Plan on Artificial Recharge to Groundwater and Water Conservation in Gudiyatham East (East) Firka, GudiyathamTaluk, Vellore District, Tamil Nadu

By

Central Ground Water Board
South Eastern Coastal Region
RajajiBhawan, Besant Nagar
Chennai

Content

AT GLANCE	
Name of Firka	Gudiyatham (East)
Taluk	Gudiyatham
District	Vellore
State	Tamil Nadu
Total area	82.46 Sq. Km
Total area suitable for Recharge	52.77 Sq. Km
Lat. & Lon.	12°55'59" to 13°05'18" & 78°50'34"to78°59'45".
Rainfall	1009 mm
Monsoon	868 mm
Non- Mon soon	141 mm
Geology	Crystalline metamorphic gneiss complex comprising Hornblende gneiss
WATER LEVEL	
Pre – Monsoon(May 2015)	2.7 to 4.7 m bgl.
Post - Monsoon (Jan 2016)	1.2 to 5.6 m bgl.
GROUND WATER RESOURCES ESTIMATION	
Replenishable ground water resources	10.263 MCM
Net ground water available	9.23 MCM
Ground water draft for irrigation	14.50 MCM
Groundwater draft for domestic & industrial water supply	1.90MCM
Total ground water draft	16.401 MCM
Stage of ground water development (%)	177.68 %
Uncommitted surface runoff available for the Firka	10.7362 MCM
Total volume of weathered zone	13.6059 MCM
Total volume available for recharge (considering 3 m depth from 3 m bgl	3.7107 MCM
ARTIFICIAL RECHARGE /CONSERVATION MEASURES	
Structures Proposed (tentative) Masonry Check dam Nalla Bund Revival, repair of pond, tanks with recharge shaft	 16 23 13
Improving Water Efficiency /Saving Micro irrigation system for 50 ha)	0.35 MCM
Excepted groundwater recharge	1.63 MCM
Excepted groundwater recharge / saving	1.98 MCM
Tentative total cost of the project	Rs 6.844 Cr
Expected raise in water level by recharge	2.46 m

Plan on Artificial Recharge to Groundwater and Water Conservation in Gudiyatham East Firka, Gudiyatham East Taluk, Vellore district, Tamil Nadu

1. Introduction

India is the largest user of groundwater in the world. Food grain security of the country is largely dependent on water resources and groundwater resources play major role in irrigation sector. Imprints of Over-Exploitation on groundwater resources are being observed as steep deepening of water levels, drying of shallow groundwater abstraction structures, ingress of salinity in fresh aquifers etc. which signal towards taking necessity of emergent action for artificial recharge and rainwater harvesting by utilizing surplus runoff and maintaining groundwater resources at sustainable stage.

In Tamil Nadu dependency on groundwater has increased many folds during the recent years and the groundwater extraction for irrigation, domestic and industries have resulted in lowering of water levels, long-term water level declining trend and even drying up of wells. In order to regulate the groundwater development, Central Ground Water Board in association with State Ground Water Departments has computed Dynamic Groundwater Resources and categorized blocks as Over Exploited, Critical, Semi Critical and Safe.

Out of 1129 firkas (assessment units) in Tamil Nadu the groundwater situation in 374 firkas overexploited, 48 firkas critical, 235firkassemi-critical, 437 firkas safe and 35 firkas are saline. Various measures such as rainwater harvesting, artificial recharge and water use efficiency are successfully practiced by some NGOs, Central and State govts., which need replication at larger scale in close coordination with State govt. agencies and stakeholders so that capacity building of state implementing agencies and awareness of stakeholders towards artificial recharge and rainwater harvesting can be made.

2. Objectives of the scheme

Objectives of the proposed scheme are

- To upscale recharge activities, supplement additional groundwater resources by harvesting surplus runoff, sustainability of groundwater resources at shallow depths
- Recovery of over-exploited groundwater areas by implementing artificial recharge measures in groundwater stress areas.
- Conservation, development and sustainable management of natural resources including their use.

3. Study area details

3.1 Location

The total area of Gudiyatham East firka is 82.46 sq.km and Gudiyatham East firka lies between North latitudes 12°55' 59 "to 13° 05'18" and east longitudes 78° 50' 34"to 78°59' 45.6". Location map of Gudiyatham East firka is given in Figure 1.

