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भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

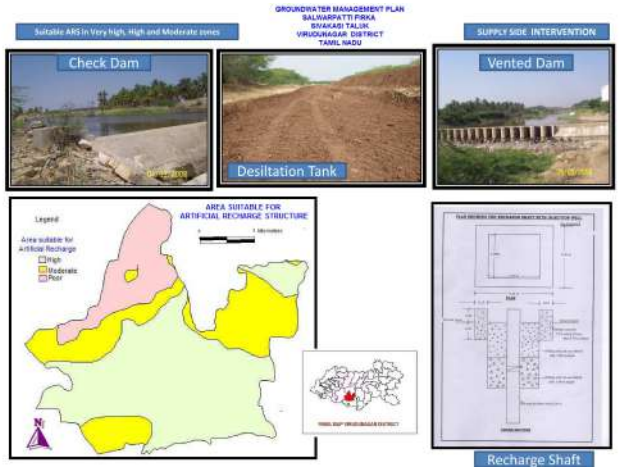
AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

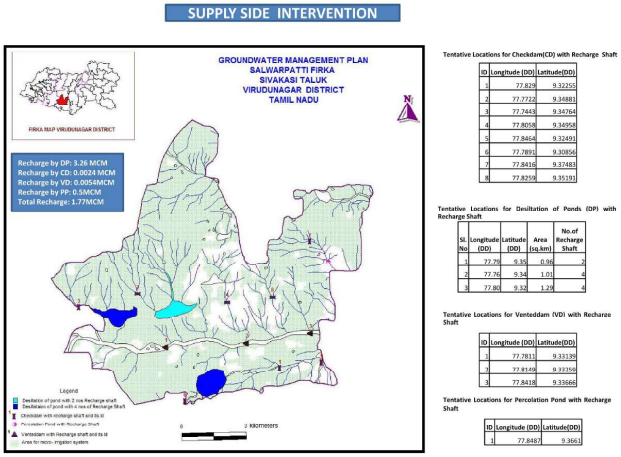
NINE FIRKAS OF ASPIRATIONAL VIRUDHUNAGAR, TAMIL NADU

दक्षिण पूर्वी तटीय क्षेत्र, चेन्नई

South Eastern Coastal Region, Chennai

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, NINE FIRKAS OF ASPIRATIONAL VIRUDHUNAGAR DISTRICT TAMIL NADU





Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.829	9.32255
2	77.7722	9.34881
3	77.7443	9.34764
4	77.8058	9.34958
5	77.8464	9.32493
6	77.7891	9.30856
7	77.8416	9.37483
8	77.8259	9.35191

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.79	9.35	0.96	2
2	77.76	9.34	1.01	4
3	77.86	9.32	1.29	4

Tentative Locations for Venteddam (VD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.7811	9.33139
2	77.8149	9.33766
3	77.8418	9.33666

Tentative Locations for Percolation Pond with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.8487	9.3661

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Ministry of Water Resources, River Development & Ganga Rejuvenation

Central Ground Water Board, South Eastern Coastal Region

Chennai

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Foreword

Groundwater is the major source of freshwater that caters the demand of ever growing domestic, agricultural and industrial sectors of the country. This renewable resource has been indiscriminately exploited in some parts of the country by several users as it is easily available and reliable. Intensive and unregulated groundwater pumping in many areas has caused rapid and widespread groundwater decline. Out of 6607 ground water assessment units (Blocks/ mandals / taluks etc.), 1071 units are over-exploited and 914 units are critical. These units have withdrawal of ground water is more than the recharge (over exploited) and more 90% 7 less than 100% of recharge (Critical).

Central Ground Water Board (CGWB) has taken up largest Aquifer mapping endeavour in the world, targeting total mapable area of country ~ 23.25 lakh sq. km with a vertical extent of 300 m in soft rock area and 200 m in hard rock area. The extent of aquifer, their potential, resource availability, chemical quality, its sustainable management options will be addressed by National Aquifer Mapping (NAQUIM). The NAQUIM programme will also facilitate participatory management of ground water to provide long term sustenance for the benefit of farmers. Currently, focus is on ground water stressed areas of eight states comprising 5.25 lakh sq.km viz. Tamil Nadu, Haryana, Punjab, Rajasthan, Gujarat, Andhra Pradesh, Telangana, Karnataka and Bundelkhand region.

South Eastern Coastal Region, Central Ground Water Board, Chennai under NAQUIM has been envisaged with the Mapping of an area of 70,102 sq.km during 2012-17 (XII five-year plan) in Tamil Nadu and UT of Puducherry. This report deals with the Aquifer mapping studies carried out in water stressed Nine firkas of Aspirational district covering an area of 1014sq .km About 20% of the area is used agriculture land and mainly dependent on groundwater (83%) for agricultural needs. The major issues in the basin include declining groundwater levels and sustainability of wells, Two aquifer units were deciphered with aquifer Unit - I being the weathered, occurs from ground level to 21m bgl and Aquifer Unit –II is the fractured/Jointed zone existing from 10 to 101 m bgl (3-4 fractures are encountered) in hard rock formation In order to arrest the declining groundwater levels and to increase the sustainability of wells groundwater management plans for supply and demand side interventions have been formulated firka wise.

I hope this report will be useful for the district administrators, water managers, stakeholders including farmers in knowing the aquifer and managing it resources effectively in the Nine firkas of the aspirational Virushunagar district aquifer system.

(C. Paul Prabhakar)
Regional Director

EXECUTIVE SUMMARY

Aquifer mapping study was carried out in the aspirational Virudhunagar district covering nine firkas of the district. The data pertinent to geology, geophysics, hydrology, hydrochemistry were collected, synthesised and analysed to bring out this report. This report mainly comprises the Aquifer geometry and properties of the study area which are considered to be measuring scales for groundwater availability and potentiality. Keeping these parameters in view a sustainable management plan has been suggested through which the groundwater needs can be fulfilled in a rational way.

Area experiences semi-arid climate with 852 mm average annual normal rainfall (100 years). About 20% of the geographical area is under agricultural activity in the area. The main crops irrigated are cotton and paddy.

Integrated study helped in deciphering main aquifer units, weathered zone at the top followed by a discrete anisotropic fractured/fissured zone at the bottom in hard rock formation. Groundwater occurs under unconfined condition in the weathered zone and unconfined to semi-confined conditions in the fractured/fissured zone and flows downward from the weathered zone into the fracture zone. In sedimentary formation, aquifer-I is under unconfined conditions and other aquifers are under confined conditions. The net annual ground water availability is 115 MCM and the gross ground water draft is 134MCM. The average stage of groundwater development is 116%.The issues in the basin include declining groundwater levels, sustainability of wells and poor yield aquifer.

Aquifer systems from the area can be conceptualized as weathered zone down to ~40m and fractured zone between ~10-200 m bgl with possibility of occurrence 3 to 4 fractures. The weathered zone is disintegrated from the bed rock (upper part–saprolite zone) and partially/semi weathered in the lower part (sap rock zone) with yield ranging from 1- 72m^3/hr and can sustain for 1 to 2 hrs of pumping during summer period (April to June). The fractured zone is fractured Gneiss or Charnockite which occur in limited extent, associated sometime with quartz vein. The average yield ranges from 1 - 105 m^3/hr and can sustain for 3 to 4 hrs of pumping during summer period.

Fast growing urban agglomeration shares the groundwater which otherwise is being used for irrigation purpose resulting in either shortage for irrigation needs or creates excessive draft to meet the both demands in groundwater potential areas. The study formulates management strategies for supply side as well as demand side. The supply side measures include construction of artificial recharge structures of 73Check dams, 16 Vented dam, with 1977nos of recharge shafts in addition to the 40 ponds earmarked for rejuvenation with recharge shafts in all the 9 OE & Critical firkas of the basin. The estimated recharge to groundwater system through these structures will be in the order of 28.57MCM. In addition water conservation plan is proposed digging of 80 recharge ponds which support storage as well as recharge. Demand side management is also recommended by change in irrigation pattern from flooding method to drip for crops. This intervention would save 82.2 mcm of water annually. By carrying out both supply and demand side interventions the stage of groundwater development would be lowered from 116 to 60%.

The existing regulatory measures may be modified suitably for optimal utilization of groundwater as well as for sustainable development of rural agricultural based economy. To achieve this goal opinion pool has to be obtained from more user groups and valid suggestions may be incorporated in the regulatory acts for the firkas.

CONTRIBUTORS' PAGE

Groundwater Management Plan

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1 INTRODUCTION

Central Ground Water Board, Ministry of Water Resources, River Development and Ganga Rejuvenation, New Delhi had been assigned to carry out National Aquifer Mapping (NAQUIM) in country wide under XII five-year plan on 1: 50,000 scale. National Aquifer Mapping (NAQUIM) involves in deciphering the aquifers in terms of configuration, quantity, quality, rejuvenation and sustainability. Aquifer mapping is prepared by integrating hydrogeological information such as geology, geophysics, hydrology and hydro-chemistry and analysed to characterise the quantity, quality and sustainability of ground water in aquifers.

The unplanned ground water development due to intensive agricultural practices and unorganised urban acclamation, erratic rainfall had changed the groundwater scenario into stress conditions. The groundwater in stressed aquifer is required planned and proper management in respect of demand and supply side intervention. The groundwater occurs in very complex conditions particularly in hard crystalline formation wherein high varied and diverse hydrogeological settings exist. The groundwater movement and occurs in weathered and fractured hard rock formation. It is essential to understand the complex geometry of the aquifer systems of the area to prepare implementable ground water management plans. Hence, aquifer mapping is required to have groundwater management plan. The proposed management plans will provide the “Road Map” for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. The aquifer mapping and management plan will be shared by the groundwater user agency and stock holder. The user agency is mainly of the State Government and Agriculturist. The application of aquifer mapping is felt only when it reaches to effective implementation of the management plan. This can be achieved only through community participation.

1.1 Objective and Scope

Aquifer mapping itself is an improved form of groundwater management – recharge, conservation, harvesting and protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan. The activities under NAQUIM are aimed at:

- Identifying the aquifer geometry,
- aquifer characteristics and their yield potential
- quality of water occurring at various depths,
- aquifer wise assessment of ground water resources
- preparation of aquifer maps and
- Formulate Firka wise ground water management plan.

This clear demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control.

1.2 Approach and Methodology

The ongoing activities of NAQUIM include toposheet wise micro-level hydrogeological data acquisition supported by hydrogeological, geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depth of 200 / 300 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilisation for preparation of various thematic maps.

The approach and methodology followed for Aquifer mapping is as given below:

Compilation of existing data
(Central & State Govt.)

↓

Identification of Primary Aquifer

↓

Identification of data gaps

↓

Data generation
(water level, exploration, geophysical, hydro-chemical, hydrogeological etc.)

↓

Data integration and Aquifer Maps with 2D & 3D disposition

↓

Generation of different thematic layers

↓

Firka wise Aquifer Management Plan

1.3 Study area

The Virudunagar district lies in southern parts of the Tamil Nadu and bounded by Sivagangai and Madurai districts on the north, Tirunelveli and Tuticorin districts on the south and Ramanathapuram district on east and the Kerala state on the west and Theni district on the northwest (**Fig. 1**). This district has 36 (Nos.)of firkas, out of which 9 Nos. of firkas are under over exploited and critical categories. Artificial Recharge plan is prepared for these nine firkas. The total geographical area of the nine firkas is 1014 Sq. Km. and details are presented in **Table -1.**

Table-1. Details of the study area

S. No.	Name of Firka	Block	Area (Sq. km)	Category
1	Cholapuarm	Rajapalayam	75.39	OE
2	Eithirkottai	Virudunagar	166.66	OE
3	Keelarajakularaman	Keelarajakularaman	105.58	OE
4	Mallankinar	Virudunagar	89.23	Critical
5	Mangalam	Sivakasi	143	Critical
6	Nathampatti	Watrap	79.0	OE
7	Pillaiyarkulam	Srivilliputhur	90.86	OE
8	Salwarpattti	Sivakasi	139.9	Critical
9	Vatchakarapatti	Virudunagar	124.85	Critical

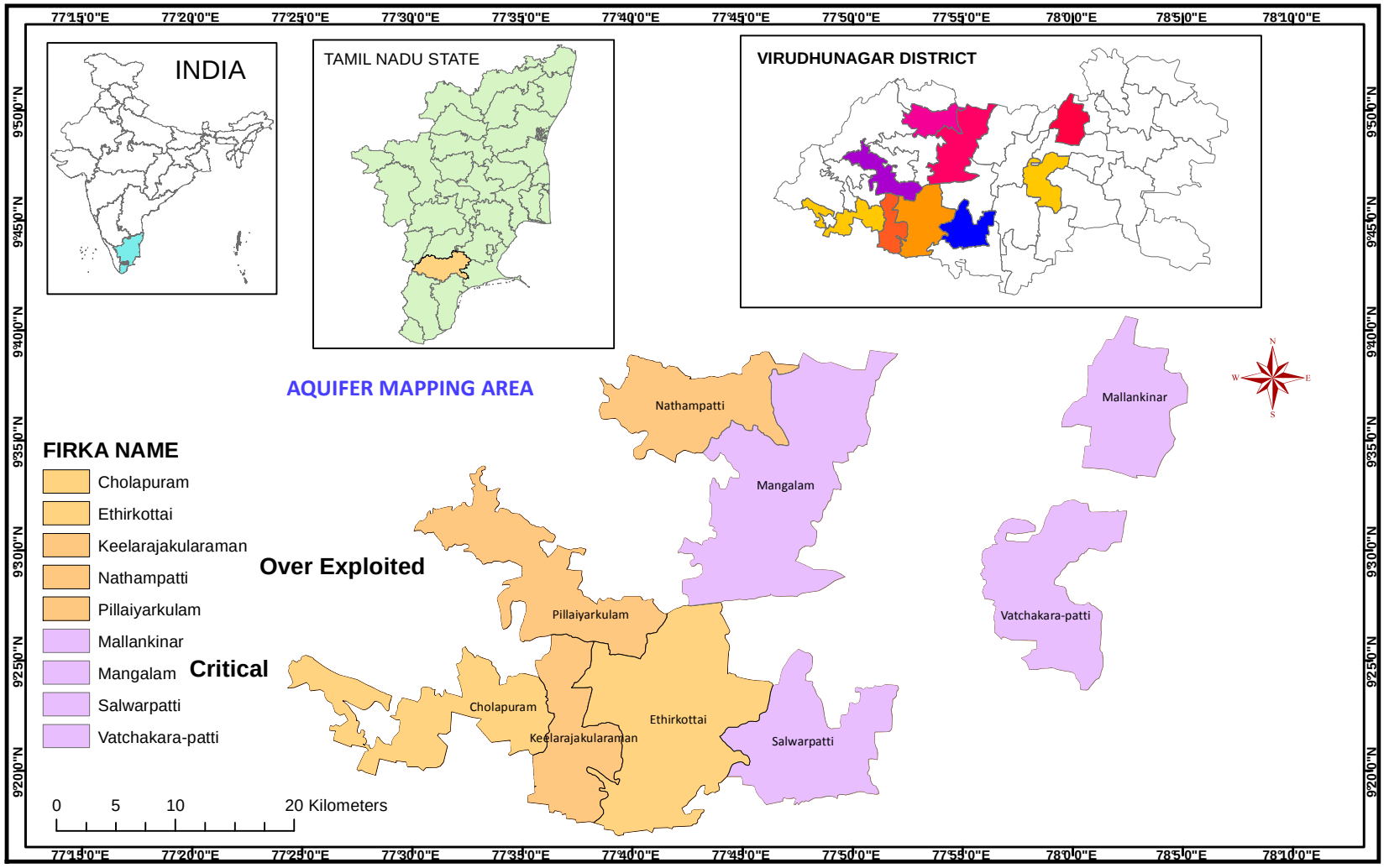
1.4 Data Adequacy and Data Gap Analysis

The available data such as Exploratory wells, Vertical Electrical Sounding (VES), ground water monitoring stations and ground water quality stations of Central Ground Water Board, South Eastern Coastal Region, Tamil Nadu Water Supply and Drainage Board (TWAD), State Surface and Ground Water Resources Data Centre of Public Works Department, Government of Tamil Nadu were compiled and analysed as per the nomenclature for adequacy of the data. The summarised detail on Data Adequacy and Data Gap Analysis is presented in the table 1.2.

Table – 1.2: Data Adequacy and Data Gap Analysis

Sl.no	Data	Required	Available	Gap
1	Exploratory well	9	15	Nil
2	Geophysical survey			
3	Groundwater Monitoring well	8	7	Nil
4	Groundwater Quality Monitoring well	8	7	Nil

LOCATION MAP OF OVER EXPLOITED AND CRITICAL FIRKAS
VIRUDHUNAGAR DISTRICT TAMIL NADU



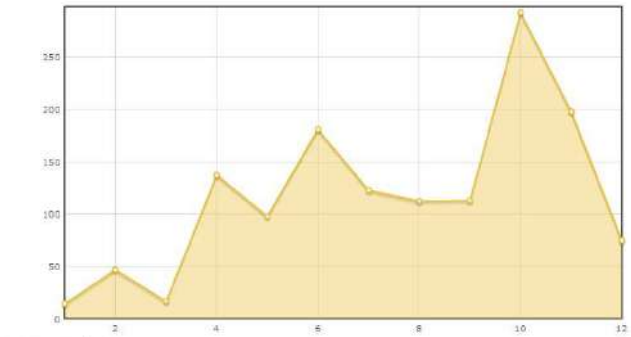
1.5 Rainfall, Temperature and Evapotranspiration

The average annual rainfall of the area is 852 mm The normal rainfall are computed based on the station located nearest to firka. The normal rainfall is ranging from 764mm (Sundhirapandiyan) to 1153mm (Thenkarai. Details of station given in table -1.3

Table – 1.3: Details of Rain Gauge station

Sl.No	Name of station	Normal Rainfall in mm
1	Vembakottai	821.51
2	Salwarpattti	865.18
3	Narikudi	686.07
4	Thenkari	1153
5	Sundhirapandiyan	764
6	Virudhunagar	827.38
7	Srivalliputtur	865.18

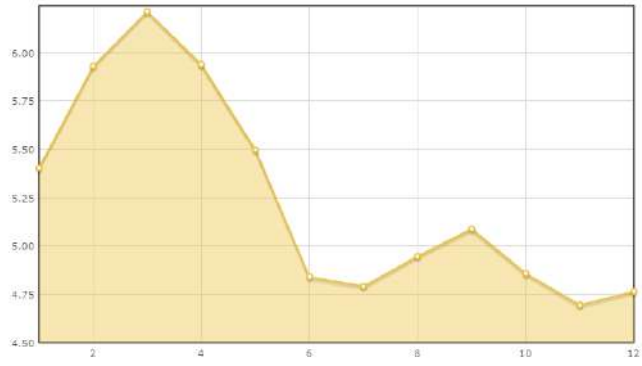
The highest rainfall is experienced in Thenkari and in other rain gauge stations is almost same normal rainfall. The area receives rainfall from both monsoon, south west (June-September) and north-east monsoon (October-December). The lion share of rainfall is from north-east monsoon for the entire area

Fig – 1.2: 

10 Years Monthly Average Rain fall (mm)

Units: Integer / mm

jan	feb	mar	apr	may	jun	jul	au
14.10	46.76	16.70	127.36	97.76	180.92	122.76	112

Fig – 1.3: 10 Years monthly average Evapo-transpiration 

Units: mm / Day

jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
5.40	5.93	6.21	5.94	5.50	4.84	4.79	4.95	5.09	4.86	4.69	4.76

Based on monthly 10 Years (1993-2002) average Rainfall of the district, Al most every month is raining in the district. The minimum rainfall is 14.10 mm in the month of January and the maximum rainfall is 292.79 mm in the month of October. The south west monsoon in the region gives considerable contribution towards the annual rainfall of the region. The rainfall from June-September is moderate to high that is ranging from 112 mm to 180mm. During the north east monsoon, the area receives highest rainfall of 292mm in the month of October. These are clearly indicating that area receives both the monsoon significantly (Fig-1.2).

The mean normal maximum temperature is ranging from 29.8 to 36.1degree Celsius. The mean normal minimum temperature is ranging from 23.1 to 30.1degree Celsius. The actual temperature is ranging from 25.1 to 40.7 degree Celsius(Table-1.4). The evapotranspiration of the region is ranging from 4.69 to 6.21 mm/day. The evapotranspiration(ET) of above 5mm/day is observed from Febuary to April months and remaining yeas is below 5mm/day. ET during the summer period may due to high temperature in the region (Fig-1.3).

Table – 1.4: Details of Temperature

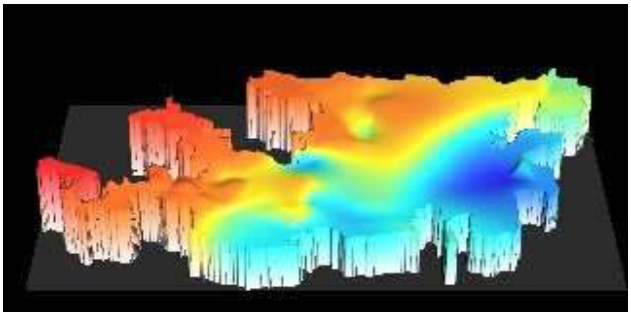
Name of the Station: Cotton Research Station, Srivilliputhur.

Months	Mean Maximum		Mean Minimum		Humidity	
	Normal	Actual	Normal	Actual	8.30hrs	14.30hrs
2015 April	34.9	34.8	24.8	29.1	87.8	75.3
May	34.2	34.6	29.4	28.5	88.2	72.7
June	35.8	36.2	30.1	29.8	89.5	68.4
July	36.1	37.6	23.1	31.1	90.4	58.3
August	35.0	38.3	24.5	30.9	87.2	56.1
September	33.4	37.6	23.8	30.7	76.5	61.2
October	31.7	37.1	23.8	28.0	91.3	79.7
November	30.0	35.1	22.6	27.2	90.2	57.4
December	29.8	34.8	26.8	28.6	88.3	65.7
2016 January	31.4	33.8	26.9	27.5	86.7	66.2
February	31.7	38.8	25.8	25.1	85.9	61.9
March	33.9	40.7	24.8	27.2	82.6	58.8

Source: Professor, Cotton Research Station, Srivilliputhur.

1.6 Physiography

All nine firkas are falling in eastern side of Western Ghat hill range and falling in elevation ranges from 25 to 156 mamsl. The low elevation is occurring in the eastern parts of the study area. The higher elevation is found in the western parts of the area. All the nine frikas are falling in plain topography. The general slope of the topography is towards south easterly direction. Cholapuram, Keelarajakularaman, Pillyarkulam and Nathampatti frikas are falling in the higher elevation and foothills of Varashanadu Hill. Eithirkottai, Malankinar, Salwarpatti, Mangalam and Vatchakarapatti firkas are falling in plain land.



1.7 Drainage

All nine firkas are drained by streams and tributaries of three major rivers sush as Vaippar River, Arjunanadhi and Gundar Rivers. In The Vaippar river rises on the Eastern slopes of the Varushanadu hill ranges of the Western Ghats near Sivagiri in Thirunelveli district in Tamil Nadu at an elevation of about 1644 m. It flows generally in an Easterly direction for a length of about 125 km through Thirunelveli, Virudhunagar and Tuticorin districts in Tamil Nadu and joins the gulf of Mannar near Kalattur. The river basin is located on South of Vaigai. It drains a total catchment area of 5,069 Sq.Km. The catchment area lies entirely in Tamil Nadu. The Arjunanadhi and Vijayanadhi are the important tributaries. Both the tributaries are left tributaries.

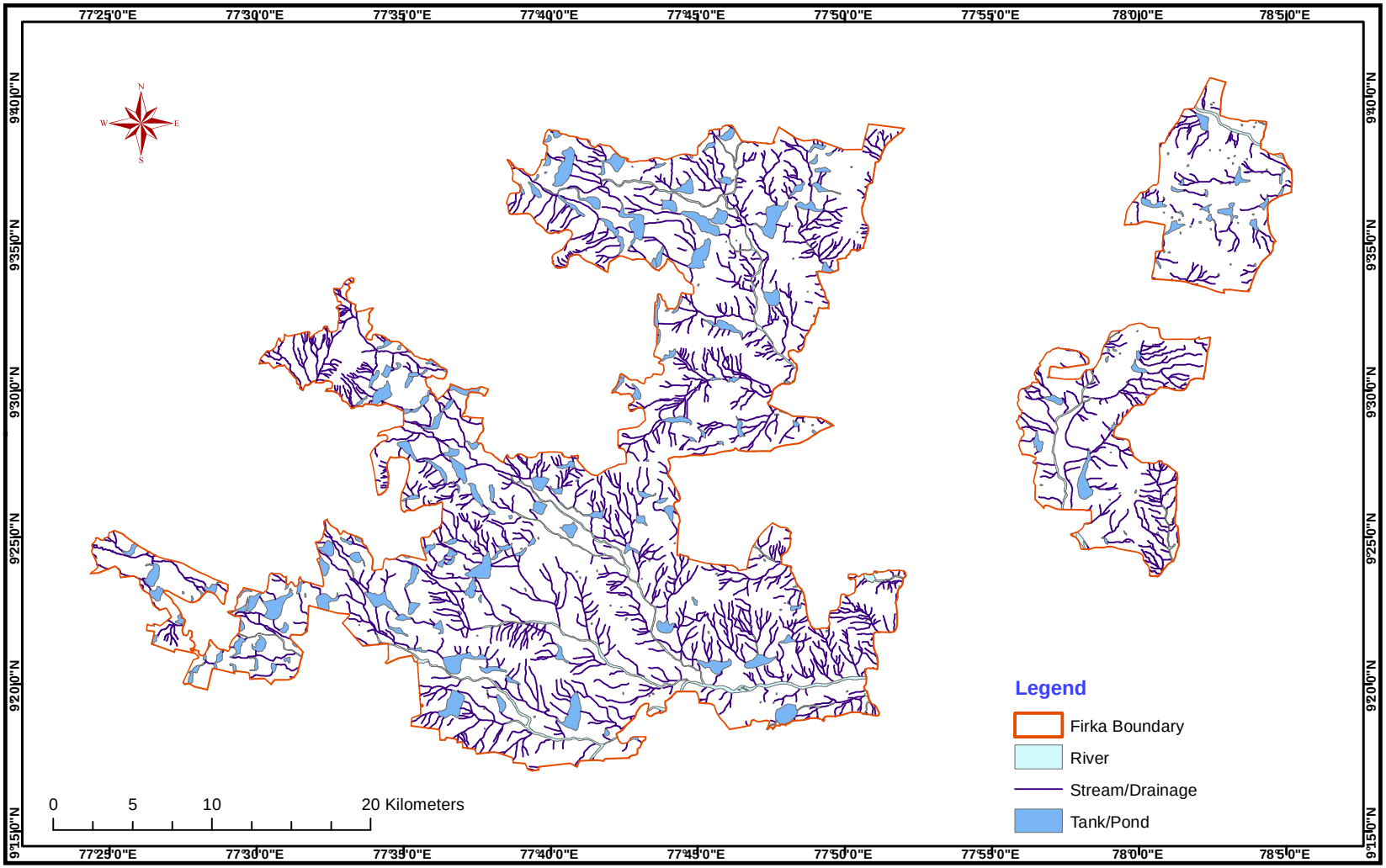
The Vaippar Basin has been divided into 13 sub basins and Arjunanadhi is one of the sub basins. The surplus course of Watrap Periyakulam is the origin of Arjunanadhi. It had two reservoirs Periyar and Kovilar prior to 1989. During 1989, two more reservoirs namely Anaikuttam reservoir and Golwarpatti reservoir were constructed across the Arjunanadhi. Arjunanadhi Sub basin area is 1096 Sq. Km with a hilly area of 195 Sq. Km. The taluks covered in the sub basin are Srivilliputhur, Sivakasi, Sattur and Virudhunagar of Virudhunagar District and Peraiyur of Madurai District. Vembakottai dam is constructed in the river for irrigation purposes and located near Vemakottai.

Gundar basin is falling Ramanathapuram, Virudhunagar, Sivagangai, Madurai and Tuticorin districts. Gundar, the non-perennial river originates at an altitude of 500 meters above MSL, near Kottamalai of Saptur Reserve Forest belonging to the Varushanadu hills. Two other main streams Goundanathi and Therkaar originate from Elumalai hills and part of eastern ghat near Usilampatti respectively and join the river. The river confluences the sea at with Gulf of Mannar, at about 6 km south-east of Sayalkudi in Ramanathapuram district, after traversing about 150 kms. Many drainage channels join of Gundar River along its entire course.

In the study area, Cholapuram, Keelarajakularaman, Ethirkottai, Pilliyarkulam and Salwarpatti firkas are falling in Vaippar basin. Nathampatti , Mangalam and Vatchakara patti firkas are falling in Arjuna Nadhi . Malankinar is falling in Gundar basin. The drainage pattern is dendrite in all nine firkas. All the medium irrigation projects are falling in the outside of of the firkas.

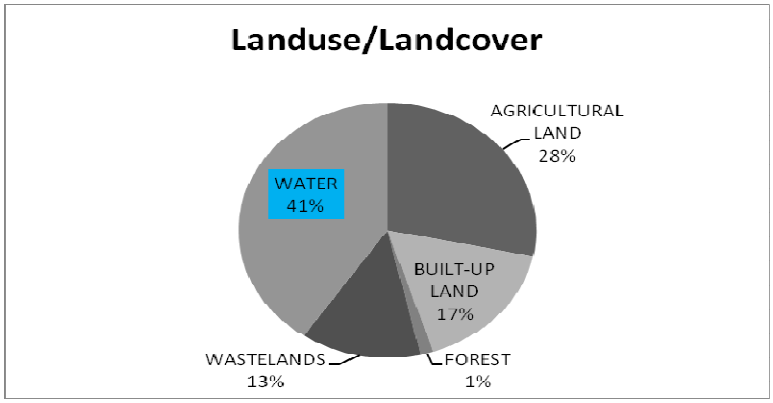
Fig.1.4: Drainage Map of the area

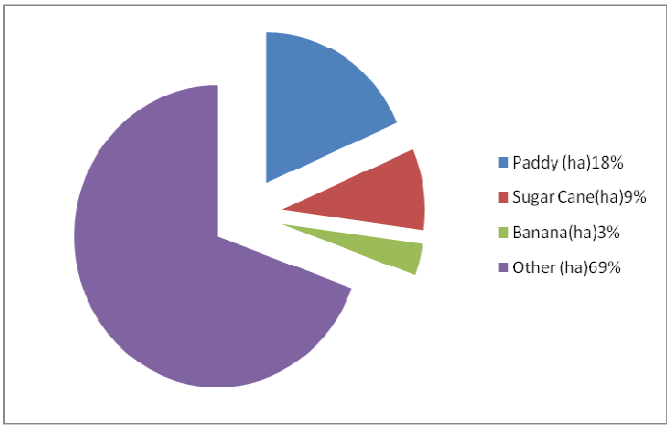
DRAINAGE MAP OF OVER EXPLOITED AND CRITICAL FIRKAS
VIRUDHUNAGAR DISTRICT TAMIL NADU



1.8 Agriculture and Cropping Pattern:

In the study area, the agriculture and water bodies are main two landuse and land cover prevailing in the area. The agriculture land is covering about 28% of the total geographical area of the area and water bodies are occupied by 41 % of the area. The wasteland and Settlement are covering significantly high and representing 13% and 17% of the total geographical area respectively. Forest is covering l% of the total geographical area of the area. The water bodies are very abundant in the foot hills of Varashanadu hill ranges and mainly found in the Cholapuram, Nathampatti, Pilliyarkukam and Keelarajakualaraman firkas trending NE-SW direction. The agriculture land is covering less than the water bodies in the firkas which indicates that land was developed for mining operation.





