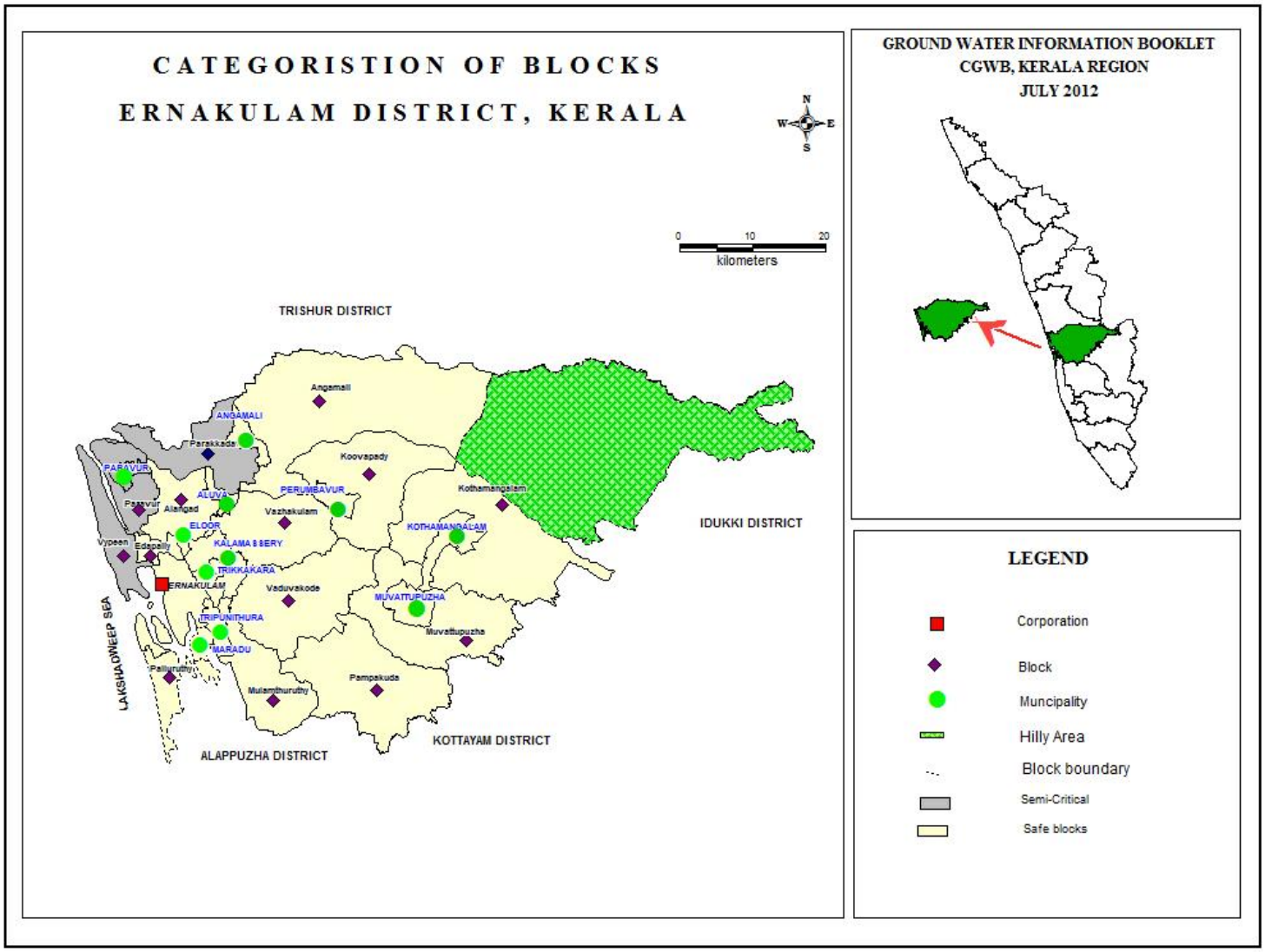