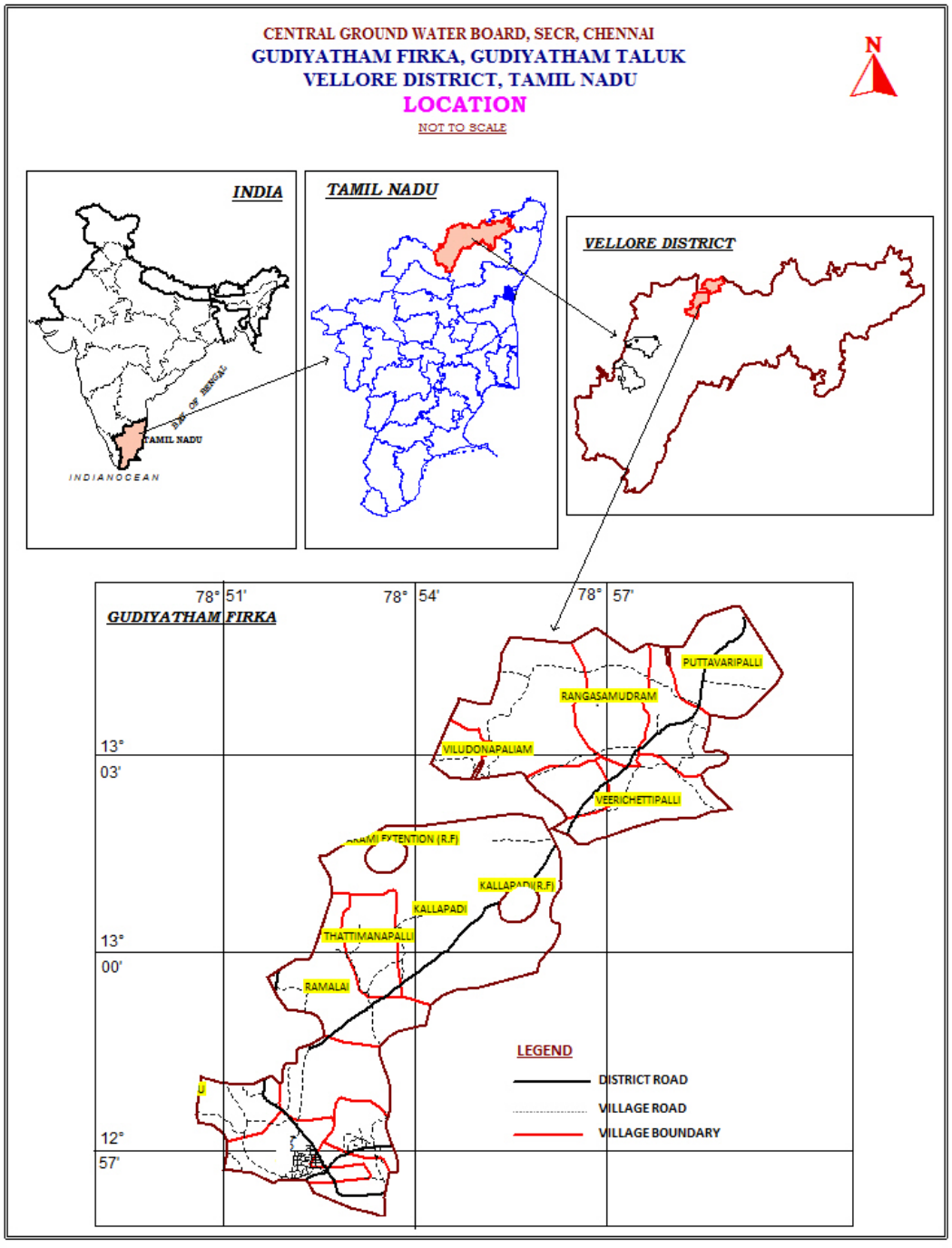


Figure 1. Location map of Gudiyatham East firka

3.2 Geomorphological Set up

Geomorphologically, the area consists of Moderate and Shallow pediments dominates the firka followed by Dissected/Undissected pediments andDenudationalhills/Residual Hills. In plain landforms, Valley fills and flood plain also available in considerable area of the firka. These landforms are influencing the ground water recharge. Hill landform like residual hills, denudation hill and structural hills are act as runoff zone. (*Source: IRS, Anna university, Chennai Tamil Nadu). Geomorphological map prepared using IRS- 1D data on 1: 50,000 scale and units are as per NNRMS standard*s. The hills tract on the North West part of firkaare ResidualHills. The range consists of a series of detached hills covered by reserved forests.The various geomorphological units shown in figure-2 with its % of coverage area are given in table 1.

Table 1. Various geomorphological units with its % of coverage area in Gudiyatham East firka

Land Forms	**Percentage of Land Forms**
RIVER	0.45
PEDIMENT-INSELBERG COMPLEX	0.51
FLOOD PLAIN	2.16
VALLEY FILL	2.54
DEEP	3.31
DEFLECTION SLOPE	4.37
HIGHLY DISSECTED	4.47
DENUDATIONAL HILLS / RESIDUAL HILLS	10.30
DISSECTED/UNDISSECTED	21.94
SHALLOW	22.64
MODERATE	27.30
	100

GEOMORPHOLOGY
GUDIYATHAM EAST FIRKA,GUDIYATHAM TALUK
VELLORE DISTRICT

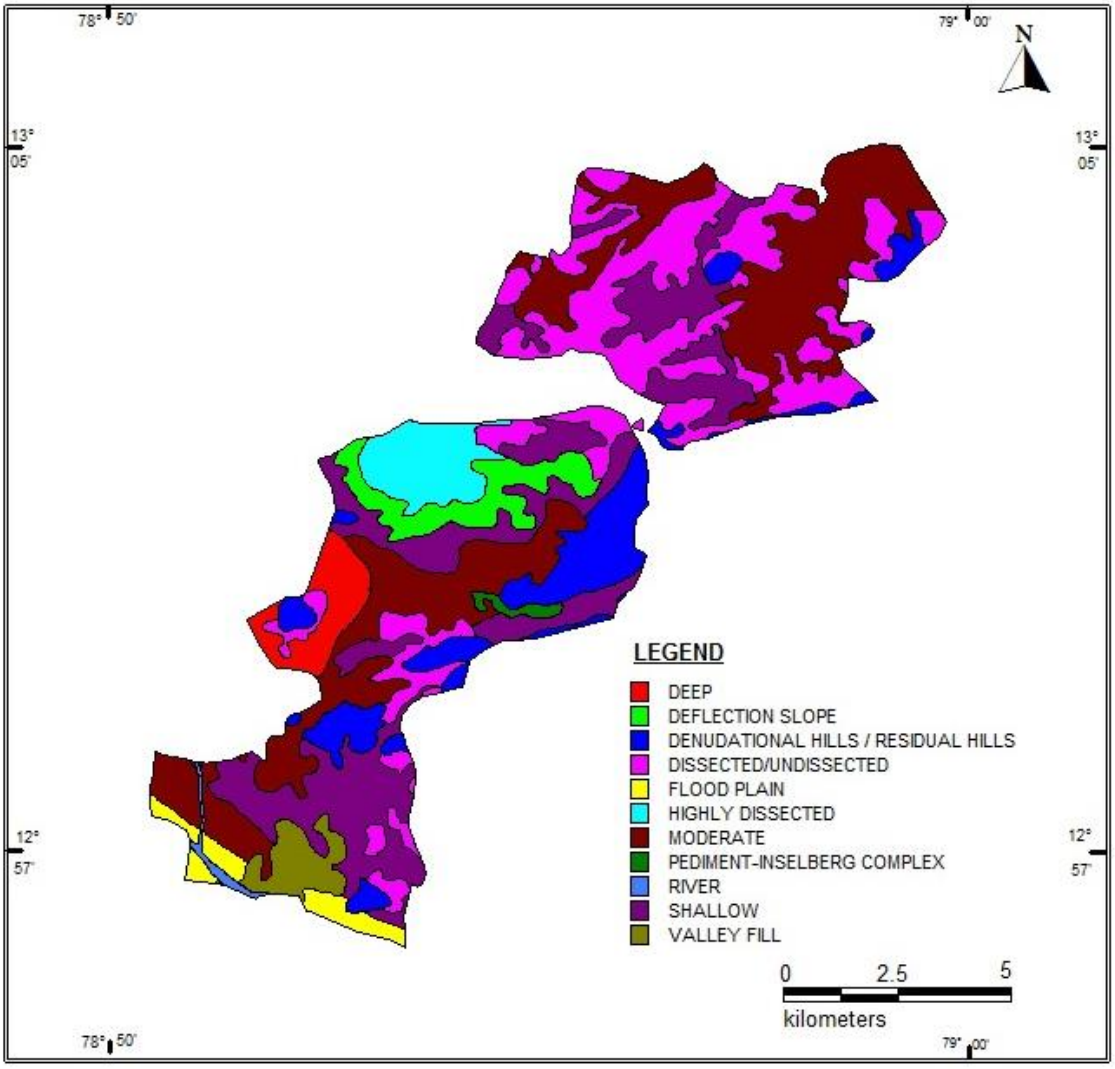


Figure 2. Geomorphology of Gudiyatham East firka

3.3 Land use and soil

The land use pattern of the Gudiyatham East Firka is given in figure 3. Predominantly the most of the area is characterised by the plantation, wet crop and dry crop (i.,e agricultural field)and accounts for 56.77 % of the total area of the firka (Source: IRS, Anna university, Chennai Tamil Nadu). This area is highly suitable for water conservation and recharge. The entire Firkas is occupied by alluvial with loamy soil.