The agriculture land is covering 278sq.km of the total area based on remote sensing data interpretation and represented by 26 % of the total geographical area of the basin. Based on GEC-2013, The total crop area is 101 sq.km in nine firkas. The total 30 sq.km area of the agriculture land are used for taking crops such as paddy, sugar cane and banana. The dry crops are taken from 70 sq.km area having 70% of the total agricultural land. The water intensive crops such as paddy, sugar cane and banana are taken from 18 sq.km, 9 sq.km and 4 sq.km respectively. Dry land crops are taken from only 7% of the total geographic area. The wet crops are taken from only 3.8 % of the total geographic areas. The details of the agriculture lands against the total geographic area of the nine firka are presented in fig-1.5 and also the distribution of paddy and non paddy crops taken in all nine firkas are laos given in Fig-1.5

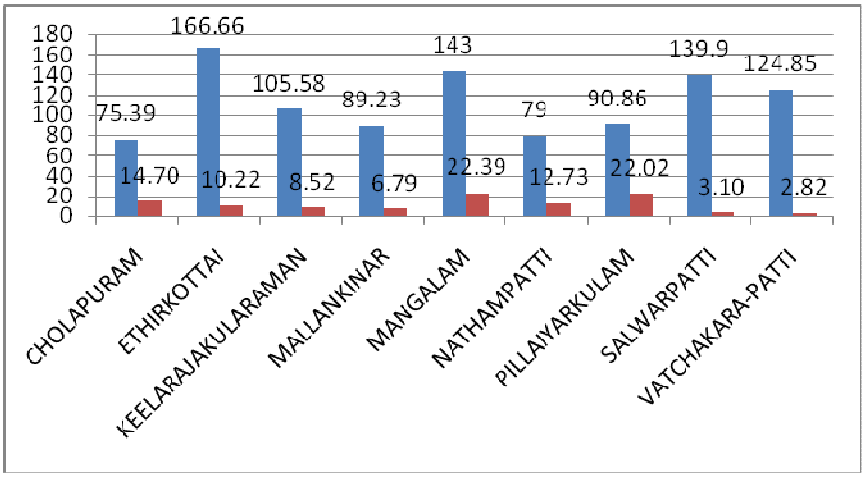


Fig 1.5 Area in sq.km Vs Agriculture land

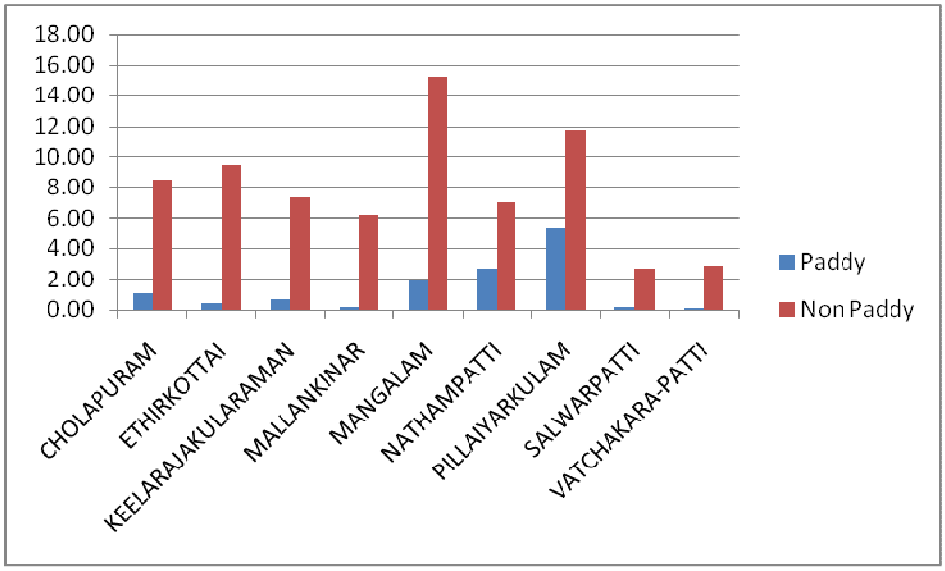


Fig 1.6. Details of paddy and non paddy crops.

The total area of the agriculture land in all nine firkas is very less and covering less than 20-sq.km areas. Cholapuram, Mangalam and Pilliyarkualm firkas are having more than 10 sq/km area under agriculture land. In agricultural land, water intensive crops taken less than 6sqkm area. The frikas namely Cholapuram, Mangalam, Nathampatti and Pilliyarkualm are mainly taking paddy crops from 1 to about 6sq,km ares. The dry crops are taken from 2 sq.km to 15sq.km areas. In mangalam frika, the dry crops are taken from maximum areas, Ethirkottai, Mangalam.Nathampatti and Pillyarkulam frikas are taken both wet and dry crops from considerable areas.

2 DATA COLLECTION AND GENERATION

Hydrogeological data includes quantity and quality from existing data were collected and analysed in GIS platform to validate and avoid discrepancy while preparing the aquifer mapping in the basin. The date collected from allied department such as TWADB, SSGWDC of PWD, Agriculture departments and administrative department were also included in the data collection and analysis.

2.1 Groundwater exploration

The groundwater exploration through drilling of borewell upto the depth of 200m is being carried out by CGWB, SECR to decipher the aquifer depth and its characteristics. The state departments such as TWAD and PWD is drilling the borewell for hydrogeological data and for drinking water purposes. The hydrogeological data generated from drilling were collected and synthesised for demarcating the aquifer system of the basin. As per the data collection in the study area, 17 nos exploratory well drilled before the NAQUIM were collected for aquifer mapping. These wells were plotted and analysed as per the norms of data gap for demarcating aquifers in the area. 20 nos of well were drilled in the area where data gap is found during aquifer mapping. The details of the exploratory well are presented in table-2.1 and the location of the exploratory well are shown in Fig-2.1

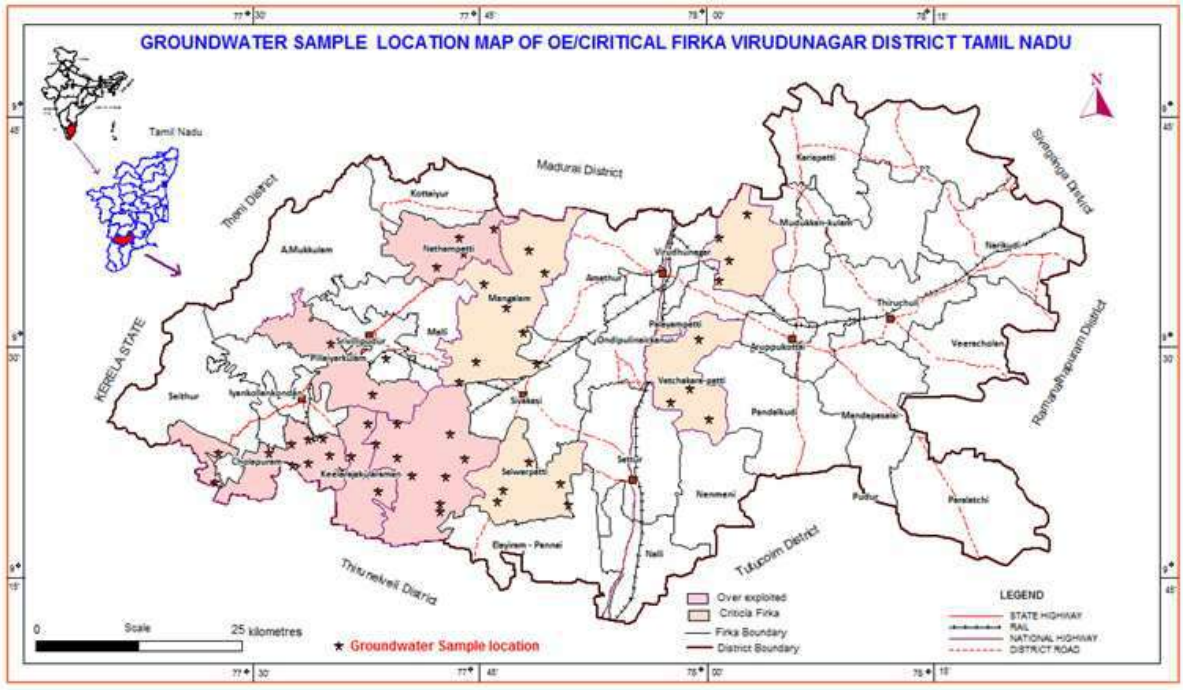


Fig-2.1. Exploratory well location map

2.2 Groundwater Level Monitoring Well

Groundwater level monitoring well as observation well was established to monitor the groundwater level four times in a year for shallow aquifer (water table aquifer) and fractured aquifers separately which will give clear picture about the groundwater recharge in aquifer system by CGWB, SECR Chennai. Dug wells which represents water table aquifer are being monitored for water level in the area. The fractured aquifer of water level is also being monitored using the bore well called piezometers.

SSGWRDC of PWD and TWAD Board are also monitoring the groundwater level monthly in each district for water table aquifer as well fractured aquifer. The water level data monitored by CGWB and other departments were collected for analysing pre-and post-monsoons water level for aquifer mapping. The data were incorporated for analysing the recharge to groundwater in the study area. In the study area, 55nos of dug well were monitored for water table aquifer and 10nos of piezometer were monitored for fractured well. The groundwater level monitoring well locations are shown in Fig-2.2.

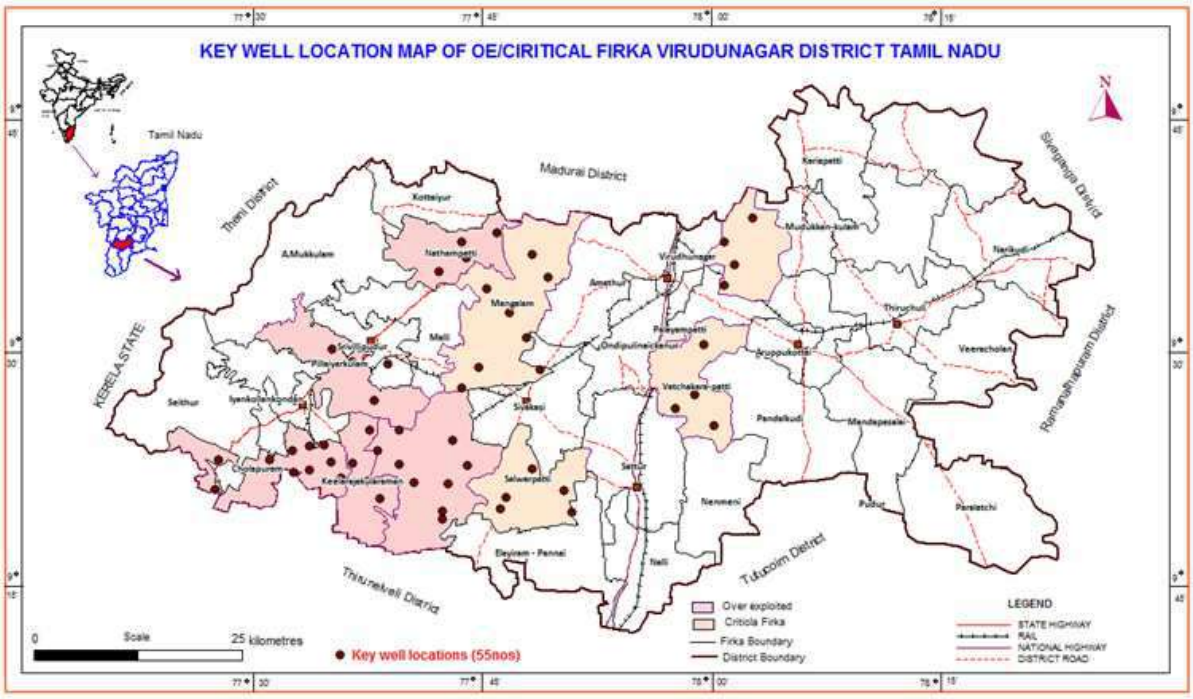


Fig-2.2. Groundwater Level Monitoring well location map

2.3 Groundwater Quality Monitoring Well

Groundwater quality monitoring wells were established by CGWB, SECR, Chennai to monitor the groundwater quality of shallow aquifer once in a year. SSGWRDC of PWD and TWAD Board are also monitoring the groundwater quality of water table aquifer mainly of dug well.in each district. All the groundwater quality data are incorporated for analysing the groundwater quality issues. In the study area, 55nos of well were monitored for groundwater quality. The groundwater quality monitoring well is shown in Fig-2.3.

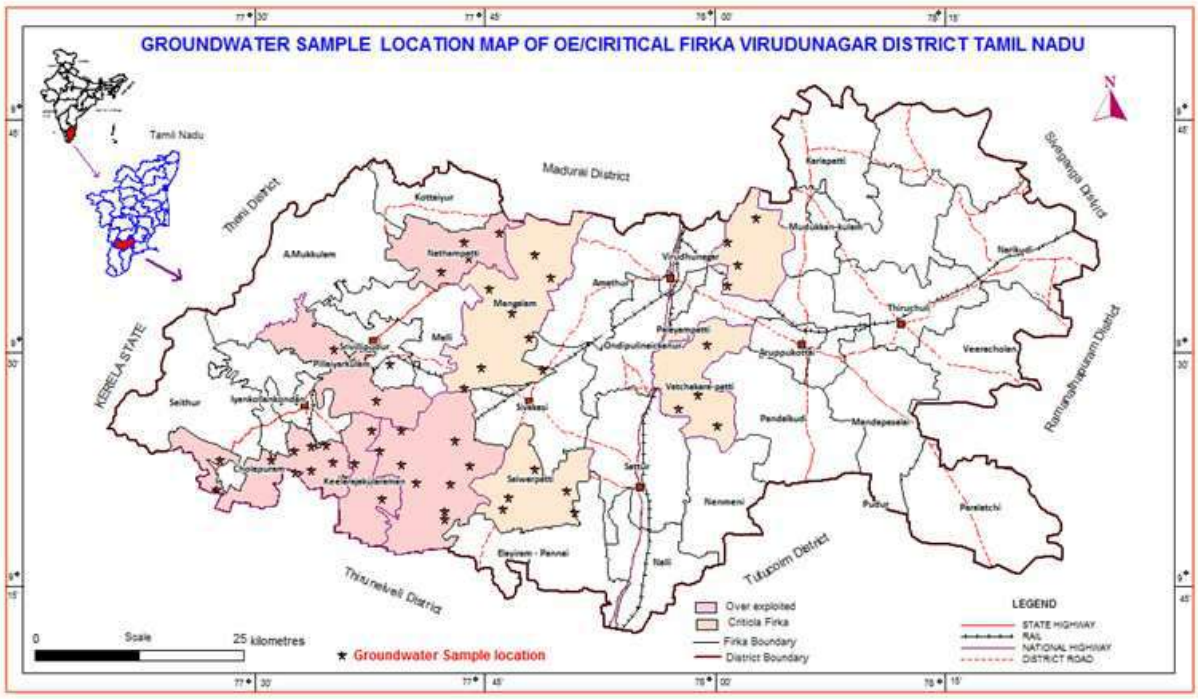


Fig-2.3. Groundwater Quality Monitoring well location map

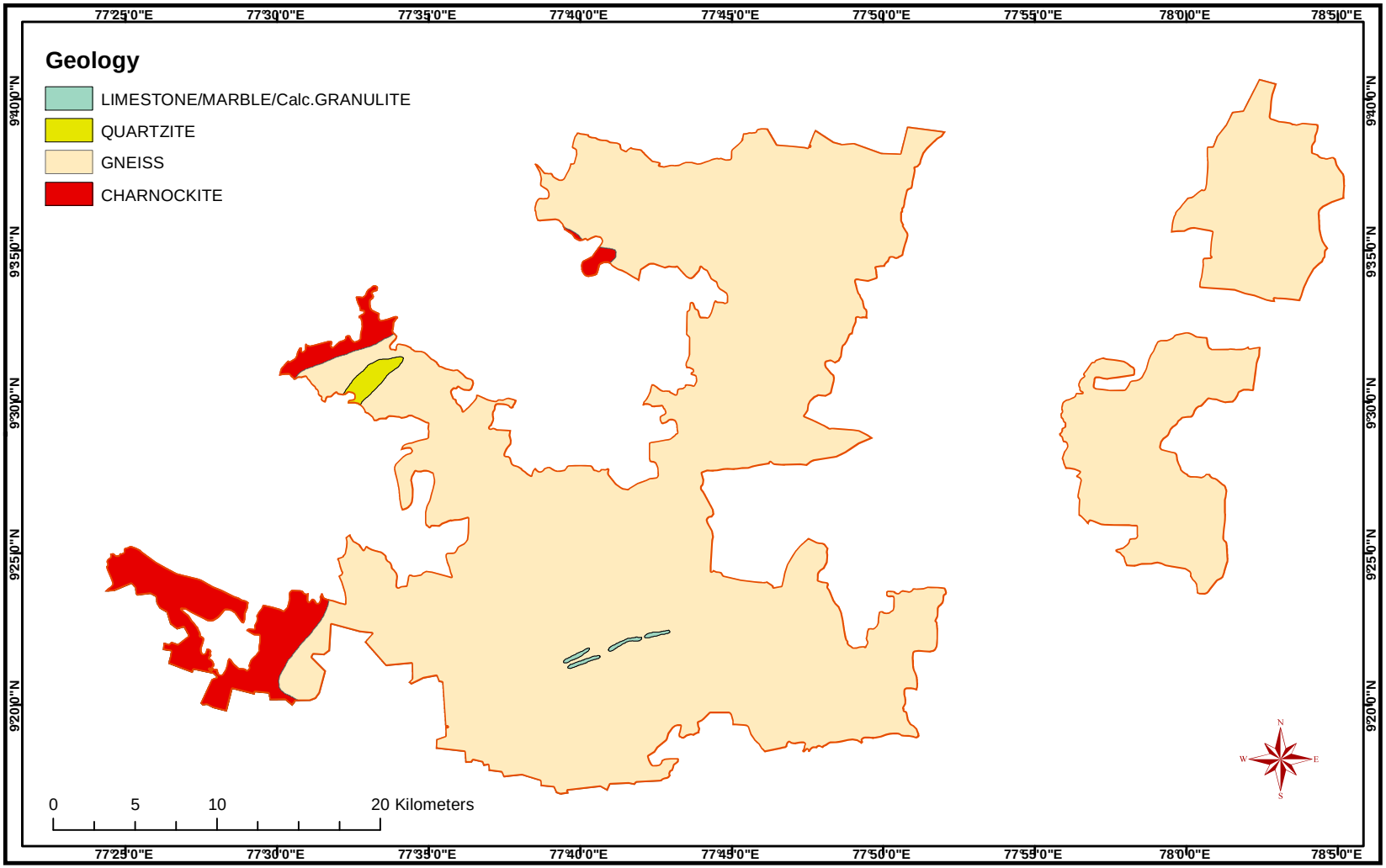
2.5 Data Generation

Based on the data collected, data adequacy was worked out to decide the scope and extent of further data generation. The data requirement was optimised and decided that the existing hydrogeological data is sufficient to generate the desired outputs of aquifer map and management plan. However, about 56 nos of bore well were drilled and generated data which was used for preparing aquifer mapping in the area. The groundwater management plan, includes supply side and demand side intervention is prepared based on the spatial information such as geology, geomorphology, drainage, surface water body and landuse/ landcover. All spatial information is generated using remote sensing data and digitally recorded in GIS environ. The same has been used to prepare management plan.

2.5.1 Geology

Geologically the area is underlain by the hard-crystalline formation of Achaean age. Gneiss, charnockites, quartzite and limestone are major rocks types occupied predominantly in the study area (Fig-2.4). The gniess occupied in the entire area. The charnockite is exposed in the western parts of the study area trending NE-SW direction. The limestone and quartzite are emplaced in the gneissic formation and are occupied in small area . It is not having any significant in aquifer system. Aquifer systems of the area is mainly formed by the gneiss and charnockite of the area..

GEOLOGY MAP OF OVER EXPLOITED AND CRITICAL FIRKAS
VIRUDHUNAGAR DISTRICT TAMIL NADU



2.5.2 Geomorphology

The different landforms discernable on the imagery have been broadly classified into Denudational hill, dissected hill and fluvial landforms. The landforms delineated are Hills and plateau, pediplain and flood plain (Fig-2.5)

Hills and plateau: Hills and plateau is highly elevated hills prone for dissection and denudation. It devoid or wear very thin soil development. The landforms are un-dissected / less dissected, structural hill, deflection slope and denudational / residual hill. These landforms are generally formed in the charnockites area falling western parts of the area. These are only confined in small pockets of Nathampatti, Pilliyarkulam and Cholapuram firkas.

Pediplain: This landform is formed by disintegration of county rock. The landforms are Buried pediplain shallow, Buried pediplain moderate and Buried pediplain deep. It is classified on basis of the thickness of the soil development. The buried pediplain shallow is having thickness of soil ranging from 1-5mts and the buried pediplain moderate thickness is ranging from 5-10mts. The buried pediplain deep thickness is more than 10mts. These landforms are formed all nine firkas and generally occupied in the valley portion and all along the river system.

Flood Plain: It has been developed mainly in the river course and consisting of unconsolidated materials by fluvial agencies. The materials are silt, fine sand and at places pebbly. The thickness of sediments layers are ranging from 1 to 15 m and it act as good recharge zone. It is only occupied in Malankinar firka

2.5.3 Landuse /landcover

Landuse / Landcover map was generated using satellite data for the area. There are three main classes in landuse/landocver such as Agricultural land, water body, waste land and forest. In agricultural al al land further classified in to four classes namely dry crops, wet crops and Plantation. Wet crops rare generally water intensive crops such as paddy, sugar cane and banana. The dry crops are rain fed crops such cotton, maize and other crops. Based on the mapping (Fig-2.6)

Table – 2.1: Details of classes of Agriculture land occurring in the area

AGRICULTURE LAND	Area in sq.km	Percentage of total agricultural land	Percentage of total geographical area
DRY CROP	43	15.4	4.2
FALLOW	17	6.1	1.7
PLANTATION	179	64.2	17.7
WET CROP	40	14.3	3.9

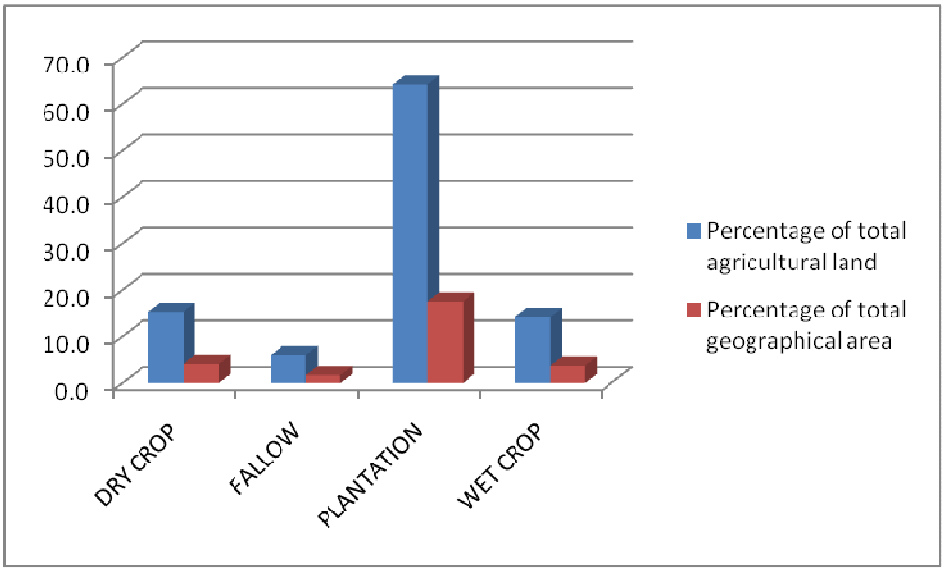


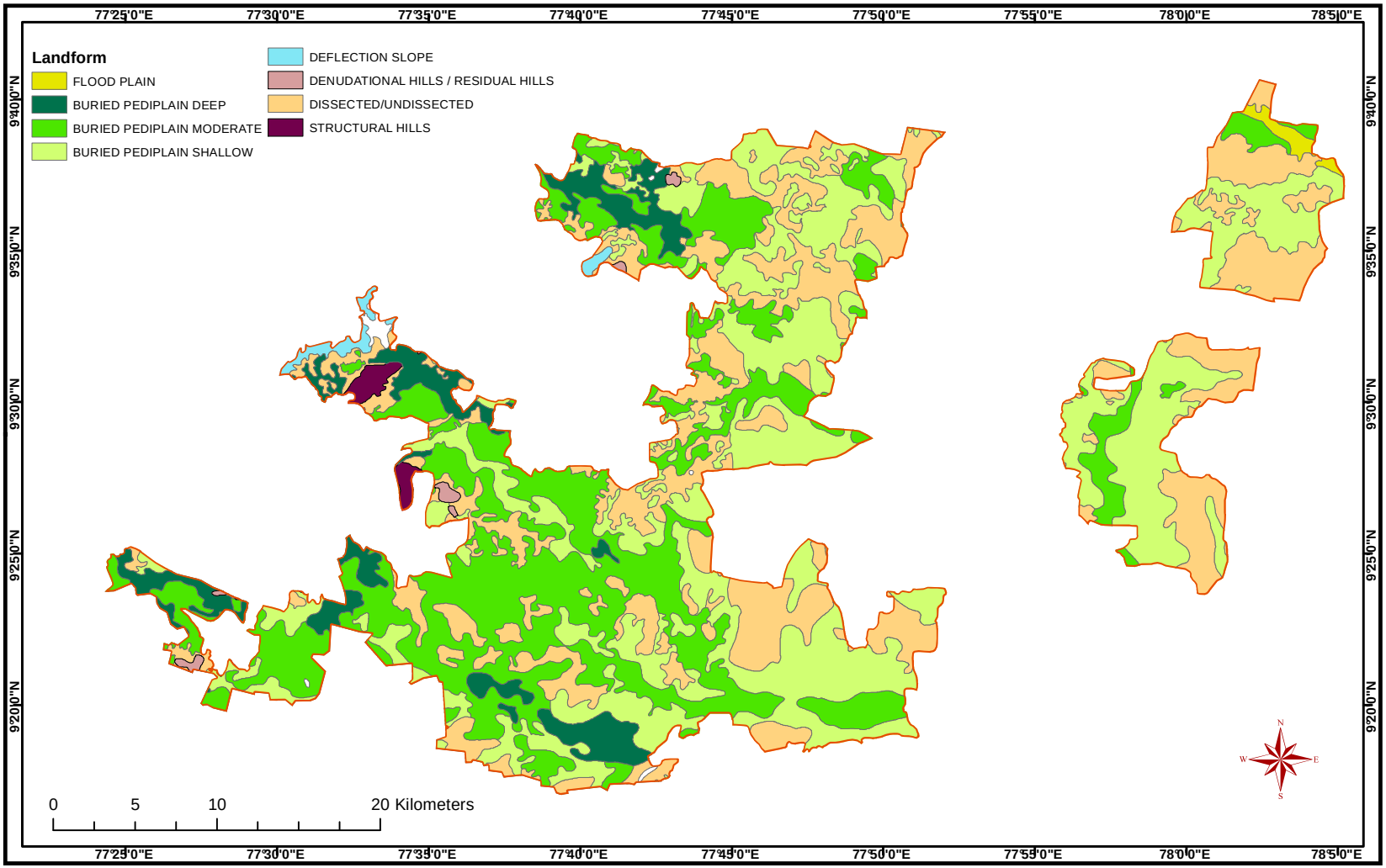
Fig-2.7. Details of class of agriculture land

Based on mapping, the total agriculture area is 279 sq.km and representing about 27% of the total geographic area. In agriculture land, plantation covers 179 sq.km area and representing 64% of the agriculture land and 17.7 % of the total geographic area. Wet crops and dry crops are covering almost equal in areas representing each 15% of the total agriculture land and about each 4% of total geographic area. The remaining area is covered by fallow land representing 6% of the total agriculture land. Agriculture lands are occurring in all nine firkas. Plantation is generally found in the western parts of the Cholapuram, Pilliyarkulam and Nathampatti firkas and around the river course of the all nine firkas. The Dry crops are generally taken in the buried pediplain landforms and wet crops are taken in the dissected plateau of Cholapuram, Ethirkottai and Keelarajakularaman firkas. The most prominent class of landform is water body which covers about 38 % of the total geographic area. Waste land is covering 12 % of the total geographic area. Salt affected land is covering about 33 sq.km of the total geographic area and found in Ethirkottai firkas. Settlement is covering about 133 sq.km and Forest is covering about 13 sq.km of the total geographic area.

