केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

AQUIFER MANAGEMENT PLAN

Parts of South Tripura District, Tripura

उत्तरी पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

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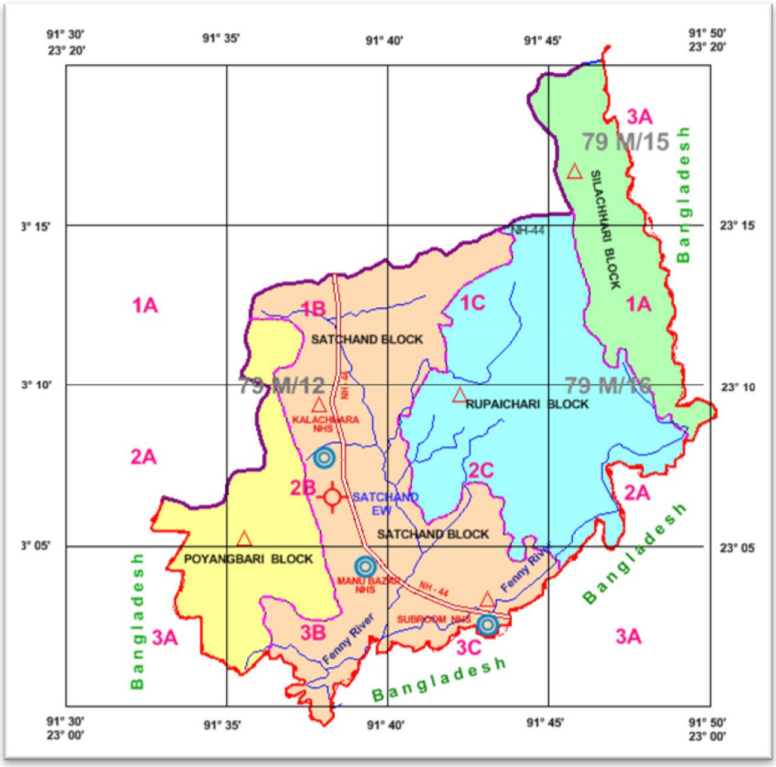
Govt. of India
Central Ground Water Board
Ministry of Water Resources, River Development & Ganga Rejuvenation

REPORT ON
AQUIFER MANAGEMENT PLAN
IN PARTS OF SOUTH TRIPURA DISTRICT, TRIPURA



State Unit Office
Agartala
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1. Introduction

1.1 Objectives :

The ground water development in the North Eastern Region of India, particularly in the State of Tripura, is in nascent age. However, with the spurt of developmental activities, the traditional methods of water supply are gradually lagging behind the rising water demand. To address this issue, it is pertinent to decipher the existence, numbers, depths and disposition of the potential aquifers and then to understand the occurrence and movement of ground water i.e. to unfold the total scenario of the sub-surface formations in respect to availability of extractable ground water and finally formulate a complete, sustainable and effective plan for water management at micro level as well as macro level.

1.2 Scope of the Study :

The activities of the Aquifer Mapping and Management Program can be envisaged as follows:

1. Data Compilation & Data Gap Analysis: One of the important aspect of the aquifer mapping programme was the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were assembled, analysed, examined, synthesized and interpreted from available sources. These sources were predominantly non computerized data, which was converted into computer based GIS data sets. On the basis of available data, Data Gaps were identified.

2. Data Generation: There was also a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This was achieved by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing, besides detailed hydrogeological surveys to delineate multi aquifer system; to bring out the efficacy of various geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environs.

3. Aquifer Map Preparation: On the basis of integration of data generated from various studies of hydrogeology & geophysics, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out Characterization of Aquifers, which can be termed as Aquifer maps providing spatial variation (lateral & vertical) in reference aquifer extremities, quality, water level, potential and vulnerability (quality & quantity).

4. Aquifer Management Plan Formulation: Aquifer Maps and ground water regime scenario will be utilized to identify a suitable strategy for sustainable development of the aquifer in the area.

1.3 Approach and Methodology : Aquifer mapping has been carried out by adopting a multi-disciplinary approach :

(i) Geophysical Surveys through Vertical Electrical Sounding (VES),

(ii) Exploratory drilling and construction of tube wells tapping various groups of aquifers,

(iii) Ground Water Regime monitoring by establishing monitoring wells tapping different aquifers at different depths for long term monitoring of water level and quality,

(iv) Pumping test, soil infiltration test, specific yield determination, slug tests for determination of ground water recharge scope, intensity and potentials and also to determine the characteristics and performances of existing aquifers at various depths

(v) Collection of various relevant technical data from the field in aquifer mapping area and also from the concerned State Govt. Agencies and other Institutes dealing with ground water and incorporating these data along with CGWB data for final output.

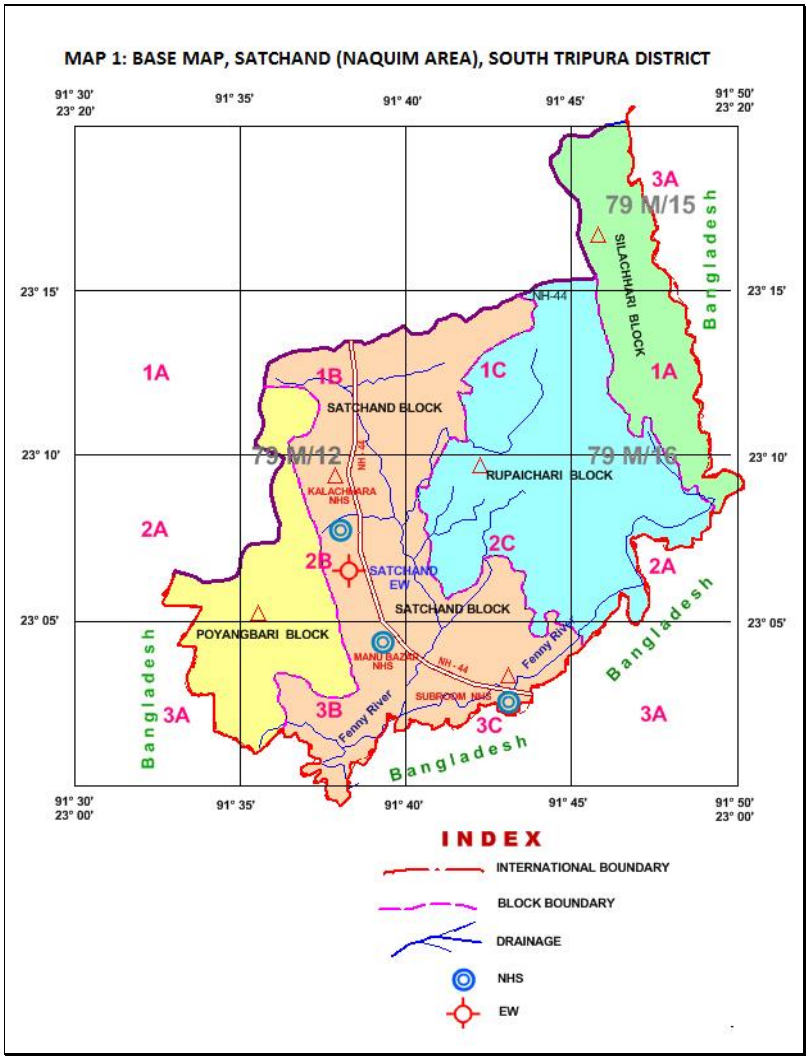
(vi) Preparations of a micro level mapping of existing aquifers, their potentials depth wise and sideways in 2D and 3D forms viewed from different angles by various GIS Layers.

1.4 Area Details :

Central Ground Water Board, NE Region had taken up aquifer mapping under National Aquifer Mapping Programme (NAQUIM) under which the work of aquifer mapping and management has been taken up in Annual Action Plan 2014ï 15 of SUO, Agartala for an area of 559.65 sq. km. covering the blocks of Satchand, Poyangbari, Rupaichari and Silachhari (collectively comes under 2 former blocks of Satchand and Rupaichhari and even before under undivided Satchand block) of Sabroom Sub-Division, South Tripura district in order to delineate the available aquifers in this far flung area of Tripura bordering Bangladesh. The area has around 74 villages and 2 small towns (Sabroom & Manu Bazar) with a population of 1,42,311 dominated by SC, ST and OBCs.

The aquifer mapping area lies in the southernmost part of South Tripura District and Tripura State as well and is confined within North Latitudes 23^0 00ô and 23^0 20ô and East Longitudes of 91^0 33ô and 91^0 50ô. The area is falling partly or fully in 11 nos. of Quadrants in the Survey of India Toposheets bearing nos. **79 M/12 (8** Quadrants)**, 79 M/15 (1** Quadrant) **& 79 M/16 (2** Quadrants) and is bounded in the southwest, south and east by the international boundary with Bangladesh, in the west by Hrishyamukh block and in the north by Jolaibari block of South Tripura district and Karbook block of Gomti district. Map 1 depicts the base map of the NAQUIM area.

The aquifer mapping area is characterized by various geological formations ranging in age from Upper Tertiary to Recent. The assemblages of different formations play important role in controlling occurrence, distribution and movement of ground water.



1.5 Data Availability & Data Adequacy before conducting Aquifer Mapping:

Present aquifer mapping area may be called as almost a virgin one in terms of geophysical studies, exploratory drilling and development of ground water. However, the sparsely available meager data are as follows:

- **Exploration Data** : There are only 1 (one) exploratory well and 1 (one) deposit well in the aquifer mapping area, which were constructed by CGWB in Satchand block at Satchand and at Manu Bazar respectively, which fall in 2B quadrant of Toposheet - 79 M/12. The exploratory drilling for construction of the Exploratory Well at Satchand was conducted up to the depth of 253.40 m and for the Deposit Well at Manu Bazar was conducted up to 233 m bgl. Details of these drilling operations, aquifer parameters are furnished in the Table (Data Sheet ï 2).

There is no exploration in the Toposheets 79 M/15 (only one quadrant i.e. 3A comes under the mapping area and the rest of the quadrants are either falling in Bangladesh or in other blocks of Tripura outside stipulated mapping area) and 79 M/16

(only 2 quadrants - 1A & 2A come under the mapping area and rest of the quadrants are falling in Bangladesh) due to extremely poor communication and sporadic habitations in these areas owing to existence of hilly and/or forest terrain.

There are some reported ground water structures, which might be constructed long back by the State Agencies, which might not be properly documented as in spite of solicitation no technical data have been received from the State Departments.

- **Geophysical Survey (VES) Data**: Neither CGWB nor the State Govt. Departments have conducted any VES survey in this area till date. However, CGWB had carried out Geophysical Electrical Logging in the naked borehole during construction of Exploratory Well at Satchand in 1979.

- **Ground Water Level Monitoring Data :** CGWB has 3 (three) water level monitoring stations (NHNS) at Kalachhara, Manu Bazar and Sabroom, all in Satchand block, where water levels are measured 4 times in a year. All these 3 stations are falling in Toposheet no. 79 M/12. State Ground Water User Departments, viz. PWD (WR), PWD (DWS) do not have any periodic ground water level monitoring station.

- **Ground Water Quality Monitoring Data**: CGWB collects water samples from 3 monitoring stations (NHNS) once (Pre-monsoon) in a year and carries out physical and chemical analysis in its own laboratory.

Therefore, the presently available sub-surface data /information related to the presence, dimension, relative disposition, character and ground water potential of aquifer zones and the ground water level and quality data in the Satchand aquifer mapping area are certainly inadequate. Thus the data adequacy is very low here.

1.6 Data Gap Analysis & Data Generation :

1.6.1 Data Gap Analysis:

- **Exploration Data Gap :**

CGWB, NER has constructed 1 (one) exploratory well and 1 (one) deposit well in the 2B quadrant of Toposheet no. 79 M/12 only. Based on this drilling work, very scanty hydrogeological data have been gathered. Due to the approachability problem of the rig owing to hilly terrain or for presence of reserve forest area under regulations, all the pertinent quadrants (11 Nos.) from 3 nos. of Toposheets could not be covered by exploratory drilling of CGWB and thus a huge gap of exploration data was prevailing earlier in the rest 10 quadrants in terms of non-availability of information about the aquifer dimensions, geometry and the parameters like Transmissivity, Storativity etc.

- **VES and Profiling Data Gap :**

Data gap related to Resistivity Surveys i.e. VES and Profiling was extended over the whole aquifer mapping area containing parts of the Toposheets Nos. ï 79 M/12, 79 M/15 &

79 M/16, as no such Geophysical survey had ever been carried out by CGWB or by any State Govt. Departments in any of the 11 relevant quadrants.

- **Ground Water Level Monitoring Data Gap :**

Only 3 nos. of Ground Water Monitoring Stations, i.e. NHNS (all dug wells) at Sabroom, Manu Bazar and Kalachhara in Toposheet No. 79 M/12 were existing in the mapping area, which were confined within only 3 contiguous quadrants 2B, 3B & 3C. Thus, Ground Water Level Monitoring was prevailing in the major area of mapping, as no Ground Water Level Monitoring station exists in the other 8 quadrants.