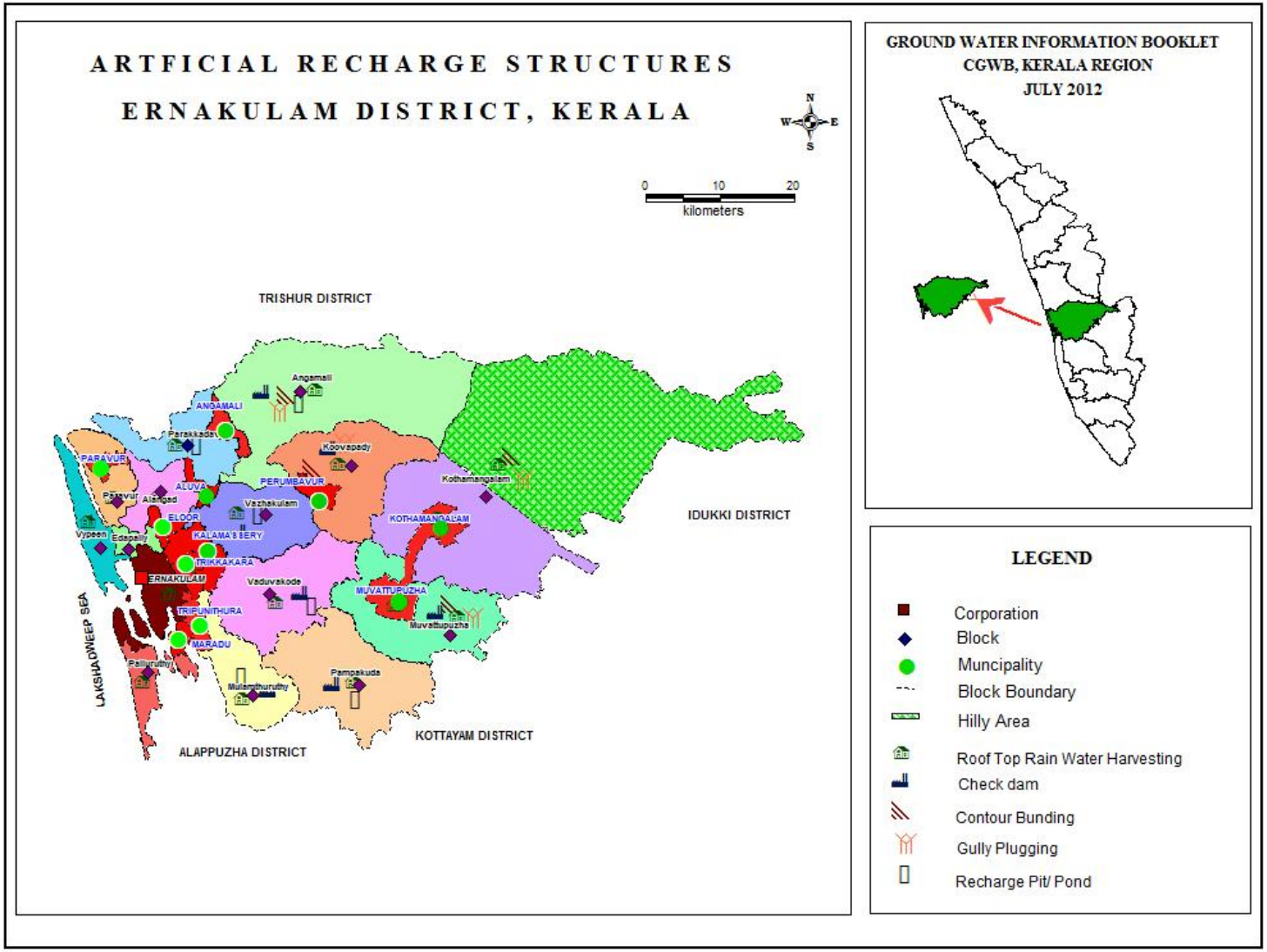