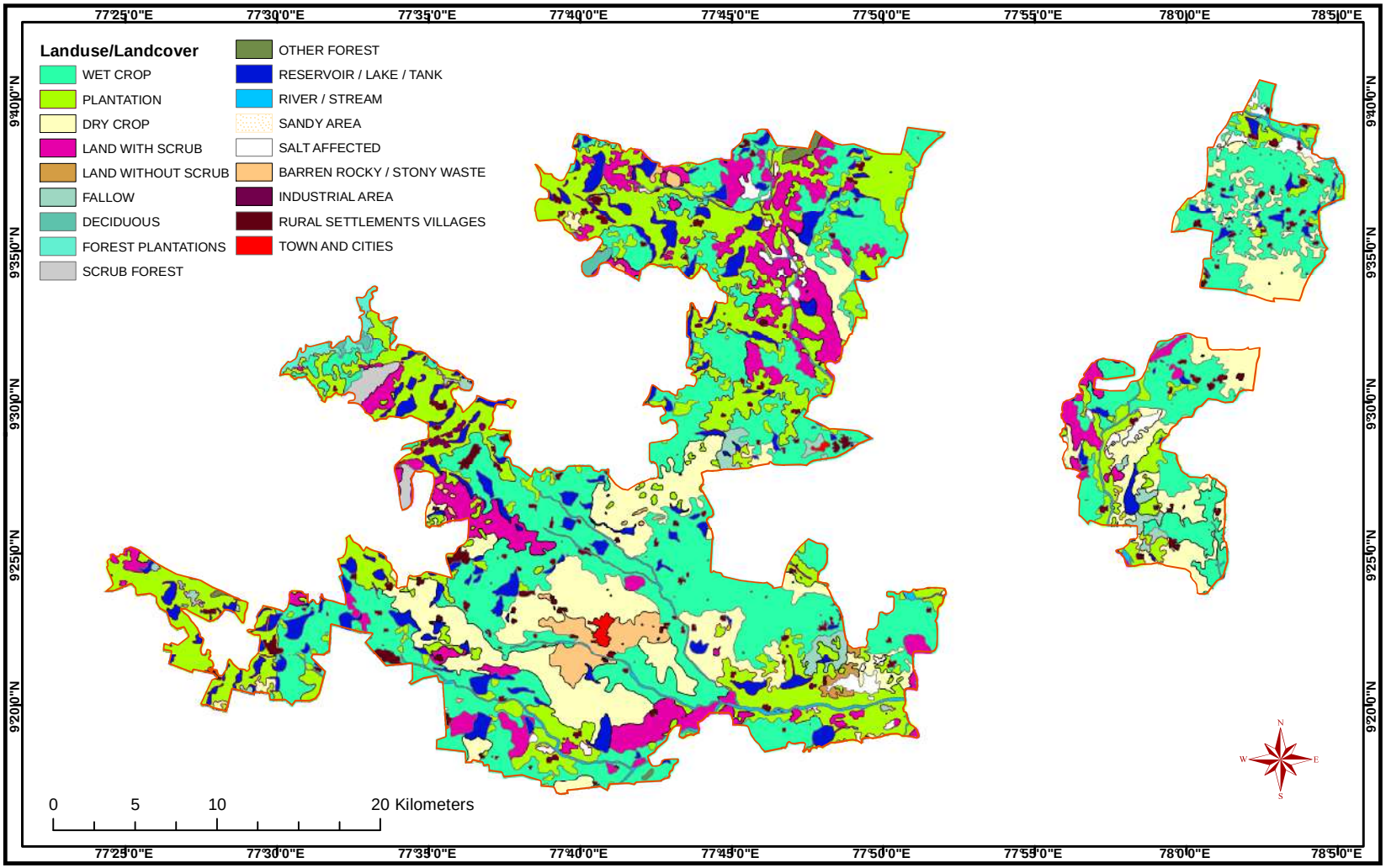
2.5.4 Soil

Based on the interpretation, Loamy, Red Loamy, Alluvial clay, Black cotton soil and Hill soil have mapped for the area. Loamy soil is occupied in small pockets covering in northern parts of Keelarajakularaman firka and central part of Eithirkottai firka. Red Loamy soil is formed in the foot hills Varshanadu hill range and occupied in the Cholapuram, Pilliyarkulam and Nathampatti firkas. Alluvial clay soil is occupied all along the valley portion of river and found in the southern parts of Keelarajakularaman firka and central parts of Ethirkottai firka. Northern parts of Nathampatti and central parts of Mangalam firkas. In the area, about 60% of the area is occupied by black cotton soil locally called Karisal kadu and mainly occupied in the high lands of Keelarajakularaman, Ethirkottai, Mangalam, Malanjinar and Vatchakarapatti firkas in the area. Hill soil is formed in the western parts os the area occupied in a small pokets. The Loamy and red loamy soil is formed about 40% of the total geographical area.(Fig-2.8)

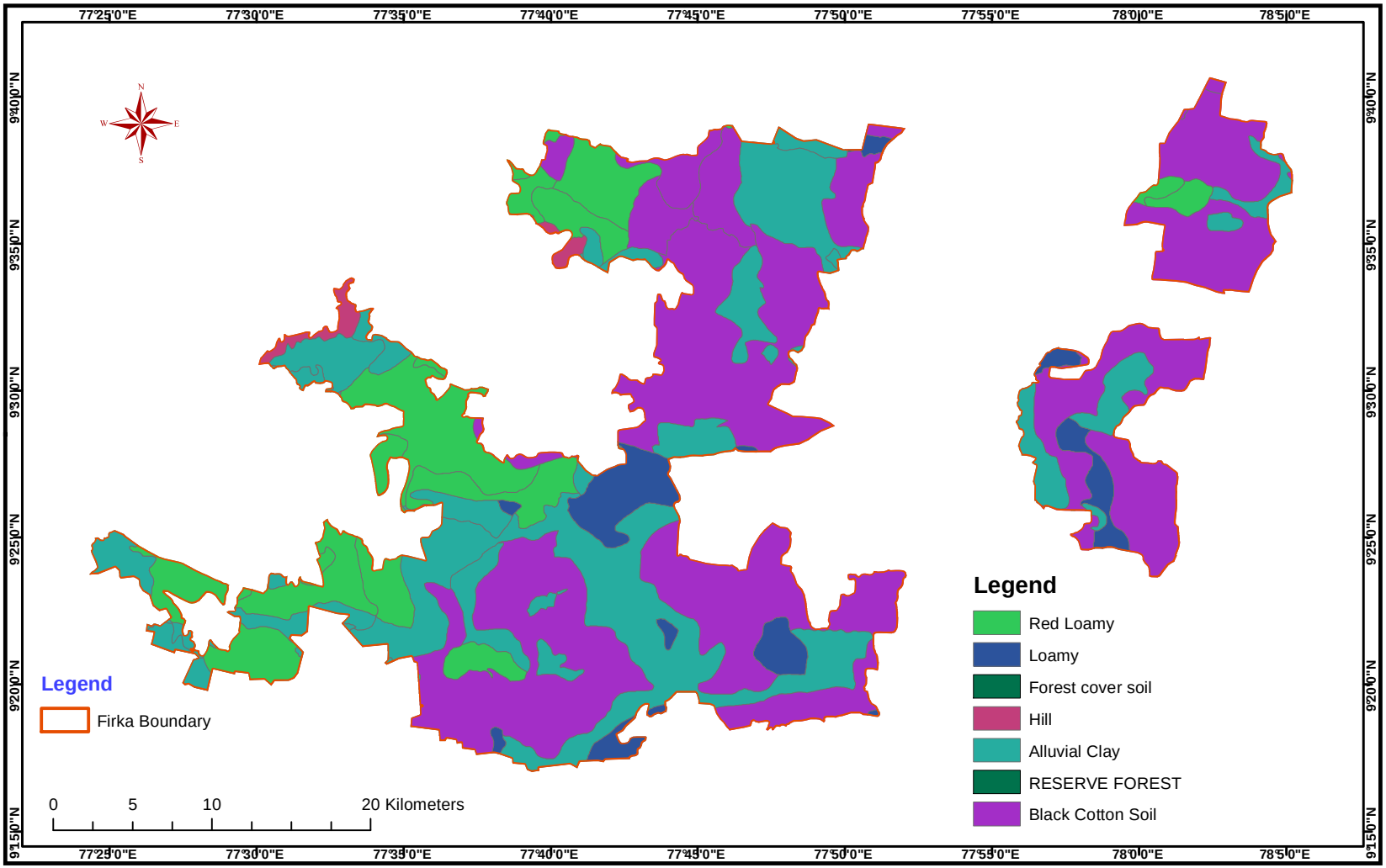
GEOMORPHOLOGY MAP OF OVER EXPLOITED AND CRITICAL FIRKAS
VIRUDHUNAGAR DISTRICT TAMIL NADU



LANDUSE/LANDCOVER MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



SOIL MAP OF OVER EXPLOITED AND CRITICAL FIRKAS
VIRUDHUNAGAR DISTRICT TAMIL NADU



3 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 Hydrogeology

In hard crystalline formation, the groundwater mainly occurs in weathered and fractured rocks. In the study area, Gneiss and Charnockites are predominant and forms the aquifer system. Recent alluvium occurring along the river course is contributing to groundwater aquifer systems sporadically. Limestone and quartzite rock formations are occupying less area and contribute less to groundwater aquifer systems. The groundwater movement is generally following the general slope of the area particularly in foot hills of the region and in plain terrain the groundwater flow towards the major river drain in the area.

3.2 Occurrence of Groundwater in Gneiss

In the study area, gneissic formation is occupying more than 90% of the area and forms main aquifer system in the area. The gneissic formation is occurring in the central and eastern parts of the area. The groundwater generally is occurring in the weathered and fractured rocks. Two types of groundwater abstraction structures such as dug well and bore well are mainly used in this formation. The depth of the dug well is upto 30m bgl and the depth of dug well varies due to surface water sources. The depth of bore well is generally 200m bgl and the fracture is encountered up to the depth of 200mts.

3.3 Occurrence of Groundwater in Charnockites

In the study area, charnockite formation is occupying less than 10% of the area and forms the aquifer system in the area. It is occurring in the western parts of the area. It forms hill region in the area, trending NE-SW direction. The groundwater generally is occurring in the weathered and fractured rocks. The groundwater is mainly occurring in the weathered formation and scanty in fractured medium. The groundwater is mainly abstracted by the dug well in the region. The depth of the dug well is upto 20m bgl and it is recharged during the monsoon. Charnockite of this region plays vital role in groundwater recharge as it is covered with thick vegetation cover and receives good to moderate rainfall. It acts as good recharge zone for the aquifer systems and contribute to surface water sources due to base flow during non-monsoon time.

3.4 Occurrence of Groundwater in Limestone

In the study area, Limestone rock formation occupies in a very small area and forms aquifer systems. It is found mainly in the western parts of the study area and contribute less to groundwater systems. It is reported in the area that it is intruded into gneissic terrain and forms as aquifers. The groundwater is mainly occurring in the weathered and fracture formation. Dug well and bore well are groundwater abstraction structure. The depth of dug well is up to 25 m bgl and the depth of the bore well is up to 200m bgl.

3.5 Water level scenario

Monitoring groundwater level of the aquifer systems implies the groundwater recharge to aquifer system and rate of groundwater abstraction in an area. In the study area, groundwater level carried out four times in a year which covers the pre-monsoon and post-monsoon period. The water level data collected from dug well and piezometer representing two aquifer systems are analysed for pre and post monsoon period. The average water level data of May (2006-15) is considered for pre-monsoon and

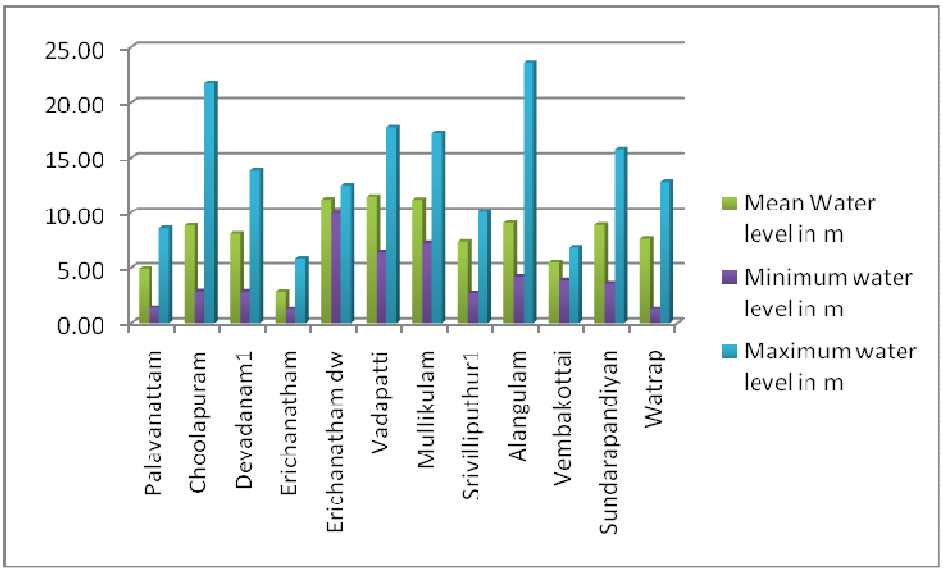
January (2007-16) is considered for post-monsoon water level data. The long-term water level data have been used to describe water level trend of the aquifer system.

3.5.1 Average Pre-monsoon water level Aquifer-I

Average water level data collected from May-2006 to 15 was analysed for pre-monsoon. 12 nos of well are considered for water level analysis. The average water level is ranging from 2.86 to 11.46 mgl. The minimum water level is 1.32mgl (Erichanatham) and maximum is 23.6mgl at Vadapatti. The average water level data is classified into five zones such as 0-2, 2-5, 5-10 and 10-20. Water level of the area is generally falling in two zones 5 to 10 and 10-20mbgl representing 75% and 25% of wells. The details of water level zone of pre monsoon are given in table-3.1.

Table: 3.1 Water level of Pre monsoon data of Aquifer-I

Sl.No	BLOCK	FIRKA	LOCATION	Mean Water level in m	Minimum water level in m	Maximum water level in m
1	ARUPPUKOTTAI	Near Malankinar	Palavanattam	4.90	1.42	8.6
2	RAJAPALAYAM	Choolapuram	Choolapuram	8.84	2.91	21.7
3	RAJAPALAYAM	Choolapuram	Devadanam1	8.12	2.9	13.79
4	SIVAKASI	Mangalam	Erichanatham	2.86	1.32	5.9
5	SIVAKASI	Mangalam	Erichanatham dw	11.20	9.94	12.45
6	SIVAKASI	Mangalam	Vadapatti	11.46	6.48	17.7
7	SRIVILLIPUTTUR	(Malli)Mangalam	Mullikulam	11.19	7.28	17.2
8	SRIVILLIPUTTUR	Pilliyarkulam	Srivilliputhur1	7.40	2.76	10.06
9	VEMBAKOTTAI	Eithirkottai	Alangulam	9.07	4.22	23.6
10	VEMBAKOTTAI	Salwarpatti	Vembakottai	5.47	3.9	6.9
11	WATRAP	Nathampatti	Sundarapandiyan	8.89	3.6	15.75
12	WATRAP	Nathampatti	Watrap	7.67	1.32	12.78



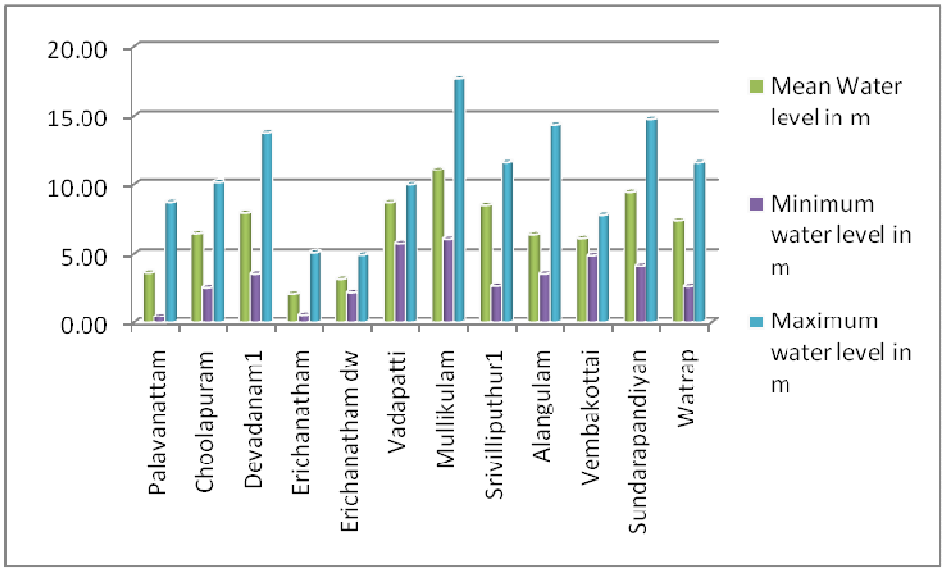
The minimum water level is ranging from 1.32 to 9.94 mbgl and about 8 nos of wells is having water level below 5mbgl. The maximum water level is ranging from 5.9 to 23.6 mbgl and about 7 nos of wells is having water level between 10-20 mbgl. 2nos of well showing more than 20 mts water level. Nathampatti, Mangalam and Cholapurm firkas are showing deeper water level in the area.

3.5.2 Average Post-Monsoon water level Aquifer-I:

Average water level data collected from Jan-2007 to 16 was analysed for post-monsoon. 12 nos of well are considered for water level analysis. The average water level is ranging from 2.18 to 11.08 mgl. The minimum water level is 0.47mgl (Palavanatham) and maximum is 23.6mgl at 17.66. The average water level data is classified into five zones such as 0-4, 4-6, 6-8 and above 8 mbgl. Water level of the area is generally falling in three zones less than 4, 4 to 6 and 6 to 8 mbgl representing 75% of wells (Fig. The details of water level zone of pre monsoon are given in table-3.2.

The minimum water level is ranging from 0.47 to 6.05 mbgl and about all wells are having water level below 5mbgl except in one well. The maximum water level is ranging from 4.95 to 17.66 mbgl and about 50% wells is having water level between 10-20 mbgl and remaining 50% of well having water level is less than 10m water level. Nathampatti, Mangalam and Cholapurm firkas are showing deeper water level in the area.

Sl.No	BLOCK	FIRKA	LOCATION	Mean Water level in m	Minimum water level in m	Maximum water level in m
1	ARUPPUKOTTAI	Near Malankinar	Palavanattam	3.59	0.47	8.75
2	RAJAPALAYAM	Choolapuram	Choolapuram	6.44	2.54	10.16
3	RAJAPALAYAM	Choolapuram	Devadanam1	7.99	3.51	13.75
4	SIVAKASI	Mangalam	Erichanatham	2.10	0.6	5.11
5	SIVAKASI	Mangalam	Erichanatham dw	3.15	2.2	4.95
6	SIVAKASI	Mangalam	Vadapatti	8.74	5.75	10.01
7	SRIVILLIPUTTUR	(Malli)Mangalam	Mullikulam	11.08	6.05	17.66
8	SRIVILLIPUTTUR	Pilliyarkulam	Srivilliputhur1	8.53	2.66	11.66
9	VEMBAKOTTAI	Eithirkottai	Alangulam	6.38	3.52	14.3
10	VEMBAKOTTAI	Salwarpatti	Vembakottai	6.11	4.9	7.85
11	WATRAP	Nathampatti	Sundarapandiyan	9.47	4.16	14.8
12	WATRAP	Nathampatti	Watrap	7.37	2.63	11.65

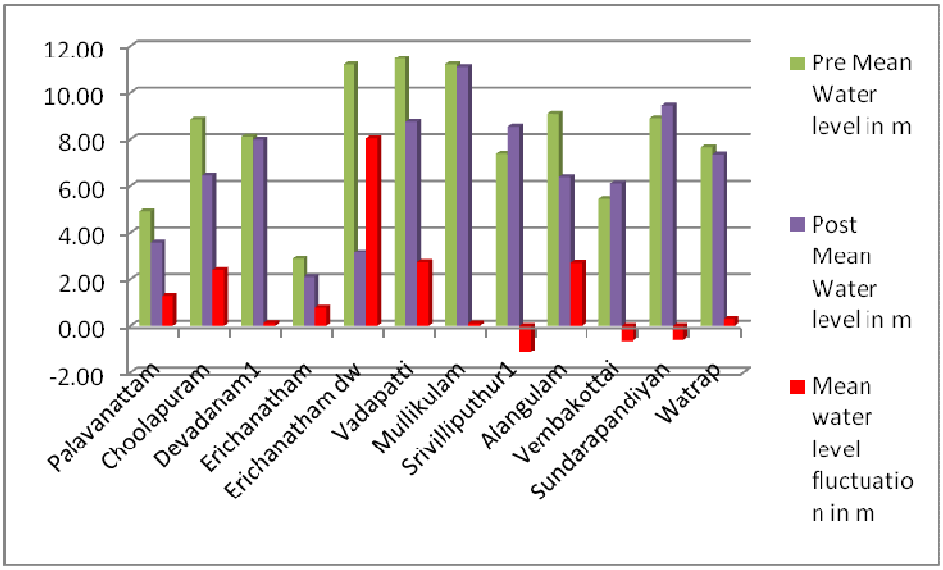


3.5.3 Average Water level fluctuation

Water level fluctuation was analysed using average pre and post monsoon water level. 90 % of wells are showing positive water level and 10% of wells are showing negative water level in the area. The highest positive fluctuation is observed in Mangalam firka and lowest positive fluctuation is observed in Cholapuram firka. The positive fluctuation is ranging from 0.11 m to 8.05m. In positive fluctuation, less than 1m is observed in four wells and above 1m is observed in 5 wells. The negative fluctuation was observed in three wells located in Pilliyarkulam, Nathampatti and Salwarpatti firkas. The negative fluctuation is ranging from -0.58 to -1.13m.

Table: 3.1 Water level fluctuation Aquifer-I

Sl.No	BLOCK	FIRKA	LOCATION	Pre Mean Water level in m	Post Mean Water level in m	Mean water level fluctuation in m
1	ARUPPUKOTTAI	Near Malankinar	Palavanattam	4.90	3.59	1.31
2	RAJAPALAYAM	Choolapuram	Choolapuram	8.84	6.44	2.39
3	RAJAPALAYAM	Choolapuram	Devadanam1	8.12	7.99	0.12
4	SIVAKASI	Mangalam	Erichanatham	2.86	2.10	0.77
5	SIVAKASI	Mangalam	Erichanatham	11.20	3.15	8.05
6	SIVAKASI	Mangalam	Vadapatti	11.46	8.74	2.72
7	SRIVILLIPUTTUR	(Malli)Mangalam	Mullikulam	11.19	11.08	0.11
8	SRIVILLIPUTTUR	Pilliyarkulam	Srivilliputhur1	7.40	8.53	-1.13
9	VEMBAKOTTAI	Eithirkottai	Alangulam	9.07	6.38	2.69
10	VEMBAKOTTAI	Salwarpatti	Vembakottai	5.47	6.11	-0.64
11	WATRAP	Nathampatti	Sundarapandiyan	8.89	9.47	-0.58
12	WATRAP	Nathampatti	Watrap	7.67	7.37	0.30



Water level fluctuation is indicating that the fluctuation thickness is very small and still there is lot scope for the infiltration to aquifer system in the area.

3.5.4 Pre-monsoon water level Aquifer-I

Total of 55 nos of key wells were established in the study area during Water level data collected from May-2006 to 15 was analysed for pre-monsoon. 12 nos of well are considered for water level analysis. The average water level is ranging from 2.86 to 11.46 mgl. The minimum water level is 1.32mgl (Erichanatham) and maximum is 23.6mgl at Vadapatti. The average water level data is classified into five zones such as 0-2, 2-5, 5-10 and 10-20. Water level of the area is generally falling in two zones 5 to 10 and 10-20mbgl representing 75% and 25% of wells. The details of water level zone of pre monsoon are given in table-3.1.

WATER LEVEL (DECADAL MEAN) MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU

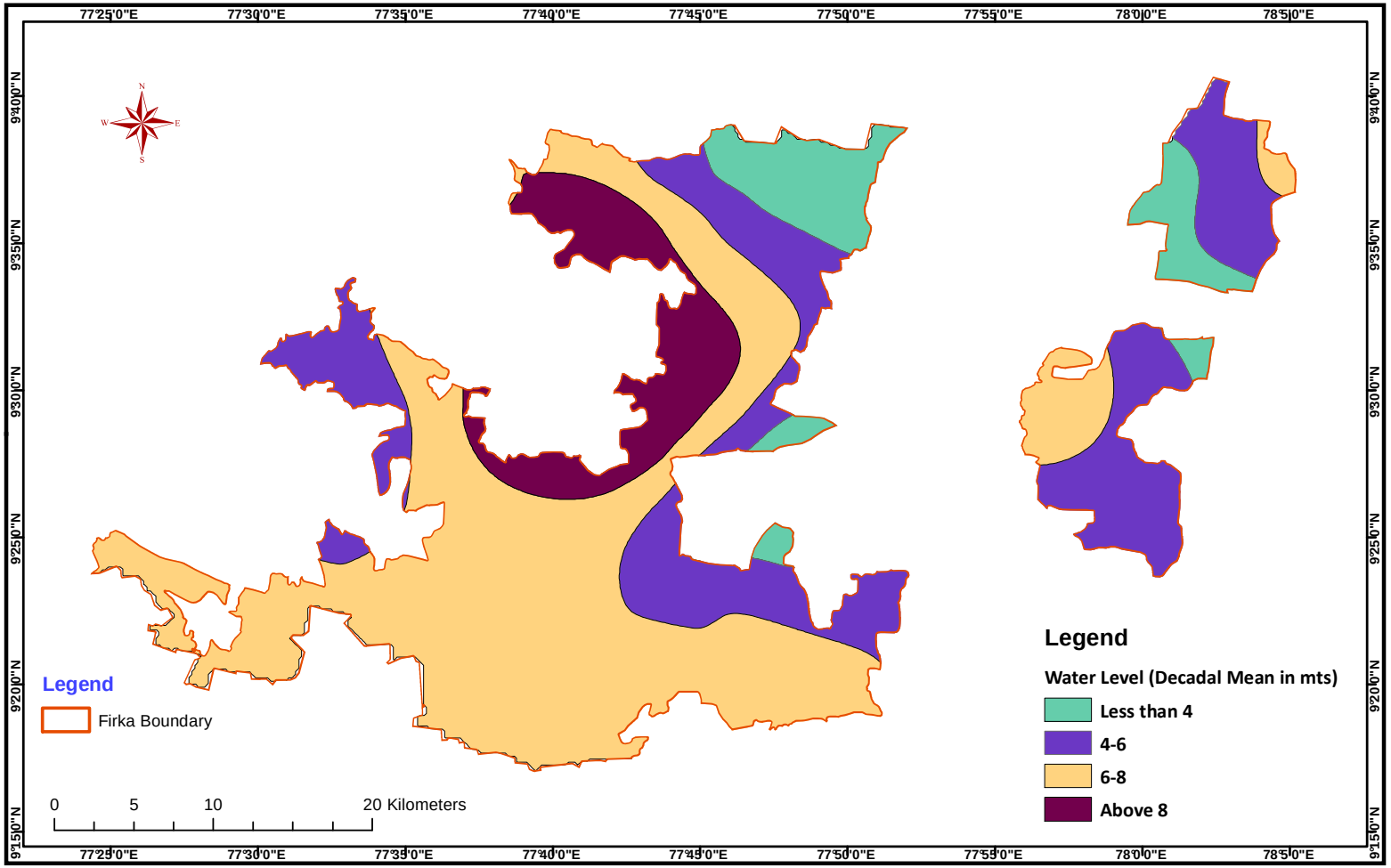
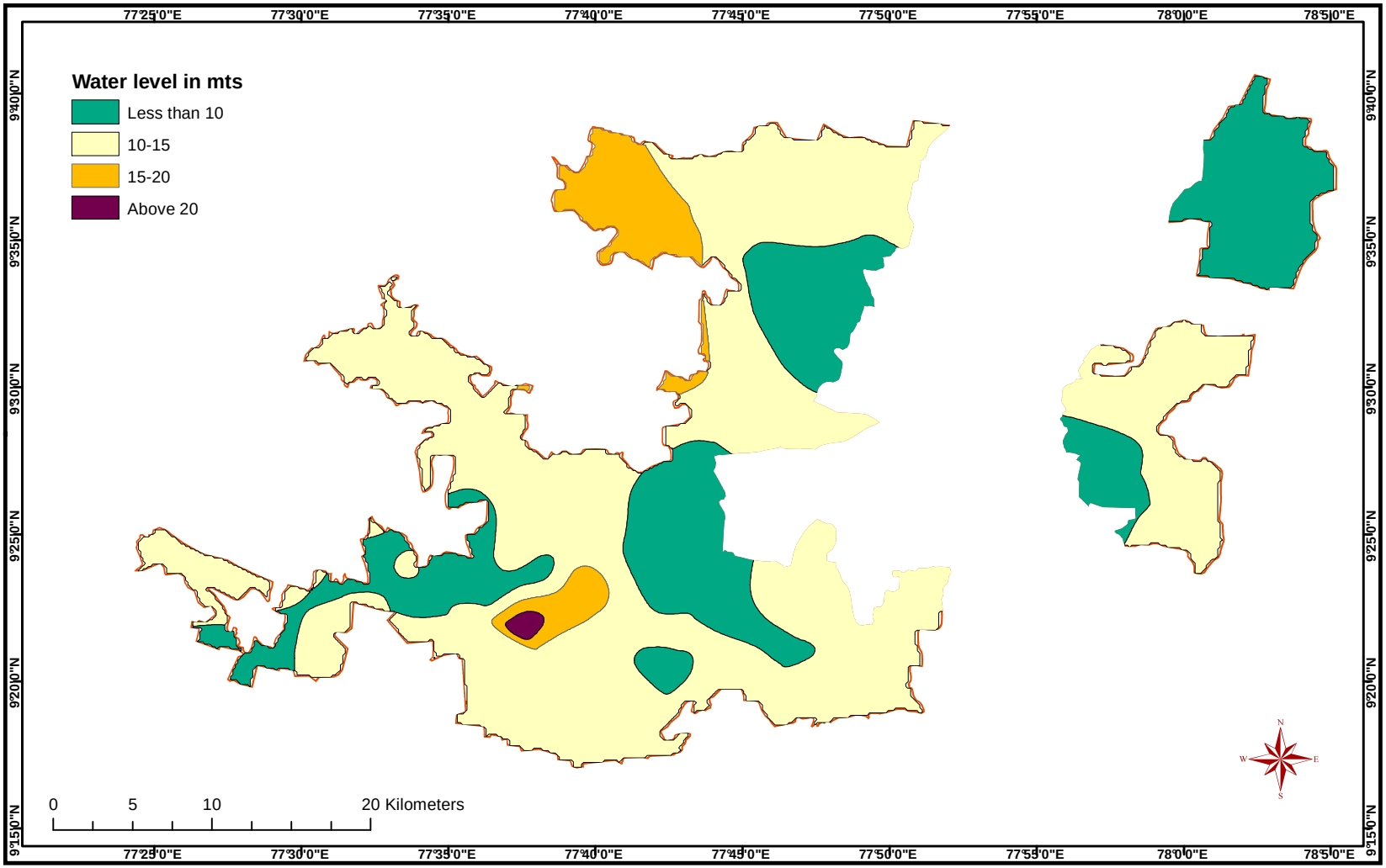
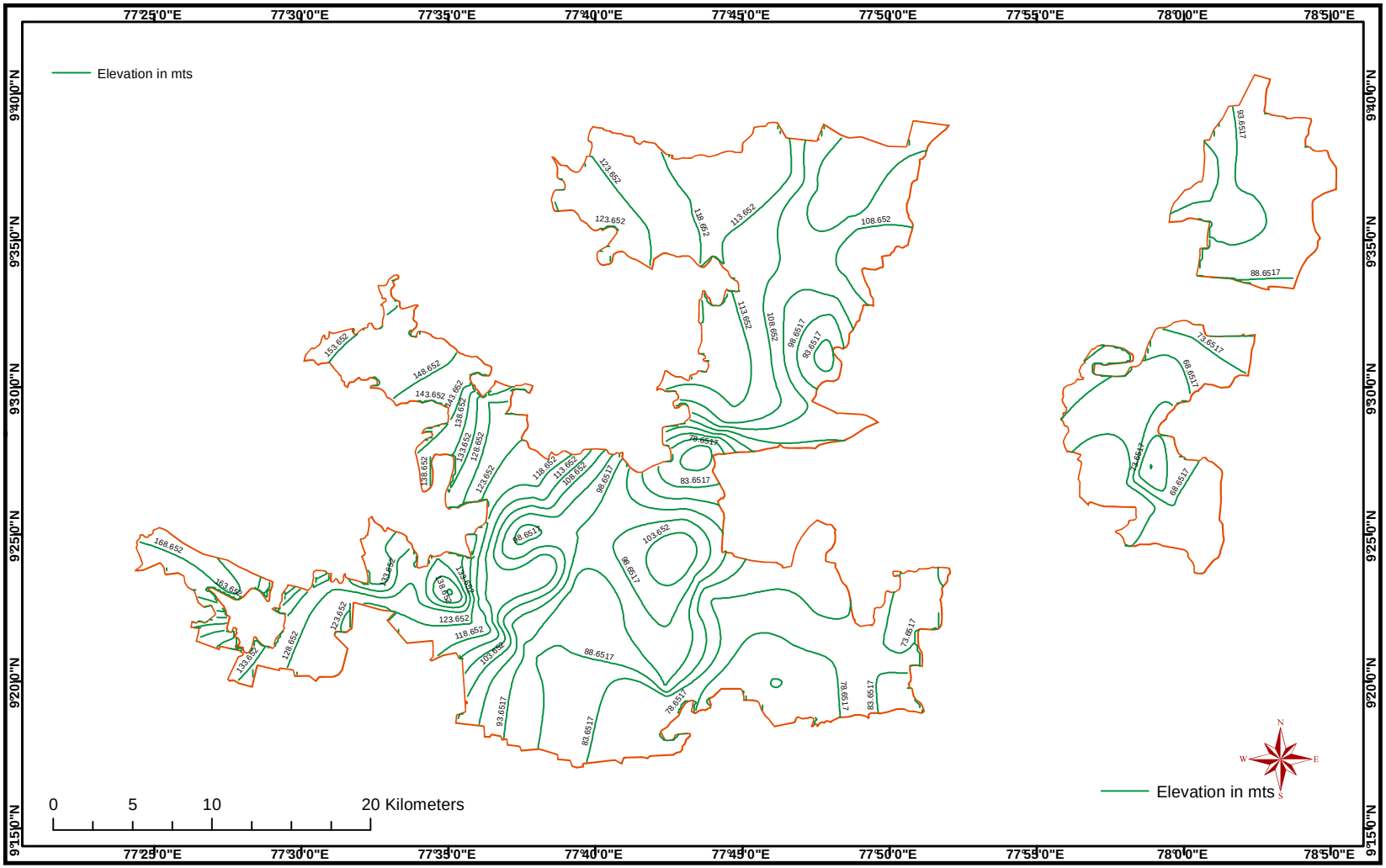


Fig-3.4 Depth to water level zone map (January 2007-16) of Aquifer-I

WATER LEVEL MAP OF OVER EXPLOITED AND CRITICAL FIRKAS
VIRUDHUNAGAR DISTRICT TAMIL NADU



WATER TABLE ELEVATION MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



3.6 Groundwater quality

The groundwater samples were collected from 311 dug wells and analysed pH, EC, anion, cation and fluoride and nitrate concentrations. The EC of groundwater is discussed in the report. 42% of the sample is showing EC between 750-2250 µS/cm at 25 °C which is considered as moderately fresh water. More than 50% of the sample is falling EC of 2250 - >3000 µS/cm at 25 °C which is showing the groundwater is high concentration mineralisation. Only less than 10% of sample is showing the EC less than 750 µS/cm at 25 °C and this groundwater is considered as fresh (Table-3.3).