- **Ground Water Quality Monitoring Data Gap :**

All the 3 National Hydrograph Network Stations are falling in a small contiguous strip-like area confined within a single Toposheet ï 79M/12. Therefore, the Ground Water Quality Monitoring Data gap was huge and spread all over mapping area.

1.6.2 Recommendation on Data Generation :

The following quantity of various kinds of data had been suggested to be generated :

- **Recommendation for Exploration :**

The thickness of Aquifer Group - I, i.e. the shallow aquifer hugely varies laterally as well as vertically and the depth ranges from 3 to 50 m. Whereas the Aquifer ï II i.e. the deeper aquifer is existing generally below 50 m bgl, which is very thick, invariably persistent up to the explored depth achieved so far (253 m bgl) and mostly devoid of any distinct, thick and separating clay/shale layers/beds.

According to the data gap analysis, 3 nos. of Special Purpose Wells (SPW) (1 each in quadrant 3A, 1C and 3C of toposheet 79 M/12 piercing both Aquifer Group ï I & Aquifer Group ï II) have to be constructed. Whereas for the quadrant 2B of toposheet 79 M/12, 1 no. of Exploratory Well (EW) and 1 no. of corresponding Observation well (OW) in Aq. Group ï I and 1 no. of Observation Well corresponding to the already existing EW in Aq. Group ï II have to be constructed for generation of additional data. Another 1 no. of Special Purpose Well (SPW) exploring both the Aq. Gr. ï I & Aq. Gr. - II for the lone quadrant 3A of 79 M/15 and 1 no. of Special Purpose Well (SPW) exploring both the Aq. Gr. ï I & Aq. Gr. - II for quadrant 1A of 79 M/16 have to be constructed for filling up the exploratory data gap in this aquifer mapping area. So the construction of a total 8 nos. of wells (5 SPWs, 1 EW and 2 OWs) is being recommended for further exploratory data generation in Satchand aquifer mapping area as per the existing norm in this regard.

- **Recommendation for VES and Profiling:**

From the data gap analysis it appears that 20 nos. of VES (Composite for both Aq. Gr. - I & Aq. Gr. ï II, to be done at one go) for Toposheet No. 79 M/12; 3 nos. of VES for 79 M/15 and 6 nos. of VES for 79 M/16 are required mainly to ascertain the depth and thickness of the individual aquifers as per the recommended norms of additional data generation. Thus a total 29 numbers of VES (to ascertain depth of weathering in Aquifer Group ï I, which is extended to Aquifer Group ï II for exploring potential deeper semi-confined to confined aquifers) with a maximum electrode separation (AB) preferably ranging from 500 to 900 meter were recommended for geophysical data generation.

Recommendation for Ground Water Level Monitoring:

Based on data gap analysis and as per the recommended guidelines, 17 water level monitoring stations (13 for Aq. Gr. - I & 4 for Aq. Gr. - II) in Toposheet No. 79 M/12; 3 stations (2 for Aq. Gr. - I & 1 for Aq. Gr. - II) in toposheet 79 M/15 and 5 stations (4 for Aq. Gr. - I & 1 for Aq. Gr. - II) in Toposheet 79 M/16 had to be established additionally. As a whole, 19 more Monitoring Stations (Dug well/PZ) for Aq. Gr.ï I (Shallow) and 6 stations (PZ/OW) for Aq. Gr. - II (Deeper) i.e. total 25 nos. of water level monitoring wells covering the whole mapping area in a uniform manner were recommended to establish additionally for generation of sufficient Ground Water Level Data.

- **Recommendation for Ground Water Quality Monitoring:**

As per the suggested norm, 9 nos. of ground water quality monitoring stations (5 for Aq. Gr. - I & 4 for Aq. Gr. - II) in Toposheet 79 M/12; 2 stations (1 for Aq. Gr. - I & 1 for Aq. Gr. - II) in Toposheet 79 M/15 and 3 stations (2 for Aq. Gr. - I & 1 for Aq. Gr. - II) in Toposheet 79 M/16 were to be established additionally. Therefore, collectively 14 more Monitoring Stations, 8 Stations (Dug well/PZ) for Aquifer Group ï I (Shallow) and 6 stations (PZ/OW) for Aquifer Group - II were recommended to be established or constructed to cover the whole area for generation of ground water quality data.

Ground water sample for chemical analysis is collected once in a year i.e. only during pre-monsoon period. However, it was also recommended to collect and test the post monsoon water samples for examining the seasonal variation, if any, in the quantity of chemical constituents of ground water in this area due to rainfall recharge.

Additionally required data under exploratory drilling, geophysical survey, ground water level monitoring and ground water quality monitoring in respect of aquifer mapping in Satchand, Poyangbari, Rupaichari & Silachhari blocks of South Tripura District, Tripura are shown in the tables below and in map 2.

Toposheet No. 79 M/12 : Required number of structures to be constructed/established & surveys to be done

Quadrant No. under Mapping	No. of additional Exploratory Well required		No. of additional VES/TEM required		No. of additional ground water level monitoring stations required		No. of additional ground water quality stations required		Remarks
	Aq - I	Aq - II	Aq - I	Aq - II	Aq - I	Aq - II	Aq – I	Aq - II	
2A	--	--		1	2	--	1	--	
3A	--	1 SPW		1	2	1	1	1	
1B	--	--		3	2	--	1	--	
2B	1 EW + 1 OW	1 OW		3	1	1	--	1	
3B	--	--		3	1	--	--	--	
1C	--	1 SPW		3	2	1	1	1	
2C	--	--		3	2	--	1	--	
3C	--	1 SPW		3	1	1	--	1	
TOTAL	**1 EW + 1 OW**	**3 SPW + 1 OW**	**20**		**13**	**4**	**5**	**4**	

Toposheet No. 79 M/15 : Required number of structures to be constructed/established & surveys to be done

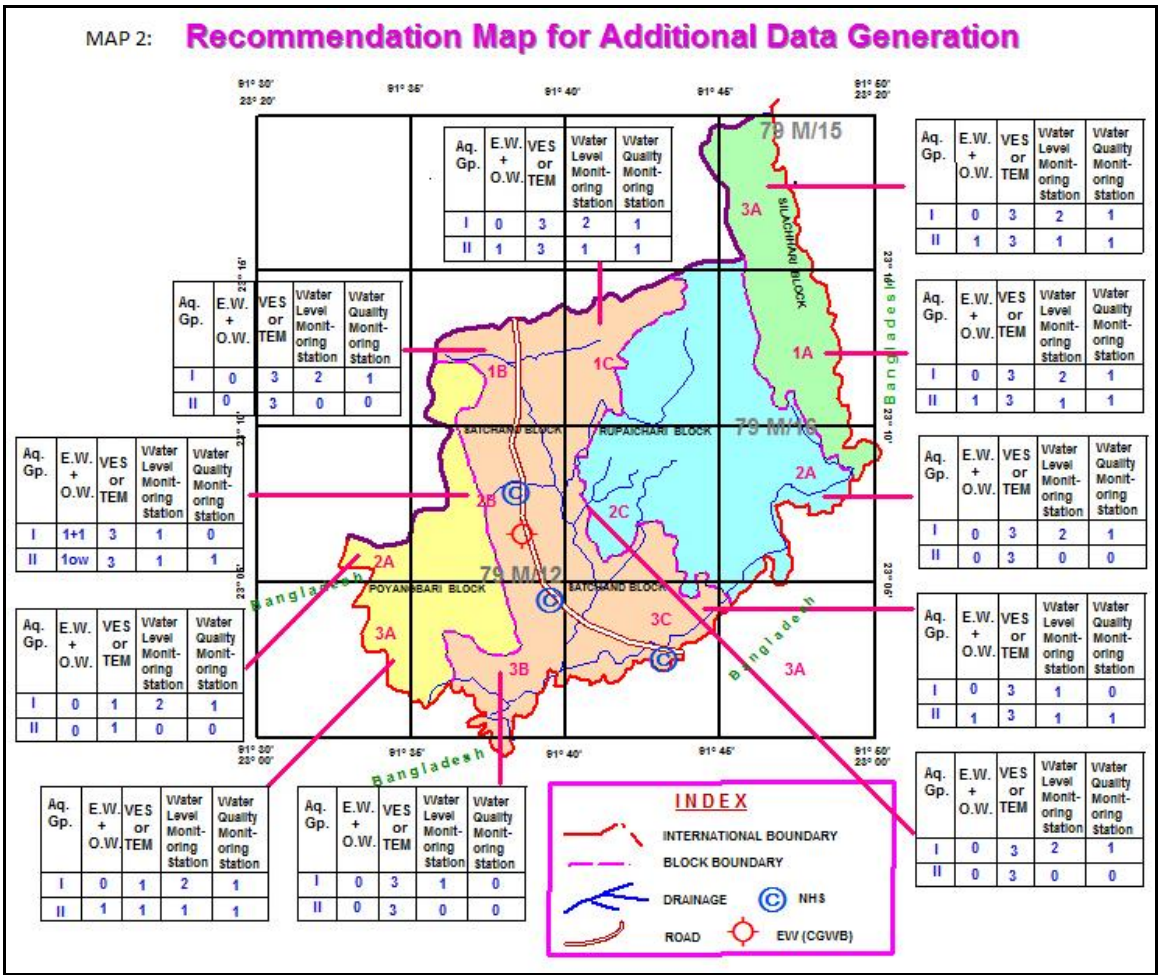
Quadrant No. under Mapping	No. of additional Exploratory Well required		No. of additional VES/ TEM required		No. of additional water level monitoring stations required		No. of additional water quality stations required		Remarks
	Aq - I	Aq - II	Aq - I	Aq - II	Aq - I	Aq - II	Aq – I	Aq - II	
3A		1 SPW		3	2	1	1	1	
TOTAL	**1 SPW**		**3**		**2**	**1**	**1**	**1**	

Toposheet No. 79 M/16 :Required number of structures to be constructed/established & surveys to be done

Quadrant No. under Mapping	No. of additional Exploratory Well required		No. of additional VES/TEM required		No. of additional water level monitoring stations required		No. of additional water quality stations required		Remarks
	Aq - I	Aq - II	Aq - I	Aq - II	Aq - I	Aq - II	Aq - I	Aq - II	
1A		1 SPW		3	2	1	1	1	
2A		0		3	2	0	1	0	
TOTAL	**1 SPW**		**6**		**4**	**1**	**2**	**1**	

SYNOPSIS OF ADDITIONAL DATA REQUIRMENT FOR THE WHOLE AQUIFER MAPPING AREA IN SATCHAND, SOUTH TRIPURA DISTRICT, TRIPURA												
Topo-sheet No.	**No. of additional Exploratory Well required**			**No. of additional VES/TEM required (Single Sounding for Aq–I & Aq–II at one go)**			**No. of additional Ground Water level monitoring stations required**			**No. of additional Ground Water quality monitoring stations required**		
	Aq- I	**Aq- II**	**Total**	**Aq- I**	**Aq- II**	**Total (Combined)**	**Aq- I**	**Aq- II**	**Total**	**Aq- I**	**Aq- II**	**Total**
79 M/12	1 EW + 1OW	3 SPW + 1 OW	3 SPW+ 1 EW +2 OW	20	20	20	13	4	17	5	4	9
79 M/15	0	1 SPW	1 SPW	3	3	3	2	1	3	1	1	2
79 M/16	0	1 SPW	1 SPW	6	6	6	4	1	5	2	1	3
AQUIM Area Total	**1 EW + 1OW**	**5 SPW + 1 OW**	**5 SPW+ 1 EW +2 OW**	**29**		**29**	**19**	**6**	**25**	**8**	**6**	**14**

MAP 2: **Recommendation Map for Additional Data Generation**



1.7 Rainfall : The climate of the aquifer mapping area is humid subtropical, mostly warm and having moderate temperatures with high humidity. The area receives rainfall mainly from SW monsoon which commences in the month of May and lasts till September. The average annual rainfall for last 40 years (1975-2014) of the study area is 2806.7 mm and shows slightly rising trend. Average nos. of rainy days at Sabroom (the lone rain gauge station in this aquifer mapping area) is 98. Rainfall trend of Sabroom rainhgauge station is depicted in fig 1 and isohyet map of the study area is shown in map 3. Results of statistical analysis of rainfall data of Sabroom rain gauge station is shown in table 1.1.