S.No.	Land Use	%
1	Barren Rocky	0.09
2	Salt affected	0.18
3	Forest Blanks	0.23
4	River	0.44
5	Plantation Forest	0.50
6	Land without Scrub	0.91
7	Tanks	1.14
8	Town/City	3.14
9	Villages	4.55
10	Fallow	4.74
11	Other Forest	5.89
12	Scrub Forest	6.14
13	Dry Crop	6.51
14	Deciduous	6.75
15	L with Scrub	8.54
16	Wet Crop	24.67
17	Plantation	25.59
		100

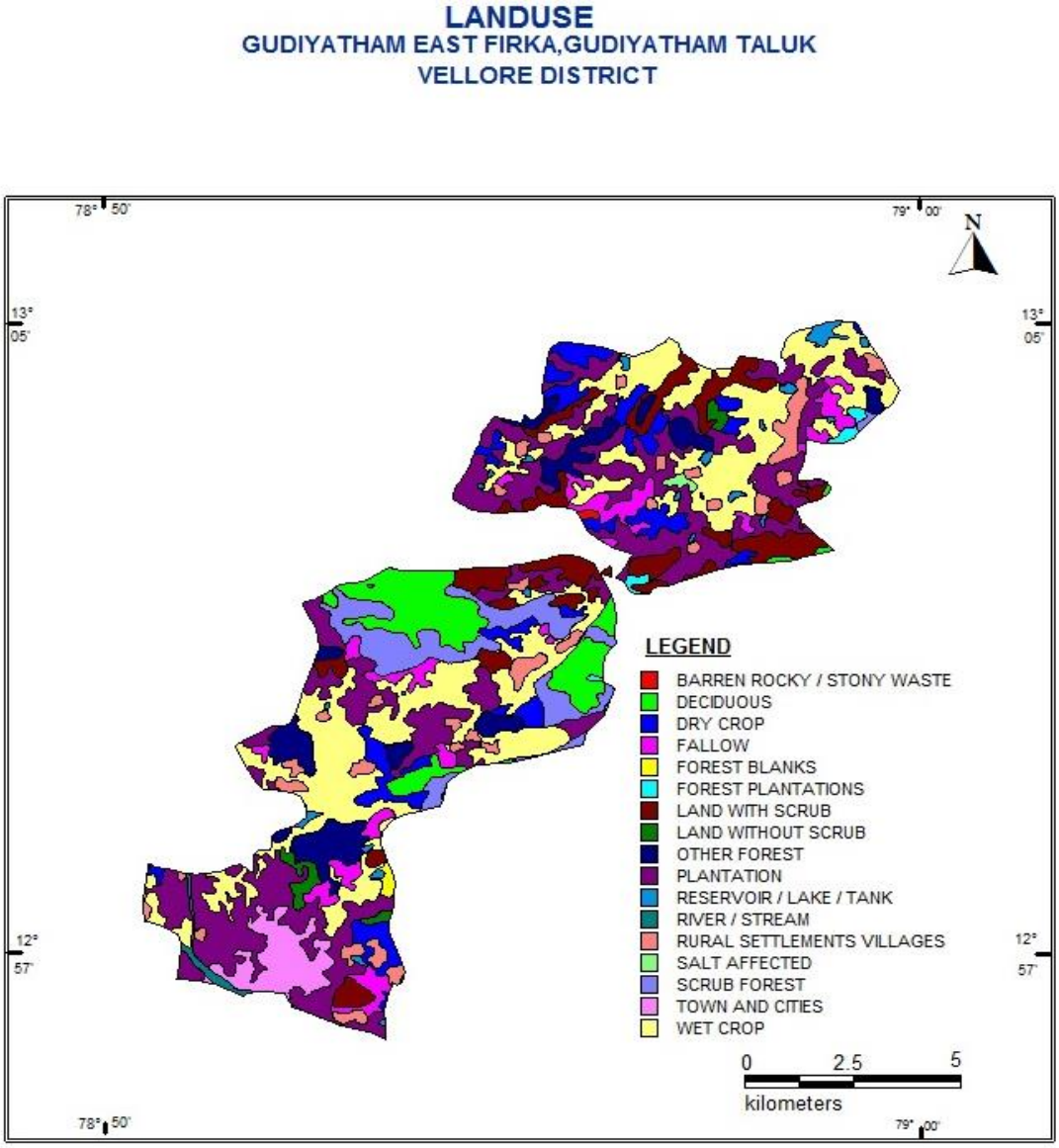


Figure 3. Landuse map of Gudiyatham East Firka

3.4 Drainage

The entire Firka area is within the Palar river basin. Number of small streams like Kanaru originates from the hills located in the NE of the Gudiyatham East firka .Only seasonal floods inundate lower parts of the basins. Basin sub soil water is used to irrigate the lands. Tanks and surface water bodies are spread over the entire firka. The drainage pattern is the dendritic and parallel. The drainage map of Gudiyatham East firka is given in Fig 4.