Figure 6: The artificial recharge schemes recommended for different blocks in Ernakulam District



Annexure – I: Details of wells drilled in Hard rock area, Ernakulam District, Kerala

Well No. EKH	Location, coordinates & toposheet No.	Lineament Direction	Depth drilled/ SWL mbgl	Depth of casing mbgl	Fracture zones with yield lpm	Discharge lpm during drilling recommended	T m^2/day	EC µS/cm at 25^0C	CI ppm	Rock type	Remarks
1	Ilanji, $9^0$49'45", $76^0$32'30", 58 C/9	NW-SE	200.53, 0.8	6.6	27-35.0/260. 111.0 – 114/456	456, 906	319	290	7.1	Charnockite	
2	Kozhipalli, $9^0$52'15", $76^0$36'50", 58 C/9	NW-SE	187.79, 2.12	4.25	12.03/260, 65/490, 145.0/610	600, 1158	35.9 $9.8*10^{-4}$	290	8.5	Charnockite	
3	Onakkur, $9^0$53'30", $76^0$31'00", 58 C/9	Nil	20.53, 2.95	9.10	Nil	Nil	NA	NA	NA	Charnockite	
4	Kadalikad, $9^0$55'20", $76^0$40'45", 58 C/9	NE-SW	200.53, 1.20	6.46	15.6/180, 38/240, 95/600	600, 1002	69.3, $2.8*10^{-2}$	260	85	Charnockite	
5	Kalady EW		101.0	15.50	63-64	9.2				Charnockite Gneiss	Quality good
6	Pallarimangalam EW		101.0	8.50	10-11	0.215				Dolerite Dyke in Hb Gneiss	
7	Neriyamangalam EW		101.0	6.90	22-23	0.07				Hb Biotite Gneiss	

Annexure – II Details of wells drilled in Sedimentary area, Ernakulam District, Kerala

Well No. EKS	Location	Year of construction	Location, coordinates	RL m amsl	Depth drilled (mbgl)	Depth constructed m bgl	Zones tapped	Discharge lps	Static Water Level in mbgl	SP capacity lpm/m	T m^2/day	EC mhos/cm at 25^0C	CI in ppm	Remarks
1	Chellanum	1973	$9^0$48'40", $76^0$16'40"	0.63	295.6	Nil	149.6-175.4	NA		NA	NA	3280		Abando-ned as water is of poor quality.
2	Kandanakadavu	1973	$9^0$51'15", $76^0$16'00"	0.76	240.8	186.8	177.4-185.1(Upper zone brackish)	10.1		59	818	TDS 2065.0		4.41 agl (Flowing)
3	Kumbalangi	1973	$9^0$52'30", $76^0$17'00"	2.178	150.8	110.76	70.1-71.9, 90.2-94.8,100.6-104.8,106.7-109.0	8.5		89.5	143	TDS 1376.0		SWL 0.04 mbgl
4	Panangad	1984	$9^0$53'50", $76^0$19'25"	2.4	69.2	60	29-38, 50-58.0(Vaikom)	6		174.5	193.6	5500		SWL 1.063 mbgl
5	Wellington Island	1998	$9^0$56'40", $76^0$16'00"	1.79	116.5	105	97-103	1.2		NA	NA	NA		SWL=5.18 mbgl
6	Vaittila	1999	$9^0$58'00", $76^0$18'10"	2.645	54.66	58	42-45	2.5		NA	NA	NA		SWL=0.34mbgl
7	Narakkal	1990	$10^0$02'45", $76^0$12'57"	0.947	118.15	101	93-99.5	7.33		NA	NA	1120	234	
8	Nayarambalam	1990	$10^0$04'20", $76^0$12'47"	1.512	106.5	70	53-61 (Vaikom)	NA		NA	NA	EC 17500	6049	SWL-0.20 mbgl. Water is saline.
9	Cherai	1989	$10^0$08'33", $76^0$11'31"	0.863	102.4	Nil	48-54,68-74	NA		NA	NA	EC 1-zone 14200 II-zone 8800		Water is saline. BH converted into slim hole
Well No. EKS	Location	Year of construction	Location, coordinates	RL m amsl	Depth drilled (mbgl)	Depth constructed m bgl	Zones tapped	Discharge lps	Static Water Level in mbgl	SP capacity lpm/m	T m^2/day	EC mhos/cm at 25^0C	CI in ppm	Remarks
10	Palluruthy-EW-I	1999-00	$9^0$55'50", $76^0$16'20"		146.25	100	95.5-96.5	3.34	2.16		4.72	3280		
11	Palluruty-EW-II	1999-00	$9^0$55'50", $76^0$16'20"		146.25	143	122.5-140.5	3.34	1.02		16.51	3290	919	
12	Malipuram-I	1999-00	$10^0$01'28", $76^0$13'30"		174	121	109-118	3.14	0.7		167.11	1292	309	Auto flow
13	Malipuram-II	1999-00	$10^0$01'28", $76^0$13'30"		173.67	170	146-167	3	0.7		105.48	1764	493	
14	Palliport –I	1999-00	$10^0$10'05", $76^0$10'40"		103.5	91	82-86	2.9	0.7			3240		