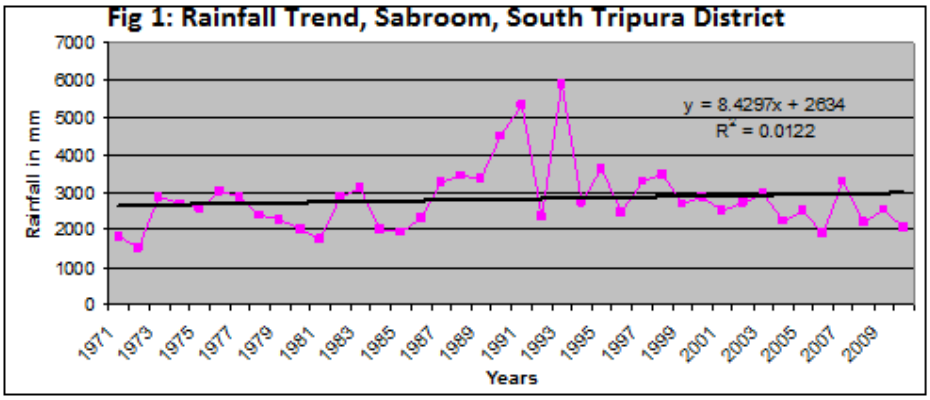
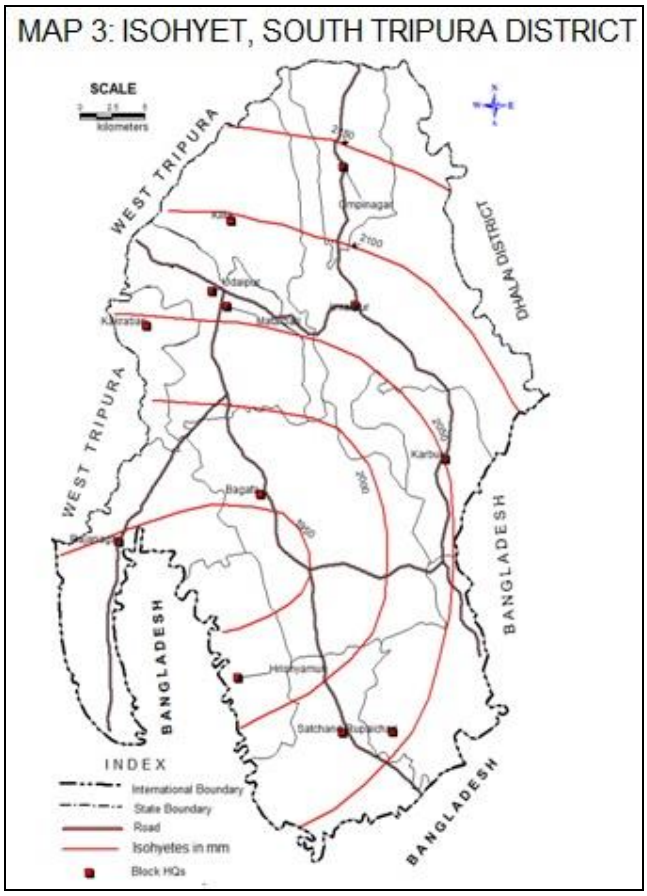


Table 1.1 : Results of Statistical Analysis of rainfall data of Sabroom rain gauge station

No. of years of data analyzed	40	Max. rainfall (year) in mm.	5900.3 (1993)
Average Annual rainfall (mm)	2806.7	Min. rainfall (year) in mm.	1500.5 (1972)
Standard Deviation	891.1	Last 10 years Average Annual rainfall (mm)	2490.6
Co-Efficient of Variation (%)	31.7	Last 5 years Average annual rainfall (mm)	2897.48



1.8 Physiography:

Physiographically, the area can be broadly divided into two parts : (1) Anticlinal hill ranges and (2) Synclinal flat bottomed valleys. The important hill ranges in the mapping area are Baramura and Bhangamura. The hill ranges are tightly folded. The trend of the hill ranges is almost N - S. The area is sloping towards west, south, and southwest. The height of the hill ranges increases from west to east and south to north. The altitude of the hill ranges in general varying from 150 - 480 m above MSL. The major broad synclinal valley is Udaipur - Sabroom valley, situated on the west of Baramura hill ranges. Valleys are gently undulating with intermittent flood plains of rivers and streams, where undulation is formed by 10 - 30 m high mounds with gullies in between, locally called ñloonga.ò Almost 68 % of the area of mapping is covered by forest and 30 % is covered by hill- hillock-tilla.

1.9 Geomorphology:

Geomorphologically, the area can be defined as a second order morpho-structural land system similar to that of ñ**Ridge and Valley Province**ò of USA. The erosional and depositional units of land system are confined mainly to the structural valleys. Genetic geomorphological map by GSI enables recognition of 3 genetic types of landform units : (i)

units of structural origin, (ii) units of denudational origin and (iii) units of fluvial origin, which can be shown in relation to their bedrock geology and structural pattern.

Units of structural origin characterize the structural pattern of folded rock bodies and include features occurring only in anticlinal hill ranges. Units of denudational origin are confined to structural valleys, where erosional processes predominate, developing an eroded topography, represented by residual hillocks/mounds and an incised net of stream beds. Incised stream beds form the conspicuous geomorphic feature of valley landscape partly filled by alluvial materials derived from adjacent hill slopes. Units of fluvial origin include only the flood plains of major rivers confined to the flat part of structural valleys.

There are two fundamentally different landform domains : **(i) Neogene Fold Ridges**, which constitute the roughly N-S aligned anticlinal ridges with rounded to nearly flat top; (ii) **Terraced alluvial terrain**, on the basis of characteristic relief, slope, degree of dissection, soil character, landform assemblage and nature of alluvial fill, is again divisible into three groups in chronological order : **(1)** table lands (tilla lands) and rolling mounds formed by the Upper Pleistocene terraces characterized by maximum dissection, drainage density and weathering; **(2)** low lands (ódoongaô) of Holocene terrace comprising stabilized, undissected, higher flood plains; **(3)** recent flood plains constituting the present-day flood-prone belts fringing the rivers. 3 distinct physiographic zones i.e. terrains are **(i)** N-S Hill Ranges, **(ii)** Undulating Plateau Land and High Lands **(iii)** Low lying Alluvial Plains on valleys.

1.10 Land Use :

Based on the land utilization, the total area is divided into various types of landforms such as forest, cultivable land, fallows lands, crop area etc. which in turn reflects the degree of development of agricultural activities and cultivation potential.

Table – 1.2 : Block wise land utilization of the aquifer mapping area

Block	Geogr a-phical Area	Fores t Area	Land Put to non-agricul - tural use	Barre n & Uncul - tivabl e	P.P. & other Grazin g Lands	Misc.Tre e crops & Groves not inclu-ded in Net Cropped Area	Culti - vable Wast e Land	Curr -ent Fall-ows	Fallow Other than Curre nt Fallow s	Net Area Sown	Singl e Crop	Doubl e Crop	Tripl e Crop	Gros s Crop -ped Area	Area Sow n mor e than Onc e	Total Culti - vable Area	Cropp - ing Inten-Sity (%)
Satchand	2870 9	19235	130 8	72	41	176	10	9	16	8340	3804	3307	1229	1410 5	453 6	8592	169
Rupaichha ri	1721 1	12985	622	0	0	179	2	13	11	3781	1987	1229	565	6140	179 4	3986	162
Silachhari	1004 5	5961	182	24	11	13	1	2	10	2775	1314	810	576	4721	142 8	2893	166
Total	**55965**	**38181**	**2112**	**96**	**52**	**368**	**13**	**24**	**37**	**1489 6**	**7105**	**5346**	**2370**	**24966**	**7758**	**1547 1**	**497**

1.11 Soil :

The soils of Satchand area in South Tripura have been developed by the high rate of chemical weathering on many types of rock formations leading to different kinds of soils due to the humid subtropical climate of the area.

1.11.1 Distribution and Classification of Soils

The soils of the aquifer mapping area belong to 5 orders, 7 suborders, 9 great groups and 19 subgroups. 5 orders are inceptiosols entisols, ultisols, alfisols and histosols. Generally inceptisols, ultisols and alfisols are observed in patches in the hills & tilla land. Entisols are seen in patches on hills and in inter hill basins. Paddy soils are mostly grouped into inceptisols with aquics moisture regime and taxonomically better known as aquepts.

1.11.2 Types of Soils

Hyperthermic temperature regime and mixed (sometimes kaolinitic) mineralogy are common for all soils and types are (i) Hill soils; (ii) Soils of flat topped denudation hills; (iii) Soils of low lying residual hill with valley; (iv) Soils of undulating plains with low mounds and narrow valleys; (v) Soils of inter hill valleys; (vi) Flood plain soils; (vii) Soils of rolling uplands.

1.11.3 Soil Characteristics

In general, soils are acidic in nature. The pH of soil ranges from 4.50 to 6.50 but for the major area, from 5.1 to 5.68 with an average of 5.52. Nitrogen and Phosphate are low, available Potash is medium to high and Calcium, Magnesium, Sulphur are deficient in these soils. In major parts of the rice based cultivated areas in the soils are strongly acidic with the pH value 5.1 to 5.5. The pH value of soil can be increased by applying Calcium Oxide or Calcium Carbonate which in turn increase concentration of Nitrogen, Phosphorus, Calcium and Magnesium in acidic soils and can enhance production of crops.

In the aquifer mapping area, concentration of iron in ground water is significantly high. Iron content in the soils increases when ground water with abnormally high iron is used for irrigation. The high iron in soil hampers the growth and production of crops.

1.12 Hydrology :

1.12.1 Surface Water Resources :

The major rivers in the mapping area are Muhuri and Fenny. It is found that every year the rivers show peak discharge (in a single day) between May to July and the lowest discharge (in a single day) is recorded during the months of March & April.

1.12.2 Irrigation Projects - Major, Medium and Minor :

The agriculture depends mostly on minor irrigation schemes. There is no major or medium irrigation project. Most of these minor irrigation projects distribute water from surface sources mainly by river lift & diversion schemes. Rural Development Dept., Govt. of Tripura constructs sluice gates, pick up weirs, permanent bund across cherras/streams to

arrest water for irrigation. Farmers also construct permanent or seasonal bund across cherras/ nalas/ streamlets to collect the water and irrigate through pump sets.

1.12.3 Ponds, Tanks and other Water Conservation Structures :

There are thousands of small ponds available in the entire aquifer mapping area. These ponds are used mainly for fish cultivation and also used for domestic purpose like washing, bathing, water for cattles etc. But rarely these are used for irrigation purpose because these ponds generally do not have much water during the dry periods.

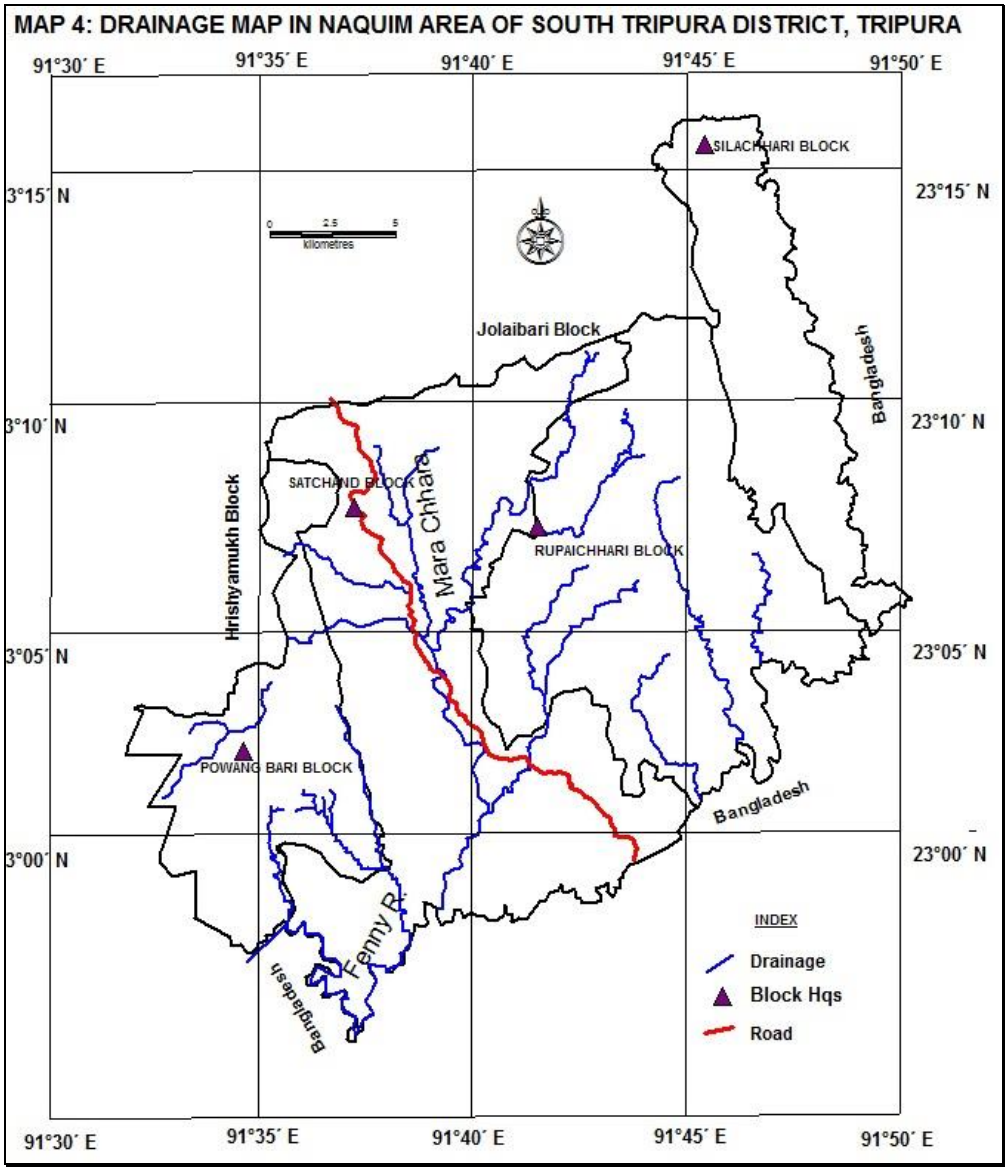
The forest, agricultural, rural development departments, block development offices of the district have constructed many rain water harvesting structures like ponds, check dams, nala bundhs etc. In the aquifer mapping area, the forest department alone has constructed 151 numbers of soil and water conservation structures under JFMC/EDC schemes of Tripura JICA Project up to 2014-15. As per the record of Fisheries Dept., Govt. of Tripura, 7039 nos. tanks (area occupied - 692.95 ha.); 1003 nos. mini-barrages (area occupied - 200.08 ha) and 125 ha of open water area (river, nala, abandoned water bodies) are existing in Satchand aquifer mapping area of South Tripura district.