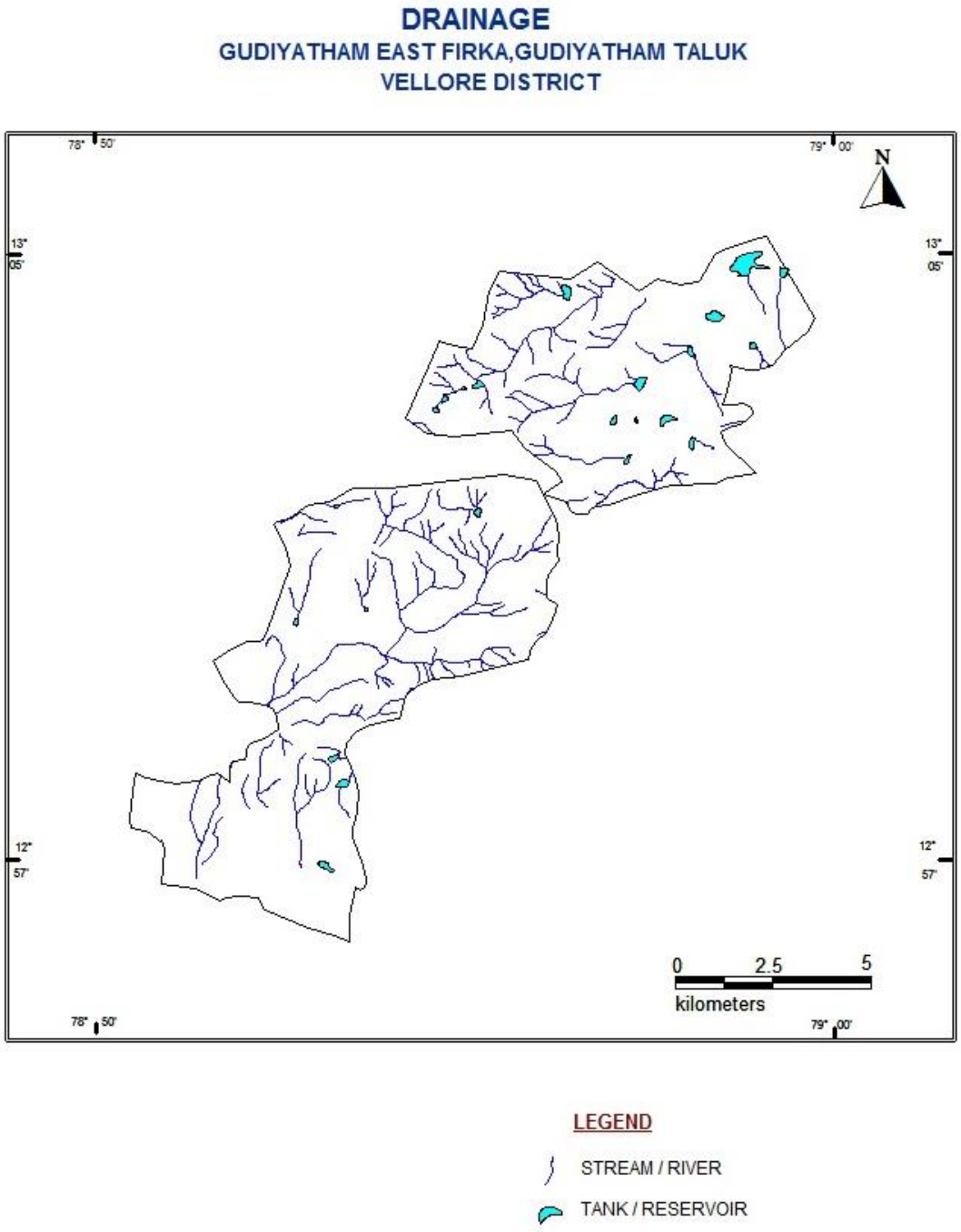


Figure 4.Drainage map of Gudiyatham East Firka

3.5 Rainfall

Gudiyatham East area falls under tropical climate with temperature in the summer months of March to May. The average temperature varies from 26 to 41° C. The humidity is also high in the order of 80%. The wind speed is high during the months of July and August. The wind speed ranges from 7.4 to 12.6 km/hr, which increases from 100 to 120 km/hr during cyclone period. Gudiyatham East Firka receives rainfall from southwest monsoon (June – September), northeast monsoon (October – December) and non-monsoon periods (January – May). The area receives the major rainfall from northeast monsoon. Rainfall is generally heavy during low-pressure depressions and cyclones during the northeast monsoon period. The normal annual rainfall is 1009 mm and the higher is towards coastal, east part of the firka.

Taluk	Name of Firkas	Area in sq.km	Monsoon rainfall (Jun to Dec) In m	Non monsoon rainfall (Jan – May) In m	Total Rainfall In m
Gudiyatham	Gudiyatham	82.46	0.868	0.141	1.009

3.6 Hydrogeology

Almost entire firka is underlain by the crystalline metamorphic gneiss complex consisting gneiss, Epidote-Hornblede gneiss and basic intrusive rocks.Near the river and in south western parts recent alluvium made up of Sand and Silt is prevalent. Ground water is occurring in pheratic conditions in weathered and fractured gneiss rock formation.The weathering is highly erratic and the depth of abstraction structures is controlled by the intensity of weathering and fracturing.Large diameter dug well is more common ground water abstraction structures in the area. The diameter of the dug well is in the range of 7 to 10 m and depth of dug wells range from 15 to 18 m bgl. The dug wells yield up to 1 lps in summer months and few wells remains dry. The yield is adequate for irrigation for one or two crops in monsoon period.

The depth of wells varies from 6.64 to 17 m bgl. The present water levels in the firka is in the range of 2.7 to 4.7 mbgl during pre- monsoon (May 2015) and from 1.2 to 5.6 mbgl during post monsoon (January 2016). The hydrogeological map of Gudiyatham East firka is given in Figure 5. Decadal mean water level ofpre-monsoon and post monsoon are given in fig 6a & b.