15	Paliport-II	1999-00	$10^0$10’05”, $76^0$10’40”		31	30	24-27	0.481	1.16			6000		
16	Edavanakkad	2000-01	$10^0$05’30”, $76^0$12’30”		116.5	106	97.0-103.0	4.4	1.4			18900		Saline
17	Kaitharam	2000-01	$10^0$07’40”, $76^0$14’00”		53	51	46.0-49.0	2.11	1.7			17530		Saline
18	Wellingdon Port Trust qtrs	2000-01	$9^0$56’45”, $76^0$16’45”		133.5	105	96.0-102.0	3.14	1.7			1360	305	
19	Subash Park	2000-01	$9^0$58’03”, $76^0$16’55”		100	96	81.0-84.0, 90.0-93	3.14	1.7			1370	355	Potable
20	Thevara	2000-01	$9^0$56’07”, $76^0$18’02”		127	99	85.0-97.0	3.7	5.5		28.07	1500	376	
21	Kannamali-EW1	2001-02	$9^0$52’00”, $76^0$16’00”		222	199	181.0-196.0	1.22	0.6			7200		
22	Kannamali-EW2	2001-02	$9^0$52’00”, $76^0$15’55”		100	100	85.0-97.0	3.7	5.82					
23	Mundanveli	2001-02	$9^0$55’30”, $76^0$15’30”		207	122	109.0-118.0	3.1	0.79		89	1560	412	
24	INS Dhronacharya Fort Kochi	2001-02	$9^0$57’00”, $76^0$14’45”		198	181	166.0-178.0					8000		
25	Fort Kochi - Veli	2002-03	$9^0$57’20”, $76^0$14’45”		186							423	27	

Annexure III Chemical Analysis Data of GWMW in Ernakulam district (2009)