1.13 Drainage :

The anticlinal hill ranges make the watersheds from where various drainage channels have emerged, which subsequently became rivers. Common drainage patterns observed in the aquifer mapping area are sub-parallel to parallel and dendritic. Up to 4^{th} order streams are found. In general, drainage pattern in the area is following the local topography, which is structurally controlled. Drainage map of the study area is shown in map 4.

The major rivers in the area are Muhuri and Fenny and a small river named Manu Gang is also present. Muhuri river originates from Deotamura hill range, flows westward, drains through Udaipur - Sabroom valley and ultimately enters Bangladesh near Belonia town. Its length is 64 km and catchment area is 1013.9 km^2.

Fenny river also originates from Deotamura hill range and it has 3 tributaries - Asalang, Rangfeny and Larigang. This river flows from north to south and forms the eastern and south-eastern boundary between Tripura and Bangladesh. Then it takes right turn towards west-southwest and uultimately it joins the Meghna river in Bangladesh.



1.14 Agriculture :

Agriculture in this aquifer mapping area mainly depends upon the timely monsoon. Fertile soils of the valleys and the abundant rainfall are very conducive to growing of better-quality agricultural and horticultural crops. Net area under agriculture (net area sown) is 14896 ha (in 2013-14), which is 26.61 % of total geographical area (55965 ha), which is very low compared to national level (51%).

Economy of the area is basically agrarian and about 55 % of the population is dependent on agriculture and allied activities for their livelihood as agricultural work is the single largest provider of employment to the rural people this aquifer mapping area. Favorable agro-climatic conditions, fertile soils, sub-tropical climate with pockets of

temperate zones, large ótillaô lands and high rainfall also promotes growing of horticultural plants like fruits, vegetables, spices, floriculture, medicinal and aromatic plants etc.

As 30 % of the geographical area of mapping is high land; 68 % covered by forest and only about 27.64 % is available for cultivation, presently there is a gap between actual production and requirement of food grains. Fragmentation of land holding is continuing and average present holding is 0.50 ha. People cultivate on high hill slopes by practicing traditional ó**JHUM'** process (shifting cultivation) to grow mainly rice in the monsoon.

The main crop is paddy; all three i.e. summer paddy (Aus), monsoon paddy (Aman) and winter paddy (Boro) are being raised, which are followed by maize, wheat, mesta, jute, cotton, pulses and oilseeds. Over a limited area cashew nut and pineapple are also grown. Rubber and tea plantations are also seen in a large scale on small mounds and foothills.

Table – 1.3 : Principal Crop Area (Ha), Production (Met. Ton) & Yield (Kg/Ha or Bales/Ha) - 2013-14

Block	Aush Paddy			Aman Paddy			Boro Paddy			'Jhum' Paddy			Maize			Wheat			Khariff Pulses			Rabi Pulses		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Satchand	288	691	2399	4276	13383	3130	3190	9851	3088	178	216	1213	113	158	1398	3	5	1667	267	181	678	101	80	792
Rupaichhari	210	489	2329	1785	5518	3091	768	2034	2648	394	375	952	235	252	1072	1	2	2000	339	204	602	49	35	714
Total	**498**	**1180**	**4728**	**6061**	**18901**	**6221**	**3958**	**11885**	**3002**	**572**	**591**	**2165**	**348**	**410**	**2470**	**4**	**7**	**3667**	**606**	**385**	**1280**	**150**	**115**	**1506**

Block	Sesamum			Khariff Ground Nut			Rabi Ground Nut			Rape & Mustard			Jute (P : Bales) (Y : Bales/Ha)			Mesta(P: Bales) (Y : Bales/Ha)			Cotton (P : Bales) (Y : Bales/Ha)		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Satchand	93	54	583	7	9	1286	11	15	1364	99	83	838	40	357	8.92	42	326	7.75	20	30	1.50
Rupaichhari	128	67	524	3	3	1000	4	5	1250	73	63	863	11	90	8.18	66	527	7.99	16	21	1.31
Total	**221**	**121**	**1107**	**10**	**12**	**2286**	**15**	**20**	**2614**	**172**	**146**	**849**	**51**	**447**	**8.765**	**108**	**853**	**16**	**36**	**51**	**2.81**

A – Area (Ha); P – Production (MT); Y – Yield (Kg/Bales per Ha)

1.15 Irrigation :

Crop irrigation is mainly dependent on the minor surface water irrigation schemes like lift irrigation schemes on perennial rivers and streams; diversion schemes with surface water; pick-up weirs (mainly by PWD,WR); sluice gates; small 5 HP pump sets attached to rivers/cherras/streams; tank and ponds; water harvesting and watershed management works like seasonal and permanent bundhs on small nalas, cherras, streams etc. and to some extent

on ground water from deep tube wells, small bore tube wells, shallow tube wells and artesian wells. The ground water potential is high but the yield of the tube wells is low. Land irrigated by one artesian well in Satchand area is 0.50 ha.

In 2013-14, total cultivable land is 15471 ha, land brought under cultivation (net area sown) is 14896 ha, total irrigable land is 5697 ha, cultivated land brought under assured irrigation (irrigation potential created) is 4332 ha (PWD, WR ï 3251 ha; Agriculture Dept. ï 111 ha; Rural Dev. Dept. STW ï 288 ha and Govt. & Pvt. Artesian Well ï 682 ha) and land actually irrigated (irrigation potential utilized collectively for single, double & triple cropped area, i.e. gross irrigated area) is 4778 ha. Therefore, 1365 ha of irrigable land in the aquifer mapping area is still not covered by assured irrigation i.e. not brought under irrigation (irrigation potential yet to be created).

Table – 1.4 : Number of different Irrigation Sources Functioning (2004 & 2011/2014)

Block	Lift Irrigation (PWD-WR)		Diversion (PWD-WR)		Pump Sets		DTW (PWD-WR)		Small Bore TW (Agri. Dept.)		Shallow TW Rural Dev. Dept.		Artesian Wells (Govt. + Pvt.)	
Year	2004	2011	2004	2014	2004	2011	2004	2011	2004	2014	2004	2011	2004	2011
Satchand	61	71	0	3	183	174	4	3	-	26	33	96	809	1185
Rupaichari	15	20	0	2	115	168	1	1	-	13	65	0	0	0
Total	**76**	**91**	**0**	**5**	**298**	**342**	**5**	**4**	**-**	**39**	**98**	**96**	**895**	**1185**

Table – 1.5 : Source Wise, Block Wise Irrigated Area, 2013 (in Ha)

Block	Lift Irrigation			Diversion			Deep Tube Wells			Shallow Tube Wells			Artesian Well		
	Nos.	Potential Created	Potential Utilised	Nos.	Potential Created	Potential Utilised	Nos.	Potential Created	Potential Utilised	Nos.	Potential Created	Potential Utilised	Nos.	Potential Created	Potential Utilised
Satchand	71	2214	2214	3	144	144	4	154	120	-		288	-		682.5
Rupaichari	20	707	707	2	20	20	1	30	30	-		0	-		0
Silachari	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**95**	**2921**	**2921**	**5**	**164**	**164**	**5**	**184**	**150**	**96**		**288**	**768**		**682.5**

Out of gross actually irrigated area of 4778 ha, 1418.40 ha (29.70 %) is irrigated by using ground water resources in 2013.

1.16 Cropping Pattern :

The cropping pattern of the aquifer mapping area is mainly paddy oriented and production amount of paddy is more than any other crop. Depending on the period of its growth the paddy is divided into three varieties ï (i) monsoon paddy (Aman), (ii) winter paddy (Boro) and (iii) summer paddy (Aush). Aush is cultivated in a very limited area. After the cultivation of Aman paddy and before the cultivation of Boro paddy, different vegetables

viz. potato, cabbage, gourds etc., oil seeds and pulses are cultivated. After Boro paddy, jute is also grown in a small scale. In most of the cultivable land only one paddy (Aman) is grown. In double-cropped areas, two paddies are grown (Aman & Boro) but in some places one paddy (Aman) and vegetables are grown. Triple cropped area is very limited and here the cropping pattern is two paddies and one vegetable or one paddy with two times vegetables. Cropping pattern not only depends on fertility of land and availability of water but also depends on individual cultivator. Over a limited area, orchards of pineapples, jackfruits, mangoes, cashew are raised. Rubber plantations are also in vogue on small mounds and foothills over a considerable area, which is ever increasing.

The cropping pattern of the aquifer mapping area shows that among paddy varieties Aman paddy is cultivated in maximum area followed by Boro, óJhumô paddy (cultivated on the hill slopes by the village tribals) and Aush. After paddy, vegetables which includes potato followed by pulses are the major cultivated crops in the area.

1.17 Prevailing Water Conservation/Recharge Practices :

In aquifer mapping area, small/medium check dams are highly feasible to be constructed in foothill areas to store water which can be used during lean periods. Forest, Agricultural, Rural Development Department, Block Development Offices have constructed many rain water harvesting structures like ponds, check dams, nala bundhs.

1.18 Sub-Surface Geology

The granular zones encountered down to 254 m depths belong to semi-consolidated Tipam and Dupitila formations and constitute medium to coarse grained, sub-rounded quartz, feldspathic material like sandstone, shale, siltstone etc. The occurrence and thickness of these zones vary laterally as well as vertically.

1.19 Geological Structure

Tectonically, the aquifer mapping area comprises a series of sub-parallel, arcuate, elongated, doubly plunging folds arranged enechelon and trending in an average north-south direction with slight convexity to the west (Kher and Ganju, 1984). The intensity of folding increases eastward. The folds are characterized by tight anticlines alternating with broad synclines. The anticlines forming ridges are asymmetrical or symmetrical and traversed in most cases by north-south longitudinal reverse faults. Most of these faults disappear towards the plunge of the folds.

2. DATA COLLECTION & GENERATION

- **Actual achievement in generating exploratory drilling data :**

Total 6 nos. of Deep Tube Wells (DTW) including 3 nos. of Exploratory Tube Wells (Production Well) and 3 nos. of Observation Wells (for Water Level Measuring only) were constructed in Satchand block under Toposheet 79 M/12.

- **Actual achievement in generating geophysical survey data :**

30 nos. of Vertical Electrical Soundings (VES) at 30 nos. of different site spread all over the aquifer mapping area of Satchand have been conducted and locations of VES sites were depicted in map 8.

- **Actual achievement in generating Water Level data :**

In addition to previously existing 3 nos. of NHNS dug wells, 20 other dug wells have been established as NAQUIM Key Wells and since pre-monsoon of 2014-15, the water levels from these total 23 nos. of wells are being monitored four times in a year.

- **Actual achievement in generating Water Quality data :**

In addition to previously existing 3 nos. of NHNS dug wells, 20 other dug wells have been established as NAQUIM Key Wells and since pre-monsoon of 2014-15, water samples from these 23 wells are being collected twice in a year during pre and post-monsoon period. Distribution of iron, pH and Ec in groundwater in the NAQUIM area is depicted in map 10, map 11 and map 12 respectively.