HYDROGEOLOGY
GUDIYATHAM EAST FIRKA,GUDIYATHAM TALUK
VELLORE DISTRICT

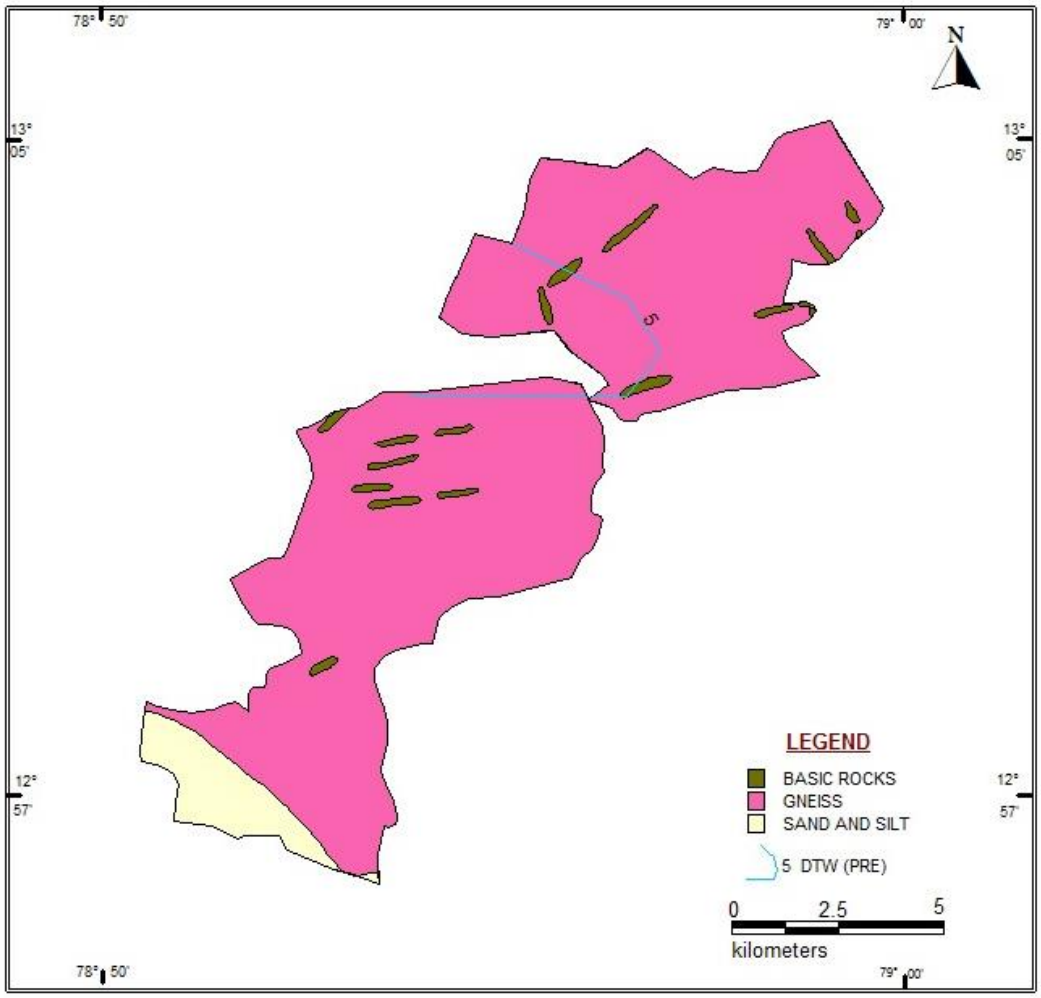


Figure-5Hydrogeological Map of Gudiyatham East firka

DEPTH TO WATER LEVEL MAP (PRE MONSOON)
GUDIYATHAM EAST FIRKA,GUDIYATHAM TALUK
VELLORE DISTRICT

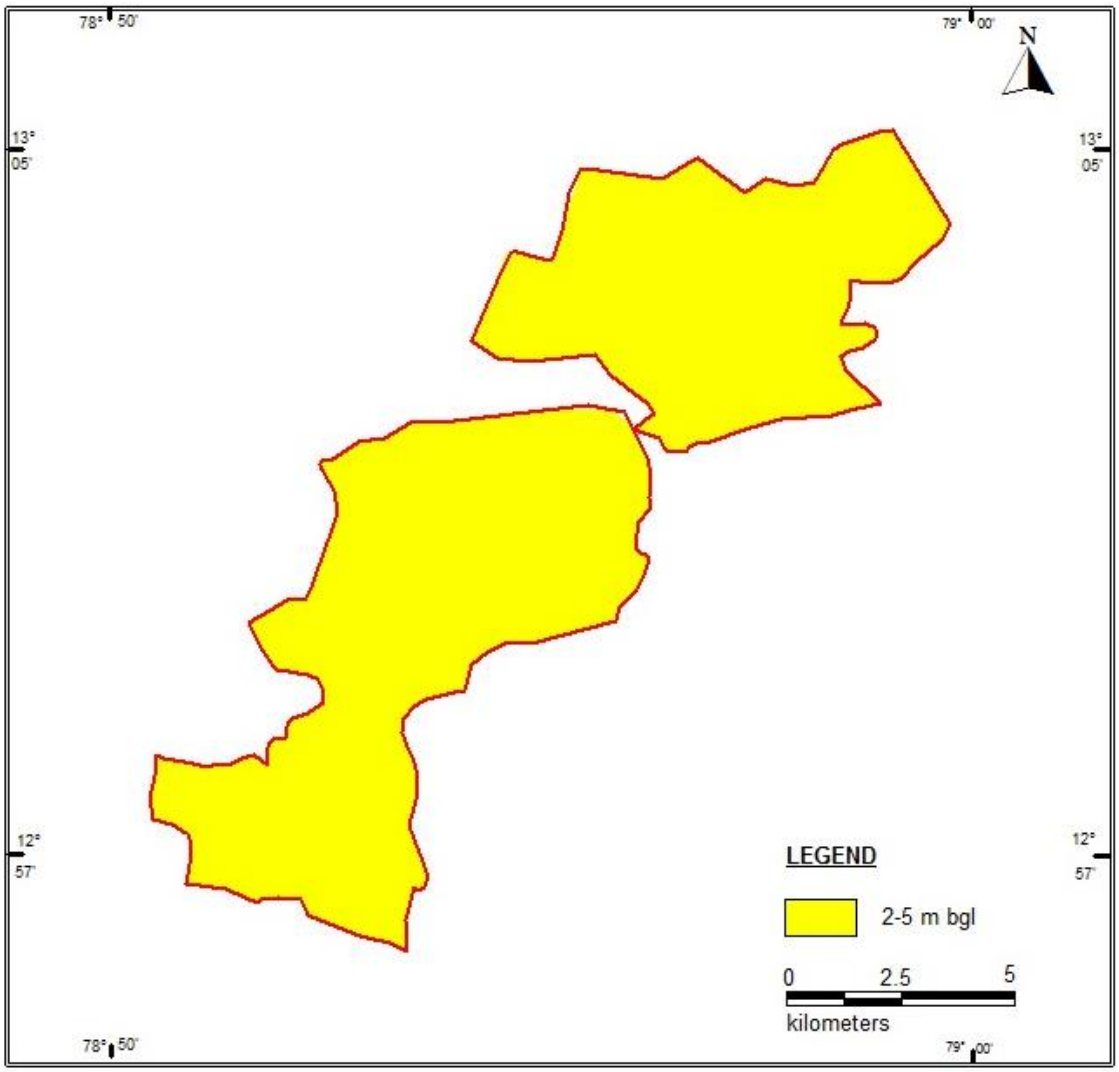


Figure 6a. Pre-monsoon Decadal water level in Gudiyatham East firka

DEPTH TO WATER LEVEL MAP (POST MONSOON)
GUDIYATHAM EAST FIRKA,GUDIYATHAM TALUK
VELLORE DISTRICT

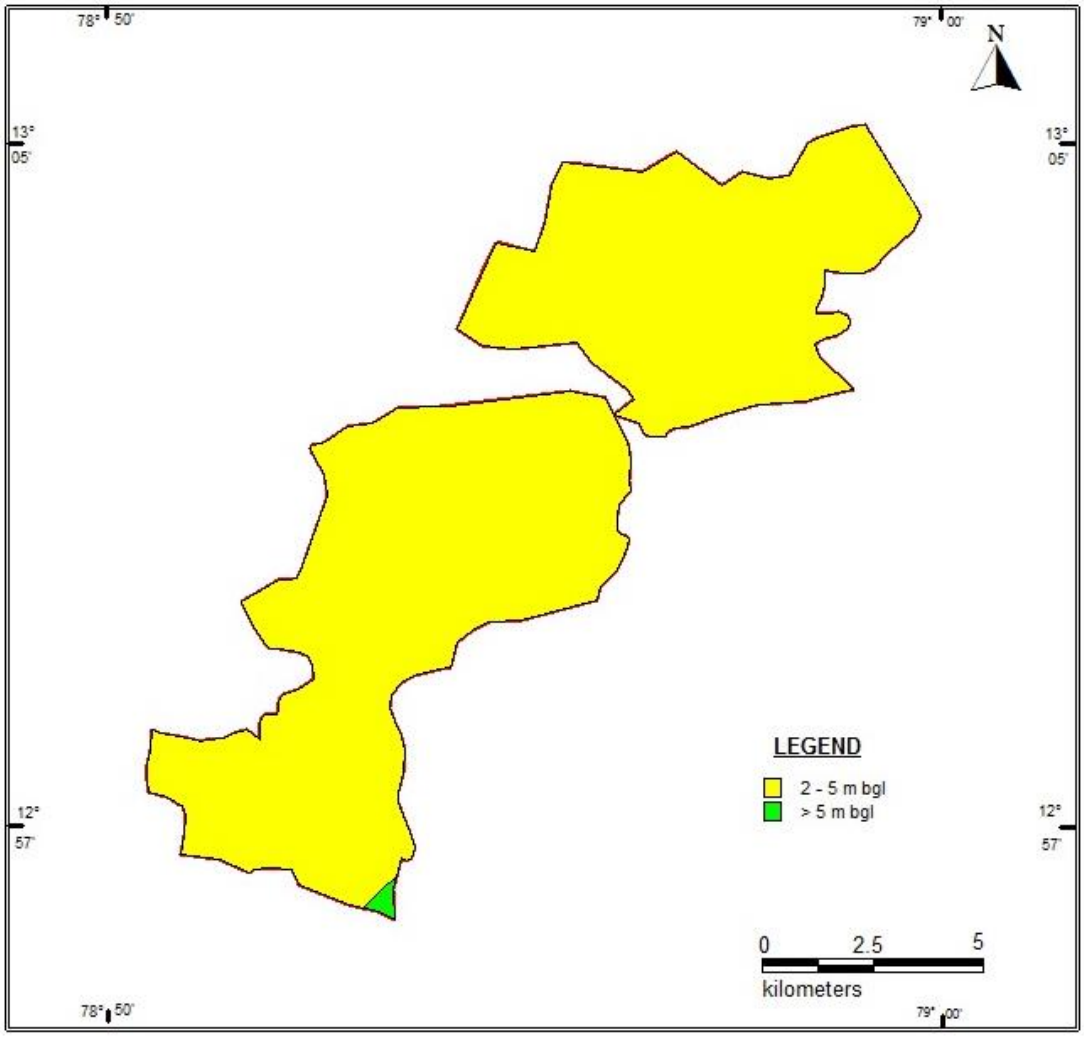


Figure 6 b. Post-monsoon Decadal water level in Gudiyatham East firka

3.7 Dynamic Ground water Resources

The ground water resources have been computed jointly by Central Ground Water Board and State Ground Water Resources Data Centre (PWD, WRO, Govt. of Tamil Nadu) as on 31st March 2011. The computation has been done using GEC1997 methodology. The salient features of the computations are furnished in table 2.