S:No	Location	pH	EC in	TH as $CaCO_3$	Ca	Mg	Cl	F	NO_3
			us/cm at 25^0C	(----------Conc. in mg/L---------->					
1	Chellanum	8.58	5260	675	90	109	1778	0.39	42
2	Kumbalangi	7.95	341	124	37	7.8	24	0	6
3	Fort Cochin	8.02	344	110	37	4.4	26	0.03	22
4	Malipuram	8.1	467	150	53	4.4	47	0.08	11
5	Edavanakkad	8.16	276	94	33	2.9	23	0.05	3
6	Munambam	8.28	287	108	38	3.4	13	0.15	4
7	Paravur North	7.97	1161	235	72	13	252	0.19	3
8	Parakadavu	7.86	388	80	16	9.7	60	0.1	15
9	Mallassery	7.81	126	16	4	1.5	23	0	11
10	Angamaly	6.18	265	40	10	3.4	38	0.07	55
11	Karukutty	7.77	275	60	17	4.4	45	0.17	13
12	Attara	7.42	37	8	1.6	1	5.7	0.33	2
13	Chulli	7.55	60	16	5.6	0.5	7.1	0.14	2
14	Manjappra	7.41	79	22	5.6	1.9	7.1	0.01	10
15	Chengamanad	7.2	191	36	9.6	2.9	30	0.27	46
16	Chalakka	7.92	1757	540	108	66	505	0.23	3
17	Sreekadapuram	8.15	609	155	34	17	114	0.23	2
18	Kottapuram	7.59	110	24	6.4	1.9	11	0.18	2
19	Varapuzha	8.2	420	116	38	5.4	36	0.09	33
20	Eloor North	8.24	247	80	24	4.9	21	0.05	2
21	Edapally	8.35	510	225	72	11	39	0.24	20
22	Alwaye	7.48	170	34	10	1.9	28	0.21	16
23	Kapprassery	7.44	98	24	8	1	2.8	0.1	1
24	Chowwara	7.59	162	48	13	3.9	20	0.18	7
25	Kanjur	7.37	48	10	2.4	1	5.7	0.05	6
26	Malayattur	7.49	87	22	5.6	1.9	8.5	0.04	6
27	Vallom	7.84	175	52	16	2.9	17	0.19	13
28	Vazhakulam	8.03	241	70	20	4.9	26	0.1	9
29	Irumbanam	8.15	1113	170	26	25	242	0.45	4

30	Trikkakkara	7.93	167	52	20	0.5	14	0.04	4
31	Puthankurissu	7.44	64	16	4.8	1	7.1	0.05	5
32	Muvattupuzha	7.81	241	78	20	6.8	17	0.18	11
33	Palakuzha North	7.83	162	36	10	2.4	24	0.16	8
34	Kallur	7.49	151	44	10	4.4	17	0.27	28
35	Pothanikad	7.7	227	54	15	3.9	21	0.1	30
36	Oonukkal	7.5	54	18	4	1.9	7.1	0.25	9
37	Neriamangalam	7.54	109	40	13	1.9	11	0.02	13
38	Thattekkad	7.25	58	12	3.2	1	7.1	0.07	9
39	Kothamangalam	7.48	62	16	4	1.5	9.9	0.11	2
40	Kottapadi	7.48	63	20	6.4	1	5.7	0.09	5
41	Kuruppampady	6.88	104	20	5.6	1.5	16	0.15	15
42	Perumbavoor	7.91	401	118	37	6.3	36	0.35	16
43	Valayanchirangara	7.46	127	20	5.6	1.5	17	0.15	22
44	Mannur	7.27	51	12	3.2	1	5.7	0.07	4
45	Aikaranadu	7.12	33	6	2.4	0	5.7	0.21	2
46	Ramamangalam	7.24	90	20	4	2.4	13	0.21	11
47	Mamallassery	7.29	38	8	2.4	0.5	5.7	0.18	2
48	Pampakuda	6.93	64	12	4	0.5	11	0.15	8
49	Anchalpetty	8.96	997	70	24	2.4	266	0.21	1
50	Kakkur	7.88	148	26	4.8	3.4	20	0.09	8
51	Koothattukulam	8.07	321	76	23	4.4	41	0.13	29
52	Perumpidavam	7.68	57	16	4	1.5	5.7	0.17	6
53	Ilanji	7.27	53	10	2.4	1	9.9	0.09	6
54	Piravam	7.88	84	28	8.8	1.5	7.1	0.06	1
55	Edakkatuvayal	7.56	58	12	4.8	0	7.1	0.1	7
56	Poothotta	7.89	179	58	18	2.9	17	0.05	4
57	Mulanthuruthi	8.07	198	50	16	2.4	31	0.23	21
58	Vytilla	7.92	155	58	22	0.5	11	0.08	2
59	Punithura	8.35	942	240	48	29	153	0.33	3
60	Maradu	8.31	319	98	28	6.8	34	0.04	1
61	Tripunithura	8.16	411	102	34	3.9	44	0.15	47
62	Kundannur	8.67	292	60	22	1	41	0.32	4