Depth to Water Level:

Total number of network hydrograph stations in the aquifer mapping area is 3. All the stations are dug wells. The depth to water level during pre-monsoon period (March 2013) lies between 4.36 to 6.21 m bgl and during post-monsoon period (November 2013, depth to water level lies between 3.50 to 5.42 m bgl. The seasonal fluctuation of water level varies between 0.62 to 0.86 m. Based on depth to water level data collected from NHS at Sabroom, the change in ground water scenario over the years is studied. Hydrographs of this NHS station shows no significant rise or fall in the water level trend (fig 2). Groundwater development in the aquifer mapping area is still at a low scale. Pre-monsoon depth to water level and post-monsoon depth to water level are depicted in map 6 and map 7 respectively.

Table – 2.1: Pre-monsoon and Post-monsoon Trend of Water Level in Aquifer Mapping area

Location	Block	Pre-monsoon Trend from March - 1991 to March – 2007			Post-monsoon Trend from Nov - 1991 to Nov - 2010		
		No of Data	Rise(m./yr)	Fall (m./yr)	No of Data	Rise (meter/yr)	Fall (meter/yr)
Subroom	Satchand	**9**	**---**	0.029	**12**	0.033	**---**

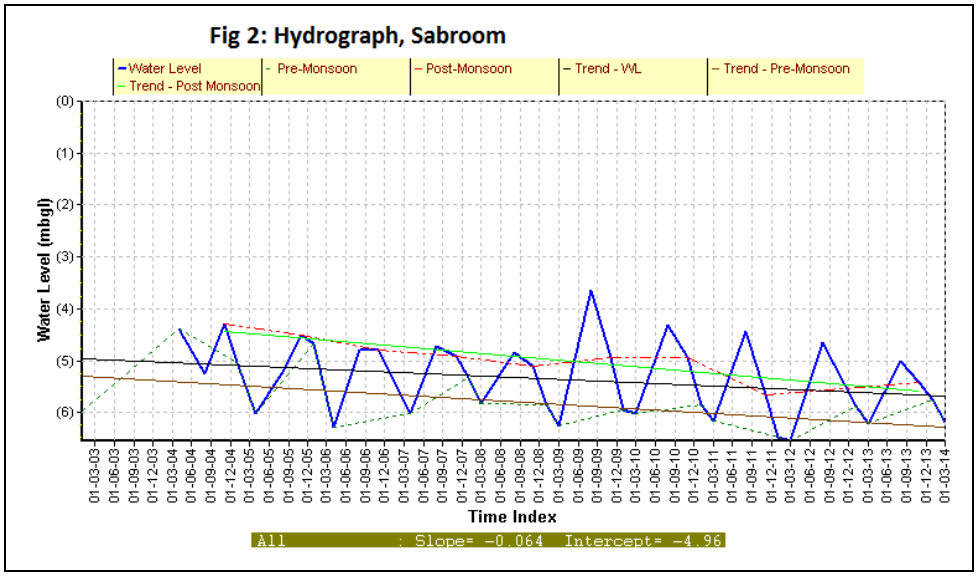
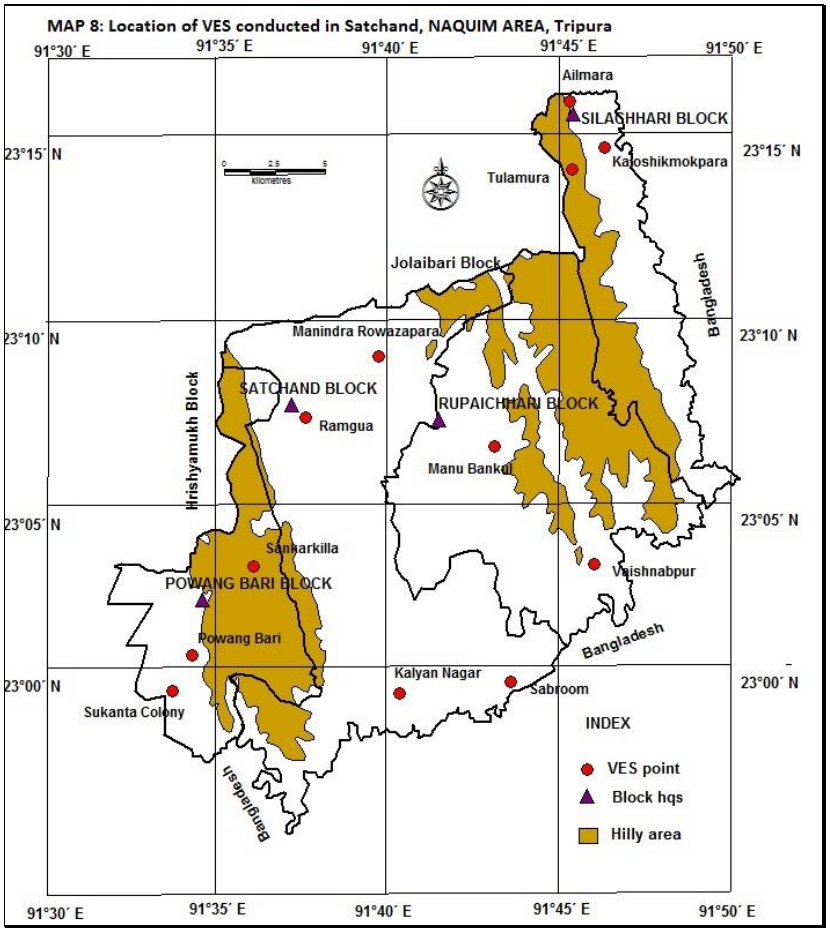
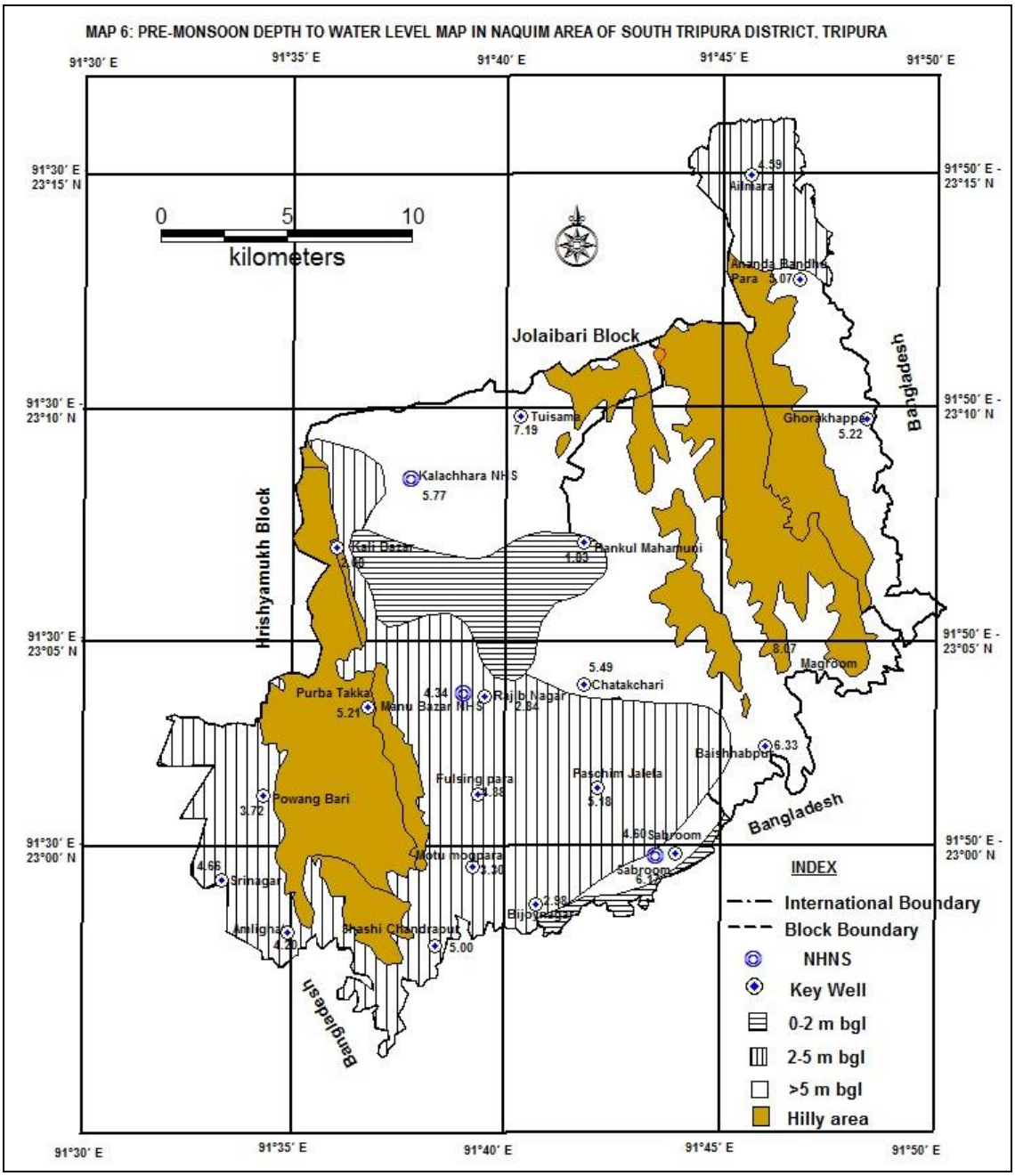
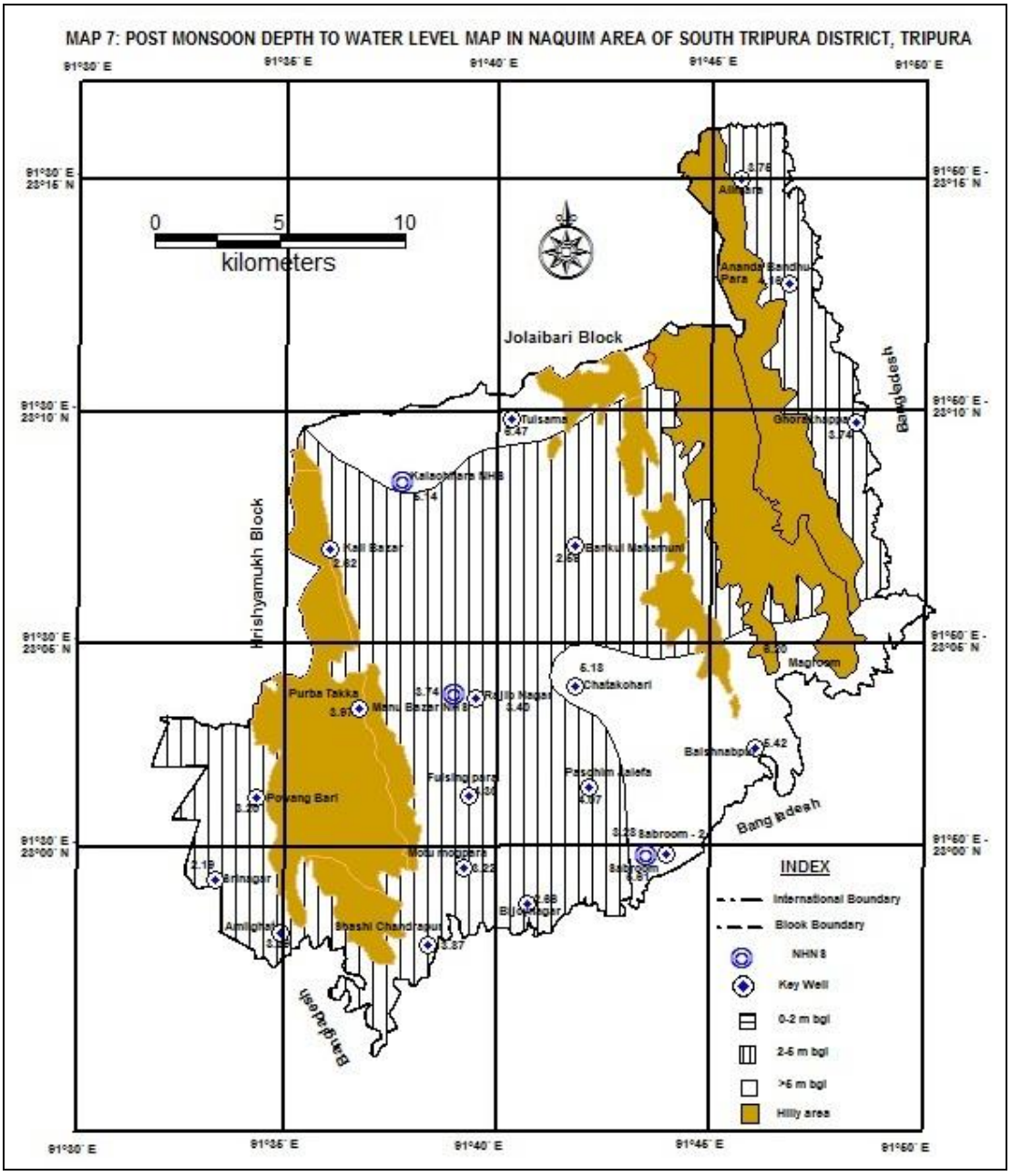