The EC data is represented spatially in Fig-3.6 and it is showing EC into four zones such as 0-750, 750-2250, 2250-3000 and >3000 µS/cm at 25 °C. The maximum area is falling under EC between 750-2250 µS/cm at 25 °C and < 750 µS/cm at 25 °C is occurring in the western parts of the area. The EC between 2250 - >3000 µS/cm at 25 °C is falling in the eastern parts of the area where upland of the gneiss and granite formation is exposed. The high mineralisation is found in the eastern parts of the area and it indicates that high concentration of chemical constituents presents in the water. It may be due to high concentration of fluoride in the groundwater.

Table-3.3 EC of groundwater

EC (µS/cm at 25º C)	**Water Class**	**Percentage of Samples**
0-750	Fresh	**10%**
750 – 2250	Moderately Fresh	**42%**
2250 – 3000	Slightly mineralized	**25%**
>3000	Highly mineralized	**23%**

Fig-3.6 Spatial distribution of EC in groundwater

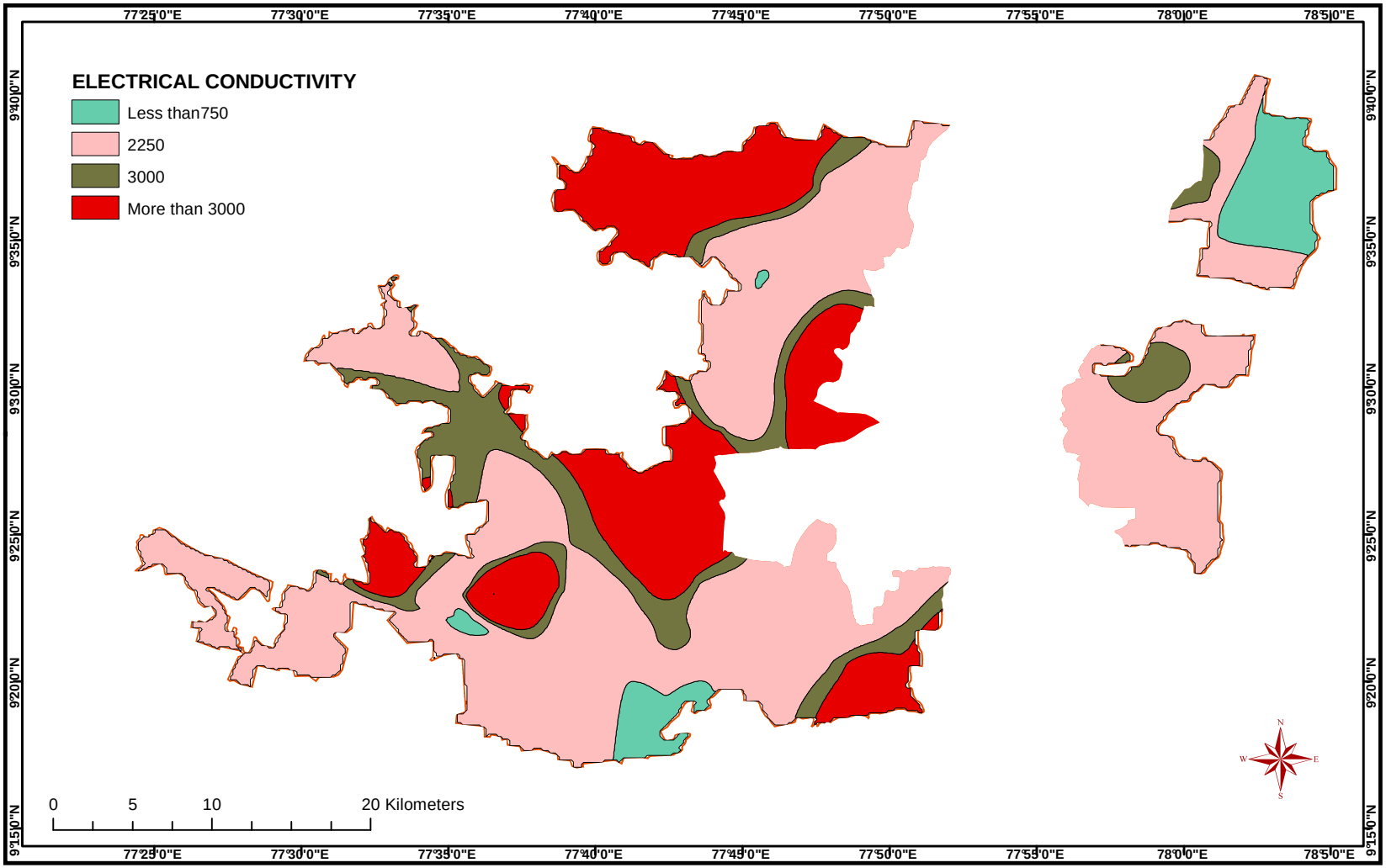
3.7 Aquifer Disposition

The aquifer disposition of the area is demarcated based on sub-surface geology which depicts the lateral and vertical configuration of the aquifers using Rockworks software. In the study area, two aquifer systems have been demarcated based on the groundwater water occurrence and movement. The first aquifer (Aquifer-I) is weathered layer of all three lithology such as gneiss, granite and charnockite formation. The second aquifer (Aquifer-II) is fractured layers of all three lithology such as gneiss, granite and charnockite formation. The bottom of the aquifer-II is demarcated using the lower most fractured depth encountered in the bore well. The aquifer demarcation of the area is depicted in 2D and 3D view.

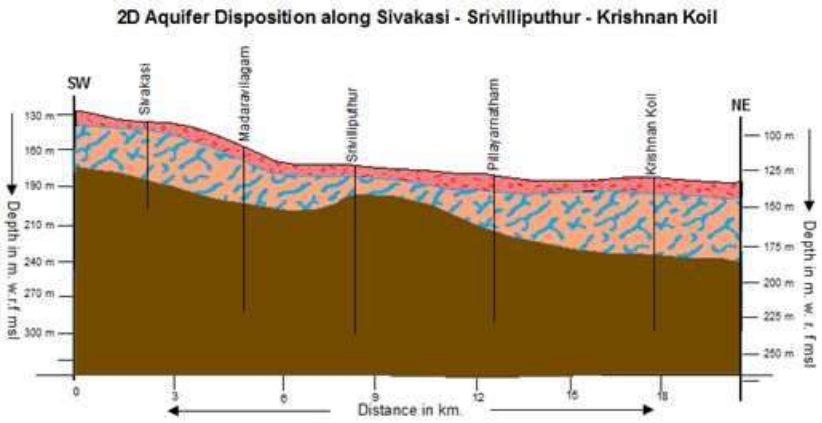
3.8.1 Hydrogeological cross section Across aquifer basin

The hydrogeological cross section across the aquifer basin is shown in Fig- 3.7 to 3.10. It indicates that the vertical and lateral extension of fractured aquifer is uniform in gneiss formation. The vertical extension is low in charnokites and granite rock formation. The high vertical extension is observed at contact between charnokites/ gneiss formation. The high thickness of fractured aquifer is observed in

ELECTRICAL CONDUCTIVITY MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



northern parts of the area (fig-3.7). The Uniform thickness is observed in the mono lithology i.e gneissic formation (fig-3.8) and (fig 3.9). The section (fig-3.10) is also showing high vertical extension at contact between gneiss/charnokites/granites.



3.9 3D Aquifer dispositions

Fence diagram of the aquifer system of the basin was prepared and shown in Fig-3.14. The thickness of the Aquifer-I is almost same in the aquifer basin. The thickness of the aquifer-II is not uniform in thickness. The thickness of the Aquifer-II is high occurring at NW and SE parts of the aquifer basin. Aquifer-II is extending latterly in uniform thickness and it fallow the general topography of the area. Low thickness is indicating the shallow fracture depth and high thickness is indicating depth of occurrences of fracture at much deeper level. This indicates that the shallow fractures can be recharged faster than deeper fracture in the area. The recharging of deeper aquifer is mainly depending upon the amount of water available for groundwater recharge.

3.10 Thickness of Aquifer-I

Thickness of the Aquifer-I was prepared based on the weathered thickness and shallow fracture depth which has connectivity with the weathered mantle. The bottom depth of the weathered/shallow layer is considered as thickness of the Aquifer-I and shown in Fig- 3.15. The thickness of Aquifer-I is depicted spatially with 5m contour intervals (0->30m). The maximum area of the basin is occupied by 15 – 20 m thickness followed by 10-15 m aquifer thickness. The thickness of 10-15 m thickness is mainly occurring in the uplands of gneissic formation. The thickness between 20-25m of Aquifer-I is found in northern parts of the study area. The thickness of more than 25 m is found southwestern parts of the study area. The thickness of Aquifer-I is directly indicating the groundwater storage in the aquifer.

3.11 Depth of occurrence of Aquifer-II

Based on the last fracture depth encountered in bore well, the depth of occurrence of aquifer-II was prepared for basin aquifer system and presented in Fig-3.16. Most of the area, the depth of occurrence of the aquifer-II is between 50-100 m and found in the eastern and western parts of the study area

followed by 100-150 m occurring in the eastern parts of the study area. The depth of occurrence of aquifer-II above 150m is a small pocket and found in the central parts of the study area. More than 50 % of the well is showing fracture less than 100 m. It is indicating that 50-100mt fracture occurrences are found to be suitable for groundwater recharge and developments as it is having very good interconnection with aquifer-I (weathered mantle) and the depth of occurrence of aquifer -II (100-150mts) is generally potential for groundwater developments. The map is also indicating that the fracture occurring below 150-200mts at the contact between the gneiss/ charnokite/granites.

3.12 Aquifer Characteristics

Based on the aquifer configuration and characteristics, two aquifer systems such as Aquifer –I & II have been demarcated for the basin aquifers. The hydraulic characteristic is main parameter to demarcate the aquifer system in the area.

3.12.1 Aquifer-I

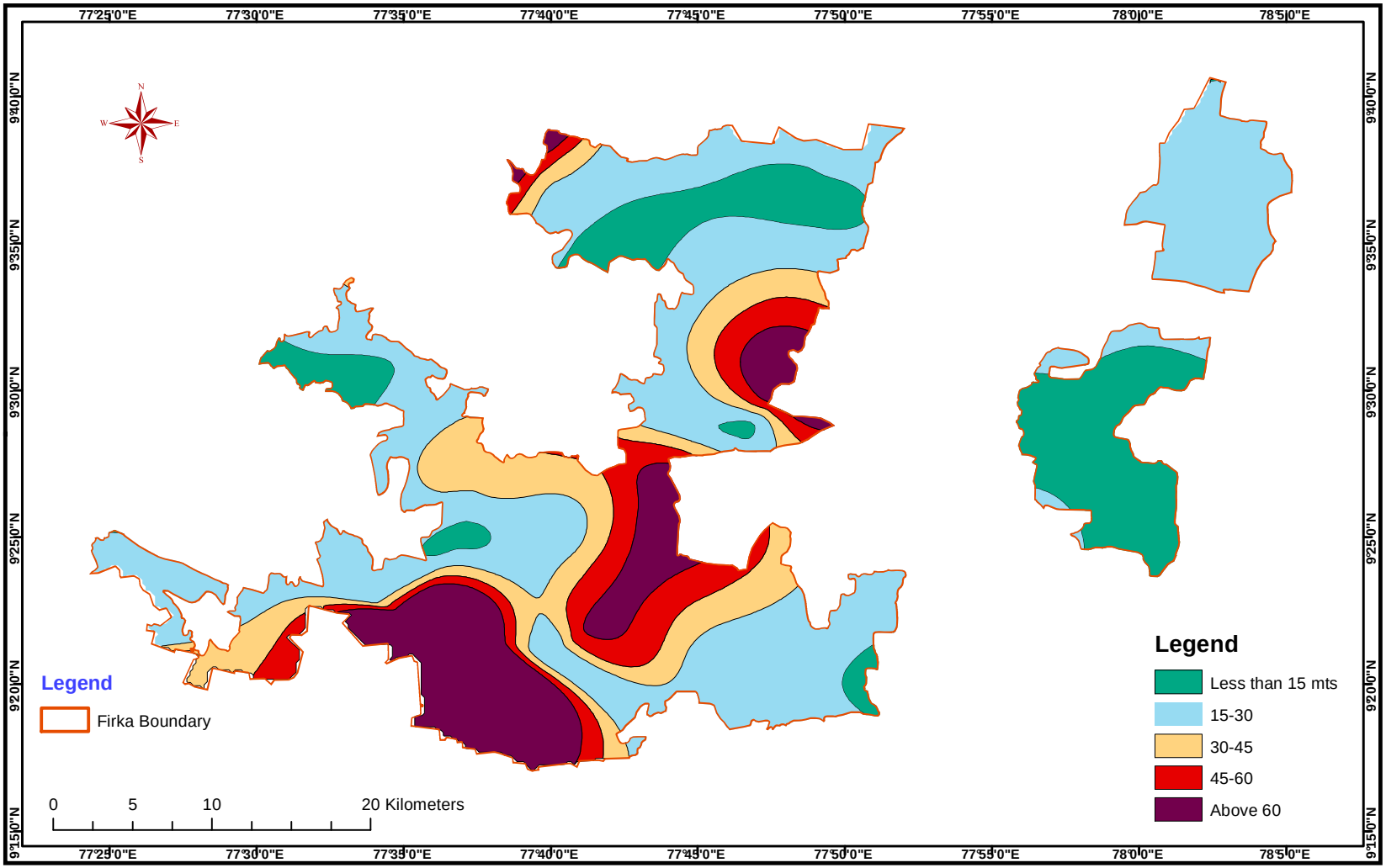
The weathered layer of the all three lithology such as gneiss and charnockites is considered for the Aquifer-I. In general, the thickness of the aquifer is ranging from 8 to 21 mts with an average thickness of 15mts. The discharge of the aquifer- I is ranging from 1 to 72 m^3/hrs which sustain for 2 -4 hrs during monsoon period whereas in summer period < 1 to 2 hrs of pumping for groundwater utilisation. Based on the long duration pumping test, the transmissivity of the aquifer is determined and it is ranging from 1.2 to 72 m^2/day. EC is ranging from 540 to 2200 µs/cm. The groundwater is found suitable except at industrial areas.

3.12.2 Aquifer-I I

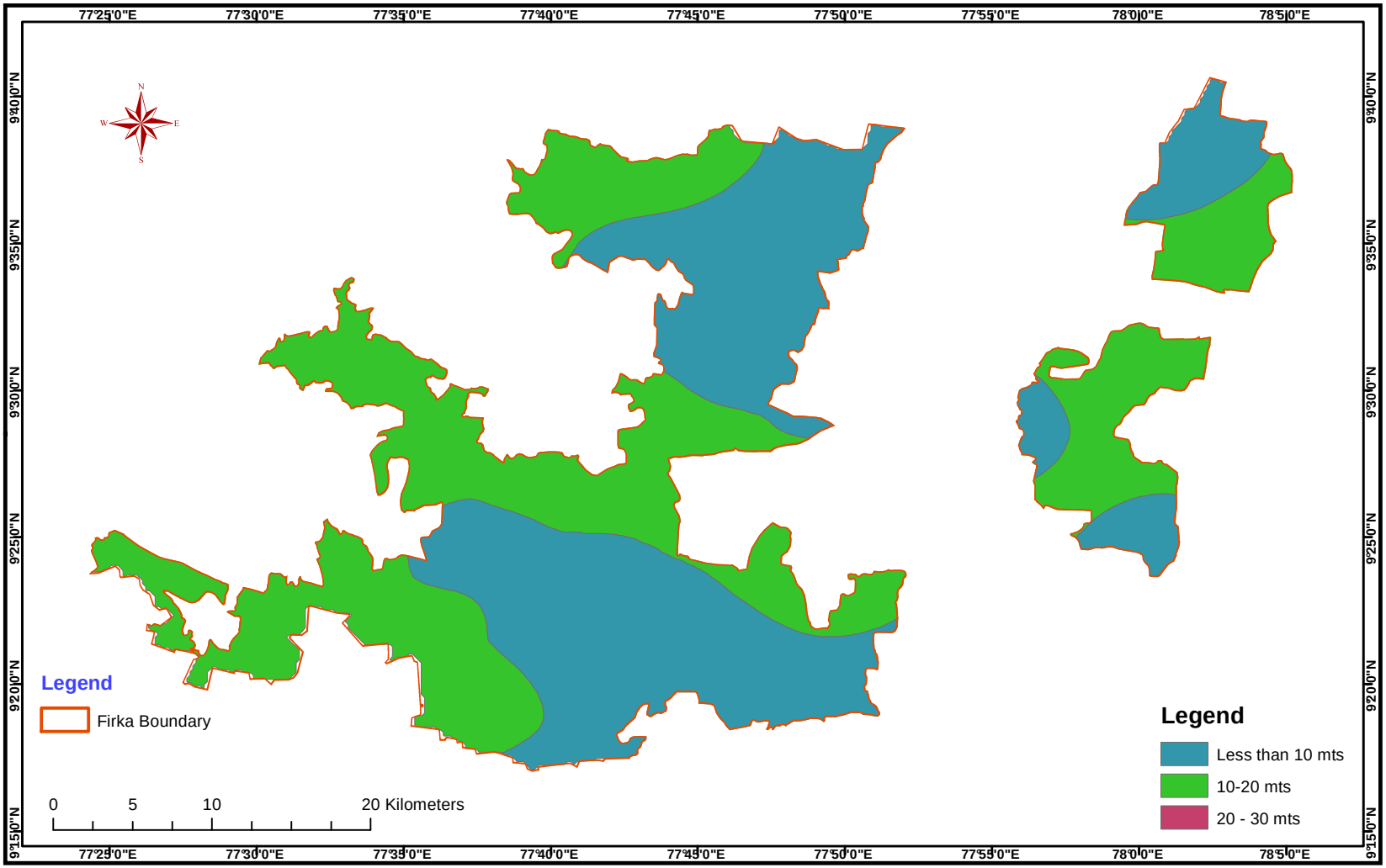
The occurrence of fracture in all three lithology such as gneiss and charnockites is considered for the Aquifer-II. In general, the thickness of the aquifer is ranging from 10 to 105 mts depending upon the occurrence of fracture upto 200mts depth. The groundwater discharge of the fracture encountered in 2 to 5 times is ranging from 1 to 105 m^3/hrs. Based on the long duration pumping test, the transmissivity of the aquifer is determined and it is ranging from 100 to 120m^2/day. The groundwater in this aquifer is contaminated with geogenic origin such as fluoride and nitrate.

Type of Aquifer	Formation	Top of the aquifers (mbgl)	Thickness/ occurrence of fractures (m)	Range of Yield (m^3/h)	Sustainability (hrs)	Aquifer parameter (Transmissivity – m2/day)	GW quality EC values (µs/cm)	Suitable for Drinking
Aquifer – I	Weathered gneiss & Charnockites	Less than 2.5 m	8 – 21	1 – 72	Mon : 2 - 4 hrs < 1 to 2 hrs	1.2 - 72.34	540-2200	Yes
Aquifer - II	Jointed & Fractured Gneiss/ charnockite	8 - 30	21 -101 (2 to 3 fractures)	1 -105	Mon 4-6 hrs 1 to 3 hrs non monsoon	100-120	400-5570 (avg 700 – 1000)	yes

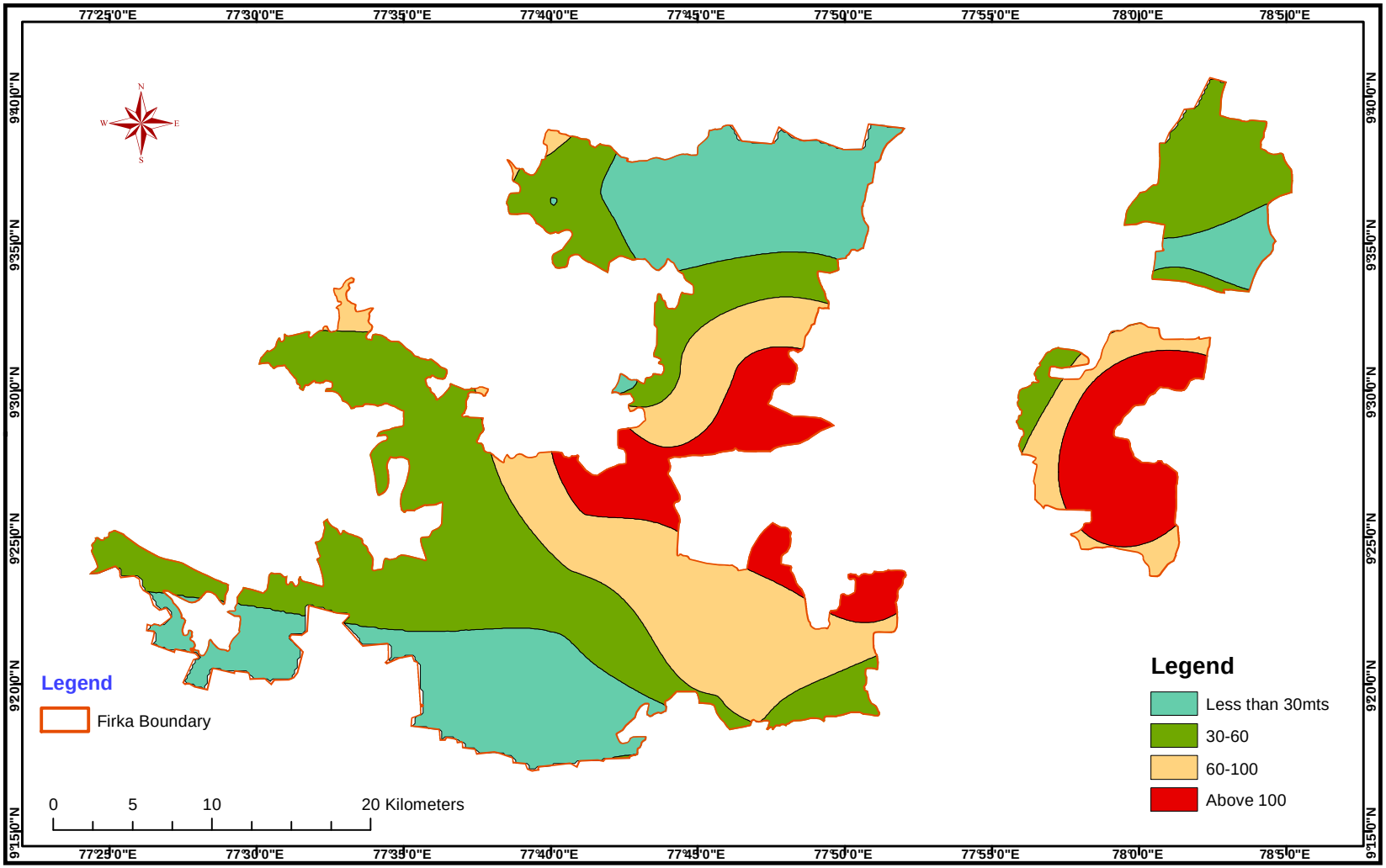
FIRST FRACTURE DEPTH MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



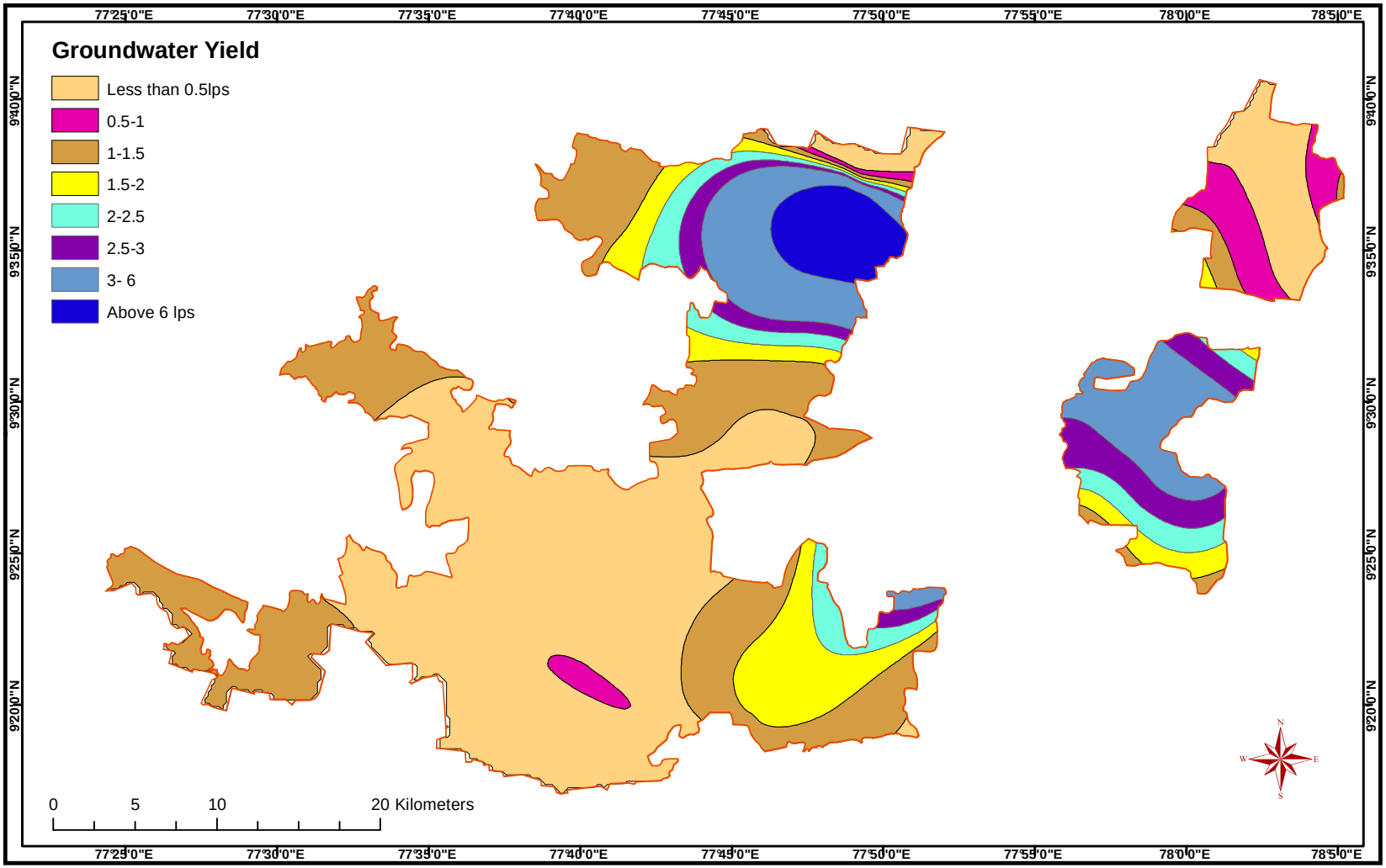
WEATHERED THICKNESS MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



SECOND FRACTURE DEPTH MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



GROUNDWATER YIELD MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



4.0 GROUNDWATER RESOURCES

The groundwater resource of Aquifer-I was estimated as on March - 13 with assessment unit of Firka, smallest administrative unit of revenue division of Tamil Nadu. The estimated Firka groundwater resources have been apportioned for the district falls in the basin aquifer system. The groundwater resource of aquifer system was estimated based on GEC-1997 methodology. The recharge of groundwater was estimated for command and non-command area separately and added together for discussion purposes.

4.1 Groundwater Resources

Based on the groundwater resources estimation, the net groundwater availability of the area is 11582.70 HAM (Table 4.1). The groundwater draft for irrigation is 12959.55 HAM which is more than 100% of the total availability and the groundwater draft due to domestic and industry is 519.58HAM. The existing groundwater draft from all purposes is 13479.13HAM. The stage of groundwater development of the area is 116.37% and falls in over exploited category. Based on the stage of groundwater development, Firka has been categorised into safe (>70%), semi-critical (70-90%), **Critical (90-100%)** and **over-exploited (100<)** in the area. The western part of the area is mainly showing as over exploited category where the groundwater utilisation for irrigation purposes is high and critical category is falling eastern parts of the area (Fig 4.1).