Table 2. Dynamic Ground water resources estimation of Gudiyatham East firka

Firka	GW WORTHY AREA	REPLENISHABLE GROUND WATER RESOURCES	NET GROUND WATER AVAILABLE	GROUND WATER DRAFT FOR IRRIGATION	GROUNDWATER DRAFT FOR DOMESTIC & INDUSTRIAL WATER SUPPLY	TOTAL GROUND WATER DRAFT	STAGE OF GROUND WATER DEVELOPMENT (%)	CATEGORY
	(Sq.Km)	(In MCM)					%	
Gudiyatham	82.46	10.26	9.23	14.50	1.90	16.40	177.68	OVER EXPLOITED

4. Spatial Data Integration

The potential area for groundwater recharge is highly influenced by Geology, Geomorphology, Land use /land cover, Drainage, Surface Water Body, Weathered Thickness and first fractured Depth in the area. In order to ascertain the suitable area for groundwater recharge in firka, spatial data integration of have been attempted using index overlay model in GIS environ. In this model,aboveseven layers have been integrated, assigningweightage andfor the theme having scale of 1-100 and sub-classes of the theme between 1 to 10 scales.The resultant map has been reclassified into four classes(High-low integrated values) indicating the suitable area for artificial recharge and given in fig-7 and described below.

ZONE	% OF AREA COVERAGE	SIGNIFICANCE*
Very high	0.44	Suitable for all major recharge structures like Percolation pond and stop dam, check dam etc.,
High	14.74	Suitable for all major recharge structures like stop dam, check dam etc.,
Moderate	48.95	Suitable for all major recharge structures like earthen check dam, Boulder check dam and Nala bund etc.,
Poor	35.88	Hilly/Forest /Catchment area

*However, the filed verification is required to confirm above potential area for groundwater recharge.

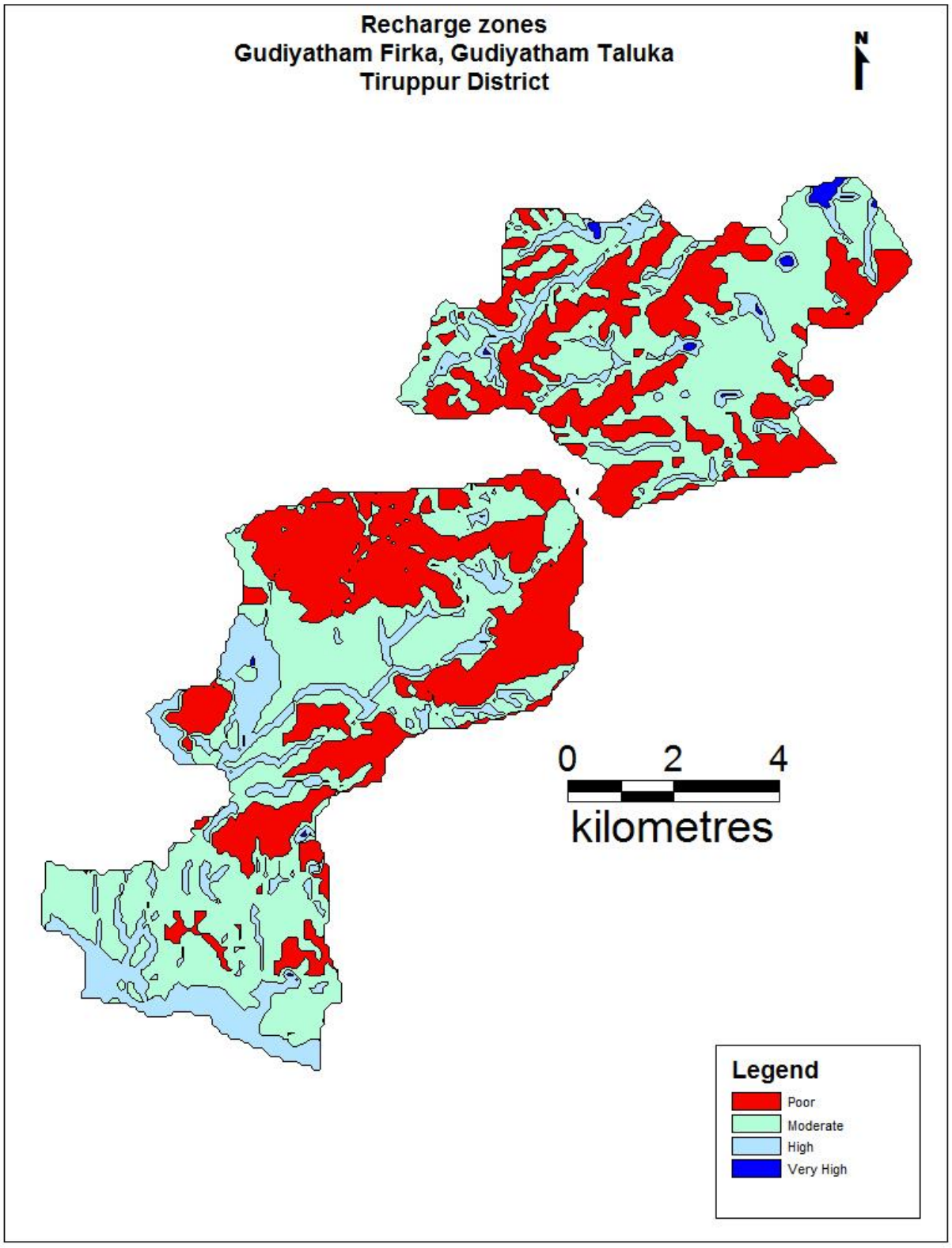


Figure 7showing the recharge worthy area Gudiyatham East firka

5. Planning for groundwater recharge /conservation

5.1 Justification of the artificial recharge & conservation measures

- The Gudiyatham East firka s is with high stage of groundwater development i.e, 177.68 % and with sufficient amount of uncommitted surface runoff/flow of 10.7362 MCM.
- The total weathered zone available beneath the ground in the firka is **13.6059** MCM. Out of this total volume available for recharge considering 3m depthis **3.7107**MCM.
- The Gudiyatham East firka consists of 27 surfacewater bodies which are well connected by the drainage. Out of this **13 numbers** were of the size of 0.250 sq.km, which are targeted for Revival and Recharge of these ponds will enhance the sustainability of the ground water abstraction structures.
- However, most of the ground water developments for agricultural purposes are met through dug-cum bore well and bore wells only. Hence, there is sufficient scope of recharge exists.
- Model generated in the Gudiyatham East areas reveals that about **64** % of areas are suitable for recharge including moderate area.
- In Gudiyatham East firka more than 56 % area is characterised by the agricultural activities, there is sufficient scope for the water conservation measures for enhance the crop production and better ground water development.

5.2 Availability of surplus surface water for artificial recharge or conservation

The uncommitted surface flow for Gudiyatham East firka is estimated as per the norms followed by State Ground & Surface Water Resources data centre, PWD, Taramani, Chennai. The available of surplus surface water for Gudiyatham East firka is 10.7362 MCM.

5.3 Proposed interventions including tentative location of artificial recharge /conservation measures

On basis of above description the following three type of approach have been made to propose artificial recharge or conservation structures.

a. Artificial recharge
b. Water conservation measure
c. Water Efficiency

5.3.1 Artificial recharge

The details of artificial recharge structure proposed along with justification are given below.