Fig 2: Hydrograph, Sabroom
Water Level
Pre-Monsoon
Post-Monsoon
Trend - WL
Trend - Pre-Monsoon
Trend - Post Monsoon
Water Level (mbgl)
Time Index
All : Slope= -0.064 Intercept= -4.96


MAP 8: Location of VES conducted in Satchand, NAQUIM AREA, Tripura
Ailmara
SILASHHARI BLOCK
Kaloshikmokpara
Tulamura
Jolaibari Block
Bangladesh
Manindra Rowazapara
SATCHAND BLOCK
Ramgua
RUPAICHHARI BLOCK
Manu Bankul
Hrishyamukh Block
Sankarkilla
POWANG BARI BLOCK
Vaishnabpur
Rowang Bari
Kalyan Nagar
Sabroom
Sukanta Colony
INDEX
VES point
Block hqs
Hilly area
91°30´ E
91°35´ E
91°40´ E
91°45´ E
91°50´ E
23°15´ N
23°10´ N
23°05´ N
23°00´ N


MAP 6: PRE-MONSOON DEPTH TO WATER LEVEL MAP IN NAQUIM AREA OF SOUTH TRIPURA DISTRICT, TRIPURA
91°30′ E
91°35′ E
91°40′ E
91°45′ E
91°50′ E
91°30′ E - 23°15′ N
91°50′ E - 23°15′ N
91°30′ E - 23°10′ N
91°50′ E - 23°10′ N
91°30′ E - 23°05′ N
91°50′ E - 23°05′ N
91°30′ E - 23°00′ N
91°50′ E - 23°00′ N
0 5 10
kilometers
Jolaibari Block
Hrishyamukh Block
Bangladesh
Bangladesh
Ainmara 4.59
Ananda Bandhu Para 5.07
Tuisama 7.19
Ghorakhapper 5.22
Kalachhara NHS 5.77
Kali Bazar 1.40
Bankul Mahamuni 1.09
Purba Takkal 5.21
Manu Bazar NHS 4.34
Raj b Nagar 2.84
Chatakchari 5.49
Magroom 8.07
Baishnabpur 6.33
Fulsing para 4.38
Paschim Jaleta 5.18
Powang Bari 3.72
Satyroom 4.60
Sabroom 6.18
Srinagar 4.66
Motu moonara 3.30
Bijoychandrapur 2.98
Anlighat 4.20
Shashi Chandrapur 5.00
INDEX
International Boundary
Block Boundary
NHNS
Key Well
0-2 m bgl
2-5 m bgl
>5 m bgl
Hilly area



Springs:

In the hilly areas springs are common and seepage or topographic type in nature. There are some spring/seepage zones occur in a small area locally known as ôUtla Jaminô. These spring/seepage zones occur in paddy fields and in low-lying marshy lands. Small springs with small seepage zones are found at many places in Satchand and Rupaichari blocks especially in the central parts of the aquifer mapping area. Discharge as measured was found to vary between 1 ï 20 litre/minute. Some perennial springs flow throughout the year but their yields decrease during the dry season (January-February). Temperature of the spring water in the

study area ranges from 14 to 23 ^{0}C. óJhumô or shifting cultivation is one of the main reasons for depleting yields.

Artesian Zones

Major Artesian zones are found in Poyangbari and Satchand blocks. These zones occur all along the N.H. ï 44, mostly on western side of it. There are no reports of artesian wells in Silachhari and Rupaichari blocks. These artesian zones mostly occur in Tipam and Dupitila sand stones. These zones are structurally controlled and mostly present along some local drainages and show some linear trends in majority of the cases. When they occur in a village, these zones are not available in the entire village and occurs as discontinuous zones and thus seen as a localized phenomenon. Artesian wells are found in the paddy fields of Kalapania, Sindukpathar, East & West Jalefa, Manubazar, Kaladhepa, Harina and Gardhang GPs. High

Name of Block	Measur-ing Point (m agl)	Depth Range (m bgl)	Yield Range in LPS				Area Irrigated in Ha/ Well	
			2004-05		2010-11			
			Pre-Monsoon	Post-Monsoon	Pre-Monsoon	Post-Monsoon	2004-05	2010-11
Satchand	0.1- 0.4	21 - 180	0.25 -1.0	0.1- 1.0	0.05 -1.0	0.1 - 0.75	0.48 - 1.0	0.16 - 1.0

discharge of Ó1 lps is not found anywhere.

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 General Hydrogeology and Occurrences of Ground Water

The main hydrogeological formation of the aquifer mapping area is Quarternary to Tertiary semi-consolidated formations, more specifically Recent Alluvium of Quarternary age and Dupitila & Tipam formation of Tertiary age. The fine to medium grained semi-compact buff colored thick Tipam Sandstone forms the principal aquifer in the area. The ground water in this aquifer mapping area occurs under unconfined, semi-confined and confined conditions. Study of dug wells, shallow tube wells and deep exploration data of CGWB reveals the presence of phreatic, shallow and deeper aquifers in the Satchand mapping area. Hydrogeological map of the study area is shown in map 5.

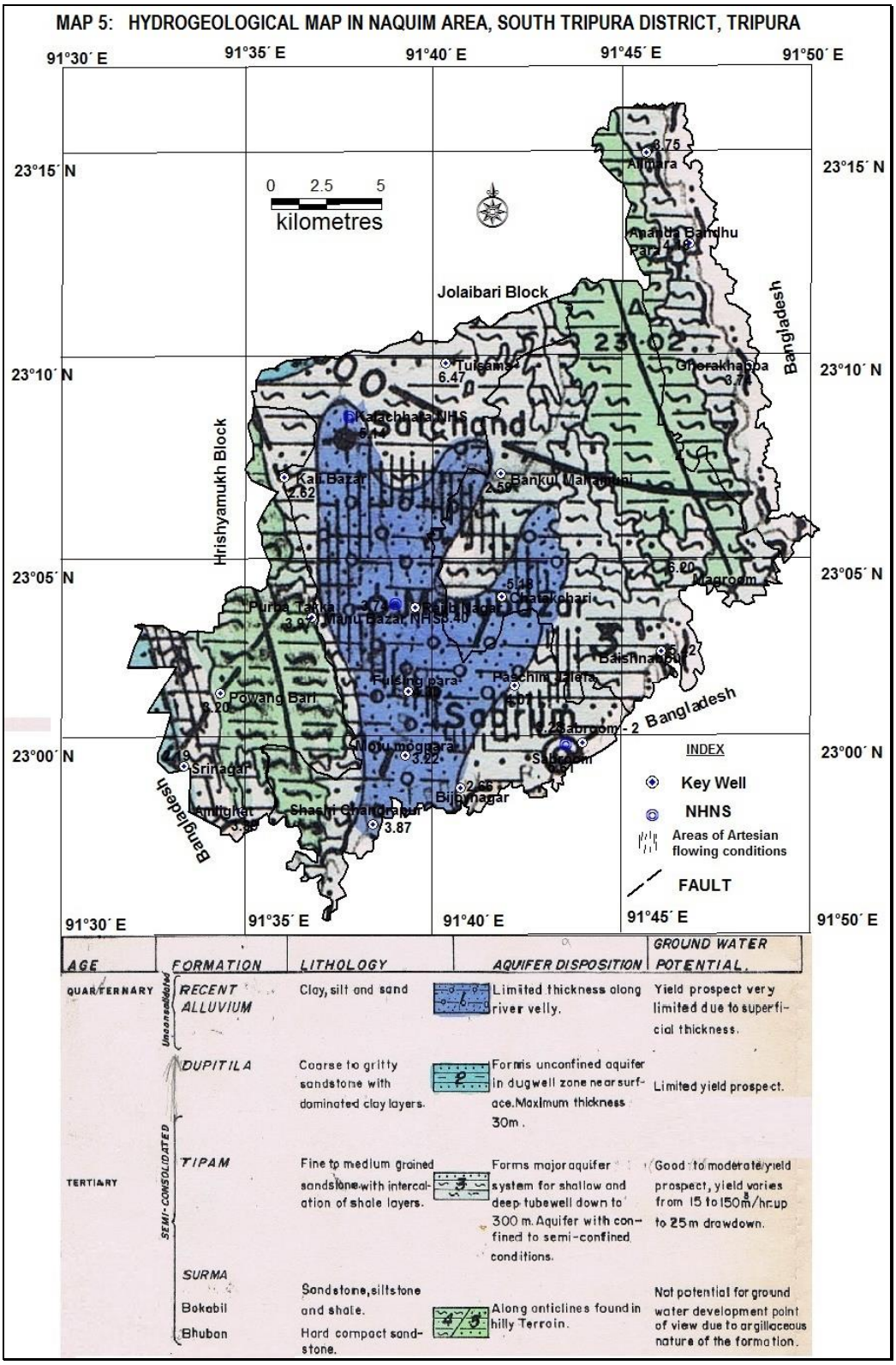
Occurrences of Ground Water in Shallow Aquifers: Shallow aquifers generally extend within the depth range of 5 to 30 m bgl. In shallow aquifer, ground water generally occurs under unconfined condition and sometimes under semi-confined to confined conditions. In major part of the area, ground water in shallow depths occurs under unconfined condition but it occurs under confined condition within shallow depths in small isolated zones in the southern part (Jalefa ï Harina area) of Satchand block. Ground water from shallow aquifers is exploited through different types of ground water abstraction structures such as dug wells (Kachha dug wells, RCC ring wells, Mark II/III fitted RCC ring wells), shallow tube wells (ordinary hand pump fitted, mark II/III hand pump fitted, electric/diesel pump fitted shallow tube wells). Shallow tube wells fitted with electric/diesel pumps are used for irrigation purpose and the others are used for drinking and domestic purposes. Ring/Dug wells are found to be tapping unconfined aquifer generally down to 4 ï 10 m bgl.

Occurrences of Ground Water in Deeper Aquifers: In deeper aquifers ground water occurs under semi-confined to confined conditions. Most of the heavy duty ground water abstraction structures for different purposes are tapping these deeper aquifers. At some places on the Satchand to Manubazar tract, the aquifer under Group ï II is continuing from 50 m to 150 m bgl uninterruptedly with some localized thin impermeable clay layer/lenses. Deep tube wells constructed by CGWB for exploration at Satchand and Paschim Jalefa in Satchand block is in artesian condition. Artesian flowing wells are found in the paddy fields of Kalapania, Sindukpathar, Manubazar, Kaladhepa and Gardhang Gram Panchayats. These artesian wells were constructed within a depth range of 100 to 180m, piezometric head is upto 1 m agl and discharge is less than 1 lps.

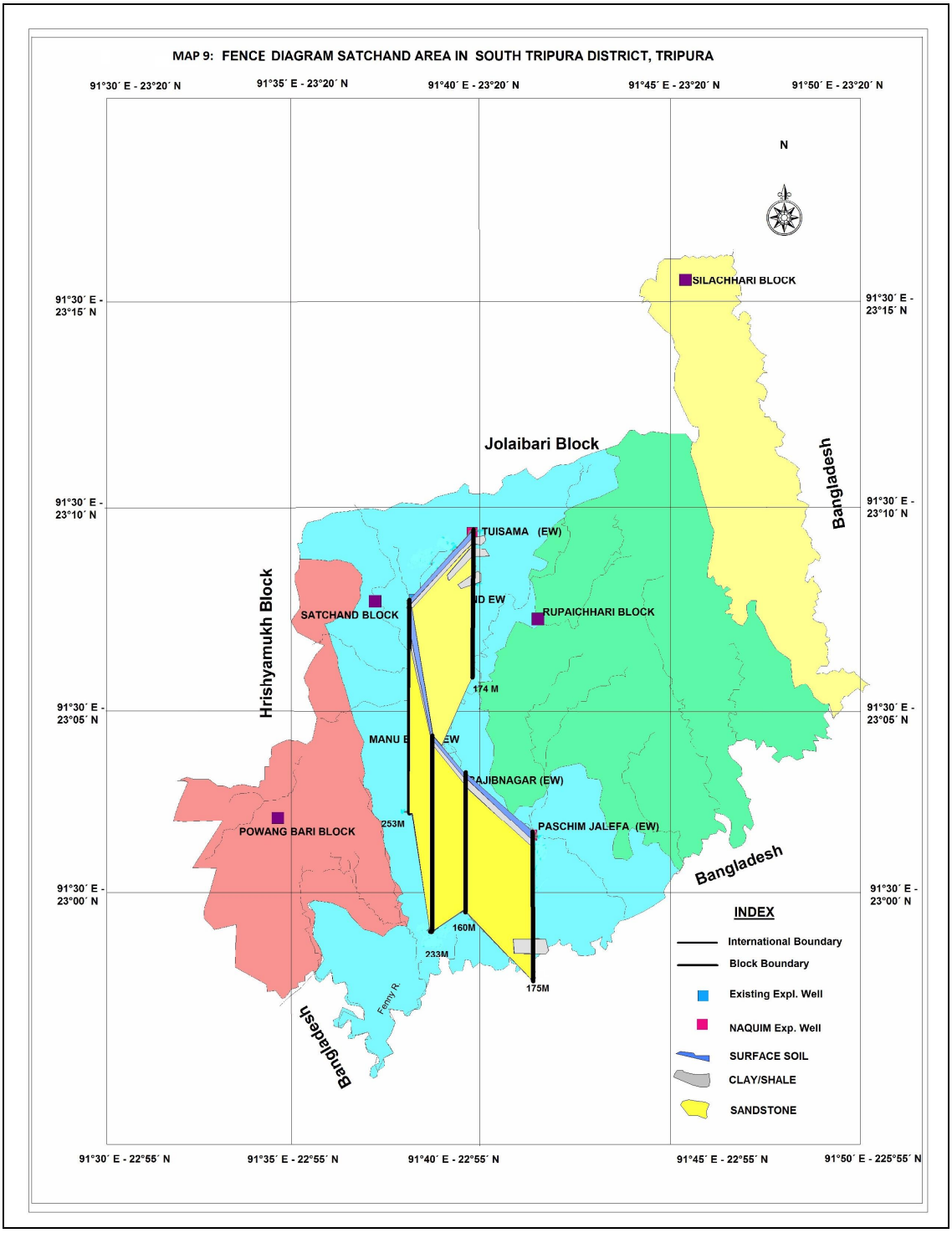
3.2 Number of Aquifers

The areas under mapping possess two aquifer systems. The first aquifer is phreatic/ unconfined aquifer. Based on existing exploration data, it is ascertained that the depth of the first aquifer is within 30 m bgl. The soft Tipam sandstone occurring below 30 m and having a reasonably higher permeability forming the second aquifer. The maximum depth of the second aquifer is encountered down to the explored depth of 200 m bgl. Thus the aquifer