Table 4.1 The details of Groundwater Resources

District	Area in sq.km	Net Annual Ground Water Availability (HAM)	Existing Gross Ground Water Draft for Irrigation (HAM)	Existing Gross Ground Water Draft for domestic and industrial water supply (HAM)	Existing Gross Ground Water Draft for All uses (HAM)	Stage of Ground Water Development %
CJOLAPURAM	75.39	1680.09	2183.40	20.72	2204.12	131
ETHIRKOTTAI	166.66	1342.87	1404.90	17.43	1422.33	106
KEELARAJAKULARAMAN	105.58	1418.77	2116.80	244.34	2361.14	166
MALLANKINAR	89.23	633.18	584.55	36.71	621.26	98
MANGALAM	143	2097.59	1969.20	37.49	2006.69	96
NATHAMPATTI	79.0	897.35	1301.40	15.64	1317.04	147
PILLAIYARKULAM	90.86	1557.83	1604.70	19.21	1623.91	104
SALWARPATTI	139.9	1081.11	1004.40	48.96	1053.36	97
VATCHAKARA-PATTI	124.85	873.90	790.20	79.09	869.29	99
Total		**11582.70**	**12959.55**	**519.58**	**13479.13**	**116**

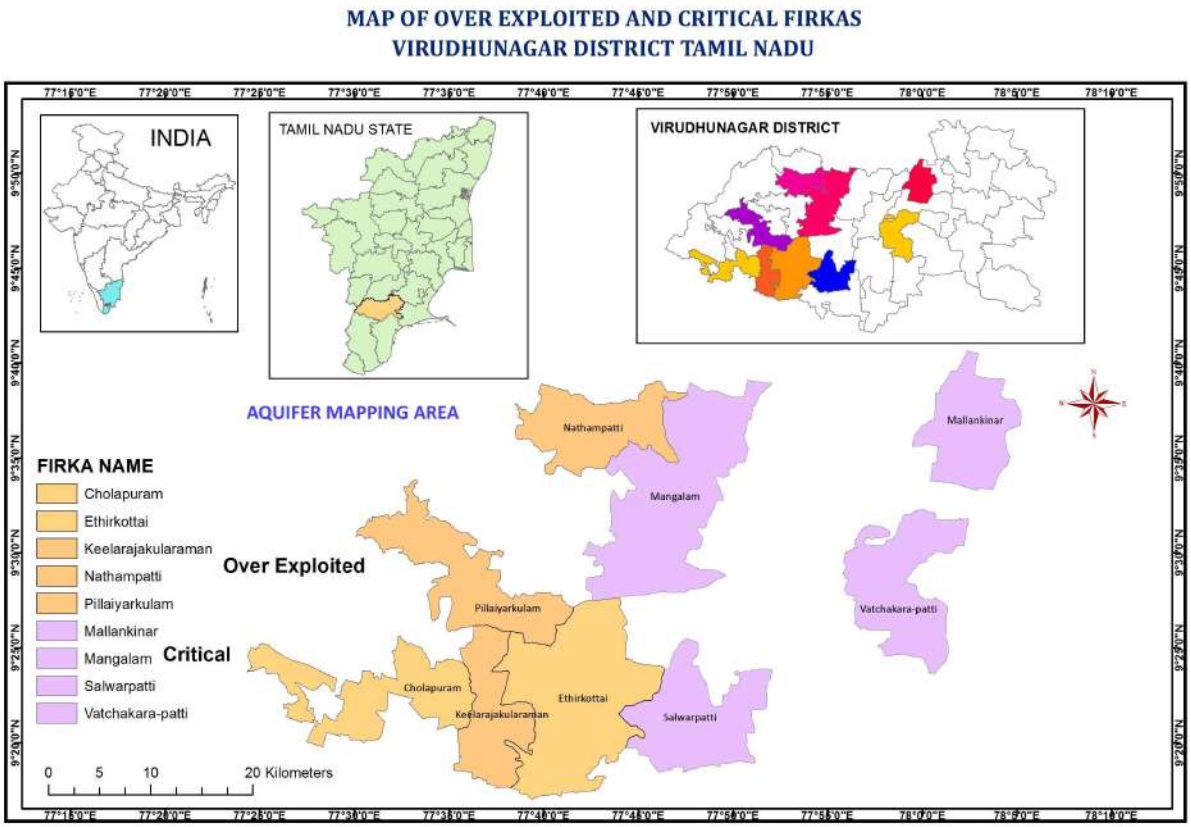
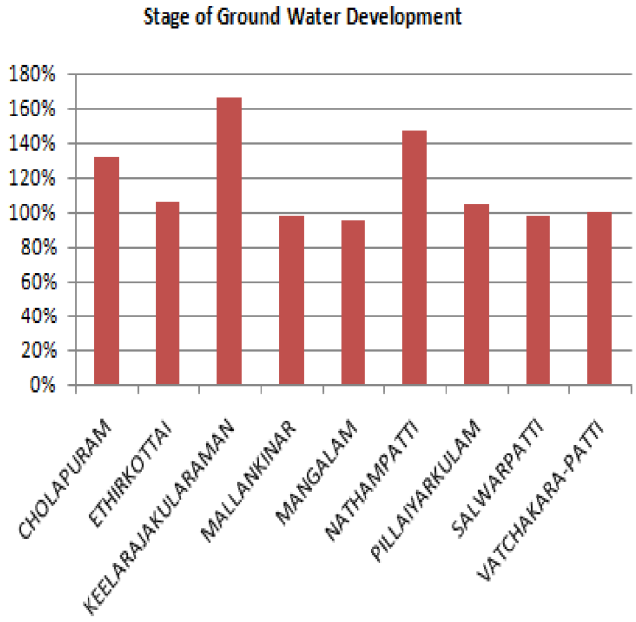


Fig-4.1 Groundwater Resources categorisation

Fig-4.2 Stage of groundwater development in nine firka



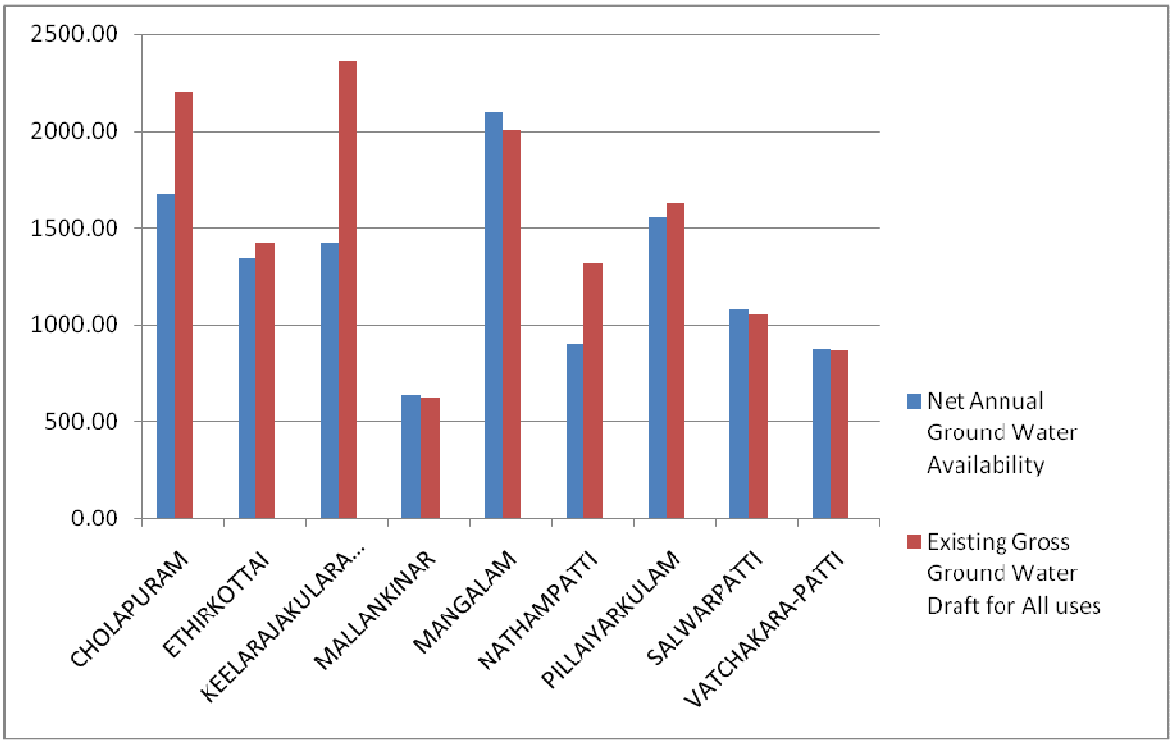


Fig-4.3 Groundwater utilisation and availability in firka

Based on the groundwater resource estimation, Of nine frikas, highest stage of groundwater development is occurring in Keelarajakularaman firka (166%) and followed by Nathampatti firka (147%). In Keelarajakularaman firka, The net groundwater availability is 1418HAM and the total draft is 2361HAM. It indicates that 943 HAM draft more than the net groundwater availability. Similarly in Cholapuram and Nathampatti firkas are utilising the groundwater more than the availably of groundwater.

5. GROUNDWATER RELATED ISSUE

The aquifer systems of the River Basin are highly stressed due to improper groundwater abstraction in the basin. The groundwater in the aquifer systems are also contaminated anthropogenically and geogenically.

5.1 Groundwater utilisation for irrigation purposes

The groundwater is main source for irrigation in the area and it is covering 5419.14 sq.km of which 2520 sq km area is being irrigated by groundwater. In the area, cash crops such as paddy, banana and sugar cane are grown in 1574.72 sq.km fed mainly from groundwater sources and the remaining area are used for the non-paddy crops. The effective utilisation of groundwater is mainly in 17% of the crop area. Due to intensive agriculture practices followed in the area, the groundwater level is declined considerably varying from 0.01 to 1.15m/year (Hydrographs). More than 50% of the well monitored for groundwater level is showing 0.50m/year. This is observed mainly in dug well showing the groundwater level lies between 10-20mts and these dug wells are located generally in the upland of the gneiss and granite formation existing in the area. During non-monsoon period, dug wells which falls in this zone are almost dry and also increases the stress on the fractured aquifer systems. The groundwater from fractured aquifer is used extensively for agriculture purposes and due to erratic rainfall, the groundwater in the aquifer is not recharged as per the demands for irrigation. Hence, the groundwater is being withdrawn from in-storage of the aquifer systems leaving aquifers either in dry state or over-exploited. This is felt in 52 nos of Firkas out of 95 nos Firka as per the groundwater resources estimation.

5.3 Geogenic contamination

5.3.1 Total Dissolved Solids (TDS) of Aquifer-I

The groundwater samples were collected from Aquifer-I and analysed for chemical properties of water, includes anion and cat ions concentration in groundwater. In addition to that Fluoride and Nitrate concentration were also analysed. In the report, TDS and Fluoride concentration of groundwater are discussed spatially. TDS of 0 to 500, 500-1000, 1000-1500, 1500-2000, and above 2000 mg/l concentration are depicted in map (Fig-5.1).

TDS of 0-500 mg/l is occurring in western parts of the study area and in eastern parts of the area, 0-200mg/l is occurring in small pockets. TDS of 500-1000mg/l is covering large parts of the area and both the classes are generally found in charnockites and gniessic Formation. TDS of > 1000mg/l is occurring predominantly in the eastern parts of the area trending N-S direction. This may be due to granitic formation is occurring in the eastern parts of the study area. The higher concentration of TDS is falling in Salem and Namakkal districts. TDS of >2000mg/l is generally found in eastern parts of the study area in small pockets.

5.3.2 Fluoride (F) concentration and distribution in Aquifer-I

Fluoride concentration of groundwater is depicted in map (Fig- 5.2) spatially indicating in three zones i.e 0.0 – 1.0, 1.0 -1.5 and > 1.5 mg/l. 0.00-1.00 Fluoride zones is occupying in very large area and falling desirable limits. The zone 1.00 – 1.5 mg/l, permissible limits is falling eastern, central and western parts of the study area trending NE-SW direction. The high concentration of Fluoride (> 1.5mg/l), above

permissible limits is predominantly found in eastern parts of the study area where granitic rock formation occurring.

Table 5.1 Groundwater Class based on Fluoride concentration

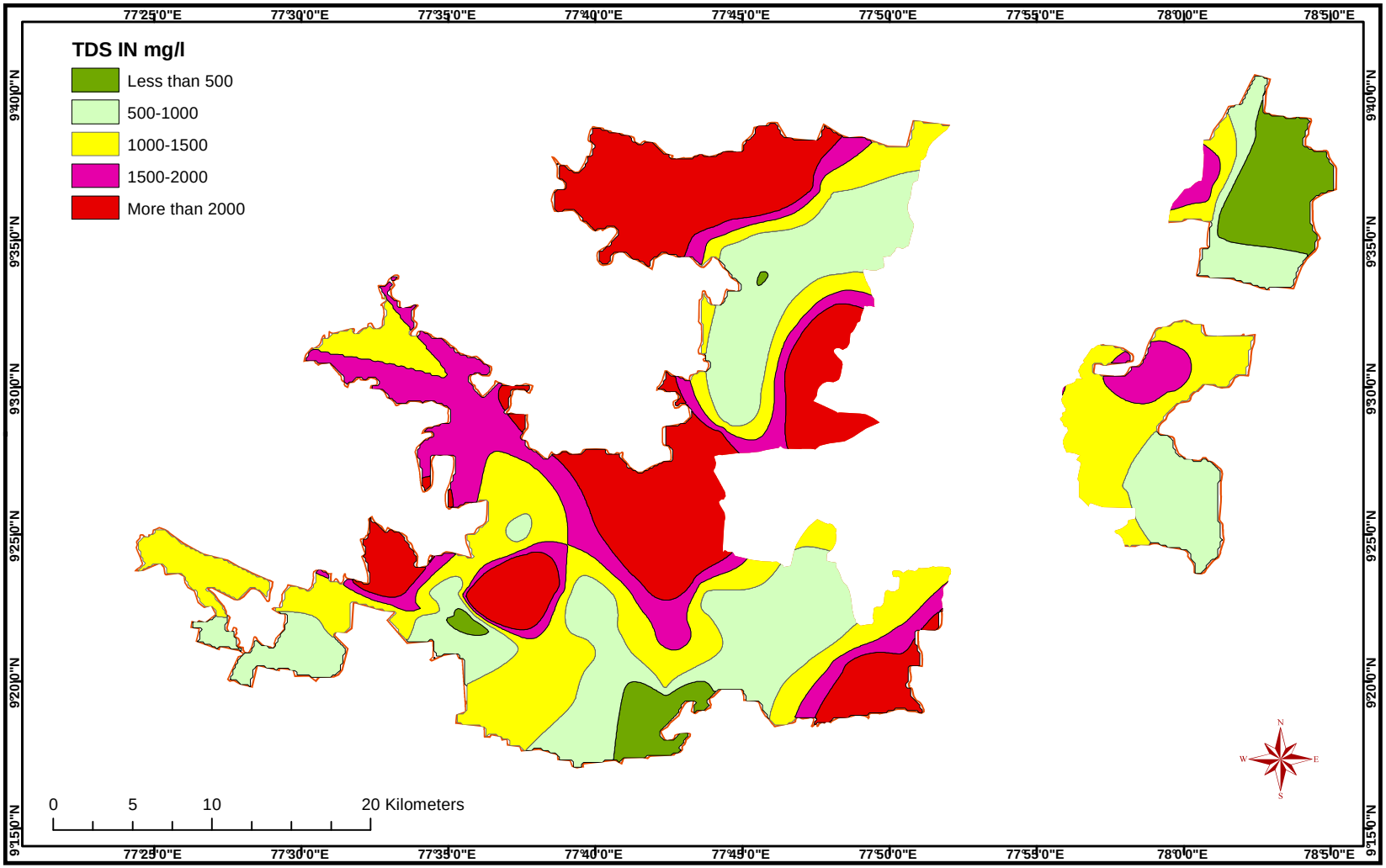
Fluoride mg/L	Water Class	Percentage of Samples
0 - 1.0	Desirable limit	68%
1.0 – 1.5	Permissible limit	8%
>1.5	Above permissible limit	24%

Based on BIS standard on groundwater quality for Fluoride concentration, groundwater is classified into three class for drinking water purposes. Fluoride concentration between 0.0 – 1.0 mg/l in groundwater is comes under desirable limits which is highly suitable drinking water purposes. Fluoride concentration between 1.0 – 1.5 and >1.5 mg/l in groundwater are falling under permissible and above permissible limits which is not suitable drinking water purposes. In the study area, 68% of the ground water samples are falling under desirable limit (Table no: 5.1) and 8% of water samples are falling in permissible limits. 24% of water samples are having Fluoride concentration >1.5 mg/l which is harmful and hazardous for human beings.

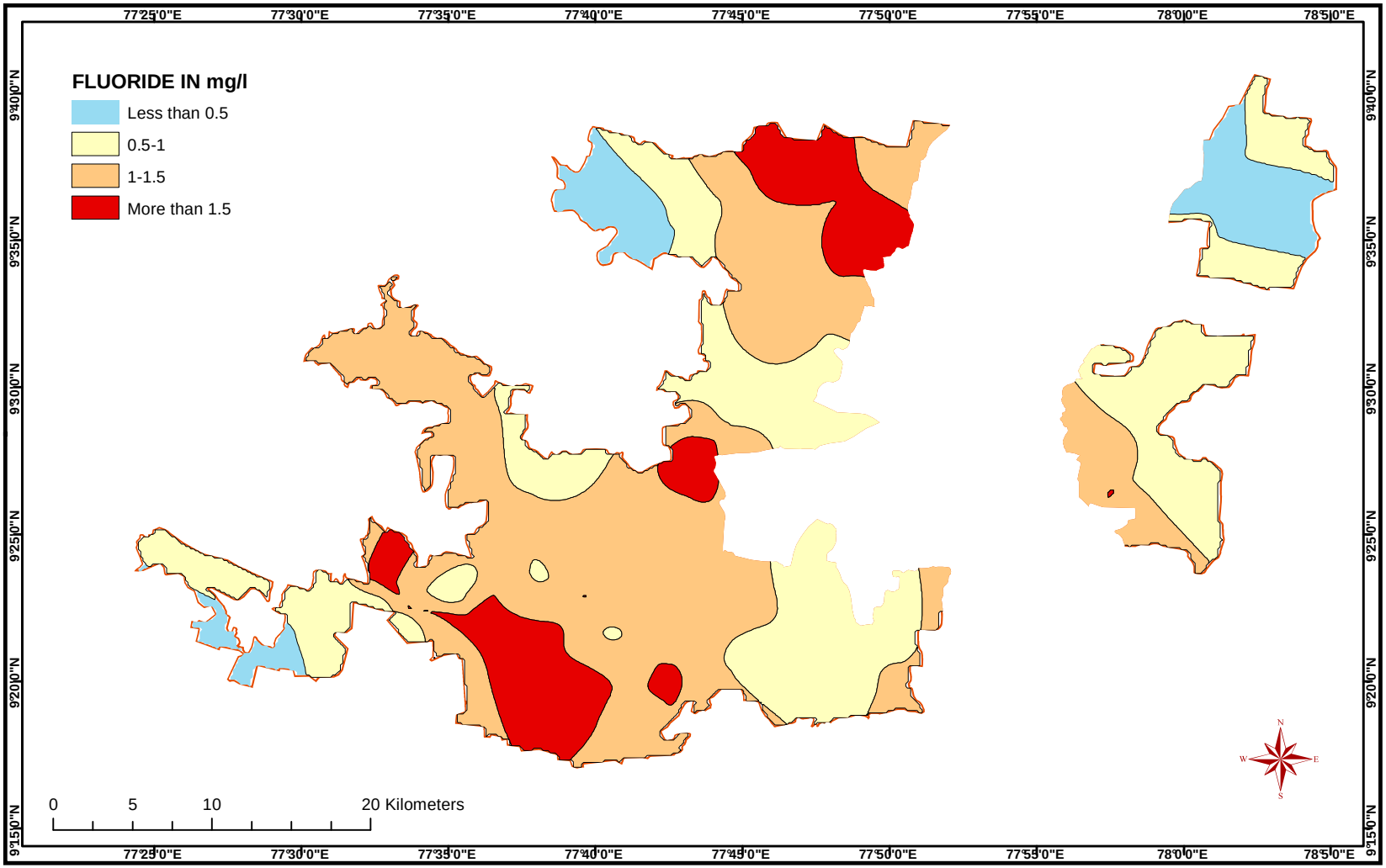
Fig-5.1 Spatial distribution of TDS in Groundwater (Aquifer-I)

Fig-5.2 Spatial distribution of Fluoride in Groundwater (Aquifer-I)

TOTAL DISSOLVED SOLIDS MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



FLUORIDE CONCENTRATION MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



6.0 AQUIFER MANAGEMENT PLAN

6.1 Management Strategies

The stage of groundwater development in the Aquifer Basin is categorised as over exploited /critical in 52 firkas. The Net availability of the resource is 116 MCM. The total ground water demand for the firkas is 135MCM. The supply of groundwater from the aquifer system is 116MCM. The gap between demand and supply is 19MCM in the basin (Table-6.1). The gap between demand and supply resources may be met from surface water sources for all purposes in the firkas. Based on the supply of groundwater resources, the stage of groundwater development of the firkas is 116%. To bring safe groundwater development, 46% of groundwater development (i.e. 63MCM) should be added to the groundwater system of the basin. Therefore, supply side intervention is proposed in the firkas through groundwater augmentation plan as sufficient uncommitted surplus runoff of 127MCM available in the basin. The most acceptable method for augmentation plan is artificial recharge to groundwater.

Table 6.1 Demand and supply groundwater resources of the basin

Sl.no	Management plan	In MCM
I	Demand	
1	Water Intensive Crops	129
2	Domestic and Industry	6
4	Total Demand	135
II	Supply	
1	Agriculture	104
2	Domestic and Industry	12
3	Total Supply	116
III	Demand - Supply Gab	63
IV	GW Utilisataion Source	
1	Replnishbale	116
2	In storage	20

6.2 Supply side intervention

Based on the water level monitoring in different seasons across the firka, as well as after having better understanding of the disposition and extent of the aquifer system through exploratory drilling, pumping tests etc. the volume of unsaturated zone available for recharge (upto 3m bgl) is 30.42 MCM. The annual uncommitted runoff is only 127 MCM out of which is about 30.42MCM of waterrequired to fill the available void space of aquifer-I. Artificial recharge and Water conservation plan is prepared firka wise to harness less than 23% of the annual uncommitted runoff of 127 MCM with a total out lay of Rs.10Crores. The suggested artificial recharge structures are mainly Check Dams, Vented dam and Recharge Shafts in addition to removal of silt in the surface tanks.

6.2.1 Spatial data integration

An attempt has been made to demarcate area suitable for artificial recharge structures using remote sensing and GIS techniques. Geology, geomorphology, landuse/landcover, drainage and surface waterbody maps were prepared using remote sensing data and generated in GIS environ. In addition to that water level and weathered zone thickness maps were prepared using data GWMW and groundwater exploratory well. These layers were assigned weightage for the theme and map classes. Geomorphology and geology layers are given higher weightage as it is playing vital role in groundwater recharge. All the layers were integrated spatially using overlay index model run in GIS. The integrated map is demarcated with four zones such as 1. Poor, 2. Moderate, 3. High and 4. Very High and it is shown Fig-6.1 for Bhavani Sagar Firka. Similarly, it was done for the entire basin.

The primary and secondary data such as geology, geomorphology, weathered thickness, first fracture depth, second fracture depth, groundwater potential, post- monsoon decadal mean water level are considered for demarcating area suitable for artificial recharge structures using index overlay model in GIS environ. The details of score and weightage assigned to thematic maps are presented in the table below.

S. No.	Layers	Classes	Area (Sq. Km.)	Score	Weightage
I	**Geology**				
1		Sand And Silt	335.75	10	20
2		Shaly Sand Stone	392.33	9	
3		Gneiss	3147.36	8	
4		Charnockite	430.93	5	
5		Quartzite	7.03	2	
6		Limestone/Marble/Calc.Granulite	1.53	1	
II	**Landforms**				
1		Alluvial Plain	145.73	10	20
2		Moderately Dissected	11.54	3	
3		Tertiary	327.06	10	
4		Deflection Slope	170.49	2	
5		Flood Plain	201.78	10	
6		Less Dissected/Un-dissected	1058.34	2	

S. No.	Layers	Classes	Area (Sq. Km.)	Score	Weightage
7		Weathered Pediment Shallow	1322.76	7	
8		Weathered Pediment Moderate	677.36	8	
9		Valley Fill	12.84	9	
10		Highly Dissected	57.70	5	
11		Inselberg	1.09	1	
12		Structural Hills	17.15	3	
13		Pediment-Inselberg Complex	0.38	1	
14		Bajada	34.89	6	
15		Weathered Pediment Deep	172.41	9	
16		Denudational Hills / Residual Hills	7.67	3	
17		Sedimentary High Ground	95.77	8	
III	**Groundwater Potential (lps)**				
1		0.1 - 0.5	1318.58	3	10
2		0.5 - 1.0	129.88	4	
3		1.0 - 1.5	1658.76	5	
4		1.5 - 2.0	273.12	6	
5		2 - 2.5	182.95	7	
6		2.5-3.0	199.92	8	
7		3.0-5.0	446	9	
8		5.0 - 7.0	105.5	10	
IV	**Weathered Thickness (m)**				
1		1 - 10	1729.22	7	10
2		10 - 20	2349.79	8	
3		20-30	164.8	9	

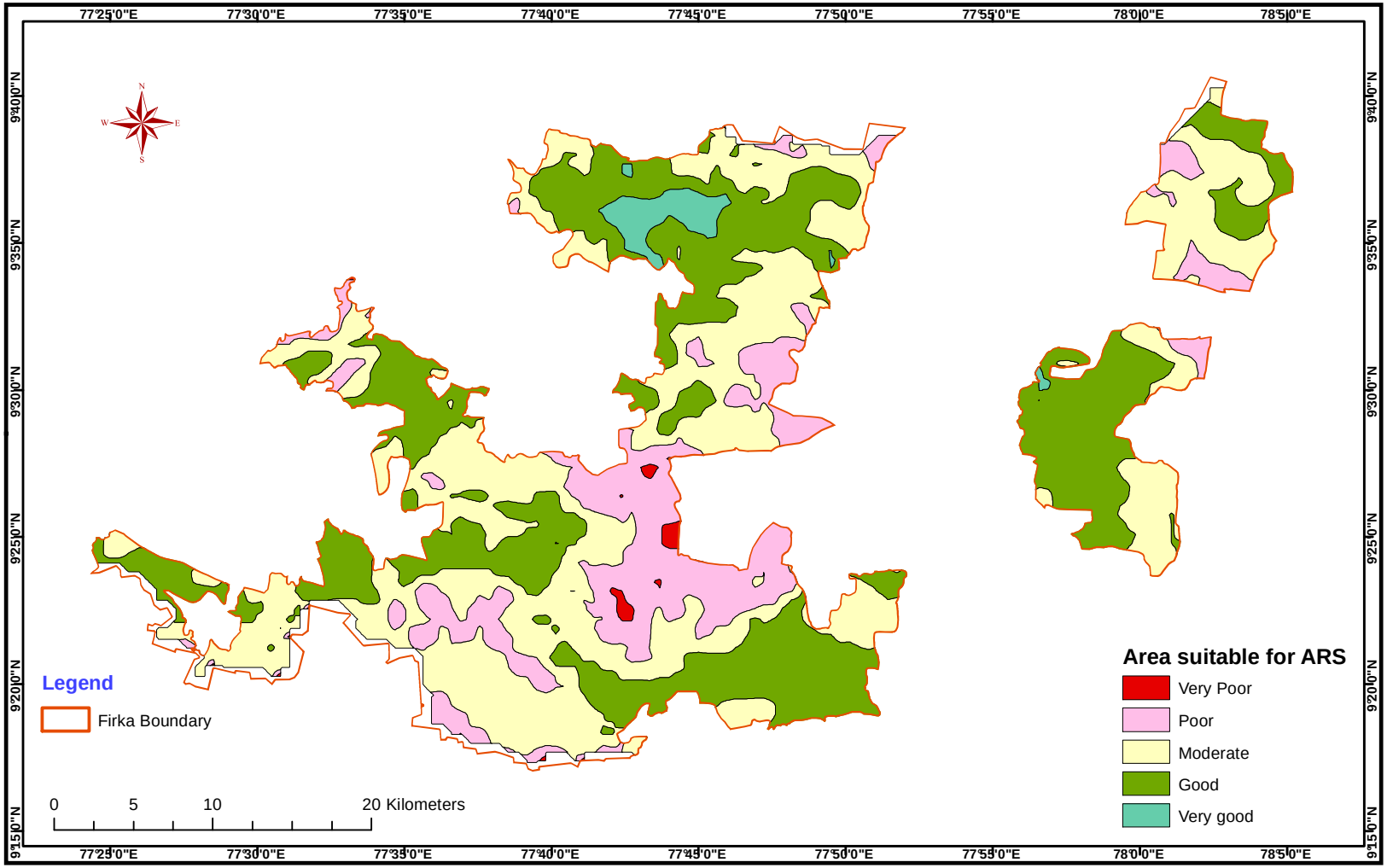
S. No.	Layers	Classes	Area (Sq. Km.)	Score	Weightage
V	**First Fracture Depth (mbgl)**				
1		9 - 15	1233.21	9	20
2		15 - 30	2210.39	8	
3		30-45	358.95	5	
4		45-60	211.15	3	
5		60-133	301.08	2	
VI	**Second Fracture Depth (mbgl)**				
1		18 - 30	566.21	9	10
2		30 - 60	1882.02	8	
3		60 - 100	1475.9	5	
4		100 - 171	390.72	4	
VII	**Depth To Water Level (mbgl)**				
1		1.42 - 4	441.28	1	10
2		4 - 6	2235.85	7	
3		6-8	1375.76	8	
4		8 - 11.1	261.46	9	

The poor zone is not suitable for any artificial recharge structures and it is acting as catchment area. Moderate suitable zone is generally falling in first order streams and shallow weathered thickness. Therefore, it is suitable for Nala bund, Boulder Check dam and small storage Check dam. High and very high suitable zones are falling in higher order streams and moderate to deep weathered thickness. Percolation pond and large storage check dam are the main artificial recharge structure which can be erected in high and very high zones. The sample map is shown for proposed ARS in Firka (Fig-6.2).

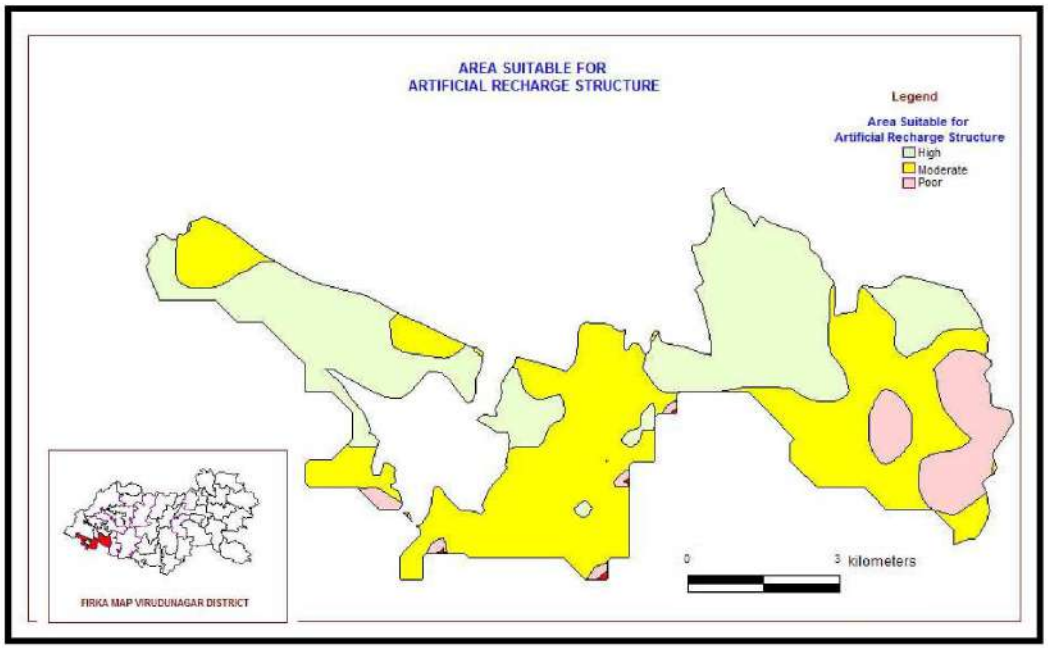
6.2.2 Firka-wise Area Suitable for Artificial Recharge and structures proposed

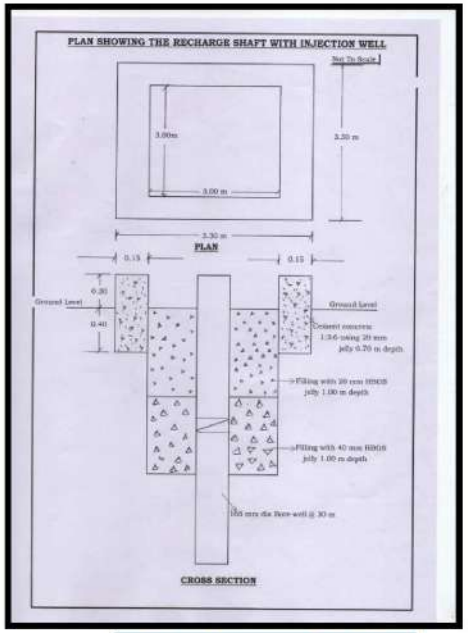
Based on the spatial data integration area suitable for artificial recharge structure was demarcated using index overlay model for the full district and classified into five class such as very poor, poor, moderate, high/good and very high/very good zones. This zone map is super imposed with drainage map and selected the structures. The firka-wise structure details are given from **Plate – I to XVIII.** The area suitable for micro irrigation system, the landuse / landcover classes of wet land, dry crops and plantation are considered with more than 1 lps discharge of bore well.