5.3.1.1 Check dam/Nala bund

Gudiyatham East firka area is covered by the seasonal nallahs/drains which carry heavy discharge during monsoon period. As per the integrated model prediction around **64 %**of the firkas areas are suitable for these structures. It is proposed to construct **16** Check dam and **23** Nala bunds. The tentative location of these **39** ARs are given below and shown in Plate 1. The location of these structures are tentative and details field survey is essential to ascertain the exact size and location.

Tentative location of proposed **16** Check dam in Gudiyatham East firka

S. NO.	LONGITUDE	LATITUDE	TYPE OF ARS
1	78.969660	13.059707	Check Dam
2	78.933944	13.049344	Check Dam
3	78.939658	13.051200	Check Dam
4	78.943309	13.054448	Check Dam
5	78.921244	13.057387	Check Dam
6	78.927911	13.060635	Check Dam
7	78.940611	13.070379	Check Dam
8	78.909180	13.009595	Check Dam
9	78.921086	13.015782	Check Dam
10	78.916482	12.993974	Check Dam
11	78.880448	13.004182	Check Dam
12	78.858225	12.952060	Check Dam
13	78.872035	12.963196	Check Dam
14	78.883941	12.964433	Check Dam
15	78.914577	13.054139	Check Dam
16	78.930769	13.074245	Check Dam

Tentative location of proposed **23** Nalla bund in Gudiyatham East firka

SL.NO	LONGITUDE(DD)	LATITUDE (DD)	TYPE OF ARS
1	78.983153	13.075173	Nala Bund
2	78.987280	13.075173	Nala Bund
3	78.970771	13.042539	Nala Bund
4	78.961088	13.060635	Nala Bund
5	78.964580	13.064347	Nala Bund
6	78.937912	13.066667	Nala Bund
7	78.936801	13.066048	Nala Bund
8	78.922514	13.058933	Nala Bund
9	78.917593	13.057696	Nala Bund
10	78.902672	13.006966	Nala Bund
11	78.882353	13.008977	Nala Bund
12	78.900132	12.993046	Nala Bund
13	78.872353	12.972476	Nala Bund
14	78.856479	12.961185	Nala Bund
15	78.860606	12.957937	Nala Bund
16	78.889814	12.962886	Nala Bund
17	78.887274	12.987633	Nala Bund
18	78.951564	13.068368	Nala Bund
19	78.949341	13.065584	Nala Bund
20	78.933626	13.051819	Nala Bund
21	78.936801	13.057387	Nala Bund
22	78.960136	13.035115	Nala Bund
23	78.862035	12.956081	Nala Bund

5.3.1.3. Revival, repair of water bodies

The existing ponds and tanks in loose their storage capacity as well as the natural ground water recharge through these water bodies has also become negligible due to siltation and encroachment by farmers for agriculture purposes. There are several such villages where ponds/ tanks are in dilapidated condition. These existing village tanks which are normally silted and damaged can be modified to serve as recharge structure in case these are suitably located to serve as percolation tanks. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure. Several such tanks are available in the area which can be modified for enhancing ground water recharge. Studies, however, are needed to ascertain whether the village tanks are suitably located to serve as recharge structures. The locations of about 13 existing ponds/tanks have been identified with latitude and longitude and are given below and marked on Plate-I. The 13 tanks/ponds could be taken up for the renovation with recharge shafts.

Tentative location of proposed de-siltation of pond/tanks with recharge shaft in Gudiyatham East firka .

Sl.NO	LONGITUDE	LATITUDE	STRUCTURE	ACTION
1	78.982	13.064	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
2	78.968	13.063	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
3	78.917	13.054	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
4	78.913	13.052	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
5	78.980	13.051	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
6	78.911	13.049	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
7	78.951	13.048	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
8	78.956	13.048	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
9	78.954	13.039	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
10	78.889	13.028	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
11	78.896	13.006	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
12	78.880	13.003	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT
13	78.936	13.001	TANK / RESERVOIR	DESILTATION AND RECHARGE SHAFT

5.3.2 Water conservation measure

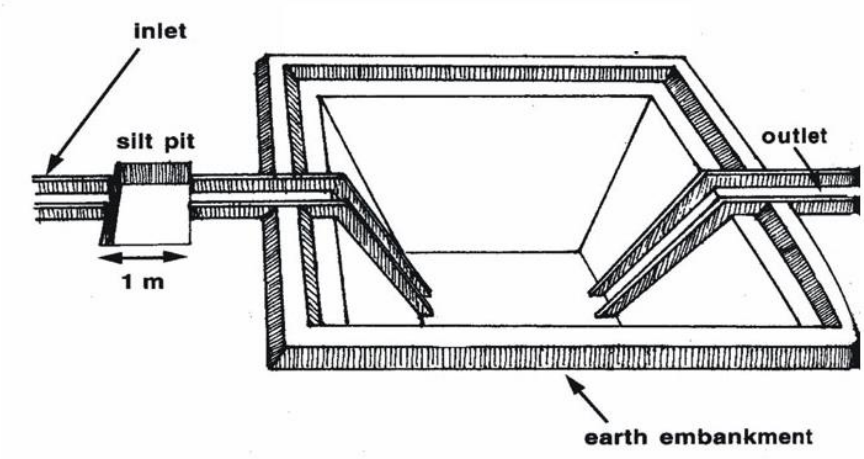
5.3.2.1 Farm Pond

A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rainwater and stores it for future use. It has an inlet to regulate inflow and an outlet to discharge excess water. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. The size and depth depend on the amount of land available, the type of soil, the farmer's water requirements, the cost of excavation, and the possible uses of the excavated earth. Water from the farm pond is conveyed to the fields manually, by pumping, or by both methods.

Advantages of Farm Ponds

- They provide water to start growing crops, without waiting for rain to fall.
- They provide irrigation water during dry spells between rainfalls. This increases the yield, the number of crops in one year, and the diversity of crops that can be grown.
- Bunds can be used to raise vegetables and fruit trees,thus supplying the farm household with an additional source of income and of nutritious food.
- Farmers are able to apply adequate farm inputs and perform farming operations at the appropriate time, thus increasing their productivity and their confidence in farming.
- They check soil erosion and minimize siltation of waterways and reservoirs.
- They supplies water for domestic purposes and livestock
- They promote fish rearing.
- They recharge the ground water.
- They improve drainage.
- The excavated earth has a very high value and can be used to enrich soil in the fields, levelling land, and constructing farm roads

As per the Landuseclassification of the firka, majority of the area is covered by the agricultural field. Hence it is proposed to construct 50 farm ponds as per the specification of AED, Govt. of Tamil Nadu (30 x 30 x 1.5 m).



5.3.2.2. Micro Irrigation System (Sprinkler/ drip/ HDPE pipes)

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line

In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant. While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The studies on different crops, has revealed that irrigation water is saved drastically. The conveyance losses (mainly seepage & evaporation) can be saved up to 25 to 40% through utilization of HDPE pipes. Initially the scheme is proposed to be implemented in worst affected areas showing deepest water levels and significant declining trends.

It is proposed to take up micro irrigation system in **50 ha**. The cost estimation for this component has been taken from SOR of Agricultural Engineering Department (AED), Govt. of Tamil Nadu.Tentativelocations of proposed micro irrigation are shown in Plate 1.