system of the mapping area is divided into two groups, viz., shallow aquifer group within 30 m bgl and deep aquifer group between 30 to 200 m bgl.



AGE	FORMATION	LITHOLOGY	AQUIFER DISPOSITION	GROUND WATER POTENTIAL
QUARTERNARY (Unconsolidated)	RECENT ALLUVIUM	Clay, silt and sand	1 — Limited thickness along river velly.	Yield prospect very limited due to superficial thickness.
TERTIARY (SEMI-CONSOLIDATED)	DUPITILA	Coarse to gritty sandstone with dominated clay layers.	2 — Forms unconfined aquifer in dugwell zone near surface. Maximum thickness 30m.	Limited yield prospect.
	TIPAM	Fine to medium grained sandstone with intercalation of shale layers.	3 — Forms major aquifer system for shallow and deep tubewell down to 300 m. Aquifer with confined to semi-confined conditions.	Good to moderate yield prospect, yield varies from 15 to 150m³/hr up to 25m drawdown.
	SURMA			
	Bokabil	Sandstone, siltstone and shale.	4/5 — Along anticlines found in hilly Terroin.	Not potential for ground water development point of view due to argillaceous nature of the formation.
	Bhuban	Hard compact sandstone.		



3.3 Aquifer Systems

The aquifers mostly consist of sedimentary formations of Tertiary age. Three hydrogeological units/ water bearing formations identified in the area are Alluvial formation, Dupitila formation, Tipam formation and Bokabil formation.

(A) Alluvial Formation : It occurs along the banks of main rivers and thickness varies from 5 to 10 m. Ground water occurs under unconfined condition and its development is not very significant because of high clay and sandy clay content of this formation. Ground water is developed through dug wells and shallow tube wells fitted with hand pumps.

(B) Dupitila Formation: Dupitila formation is nearly horizontal in disposition and its thickness varies from 10 to 30 m. The formation consists of mainly clay and silt with some intercalations of gritty & ferruginous sandstones. It is exposed in the western middle part of Udaipur - Subroom valley. Due to high clay content, it has low permeability, low storage capacity and the ground water extraction occurs through dug wells and shallow tube wells fitted with hand pumps.

(C) Tipam Formation: Sandstones of Tipam formation forms the principal aquifer system in mapping area. Permeability of this sandstone is much higher than that of Dupitila sandstone or Bokabil (Surma Group) sandstones. This formation consists of sub-rounded, fine to medium grained, friable sandstone with intercalated clay. The recharge area of these sandstones is in the neighboring anticlinal hills. Ground water occurs under unconfined, semi-confined to confined conditions. Sandstones are mostly developed by deep tube wells, mini deep tube wells, shallow tube wells and dug wells.

3.4 Aquifer Geometry

The aquifer system in the area can be deciphered as a two aquifer system. The area is dominated by thick sandstone horizons with thin intervening shale/clay horizons particularly in the northern and southern part. In the central part around Baikhora and Satchand the sandstone is quite thick and forms almost a single aquifer system with layers of clay occurs locally creating the confined conditions. Clay layers present in the area are discontinuous and pinch out after running for a few kilometers. In the northern and southern part of the area the second aquifer is having 2 granular zones due to the presence of clay / shale layers. The first granular zone is encountered in depth range of 30 to 56 m bgl. Thickness of this zone varies from 14 to 25 m. The second granular zone occurs between 60 to 140 m bgl. In Subroom - Manubazar area 60 to 90 m thick granular zone occurs between 35 - 135 m bgl and second granular zone is encountered at 150 - 195 m bgl. Sub-surface geology of the area is depicted in map 9.

3.5 Aquifer Properties (Yield, Parameters etc.)

Aquifer I: It is the unconfined aquifer. Tube wells constructed within 30 m depth generally exhibits unconfined nature of the aquifer. Pumping tests in dug wells show specific capacity varies from 4.03 to 13.63 lpm /meter of drawdown. In major part of the area, ground water in shallow depths occurs under unconfined condition but it occurs under confined condition within shallow depths in Jalefa ï Harina area of Satchand block. Piezometric head and discharge of artesian wells in this zone varies from 0.05 - 0.80 m agl and 0.04 - 1.00 lps.

Aquifer II: Most of the heavy duty deep tube wells were constructed between 50 ï 255 m bgl tapping Tipam sandstones. Discharge of the wells varies from 12 ï 151 m^3/hr and drawdown varies from 6.80 ï 25 m. Transmissivity of the wells varies from 47.4 ï 1577 m^2/day, permeability varies from 0.87ï 28 m/day and storativity varies from 2.25 x 10^{-5} to 2.4 x 10^{-3}. CGWB has constructed 1 no. Exploratory well of depth of 200 m bgl tapping Tipam sandstone at Satchand are found to be in flowing/artesian condition. Piezometric head measured varied from 0.18 ï 1.50 m agl and discharge varied from 36 ï 151 m^3/hr.

4. GROUND WATER RESOURCES

Estimation of Ground Water Resources in the aquifer mapping area has been carried out based on the methodology recommended by Ground water Estimation Committee (GEC–97), where two approaches are recommended: (i) water level fluctuation method and (ii) rainfall infiltration method. The latest dynamic resource computation based on the basis of various available technical data, the results of exploratory drilling and other hydrogeological testing by CGWB and State Govt. departments such as PWD (Water Resources), PWD (DWS) & Agriculture Dept., Govt. of Tripura, is done for the year 2012 – 2013 (1st April, 2012 to 31st March, 2013), where the smallest and undisputed administrative unit, the rural development block is taken as the unit of computation in absence of actually GEC-97 recommended assessment unit watershed wise number of ground water structures, amount of ground water draft, population and other vital geographical and economical figures or statistics. Hydrogeological formations comprising Sandstones and Shales named as Dupitila, Tipam and Surma Formations of Upper Tertiary age are spread all over the aquifer mapping area and all are considered as a single hydrogeological unit. Area with more than 20% slope has been excluded for the recharge computation. The dynamic reserve which is seasonally renewable in response to monsoon recharge has been assessed based on the seasonal fluctuation of water table and specific yield of shallow aquifer materials and also based on rainfall recharge by infiltration. The main potential aquifer in the aquifer mapping area is Tipam sandstone and the specific yield value for Tipam sandstone is taken here as 0.08 (GEC–97). As the upper aquifers are made up of medium to fine grained sandstone, which are very porous and permeable, the rainfall infiltration factor is here taken as 0.16 and the value is approved by the R&D advisory committee on Dynamic Ground Water Resource Estimation.

Dynamic resources of ground water, extent of current utilization, balance available for further development have been calculated in this procedure. There is no saline/brackish water aquifer or any other poor ground water quality area. There is no major or medium canal irrigation scheme and thus the whole aquifer mapping area has been considered as a non-command area. However, minor irrigation schemes involving river flow and lift irrigation are in vogue in the area. Irrigation through ground water is also done but in a restricted and localized manner as the discharge of individual irrigation tube well is low.

Table ï 4.1.1 : **General Description of the Ground Water Assessment Unit of the area**

Name of Ground water Assessment Unit (Block)	Type of Rock formation	Areal extent (in hectares)						
		Total Geogra-phical Area	Hilly Area	Ground Water Recharge worthy Area			Shallow Water Table Area	Flood Prone Area
				Command area	Non-command	Poor ground water quality		
Satchand (Satchand + Poangbari)	Semi-consolidated Tertiary Sandstones	28709	6251	0	22801	0	15961	0
Rupaichhari (Rupaichhari + Silachhari)	-Do-	27256	10125	0	15545	0	0	0
TOTAL		**55965**	**16376**	**0**	**38346**	**0**	**15961**	**0**

Table ï 4.1.2 : **Assessment of Dynamic GW Resources – GW Recharge from all Sources in 2013 (ham)**

Assessment Unit (Block)	Ground Water Recharge worthy Area	Recharge from rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge/ Annual Replenish-able Resources	Recharge per Unit Area (mm)	Recharge from other Sources as Percentage of Total Recharge (%)	Provision for Natural Discharges (5 % of Total Recharge)	Net Annual Ground Water Availability/ Net Annually Available Ground Water Resource [7 – 10]
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Satchand	22801	4465.8	0	2502.6	1974.5	8942.9	392.2	22.08 %	447.15	8495.78
Rupaichhari	15545	1580.9	0	1706.2	1225.0	4512.1	290.3	27.15 %	225.60	4286.49
TOTAL	**38346**	**6046.6**	**0**	**4208.9**	**3199.5**	**13455.0**	**350.9**	**23.78 %**	**672.75**	**12782.27**

Ground Water Draft for Various Uses : Ground water draft for irrigation accounts for 49.91 % of the total ground water draft, whereas draft for domestic & Industrial purposes account for 50.09 % of total ground water draft in the aquifer mapping area. However, the ground water draft for industrial use in the area is quite negligible.

Table ï 4.1.3 : **Assessment of Dynamic Ground Water Resources - GW Draft - 2013 (in ham)**

Assess-ment Unit (Block)	Command /non-Command /Total	Net Annual Ground Water Avail-ability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for Domestic & Indus-trial Water Supply	Existing Gross Ground Water Draft for All uses (4 + 5)	Provision for domestic, & industrial require-ment supply to 2025	Net Ground Water Availability / Balance Resource for future irrigation develop-ment/ Use (3 – 4 – 7)	Stage of Ground Water Develop-ment {(6/3) * 100} (%)	Net GW Availability for Future Irrigation @ 60% of Net GW Avail-ability (ham) for future irrigation	No. of ShallowTW feasible as per Resource (Unit draft as 3 ham)
1	2	3	4	5	6	7	8	9	10	11
Satchand	Non-Command	8495.8	288.00	191.71	479.71	603.92	7603.86	5.65	4562.316	1521
Rupaichhari	- Do -	4286.5	0.00	97.27	97.27	389.80	3896.69	2.27	2338.014	779
TOTAL		**12782.3**	**288.00**	**288.98**	**576.98**	**993.72**	**11500.55**	**4.51**	**6900.33**	**2300**

Stage of Ground Water Development and Categories of the Blocks : The Stage of Development of Ground Water in this Aquifer Mapping Area is below 5% which is certainly very low. All the rural development blocks fall under ó**SAFE'** category and there is always a huge scope of further development.

Table ï 4.1.4 : **Assessment of Dynamic Ground Water Resources : Block-Wise Categorization (2013)**

Assessment Unit (Block)	Stage of Ground Water Development (%)	Pre-monsoon		Post-monsoon		Category (Safe/Semi-critical/ Critical/ Over-exploited)
		Water Level Trend	Is there a significant decline (Yes/No)	Water Level Trend	Is there a significant decline (Yes/No)	
Satchand	5.65	-	No	Falling	No	Safe
Rupaichari	2.27	-	No	Falling	No	Safe

As per the dynamic ground water resources estimation of Tripura, 2013, the Satchand aquifer mapping area containing the two former blocks Satchand and Rupaichhari has a total Annual Replenishable Ground Water Resources of **13455.02 ham**, out of which **672.75 ham** is Natural Discharge and so the Net Annual Ground Water Availability is 1**2,782.27 ham**.