AREA SUITABLE FOR ARS MAP OF OVER EXPLOITED AND CRITICAL FIRKAS VIRUDHUNAGAR DISTRICT TAMIL NADU



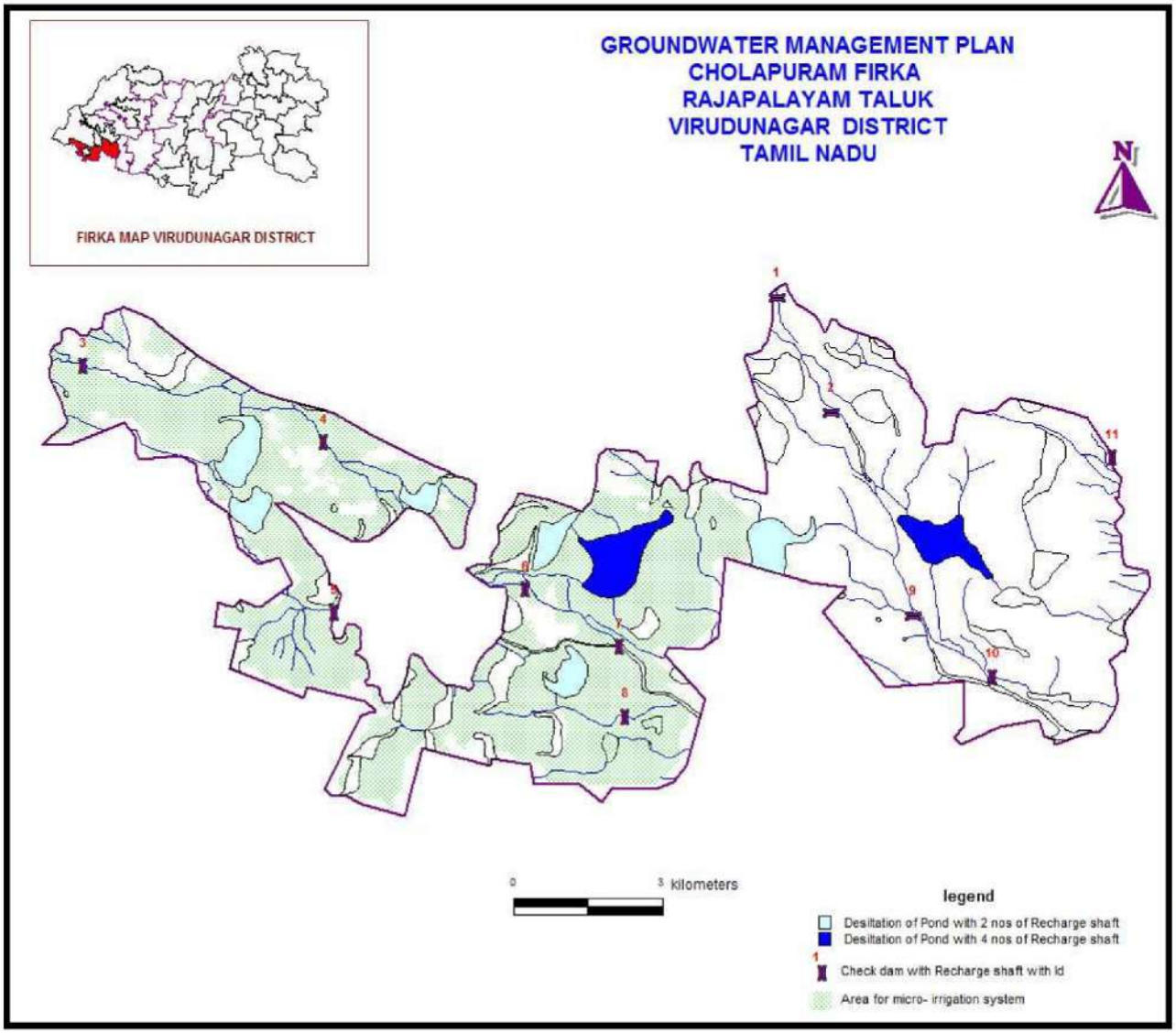
GROUNDWATER MANAGEMENT PLAN
CHOLAPURAM FIRKA
RAJAPALAYAM TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU





Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.5385	9.42534
2	77.5487	9.40461
3	77.4122	9.4103
4	77.4563	9.39716
5	77.4588	9.36636
6	77.4936	9.37133
7	77.5109	9.36315
8	77.5123	9.34841
9	77.5644	9.36811
10	77.5792	9.35688
11	77.6003	9.39702

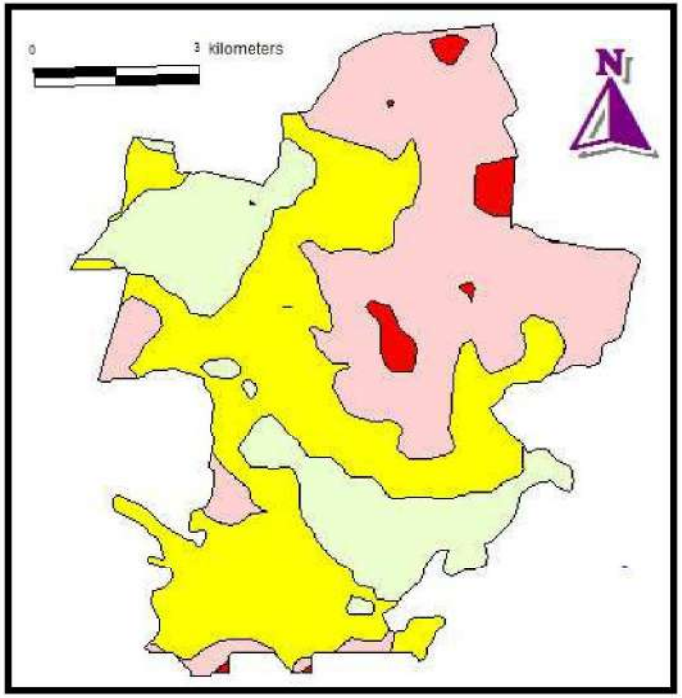
Tentative Locations for Desiltation of Ponds with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.50	9.36	0.51	2
2	77.44	9.40	0.81	2
3	77.47	9.39	0.35	2
4	77.51	9.38	1.45	4
5	77.57	9.38	1.06	4
6	77.54	9.38	0.85	4
7	77.44	9.38	0.48	2
8	77.50	9.38	0.5	2

Recharge by DS : 3.00 MCM
Recharge by CD: 0.022 MCM
Total Recharge: 3.022 MCM

GROUNDWATER MANAGEMENT PLAN
ETHIRKOTTAI FIRKA
SIVAKASI TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU

SUPPLY SIDE INTERVENTION



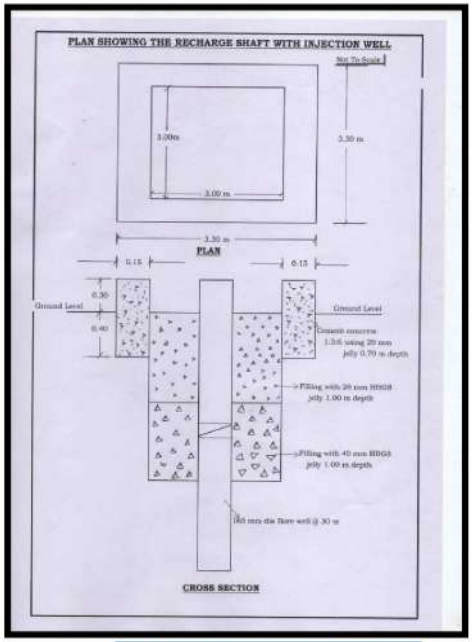
AREA SUITABLE FOR
ARTIFICIAL RECHARGE STRUCTURE

FIRKA MAP VIRUDUNAGAR DISTRICT

Legend

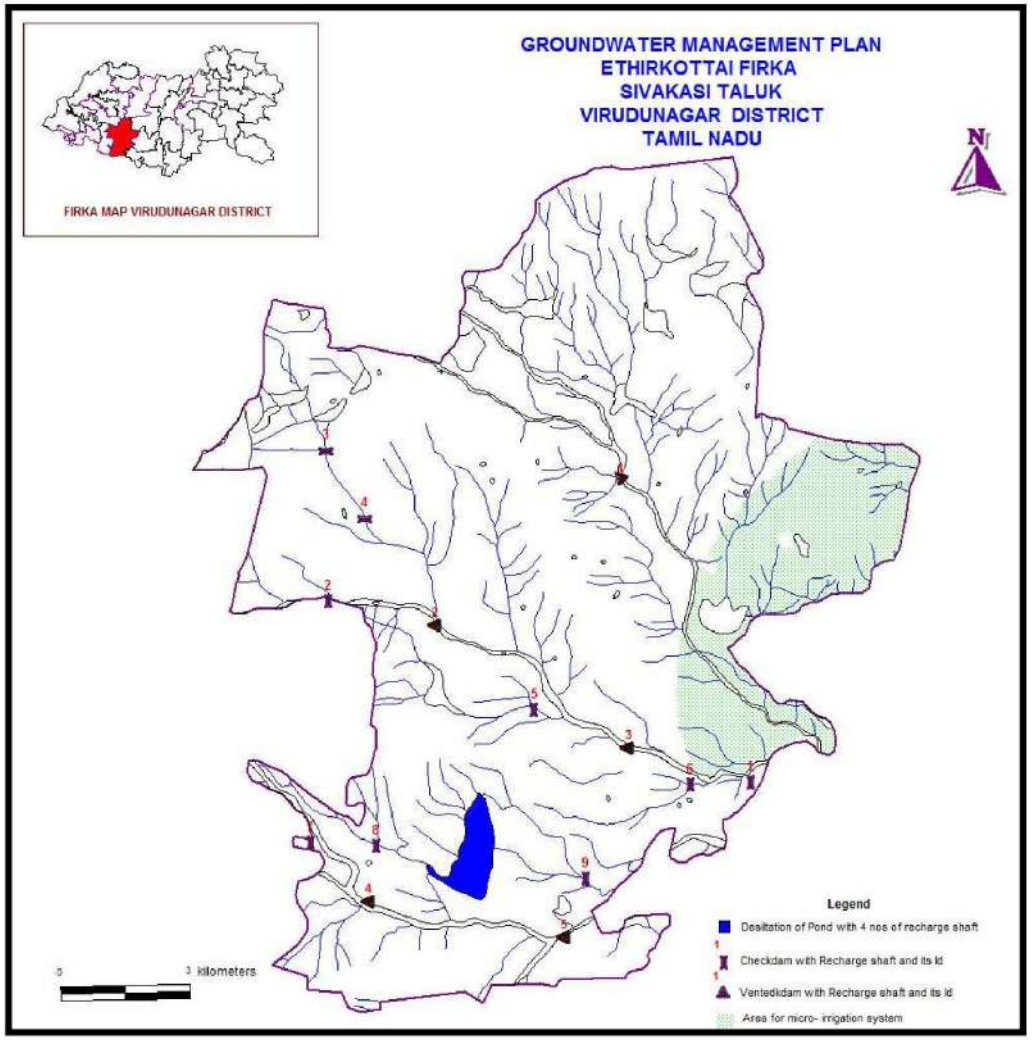
Area suitable
for Artificial Recharge

- High
- Moderate
- Poor
- Very Poor



Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.7375	9.33159
2	77.649	9.36899
3	77.6484	9.40023
4	77.6566	9.38636
5	77.6923	9.34651
6	77.725	9.33104
7	77.6453	9.31907
8	77.6591	9.31834
9	77.7031	9.31162

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

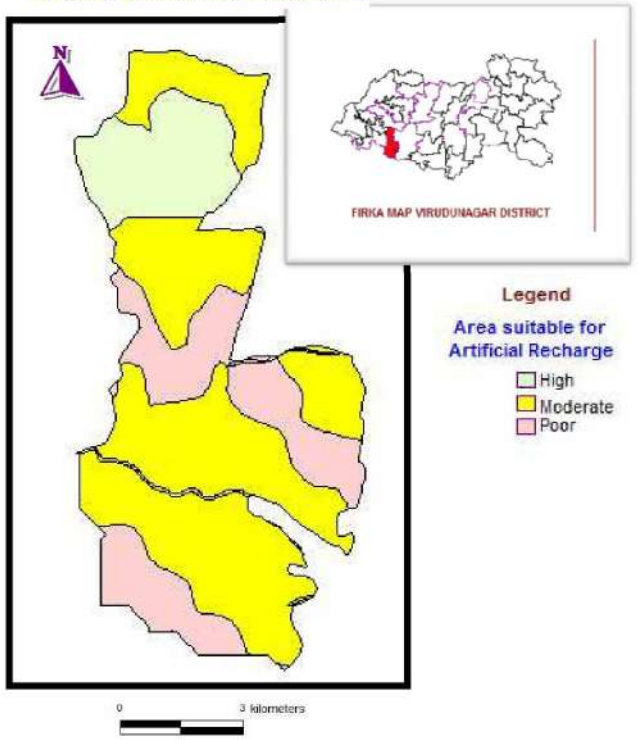
Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.68	9.32	1.65	4

Tentative Locations for Venteddam (VD) with Recharge Shaft

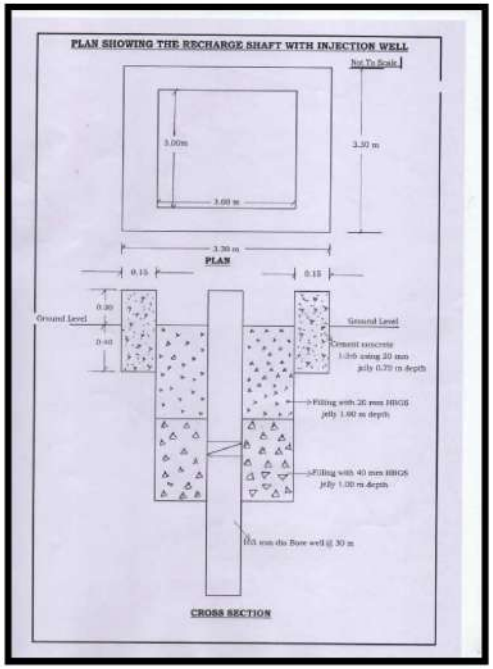
ID	Longitude (DD)	Latitude(DD)
1	77.71	9.39
2	77.67	9.36
3	77.71	9.34
4	77.66	9.31
5	77.7	9.3

Recharge by DP: 1.65 MCM
Recharge by CD: 0.0015 MCM
Recharge by VD: 0.009
Total Recharge: 1.66MCM

AREA SUITABLE FOR
ARTIFICIAL RECHARGE STRUCTURE

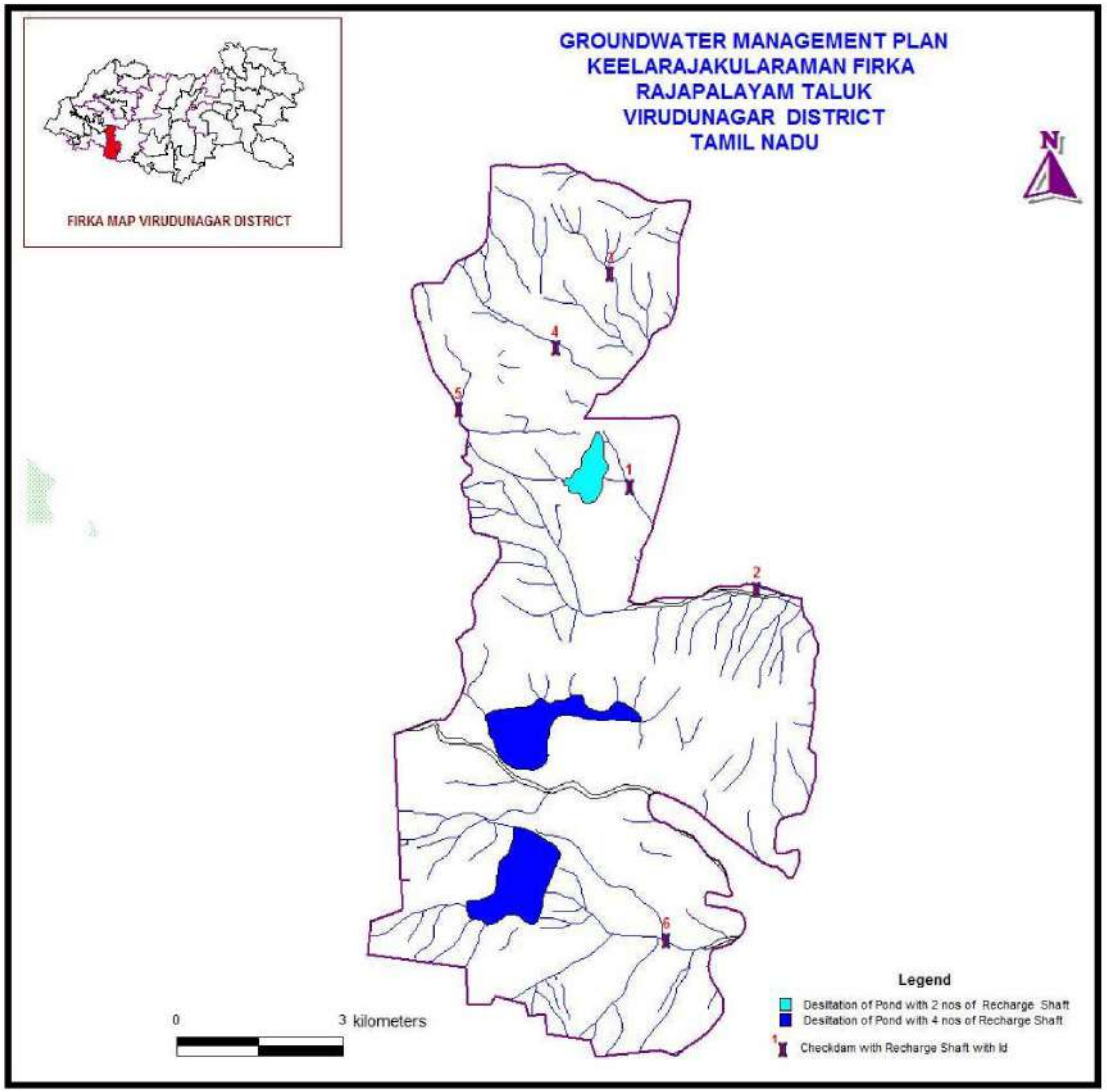


GROUNDWATER MANAGEMENT PLAN
KEELARAJAKULARAMAN FIRKA
RAJAPALAYAM TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU



Recharge Shaft

SUPPLY SIDE INTERVENTION



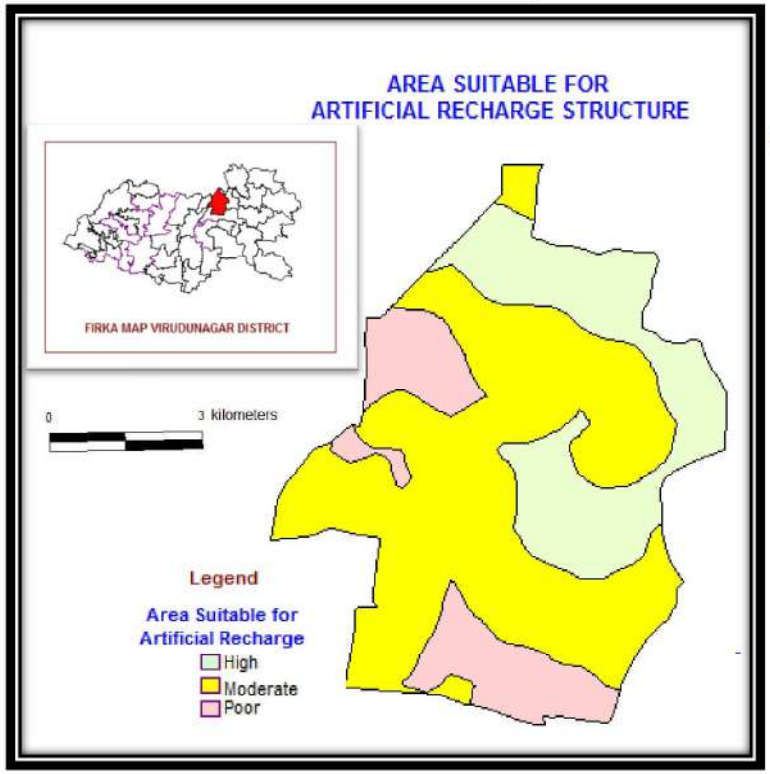
Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.6282	9.38505
2	77.649	9.36899
3	77.6245	9.4192
4	77.6159	9.40723
5	77.6003	9.39702
6	77.6354	9.31235

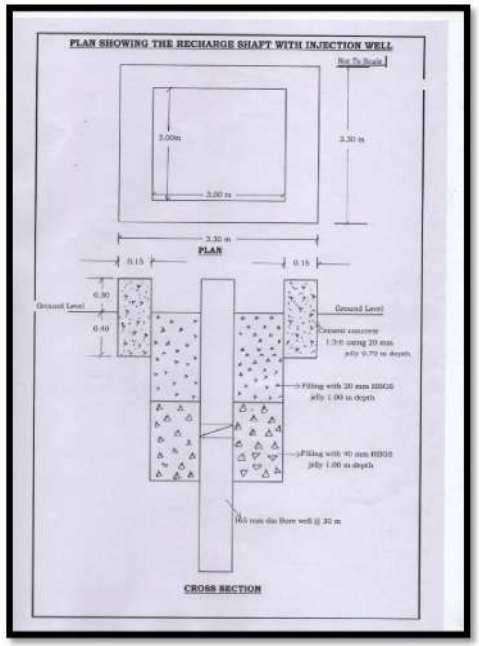
Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.62	9.35	1.5	4
2	77.61	9.32	1.56	4
3	77.62	9.39	0.51	2

Recharge by DP: 3.57 MCM
Recharge by CD: 0.0018MCM
Total Recharge: 3.58MCM

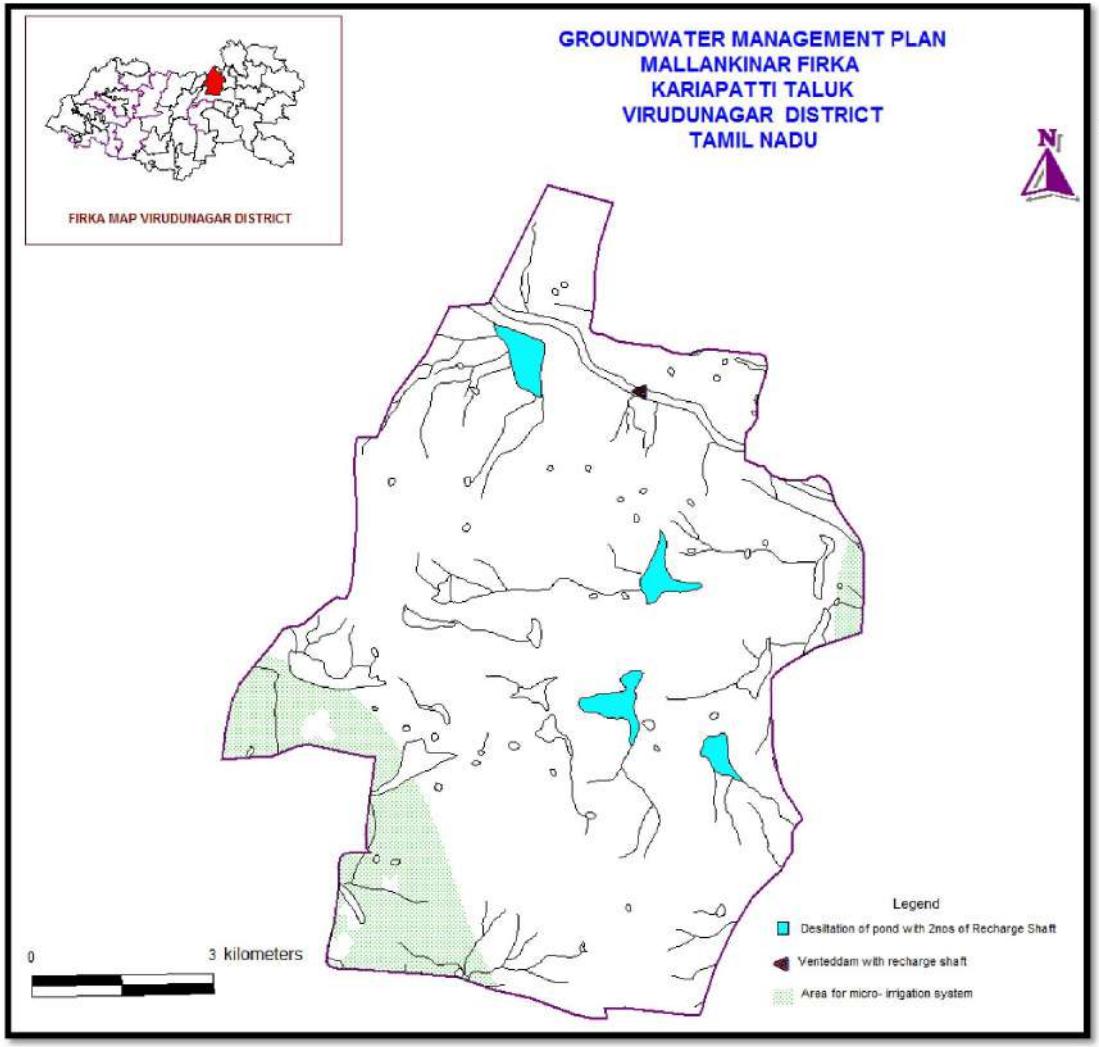


GROUNDWATER MANAGEMENT PLAN
MALLANKINAR FIRKA
KARIAPATTI TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU



Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Venteddam(VD) with Recharge Shaft

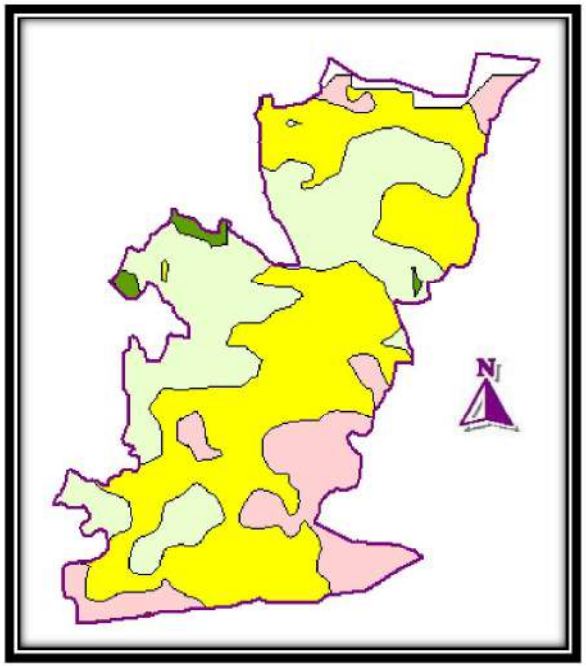
ID	Longitude (DD)	Latitude(DD)
1	77.9692	9.5867

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.62	9.35	1.5	4
2	77.61	9.32	1.56	4
3	77.62	9.39	0.51	2

Recharge by DP: 1.59MCM
Recharge by VD: 0.0018MCM
Total Recharge: 1.60MCM

AREA SUITABLE FOR
ARTIFICIAL RECHARGE STRUCTURE

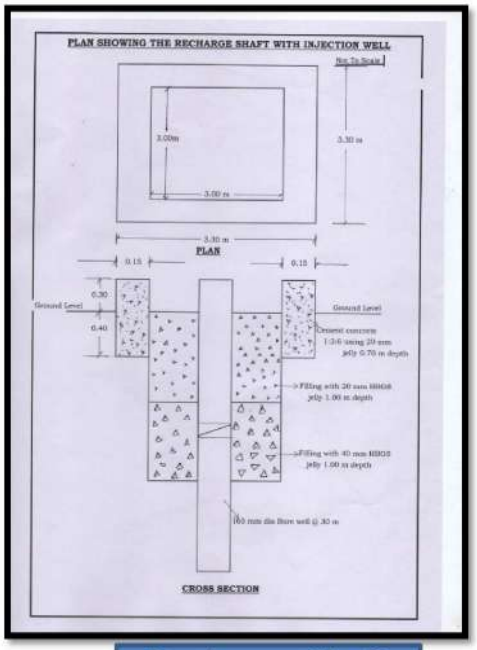


GROUNDWATER MANAGEMENT PLAN
MANGALAM FIRKA
SIVAKASI TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU

LEGEND
Area Suitable for Artificial Recharge

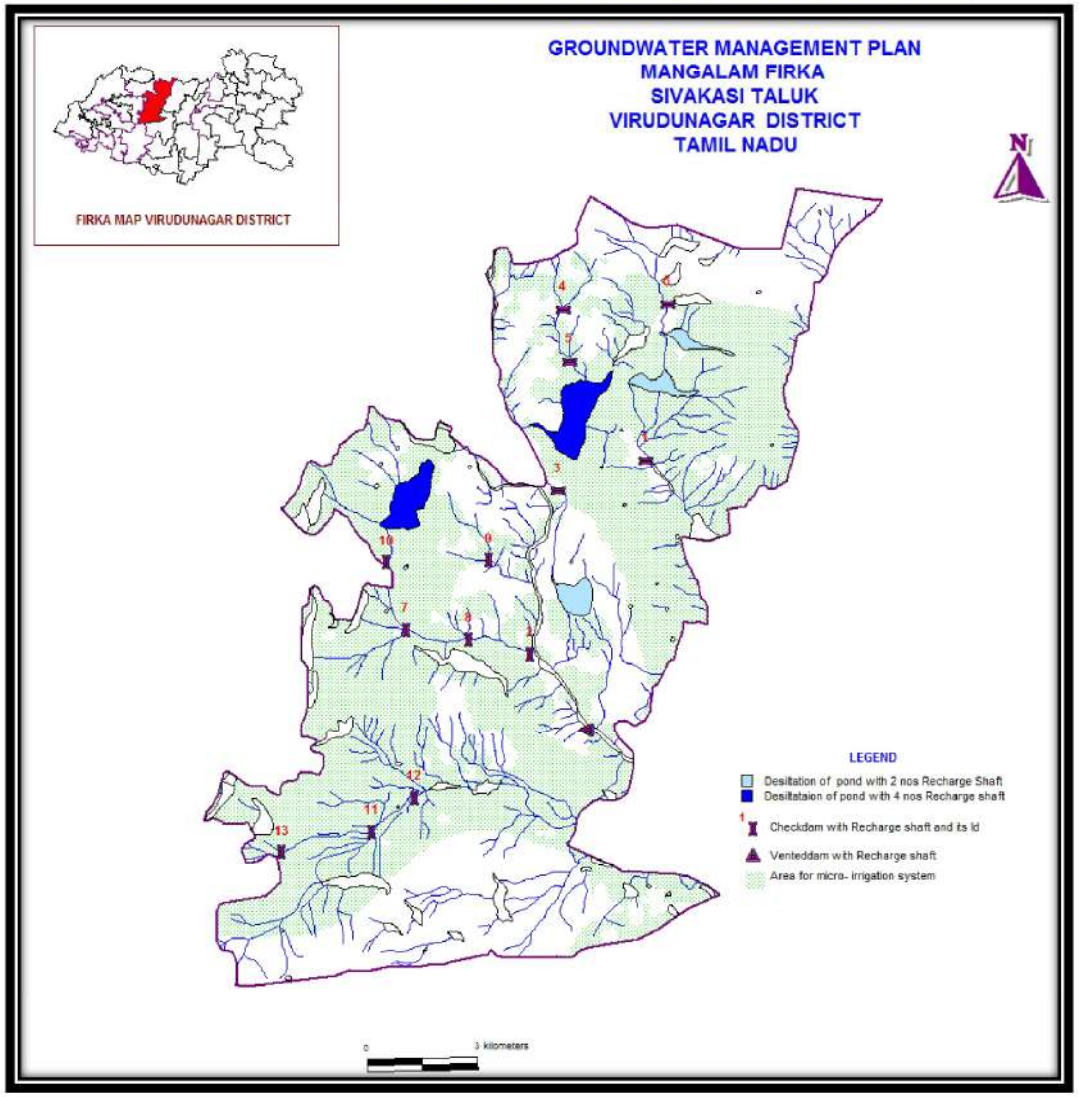
- Poor
- Moderate
- High
- Very High

0 3 kilometers



Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.81	9.59
2	77.78	9.54
3	77.79	9.58
4	77.79	9.62
5	77.79	9.61
6	77.81	9.62
7	77.75	9.54
8	77.77	9.54
9	77.77	9.56
10	77.75	9.56
11	77.74	9.50
12	77.75	9.50
13	77.72	9.49