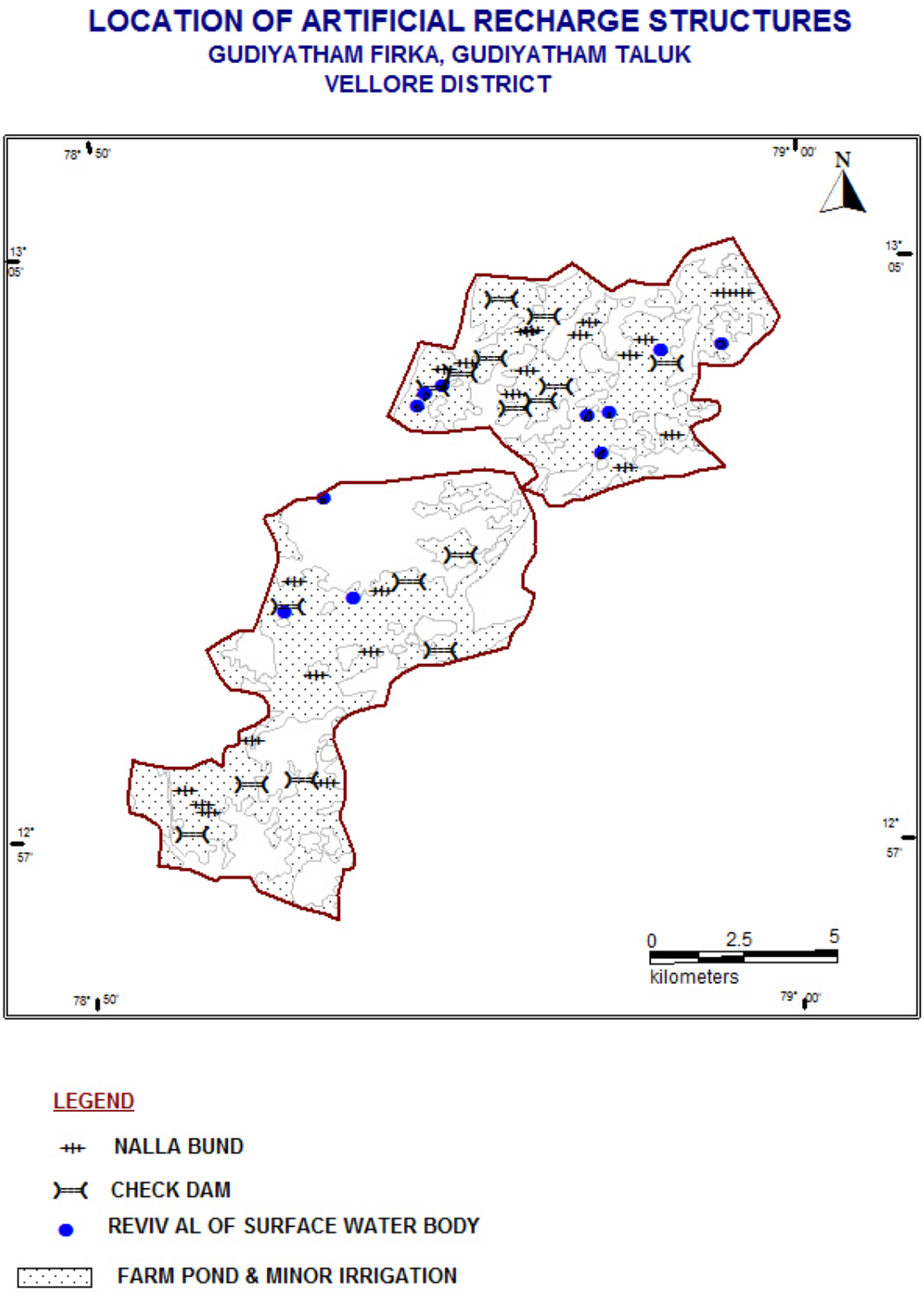


Plate 1. Location map showing the proposed AR Structures in Gudiatham firka

6. Tentative Cost Estimation

The tentative number of feasible structures, its cost and expected annual groundwater recharge/water saving is given in the table 7. The unit rates are as followed by the PWD, Govt. of Tamilnadu (Sources: Scheduled rates, Govt. of Tamilnadu 2015).

Table 7. Showing the Cost Estimation of proposed Artificial Recharge Structures

Feasible Artificial Recharge & Water Conservation structures/ activities	Tentative Design	quantity (in nos. or area in sq. m)	Total volume (cu.m)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs lakh)	Expected Annual GW recharge/Saving (cu.m)
Recharge Structures/ Activities						
Masonry Check dams (5 Fillings)	Crest- 10 -15 m; Height- 1.0 m to 1 .5 m	16	3400 (80%)	9.0	144	217600
Nala bunds/ Gabion (4 Fillings)	Width: 5 to 15 m	23	750 (80%)	2.0	46	55200
Revival, repair of water bodies (3 fillings)	(~150 m x150 m x1.5m)	13	33750 (80%)	25.0	325	1053000
Recharge shaft within the pond /tanks	Shaft = 1.5 m dia x 2m depth with filter media in lower 1 m . Bore dia =10", Casing = 6" Depth = 30 m)	13		2.0	26	
Farm Pond (in ha)(5 filling)	(30 m x 30m x 1.5 m)	50 unit	1200(85%)	1	50	300000
			Sub Total		**591**	**1625800**
Water Conservation Activities						
Sprinkler/ drip/ HDPE pipes	For 1 ha with 5 m interval HDPE pipe	50 ha		0.6 /ha	30	350000
			Total		**621**	**1975800**
Impact assessment and O & M						
Piezometers Up to 50 mbgl – 2 nos. @ 0.6 lakh (Impact assessment to be carried out by the implementing agencies)					**1.2**	
Total cost of the Project					**622.20**	
Add 5% for O & M on total cost of the scheme					**31.11**	
Impact assessment to be carried out by the implementing agencies @ 5% of Total cost					**31.11**	
				TOTAL	**684.42**	

Note:

- The type, number and cost of structure may vary according to site, after the ground truth verification.
- CD, PC- the storage of Check-dams and percolation ponds is also proposed for irrigating the surrounding areas for enhancing the groundwater recharge as well as effective utilization of the artificial recharge structures.

7. Implication modalities

The implementation of the scheme will be done by the line department of the state selected by the respective State authority. Further, it is to add that more than 50 % MGNREGA works related to water conservation/sustainable management,accordingly a convergence guideline has been made between NationalRural Employment Guarantee Act (NREGA) (Ministry of Rural Development) & Programmes of Water Resources (MoWR , RD & GR).The details of permissible works under convergence are envisaged in the Joint Convergence Guideline.

a.) Time schedule

Steps	1st Quarter	2th Quarter	3rd Quarter	4th Quarter	5th Quarter	6th Quarter	7th Quarter	8th Quarter
❖ Identification of line department /implementing agency and preparation of DPR								
❖ Approval of scheme and release of sanction of funds								
❖ Implementation of ARS								

Phase = one quarter or 3 months or equivalent to financial quarter

b.) Operation and maintenance

In all projects Impact assessment has to be carried out to ensure that projects is economically viable, socially equitable and environmentally sustainable by inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Accordingly it is proposed to have impact assessment at the rate of 5 % of the total cost of the project for 5 years from the completion of artificial recharge structures.