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.82	9.62	0.35	2
2	77.81	9.60	0.55	2
3	77.79	9.60	1.76	4
4	77.75	9.58	1.37	4
5	77.79	9.55	0.76	2

Tentative Locations for Venteddam (VD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.80	9.52

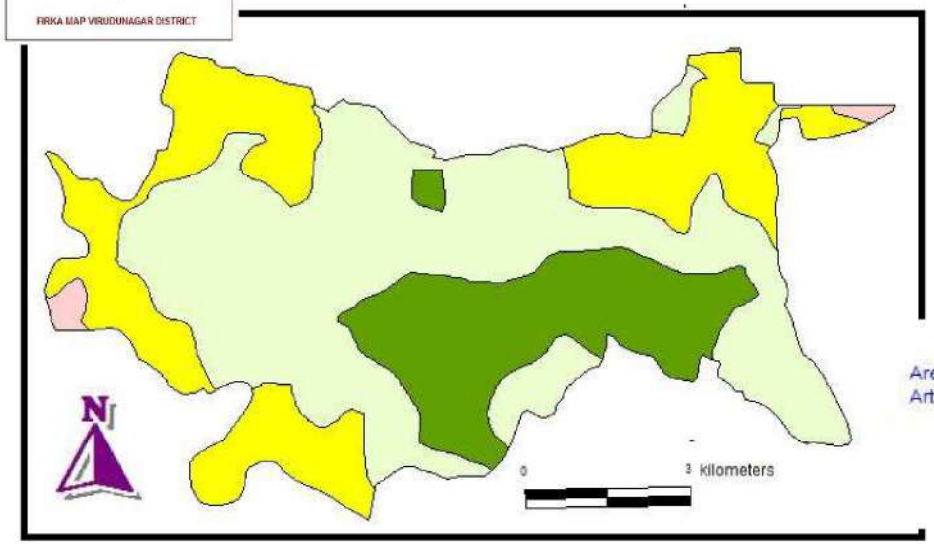
Recharge by DP: 4.79MCM
Recharge by CD: 0.0039 MCM
Recharge by VD: 0.0018 MCM
Total Recharge: MCM

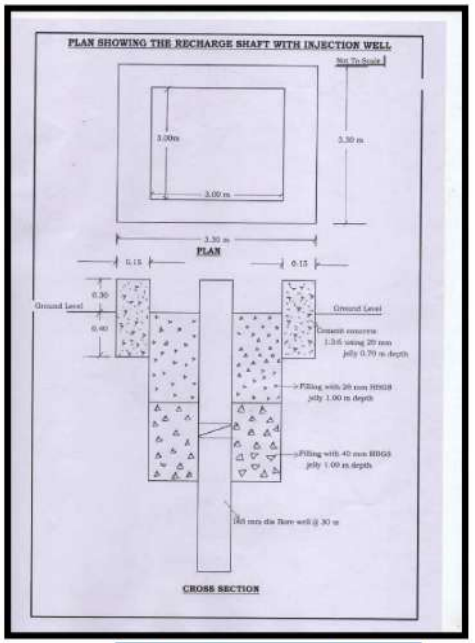
GROUNDWATER MANAGEMENT PLAN
NATHAMPATTI FIRKA
SRIVILLIPUTHUR TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU

Suitable ARS in Very high, High and Moderate zones

SUPPLY SIDE INTERVENTION

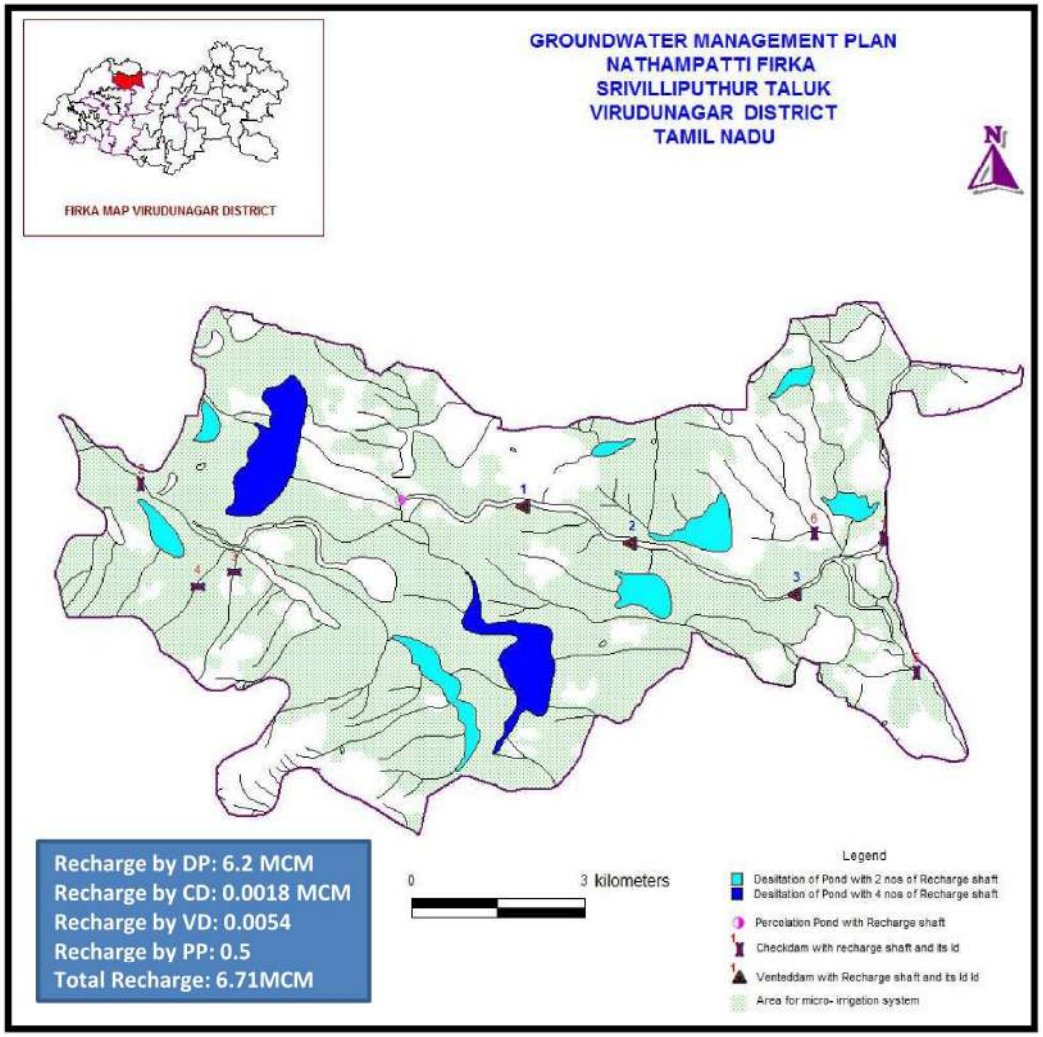
AREA SUITABLE FOR
ARTIFICIAL RECHARGE STRUCTURE





Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.77	9.61
2	77.65	9.62
3	77.67	9.61
4	77.66	9.61
5	77.78	9.59
6	77.76	9.61

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.76	9.64	0.17	2
2	77.67	9.63	1.74	4
3	77.66	9.63	0.19	2
4	77.66	9.61	0.32	2
5	77.73	9.63	0.12	2
6	77.77	9.62	0.29	2
7	77.74	9.62	0.63	2
8	77.73	9.60	0.54	2
9	77.71	9.59	1.5	4
10	77.70	9.59	0.7	2

Tentative Locations for Venteddam (VD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.71	9.62
2	77.73	9.61
3	77.76	9.61

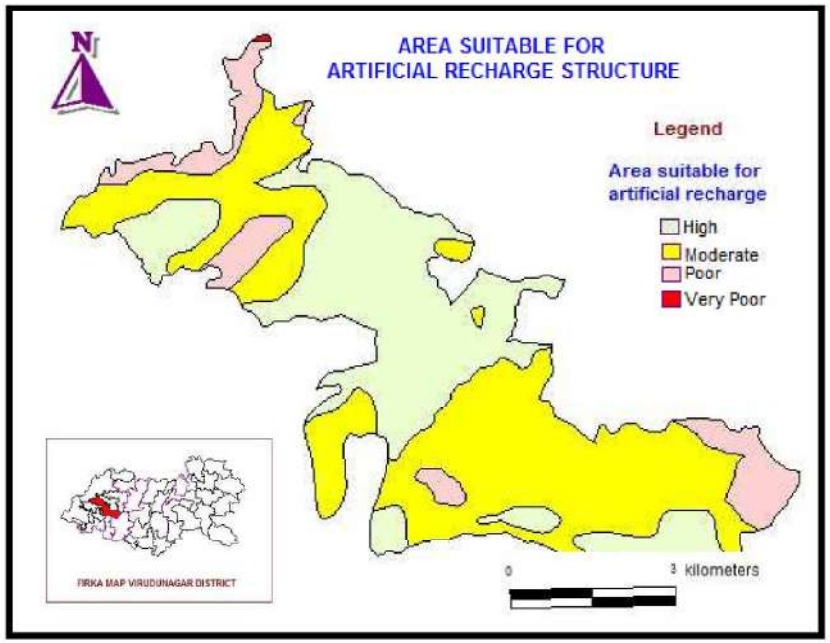
Tentative Locations for Percolation Pond with Recharge Shaft

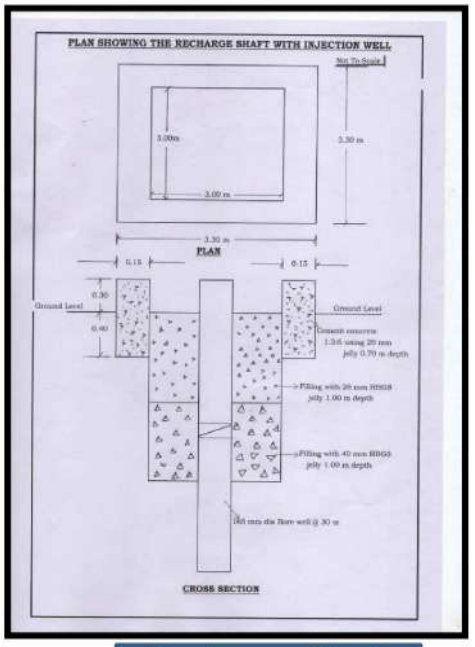
ID	Longitude (DD)	Latitude(DD)
1	77.70	9.62

GROUNDWATER MANAGEMENT PLAN
PILLAIYARKULAM FIRKA
SRIVILLIPUTHUR TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU

Suitable ARS in Very high, High and Moderate zones

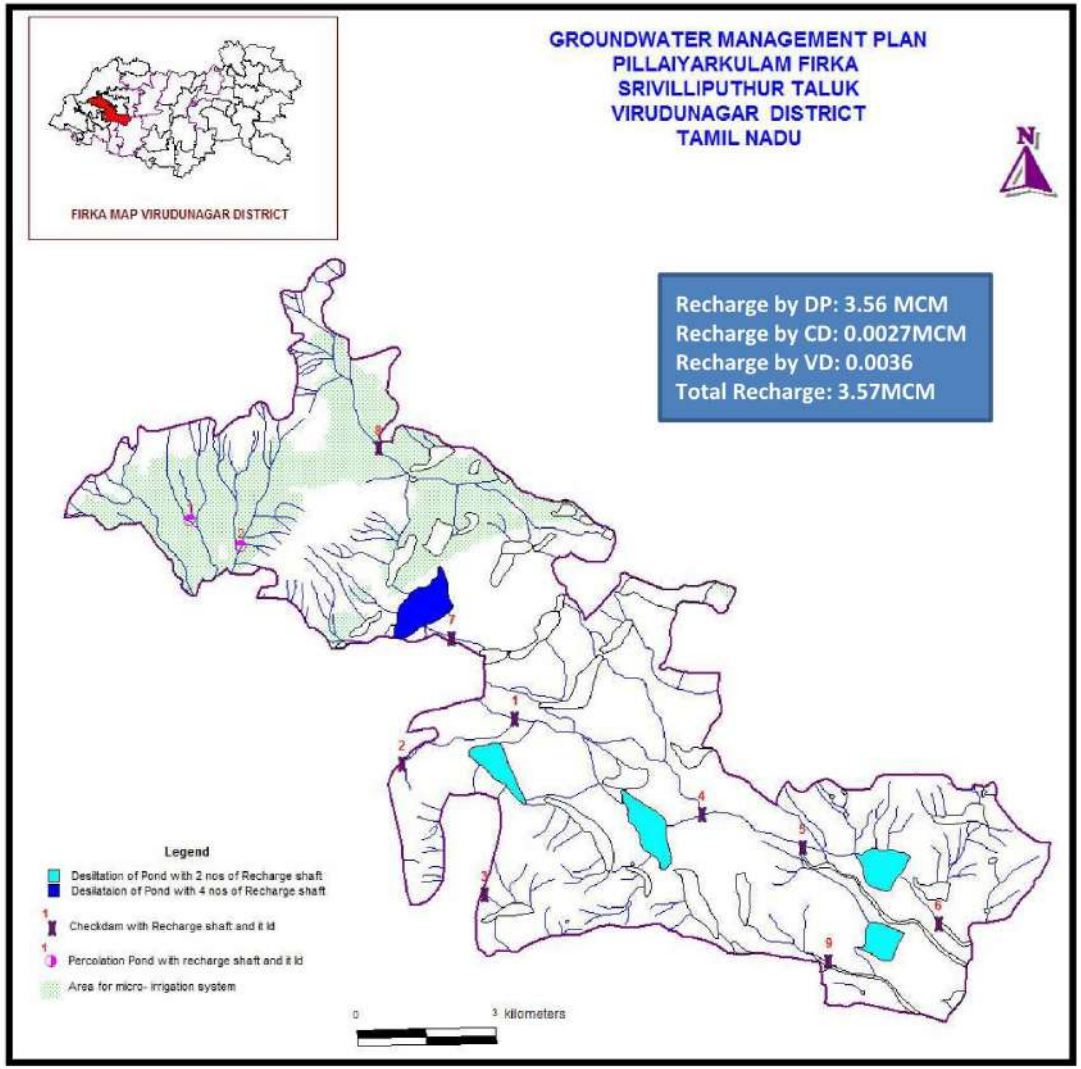
SUPPLY SIDE INTERVENTION





Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.5888	9.47613
2	77.5667	9.46752
3	77.5829	9.44241
4	77.6252	9.45774
5	77.6447	9.45132
6	77.6712	9.43687
7	77.5765	9.49161
8	77.5621	9.5281
9	77.6499	9.42957

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.59	9.47	0.57	2
2	77.57	9.50	1.02	4
3	77.61	9.45	0.8	2
4	77.66	9.45	0.68	2
5	77.66	9.43	0.49	2

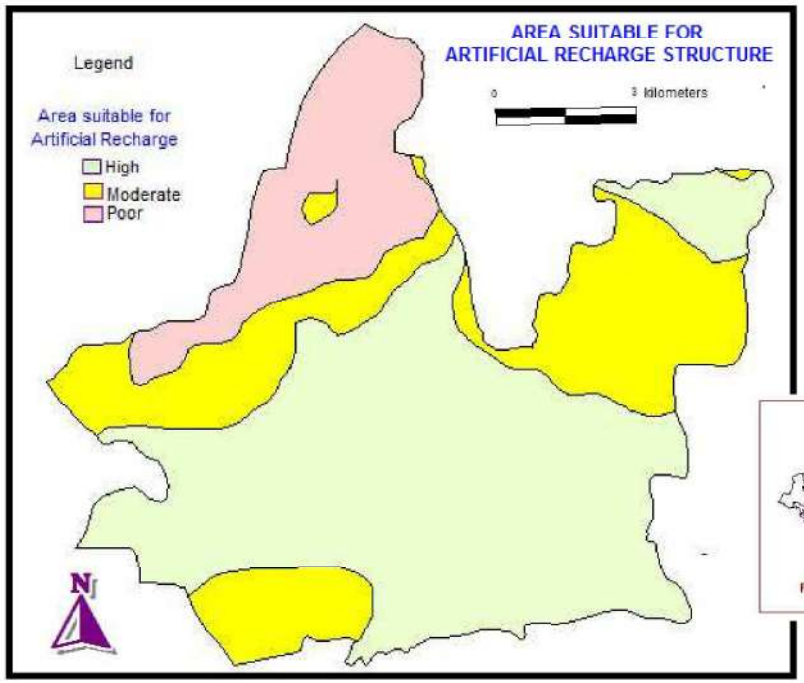
Tentative Locations for Venteddam (VD) with Recharge Shaft

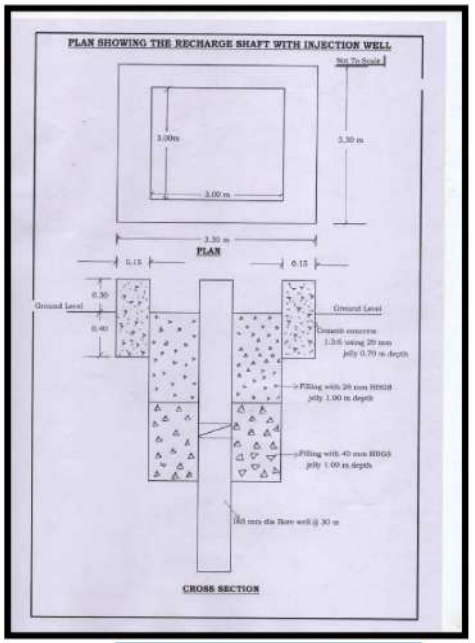
ID	Longitude (DD)	Latitude(DD)
1	77.53	9.51
2	77.54	9.51

GROUNDWATER MANAGEMENT PLAN
SALWARPATTI FIRKA
SIVAKASI TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU

Suitable ARS in Very high, High and Moderate zones

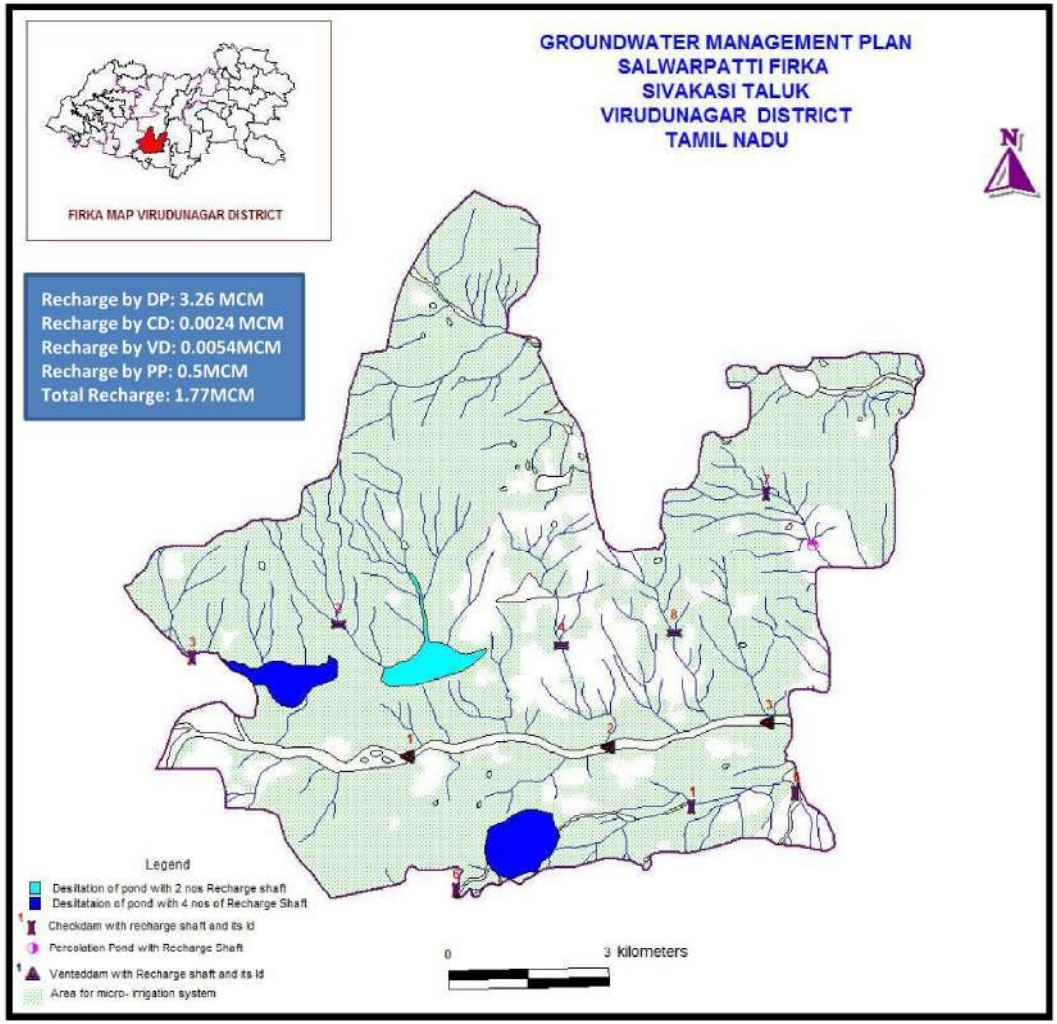
SUPPLY SIDE INTERVENTION





Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.829	9.32255
2	77.7722	9.34881
3	77.7443	9.34764
4	77.8058	9.34958
5	77.8464	9.32491
6	77.7891	9.30856
7	77.8416	9.37483
8	77.8259	9.35191

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.79	9.35	0.96	2
2	77.76	9.34	1.01	4
3	77.80	9.32	1.29	4

Tentative Locations for Venteddam (VD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.7811	9.33139
2	77.8149	9.33259
3	77.8418	9.33666

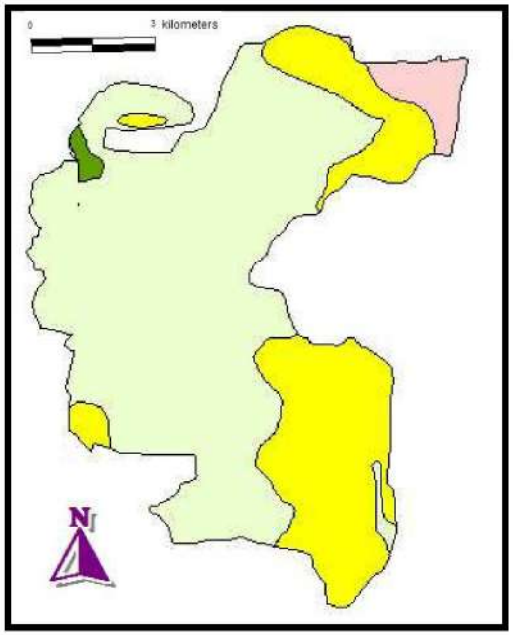
Tentative Locations for Percolation Pond with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.8487	9.3661

GROUNDWATER MANAGEMENT PLAN
VATCHAKARAPATTI FIRKA
VIRUDUNAGAR TALUK
VIRUDUNAGAR DISTRICT
TAMIL NADU

Suitable ARS in Very high, High and Moderate zones

SUPPLY SIDE INTERVENTION

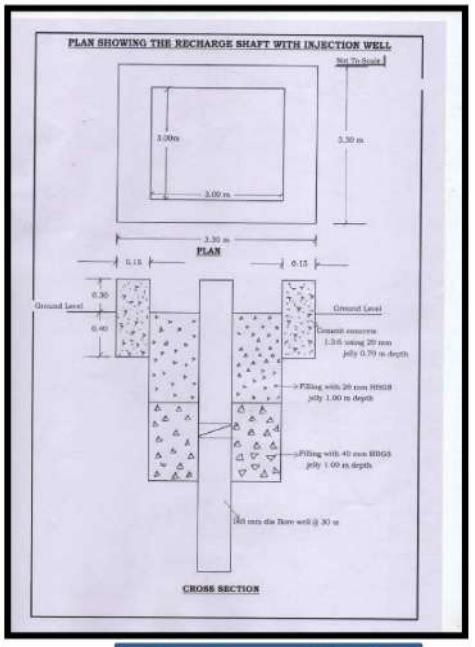


AREA SUITABLE FOR ARTIFICIAL RECHARGE STRUCTURE

Legend

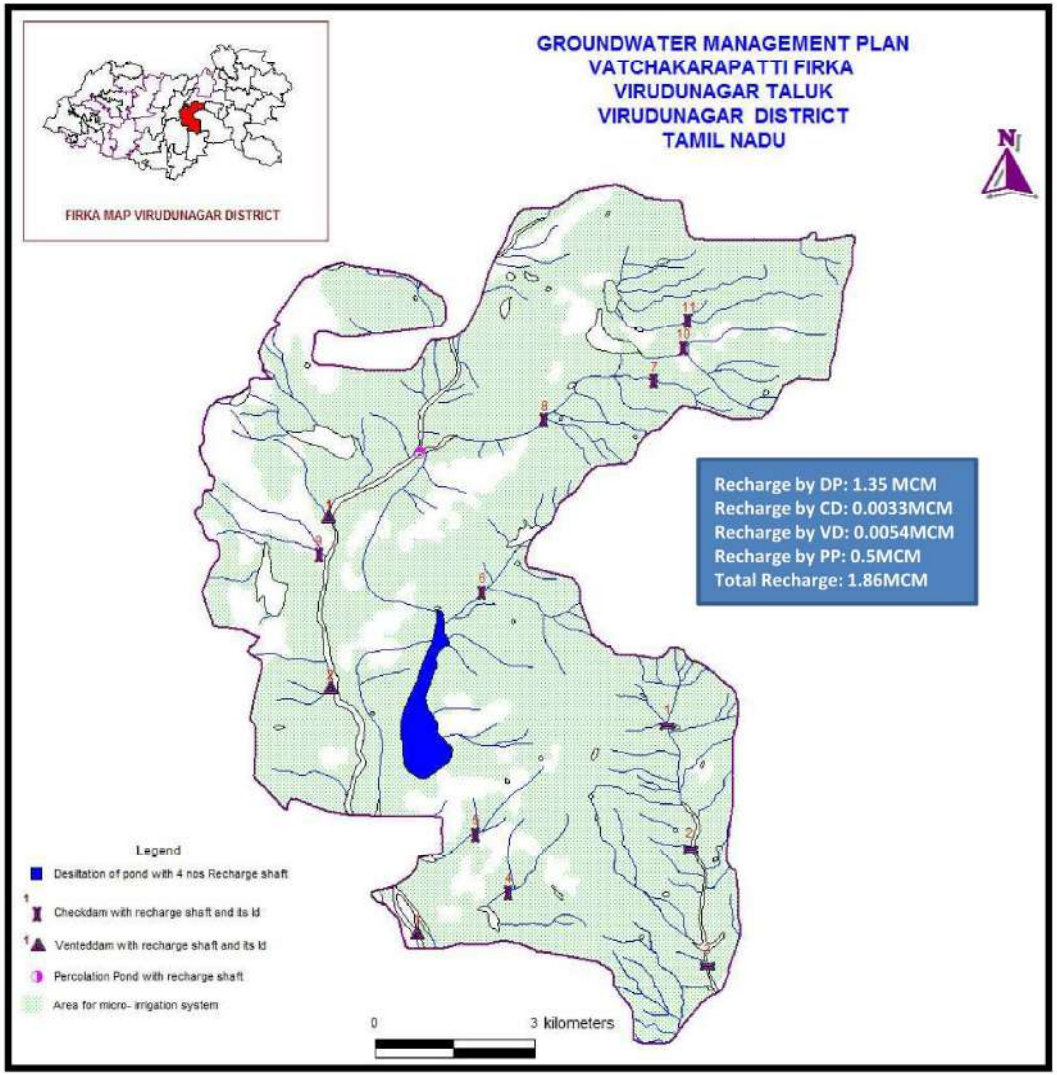
Area suitable for Artificial Recharge

- Very High
- High
- Moderate
- Poor



Recharge Shaft

SUPPLY SIDE INTERVENTION



Tentative Locations for Checkdam(CD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	78.0102	9.4480
2	78.0144	9.4272
3	78.0176	9.4077
4	77.9851	9.4196
5	77.9787	9.4286
6	77.9787	9.4696
7	78.0073	9.5056
8	77.9888	9.4989
9	77.9522	9.4757
10	78.0122	9.5113
11	78.0129	9.5158

Tentative Locations for Desiltation of Ponds (DP) with Recharge Shaft

Sl. No	Longitude (DD)	Latitude (DD)	Area (sq.km)	No.of Recharge Shaft
1	77.97	9.44	1.35	4

Tentative Locations for Venteddam (VD) with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.9526	9.4818
2	77.9533	9.4530
3	77.9685	9.4119

Tentative Locations for Percolation Pond with Recharge Shaft

ID	Longitude (DD)	Latitude(DD)
1	77.986	9.3110

S.No.	Name of Firka	Block	Categorey	Checkdam with Recharge shaft	Venteddam with recharge shaft	Percolation Pond with Recharge shaft	Desiltation of Pond with Recharge shaft of 2 Nos.	Desiltation of Pond with Recharge shaft of 4 Nos.	Quatem recharge through all structure. MCM
1	Cholapuarm	Rajapalayam	OE	11			6	2	3.02
2	Eithirkottai	Virudunagar	OE	9	5			1	1.66
3	Keelarajakularaman	Keelarajakularaman	OE	6			1	2	3.58
4	Mallankinar	Virudunagar	Critical		1		4		1.60
5	Mangalam	Sivakasi	Critical	13	1		3	2	4.80
6	Nathampatti	Watrap	OE	6	3	1	8	2	6.71
7	Pillaiyarkulam	Srivilliputhur	OE	9		2	4	1	3.57
8	Salwarpattti	Sivakasi	Critical	8	3	1	1	2	1.77
9	Vatchakarapatti	Virudunagar	Critical	11	3	1		1	1.86
			Total	**73**	**16**	**5**	**27**	**13**	**28.57**

6.2.2 Artificial recharge structure plan

Artificial recharge zones maps have been superimposed with drainage and surface water body maps to select suitable sites for artificial recharge structures. Checkdam and venteddam were selected based on the availability of drainage / streams in the basin. Check dam is constructed across the first and second order stream whereas vented dam constructed across higher order stream. The vented dams are checkdam with sluice gate. Vented dam can more water than chcekdam. Surface water body has been mapped using Remote sensing data. The village pond has been identified and those village pond having size of less than 0.025sq.km are selected for Recharge Rejuvenation Ponds (RRP) with 2nos recharge shaft. RRP is done through de-siltation of pond to increase storage which will induce the groundwater recharge. Percolation pond is also selected based on the size of surface water body more than 0.025 sq.km. in both the ponds, recharge shaft is suggested which can recharge the fractured aquifer overlain by non-permeable layers.

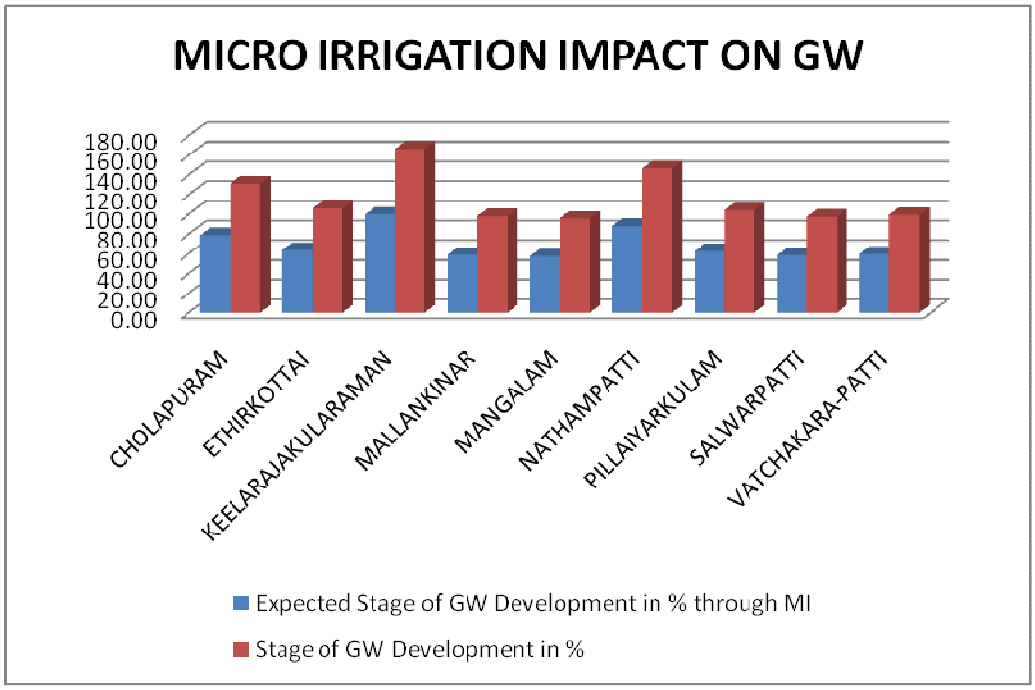
A total number of 73 Check dams, 16 Vented dam and 197recharge shafts are proposed in the area.5 Nos of percolation pond is proposed. A total number of 40 Recharge Rejuvenation Ponds are selected for desilting followed by construction of recharge shafts within the tanks. The expected recharge through these artificial recharge structures is 28.57 MCM which contributes 44% of the 63MCM.

6.3 Water Conservation Plan

The recharge ponds area has been selected based on the wet and dry crops area from landuse / landcover maps using remote sensing data. These maps were used to suggest for micro –irrigation systems. The total agriculture land in the area is 83.49 sq km and the farm pond can be constructed one in one sq.km area initially and later on numbers can be increased. As per this about 80 units of farm pond can be constructed. The proposed size for the farm pond is 10mx10mx3m and by thus 1.5 MCM of water can be conserved and also can be recharged naturally.

6.4 Demand side Management Plan

Demand side management can be accomplished through change in irrigation pattern. It is recommended to change the irrigation pattern for paddy, Sugarcane and Banana crops. The general practice for paddy irrigation is by flooding method. It is recommended for ridge and furrow method instead of flooding method in 12.57sq.km and 70.92sq,km area is proposed to shift to micro irrigation system in the area. The impact of micro irrigation and ridge and furrow is estimated and it shows that 80.7 MCM of water can be saved in the aquifer system.



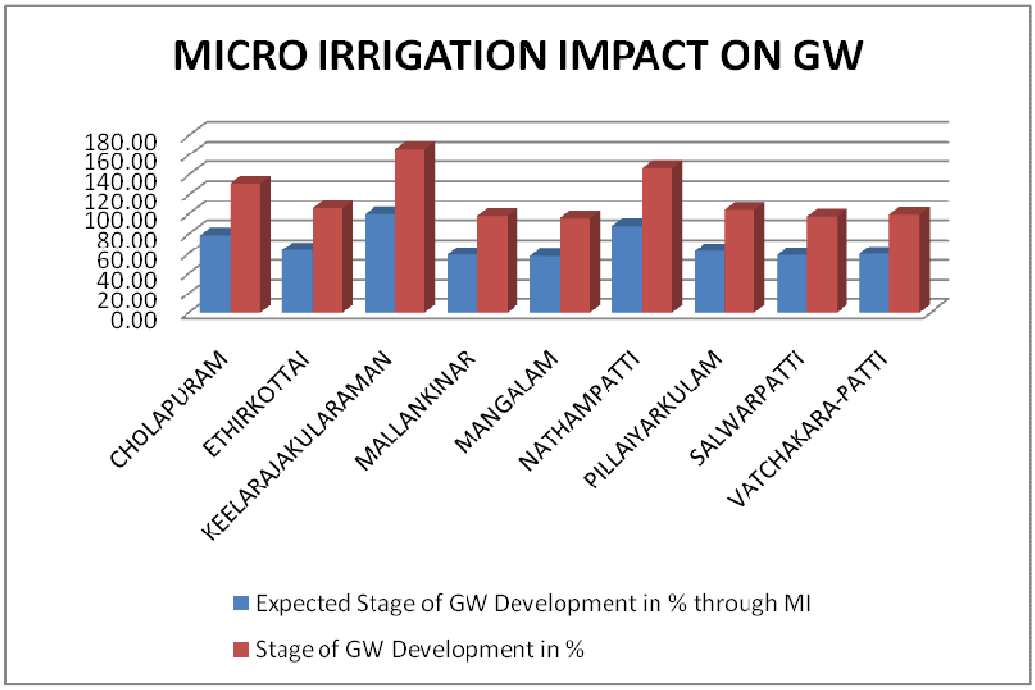
Plot-6.1 Water efficiency by implementing micro irrigation system

6.5 Savings of In-storage

The groundwater development in the area is 116% as per the prorate basis against the groundwater availability of 115MCM. Of 134MCM, 46% i.e 63MCM of groundwater is utilised more every year. To reach the safe groundwater development in the basin, measures are suggested and estimated the in-storage savings to groundwater systems. The water intensive and cash crops such as paddy, sugar cane and banana are consuming lion share of water for cultivation. By adopting the micro-irrigation systems and ridge and furrow techniques for those crops, water using efficiency various from 13 % to 40% which save 80 MCM in the aquifer system (Table 6.3 and Plot 6.2). It is contributing 100% to execs groundwater development and it implies that the groundwater can be saved by adopting micro-irrigation system and ridge and furrow method to reduce the stage of groundwater development drastically. The in-storage through ARS is 28 MCM and it contributes 20.89% to execs groundwater development.

Table 6.3 In storage savings in aquifer system

Intervention	Management Plan	In storage saving (MCM)
Supply side Management	ARS	28
	Water Conservation	1.5
Demand side Management	Ridge and Furrow	80
	Drip Irrigation	
	Total	**109.5**



Plot-6.2 In-storage in aquifer system

7.0 ACTION FOR GROUNDWATER PLANNERS, WATER USER AGENCY AND STACK HOLDERS

The main objective of the aquifer mapping in the study area is to improve the groundwater scenario in the Bhavani River basin aquifer systems by balancing the supply and demand of the groundwater. To understand the aquifer configuration in the basin, disposition of the aquifer, water holding properties including transmissivity, groundwater quality and most importantly groundwater utilisation have been carried in the basin.

The total geographic area of the basin is 1014 sq.km of which mappable is 100% of the area. It comprises of 9 firkas. The average annual rainfall is 852mm. Physiographically, the area is falling in western Ghats hill in occupied in western parts and plain in eastern parts of the study area. Vaippar, Arjunanadhi and Gundar Rivers are draining in the basin. 278sq.km of the land is used for agriculture purposes.

In the study area, two aquifer systems such as Aquifer-I (weathered) and Aquifer-II (fractured) have been demarcated. The Aquifer-I is having the thickness ranging from 8 to 21 mts and yield ranging from 1 to 72m^3/hr. The transmissivity of the aquifer is ranging from 1.2 to 72 m^3/day. The groundwater extraction from this aquifer can sustain 2 -5hrs. The aquifer-II thickness is ranging from 21 to 101 mts and having the yield is ranging from 1 to 105 m^3/hr and Transmissivity is ranging from 100 to 120 m^2/day.

The groundwater development is very serious concern in the area. Due to this, decline of groundwater level is observed and groundwater is extracted extensively for the agriculture purposes. Based on the groundwater estimation-2013, the stage of groundwater development is 116% with of available 115MCM. To have 70% of the groundwater development in the aquifer systems, micro-irrigation can be adopted which saves 80MCM of water and by artificial recharge structures, 28 MCM can be saved. Both together it works out 110 MCM. Hence, it is right time to shift water spreading/ flooding method to drip irrigation which can really save the more than 100 % of excess withdrawal.

Sl.No	Village Name	Block	Lat	Long	Toposheet No.	TD	Casing	Fractures		Lithology	T	S
1	Chatrapatti	Rajapalayam	9.436	77.51	58 G/11, B2	200	5.3	11.20-11.5		Gneiss		
2	Ilandiraikondan	Rajapalayam	9.501	77.54	58 G/11, A2	200	11.6	49.5-50	147-148	Gneiss	336	0.0002958
3	Ilandiraikondan OW	Rajapalayam	9.501	77.54	58 G/11, A2	200	11.6	49.5-50	147-148	Gneiss		
4	Kakkivadanpatti	Vembakottai	9.439	77.72	58 G/11, C2	200	11.4	Dry		Gneiss		
5	Keelarajakularaman	Rajapalayam	9.494	77.63	58G/11, B2	200	11.4	162-163		Gneiss	1.2	
6	Kottainatham	Virudhunagar	9.564	77.93	58G/15, C1	200	21.35	135-136		Gneiss	139.7	0.0003252
7	Kottainatham OW	Virudhunagar	9.564	77.93	58G/15, C1	200	21.35	135-136		Gneiss	139.7	0.0003252
8	Mangalam	Sivakasi	9.594	77.76	58 G/14, A3	200	14.95	89-89.5		Gneiss	0.55	
9	Milankinar	Aruppukottai	9.728	78.06	58 K/02, A2	200	6.6	Dry		Charnockite	1.5	
10	Naranapuram	Sivakasi	9.469	77.83	58 G/15, A1	200	11.3	Dry		Gneiss		
11	Nathampatti	Watrap	9.642	77.75	58 G/14, C2	200	23.4	124-125	151-152	Gneiss	0.98	
12	Nathikudi	Rajapalayam	9.506	77.68	58 G/11, B1	200	11.5	64-65		Gneiss	0.42	
13	Poovanathapuram	Sivakasi	9.514	77.76	58 G/15. A1	200	17	Dry		Gneiss		
14	Sholapuram	Rajapalayam	9.494	77.56	58 G/11, A2	200	6.2	41.2-41.5		Gneiss	1.2	
15	Subramaniapuram	Vembakottai	9.422	77.84	58 G/15, B2	200	7.9	81-81.5		Gneiss		
16	Thayilupatti	Vembakottai	9.456	77.8	58 G/15, A2	200	9.5	Dry		Gneiss	--	
17	Therku Devadanam	Rajapalayam	9.403	77.48	58G/07, C2	200	11.6	172-173		Gneiss	0.35	
18	Valaikulam (Mamsapuram)	Sivakasi	9.55	77.6	58 G/11, B1	200	17.5	45-46		Gneiss	1.43	
19	Veerapatti	Veerapatti	9.469	77.83	58 G/15, C2	200	3.75	Dry		Gneiss		
20	Vijayakarisalkulam	Vembakottai	9.45	77.8	58 G/15, B3	200	11.25	Dry		Gneiss		

Sl.No.	Name of the village	Firka Name	Block Name	Lattitude	Longitude	Toposheet No	Depth of DW (m bgl)	RL (m amsl)	Aquifer Group	M P (m agl)	SWL (m bgl)	Reported WL (m bgl)	GW samples	Use	Approch
1	Devadanam	Cholapuram	Rajapalayam	9˚ 23' 07"	77˚ 27' 42"	58 G/7	15.8	182	Weatherd Ch.	0.8	12.9	4.1	DW	Domestic	Rajapalayam - Thenkasi road, well located back side of Devar statue and infront of Kottai amman temple
2	Melur Duraisamipuram	Cholapuram	Rajapalayam	9˚ 21' 15"	77˚ 27' 30"	58 G/7	14.1	146.8	Weatherd Ch.	0.4	8.9	3.1	DW	Agricultural well	Rajapalayam - Thenkasi road, diversion to be taken near the IOC petrol pump, well located back side of Melur duraisamipuram Panchayat Office.
3	Elandiraikondan	Cholapuram	Rajapalayam	9˚ 23' 09"	77˚ 31' 04"	58 G/11	15.4	138.4	Weatherd Ch.	0.2	9.65	6.3	DW	Agricultural well	Rajapalayam - Krishnapuram - Cholapuram raod, well located opp to suaichandra spintex.
4	Kunangulam	Cholapuram	Rajapalayam	9˚ 22' 19"	77˚ 32' 38"	58 G/11	12.65	133.8	Weatherd Ch.	0.1	11.6	5.1	DW	Agricultural well	Rajapalayam - Krishnapuram - Cholapuram raod, well located by roadside after the village.
5	Cholapuram	Cholapuram	Rajapalayam	9˚ 22' 28"	77˚ 33' 40"	58 G/11	16.1	133.2	Weatherd Ch.	0.9	6.85	0.6	DW	Domestic	Rajapalayam - Sankarankoil raod, well located by roadside opp to Primary Health Centre.
6	Mudukkudi	Cholapuram	Rajapalayam	9˚ 24' 03"	77˚ 33' 39"	58 G/11	14.3	140.6	Weatherd Ch.	0.6	11.4	2.1	No	Domestic	Rajapalayam - Sankarankoil raod, well located by roadside opp to Vakkathi Amman Temple.
7	Therkku Venganallur	Cholapuram	Rajapalayam	9˚ 23' 44"	77˚ 32' 33"	58 G/11	12.5	151.3	Weatherd Ch.	0	8.3	4	DW	Agricultural well	Rajapalayam - Devikapuram - Therkkuvenganallur road, wells located raod side near TNLR ss19.
8	Ramalingapuram	Keelarajakularaman	Rajapalayam	9˚ 24' 07"	77˚ 34' 40"	58 G/11	28.3	138.1	We.Gra.Gneiss	0.8	4.4	2.1	No	Domestic	Rajapalayam - Mudukudi - S. Ramalingapuram - Cholapuram road, well located near Anganwadi.
9	Nallamanayakkanpatti	Keelarajakularaman	Rajapalayam	9˚ 23' 02"	77˚ 35' 04"	58 G/11	12.8	153.2	Weatherd Ch.	0	9.25	3.8	DW	Agricultural well	Rajapalayam - Nallamanayakkanpatti - Cholapuram road,

															well located opp to library and adjacent to Panchayat office.
10	Pananakulam	Keelarajakularaman	Rajapalayam	9˚ 21' 59"	77˚ 35' 44"	58 G/11	12.7	135.2	We.Gra.Gneiss	0.6	11.45	2.25	DW	Domestic	Rajapalayam - Nallamanayakkanpatti - Gopalapuram road, well is located near community hall.
11	Cholapuram (K)	Keelarajakularaman	Rajapalayam	9˚ 21' 44"	77˚ 37' 28"	58 G/11	22.8	119	We.Gra.Gneiss	0.7	22.45	8.5	DW	Domestic	Rajapalayam-mudukudi-Cholapuram road, well is located opp to Panchayat office.
12	Nathampatti	Keelarajakularaman	Rajapalayam	9˚ 22' 56"	77˚ 36' 30"	58 G/11	15.7	121.7	We.Gra.Gneiss	0.5	9.3	4.1	DW	Agricultural well	Cholapuram - Nathampatti - Keelarajakularaman raod, well is located road side before the vilage.
13	Keelarajakularaman	Keelarajakularaman	Rajapalayam	9˚ 23' 46"	77˚ 38' 08"	58 G/11	14.75	122	We.Gra.Gneiss	0.1	9.15	6.2	DW	Agricultural well	Cholapuram - Nathampatti - Keelarajakularaman raod, well is located western bank of the vilage tank, near the sluice gate.
14	Thombakulam	Keelarajakularaman	Rajapalayam	9˚ 22' 52"	77˚ 39' 34"	58 G/11	20	108.3	We.Gra.Gneiss	0.85	18.2	4.9	No	Domestic	Rajapalayam-Keelarajakularaman-Thombakulam - Alngulam raod, Village water supply well.
15	Alangulam	Ethirikottai	Vembakottai	9˚ 21' 40"	77˚ 40' 30"	58 G/11	13.8	103.5	We.Gra.Gneiss	0.3	11.2	5.8	DW	Domestic	Rajapalayam - Alankulam-Vembakottai raod, well is located near Irupplaur Nagar OHT and Eri.
16	Sivalingapuram	Ethirikottai	Vembakottai	9˚ 20' 37"	77˚ 38' 15"	58 G/11	14.7	100.5	We.Gra.Gneiss	0.85	10.6	5.75	DW	Domestic	Rajapalayam - Thiruvenkadam - Vembakottai road, well is opp to Panchayat office and backside of Rajan fancy stores in the house.
17	Valayapatti	Ethirikottai	Vembakottai	9˚ 20' 37"	77˚ 38' 15"	58 G/11	14.8	98.2	We.Gra.Gneiss	0.8	12.4	3.95	HP	Domestic	Rajapalayam - Alankulam - Thiruvenkadam road, 6 km from alankulam, opp to Vinayakar temple.
18	Keezhanmarainadu	Ethirikottai	Vembakottai	9˚ 19' 18"	77˚ 42' 22"	58 G/11	18.6	92	We.Gra.Gneiss	0.85	12.4	4.6	DW	Domestic	Rajapalayam - Alankulam - Sevalpatti road, well is located in the village pond. opp

															to VAO office and ration shop
19	Sevalpatti	Ethirikottai	Vembakottai	9˚ 19' 50"	77˚ 42' 22"	58 G/11	12.3	100.9	Weatherd Ch.	0.85	7.15	3.75	DW	Domestic	Rajapalayam - Alankulam - Sevalpatti - Sankarankoil road, well is located adjacent to PHC in the campus of amman temple.
20	Kundra Iruppu	Salvarpatti	Vembakottai	9˚ 21' 35"	77˚ 42' 45"	58 G/11	14.8	108.4	Weatherd Ch.	0	10.65	4.7	DW	Agricultural well	Vembakottai - Alankulam raod, well is located by road side, near the km stone 22/4 and 22/6.
21	Ethirikottai	Ethirikottai	Vembakottai	9˚ 22' 46"	77˚ 43' 59"	58 G/11	12.4	92.5	We.Gra.Gneiss	0.65	8.9	2.75	DW	Agricultural well	Alankulam - Sathur road, km stone showing Sathur 21 km, well located in the agricultral land of Raman.
22	Kakkivadampatti	Salvarpatti	Vembakottai	9˚ 24' 25"	77˚ 43' 02"	58 G/11	9.9	112.7	Crystalline Lst	0	6.3	2.6	DW	Agricultural well	Sivakasi - Kakkivadampatti - Puliparaipatti road, well located in the agricultural field at the end of village.
23	Kodangipatti	Pillayarkulam	Srivilliputhur	9˚ 25' 05"	77˚ 39' 35"	58 G/11	15.3	109.8	Crystalline Lst	0.4	11.45	5.6	DW	Agricultural well	Rajapalayam - Kodangipatti - Puliparaipatti road. Well is located by road side near the Anagnwadi.
24	Venkatapuram	Salvarpatti	Rajapalayam	9˚ 25' 03"	77˚ 37' 35"	58 G/11	13	110.2	We.Gra.Gneiss	0.4	12.85	5.6	DW	Agricultural well	Rajapalayam - Attaipetti mukku road - alangulam road, well is located in the Rajendiran agricultural land.
25	Vijayakarisal kulam	Salvarpatti	Vembakottai	9˚ 20' 43"	77˚ 46' 30"	58 G/15	9.6	86.3	We.Gra.Gneiss	1.3	8.6	2.4	HP	Domestic	Vembakottai - Sivakasi raod, well is located by road side, 3 km from Vembakottai, in the Bus stop.
26	Thayilpatti	Salvarpatti	Vembakottai	9˚ 22' 32"	77˚ 48' 16"	58 G/15	16.5	98.2	We.Gra.Gneiss	0.9	13.9	6.1	HP	Domestic	Sathur - Vembakottai - Rajapalayam road, well located in the village tank, village water supply well.
27	Salvarpatti	Salvarpatti	Vembakottai	9˚ 21' 10"	77˚ 50' 19"	58 G/15	19.3	91.5	We.Gra.Gneiss	0.8	13.5	6	DW	Agricultural well	Vembakottai - Manikondapuram - Salvarpatti - Sathur raod, the well is loacted near Salvarpatti graveyard.

28	Achchankulam	Salvarpatti	Vembakottai	9˚ 19' 48"	77˚ 50' 49"	58 G/15	11.2	95.6	We.Gra.Gneiss	0.4	10	4.2	DW	Agricultural well	10 km from Vembakottai on Sathur road, well located in the Agricultural land of Rasappan
29	Vanniyampatti	Pillayarkulam	Srivilliputhur	9˚ 29' 25"	77˚ 36' 30"	58 G/11	15.1	142.4	We.Gra.Gneiss	0	14.21	5.8	DW	Agricultural well	Rajapalayam - Srivilliputhur road, 6 km from Rajapalayam, well is located in the Silk research center premises.
30	Pillayarkulam	Pillayarkulam	Srivilliputhur	9˚ 26' 59"	77˚ 37' 53"	58 G/11	12.5	139.3	We.Gra.Gneiss	0.3	11.4	4.75	DW	Agricultural well	Rajapalayam - Vanniyampatti vilakku - Lakshmipuram - Pillayarkulam - Alangulam road, well located in the agriculture land near km stone 11/6 and 11/8.
31	Achchamthavizthan	Pillayarkulam	Srivilliputhur	9˚ 26' 59"	77˚ 37' 53"	58 G/11	16.1	127.1	We.Gra.Gneiss	0.4	14.8	5.85	DW	Domestic	Rajapalayam - Pillayarkulam - Nadhikkudi road, 4 km from Pillayarkulam on Nadhikkudi road, well located in the mottaisamy thirukkoil premises.
32	Athikulam	Pillayarkulam	Srivilliputhur	9˚ 29' 17"	77˚ 38' 48"	58 G/11	21.2	142.5	We.Gra.Gneiss	1	16.7	10.2	DW	Domestic	Rajapalayam - Athikulam - Srivilliputhur road, 3 km from Srivilliputhur, well is located adjacent to athikulam panchayat office.
33	Mamsapuram	Pillayarkulam	Srivilliputhur	9˚ 30' 15"	77˚ 35' 10"	58 G/11	15.25	160.3	We.Gra.Gneiss	0.6	12.75	6.4	DW	Agricultural well	Srivilliputhur - Mamsapuram - Rajapalayam road, well located before the Aircel tower in the agricultural land.
34	Vembakottai	Salvarpatti	Vembakottai	9˚ 20' 01"	77˚ 46' 11"	58 G/15	16.5	87.8	We.Gra.Gneiss	0.5	14.2	5.4	DW	Domestic	Rajapalayam - Sathur road, well is located in Vembakottai BDO office.
35	Injar	Mangalam	Sivakasi	9˚ 29' 04"	77˚ 44' 43"	58 G/11	15	127.6	We.Gra.Gneiss	0	14.4	8.4	DW	Agricultural well	Rajapalayam - Srivilliputhur - Sivakasi road, diversion to be taken at 9 km stone from Rajapalayam, well is located in the agricultural land of Ponnaiyan.

36	Thiruthangal	Mangalam	Sivakasi	9˚ 28' 58"	77˚ 48' 44"	58 G/11	18	112.4	We.Gra.Gneiss	0.7	11.2	8	DW	Domestic	Sivakasi - Virudhunagar raod, well is located in the Trijunction of Rajapalayam-Virudhunagar and Sivakasi road.
37	Sukkiraravarpatti	Mangalam	Sivakasi	9˚ 30' 58.5"	77˚ 47' 53"	58 G/14	12.65	100.1	We.Gra.Gneiss	1	7.55	2.1	DW	Domestic	Sivakasi - Thiruthangal - Sukkiravarpatti road, 4 km from Thiruthangal.
38	H.Pudupatti	Mangalam	Sivakasi	9˚ 32' 36"	77˚ 46' 47"	58 G/14	6.9	108.3	We.Gra.Gneiss	1.5	6.07	1.5	HP	Domestic	Sivakasi - Erichanatham road, 10 km from Sivakasi, well is located adjacent to Police station and Opp to GH.
39	Mangalam	Mangalam	Sivakasi	9˚ 34' 08"	77˚ 45' 18"	58 G/14	10.1	120.4	We.Gra.Gneiss	0.8	9.8	3.5	HP	Domestic	Krishnankoil-Mangalam - Pudupati - Sivakasi road, well located backside of Vetinary hospital and temple.
40	Kavundampatti	Mangalam	Sivakasi	9˚ 34' 54"	77˚ 49' 17"	58 G/14	10.1	121.7	We.Gra.Gneiss	0.5	9.8	6.2	HP	Domestic	Sivakasi - M. Pudupatti - Kavundampatti road, well is located inside the village near village sewa center and OHT
41	Sevalur	Mangalam	Sivakasi	9˚ 36' 20"	77˚ 48' 14"	58 G/14	14.5	112.3	We.Gra.Gneiss	0.6	12.1	4.5	HP	Domestic	Sivakasi - Erichanatham - Sevalur road, well is located in the village amman temple, on the way to graveyard.
42	Nathampatti	Nathampatti	Watrap	9˚ 36' 06"	77˚ 43' 56"	58 G/10	12.7	128.5	We.Gra.Gneiss	0	12.5	6.8	HP	Domestic	Alagapuri - Krishnanakoil - Srivilliputhur road, 2 km from NH, well is located on road side adjacnet to muniappan temple.
43	Kunnur	Nathampatti	Watrap	9˚ 35' 16"	77˚ 42' 10"	58 G/10	16.2	139.7	We.Gra.Gneiss	1.4	14.2	8.5	DW	Domestic	Nathampatti - Kunnur - Ramachandirapuram raod, well is located inside the vilage, water supply well.
44	Sundarapandian	Nathampatti	Watrap	9˚ 35' 16"	77˚ 42' 10"	58 G/10	24.1	144.6	We.Gra.Gneiss	0	23.05	12.4	DW	Agricultural well	Watrap - Krishnankoil - Srivilliputhur road, well is located near Sundapandian garbage dumping yard.
45	Alagapuri	Nathampatti	Watrap	9˚ 37' 46"	77˚ 45' 55"	58 G/10	12.5	128.7	We.Gra.Gneiss	1	10.57	3.1	DW	Agricultural well	Thirumanagalam - Srivilliputhur road, well is located in agricultural land of

															Muniand, near Watrap, Virudhunagar Tri junction
46	Moovaraivendran	Nathampatti	Watrap	9˚ 37' 10"	77˚ 43' 40"	58 G/10	15.8	129	We.Gra.Gneiss	0.6	12.34	4.6	DW	Agricultural well	Alagapuri - Moovaraivendran - Sundarapandian road, well is located inside the village near Panchayat office.
47	Vacchakaranpatti	Vacchakaranpatti	Virudhunagar	9˚ 27' 47"	77˚ 43' 40"	58 K/3	11.2	85.4	We.Gra.Gneiss	0.9	8.78	2.1	DW	Domestic	Virudhunagar - Sathur road, 15 kms from Virudhunagar, well is located after cement plant and inside TNEB office.
48	Avudayapuram	Vacchakaranpatti	Virudhunagar	9˚ 26' 27"	77˚ 57' 36"	58 K/3	9.15	65.4	Weatherd Ch.	0	6.75	3	DW	Agricultural well	Virudhunagar - RR Nagar - Kottur road, well is located near transformer in the agricultural well of Selvanayagam.
49	Valayapatti	Vacchakaranpatti	Virudhunagar	9˚ 27' 18"	77˚ 58' 52"	58 K/3	14.2	89.5	Weatherd Ch.	0.8	10.8	5.5	HP	Domestic	Virudhunagar- RR Nagar - Avudayarpalayam - Valayapatti road, well is located near primary school.
50	Sennelkudi	Vacchakaranpatti	Virudhunagar	9˚ 30' 31"	77˚ 59' 29"	58 K/3	14.8	80.7	Weatherd Ch.	0	13.1	5.3	HP	Domestic	Irukkankudi - Palavarnatham road, 6 km from Palavarnatham on irukkankudi road. Well is located in the agricultural land of Mani.
51	Appinayakkanpatti	Vacchakaranpatti	Virudhunagar	9˚ 25' 20"	78˚ 00' 09"	58 K/3	18.6	79.2	We.Gra.Gneiss	0.4	13.3	4.5	DW	Domestic	Virudhunagar -RR Nagar - avudayarpalayam- Appinayakkanpatti road, well is located inside the village, vilage water supply well.
52	Vazhukkalotti	Milankinaru	Kariapatti	9˚ 34' 23"	78˚ 00' 47"	58 K/2	10.5	100.9	We.Gra.Gneiss	0.1	8.65	4.1	DW	Agricultural well	Palavarnatham - Milankinaru road, 3 knm from Milankinaru, well is located in the agricultural land near the graveyard.
53	Varalotti	Milankinaru	Kariapatti	9˚ 35' 39"	78˚ 01' 27"	58 K/2	11	104.5	We.Gra.Gneiss	1	9.45	2.1	HP	Domestic	Virudhunagar - Milankinaru - Kallupatti road, well is located near the Varalotti bus stop.

54	Milankinaru	Milankinaru	Kariapatti	9˚ 37' 10"	78˚ 00' 47"	58 K/2	10.2	108.5	We.Gra.Gneiss	0.75	8.7	1.8	DW	Domestic	12 km from Virudhunagar on Virudhunagar - Kariapatti -Kallupatti road, well is located roadside near the temple of drama kottai.
55	Achchankulam	Milankinaru	Kariapatti	9˚ 38' 43"	78˚ 02' 42"	58 K/2	12.8	98.4	We.Gra.Gneiss	0.7	9.45	3.6	DW	Domestic	Virudhunagar - VV Nagar - Milankinaru - Vaiyampatti road, well is located Achankulam panchayat office.