The present Gross Annual Ground Water Draft for irrigation, domestic and industrial uses is **576.98 ham (**Irrigation Draft ï 288 Ham + Domestic and Industrial Draft ï 288.98 ham). The projected demand for domestic and industrial uses i.e. Annual Allocation for Domestic and Industrial uses based upon the population data projected up to 2025 is **993.72 ham.** The Ground Water Availability (as Balance Ground Water Resources Available) for Future Irrigation is **11500.55 ham**. The overall Stage of Dynamic Ground Water Resource Development for the whole aquifer mapping area is only **4.51 %.** So, there still remains a huge scope for further ground water development for drinking, domestic and irrigational use and is considered a ñ**SAFE**ò area in terms of ground water development. The irrigation potential computed assuming a stage of development of 90% is on a higher side. On the other hand, assuming a stage of development of 70% the dynamic ground water resource development can be kept well within the safe limits.

4.3 Groundwater Development from Deeper Aquifers

Ground water from deeper aquifer is extracted both for irrigation and drinking-domestic purpose mainly by deep tube wells of depth limited to 250 m. and small bore tube well with depth up to 90 ï 100 m. There are 96 nos. of DTW and 33 nos. of SBTW (mini deep TW) being utilized for drinking-domestic purpose, by which 1827 ham/year (for DTW ï 1728 ham, calculated @ 18 ham/DTW/year and for SBTW ï 99 ham, calculated @ 3 ham/SBTW/year) ground water is being extracted.

For irrigation purpose, 5 nos. of DTW (PWD-WR Dept.) and 39 nos. of SBTW (Agri. Dept.) are being used which are extracting an approximate 267 ham/year(for DTW ï 150 ham, calculated @ 30 ham/DTW/year and for SBTW ï 117 ham, calculated @ 3 ham/SBTW/year). There are 417 nos. of artesian wells also, which have been constructed by both govt. and private initiatives by tapping deeper aquifers up to 194 m bgl and are extracting ground water in the tune of 625 ham/year. Therefore, the total ground water extraction from deeper aquifers for all uses may be estimated as 2818 ham/year.

5. GROUND WATER RELATED ISSUES

Major groundwater related issues found in the study area are low stage of dynamic groundwater development but deeper aquifer in more developed, shallow groundwater level, water shortage and water borne diseases in hills and in major parts of the study area higher concentration of iron in groundwater. Wastage of water from artesian flowing wells. In 70% of net sown area no irrigation facility is available. It is an agrarian society where majority of farmers are categorized as marginal and small. Average land holding of marginal farmers is 0.4 ha.

5.1 Dynamic groundwater development Vs. deeper aquifer development

As per the dynamic ground water resources estimation of Tripura, 2013, the Satchand aquifer mapping area containing the two former blocks Satchand and Rupaichhari has a total Net Annual Ground Water Availability of 12,782 ham and Gross Annual Ground Water Draft for all uses is 577 ham.

Whereas the total ground water extraction from deeper aquifers for all uses through deep tube wells, mini deep tube wells and artesian flowing wells was estimated as 2818 ham.

5.2 Shallow Water Level

During pre-monsoon period isolated pockets of very shallow water level i.e. within 2 m bgl is observed in mapping area. They are located in Daulbari (Sabroom) area, in and around Manubazar area of Satchand block and Amlighat-Srinagar area of Poangbari block (map 6 and 7).

5.3 Rainwater Harvesting

Physiographically, the area is divided into hills and valleys. Ground water development is taking place mostly in the valleys. Depth to water level maps of the area reveals that water level is within 5 m bgl in major part of the valleys. The pre-monsoon water level invariably remains deeper (Ó 6 m bgl) in some small pockets like Tuisama, Sabroom, Magroom etc. The study area is receiving about 2000mm of average annual rainfall but most of it is draining to Bangladesh within a short span of time. Rainwater harvesting structures like percolation tanks, check dams, nala bunds and gabion structures may be constructed to arrest this wastage of rainwater. These structures can be constructed in the foot-hill areas.

Already State Govt. departments have constructed a few thousands of small ponds, check dams etc. to harvest rainwater.

5.2 Geogenic Pollution of Ground Water :

The high Iron concentration in ground water from the aquifers throughout the geological succession is the major problem, which ranges from 0.05 to 5.0 ppm, whereas the prescribed desired limit is 0.3 ppm and the maximum permissible limit is 1 ppm. Distribution of iron in groundwater in the NAQUIM area is depicted in map 10.

Iron concentration in shallow aquifers - more than 30% of the aquifer mapping area falls under Iron content more than 1 ppm. Iron concentration in shallow zones is less than 1 ppm in ground water discharge areas i.e. in Satchand and Rupaichhari blocks.

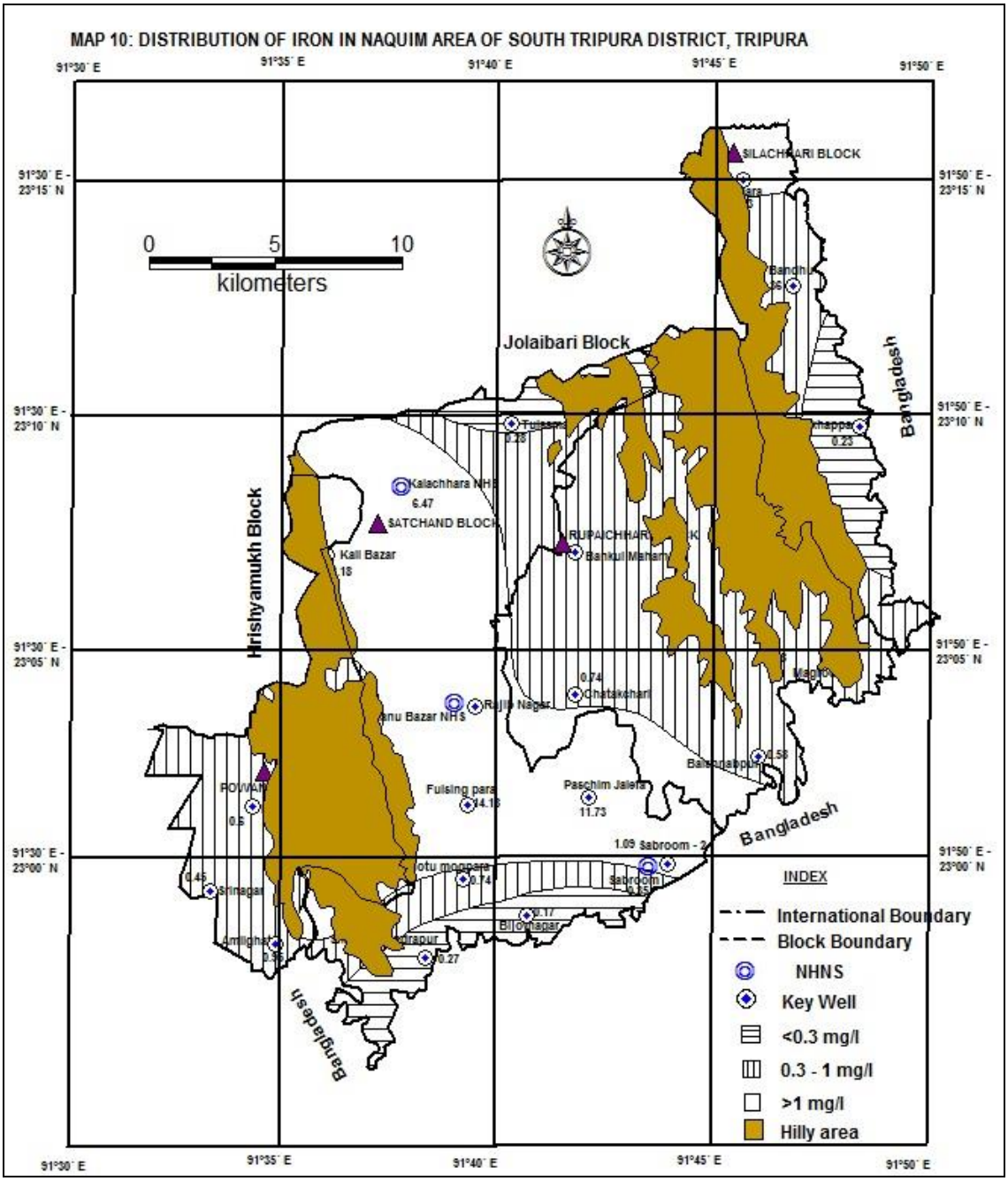
Iron concentration in Deeper Aquifers - The Iron concentration in deeper aquifers is mostly more than 1 ppm, which ranges from 0.043 ppm to 5 ppm. In deeper aquifers also the iron concentration is relatively less in the discharge areas of Satchand (at Kalir bazar - 0.06 ppm) & Rupaichhari (at Rupaichhari - 0.175 ppm) blocks.

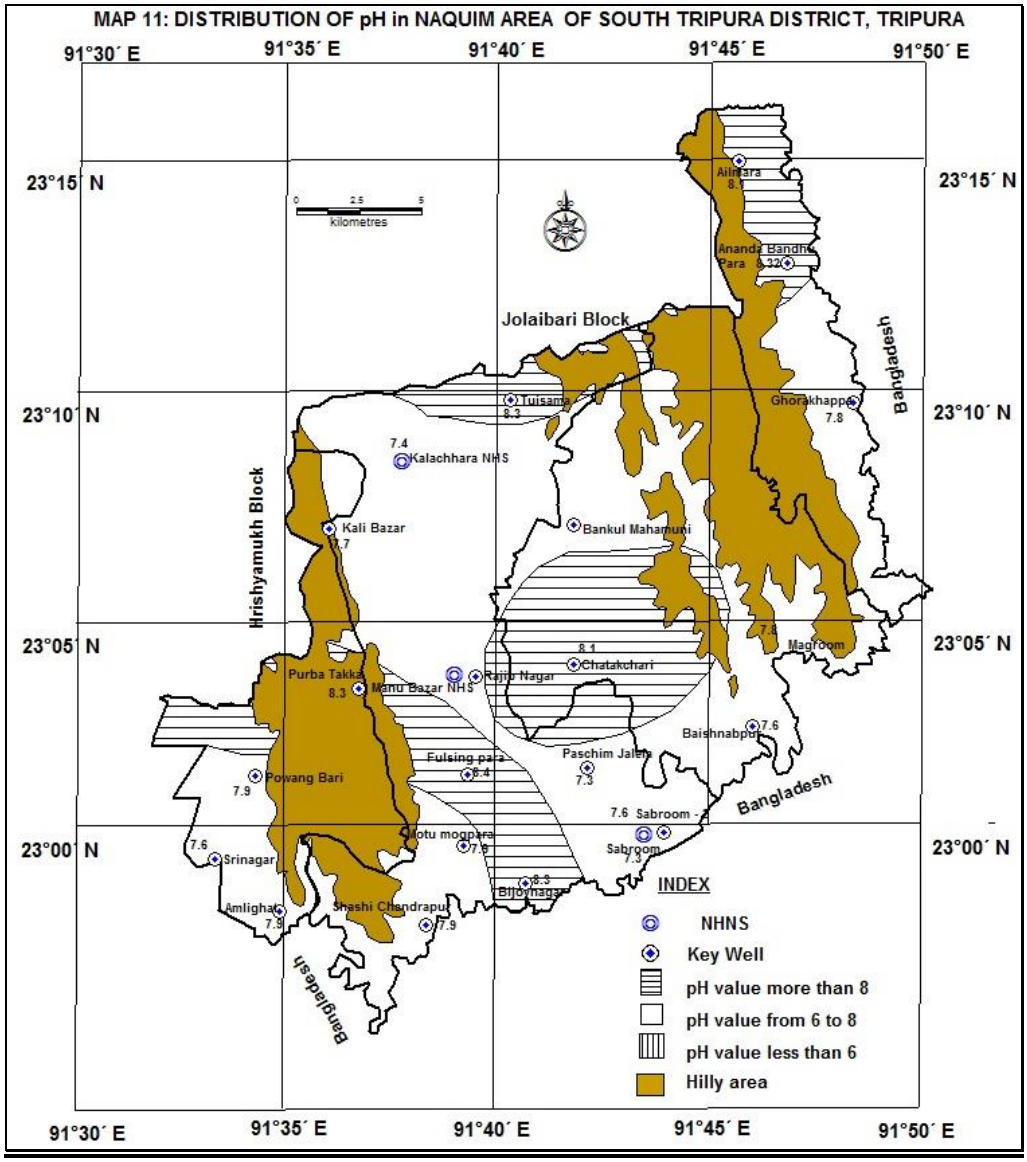
In Dug Wells the Iron concentration is in the range of 0.05 to 1.32 ppm; in hand pumps 0.233 to 3.54 ppm and in deep tube wells it is in the range of 0.06 to 4.45 ppm

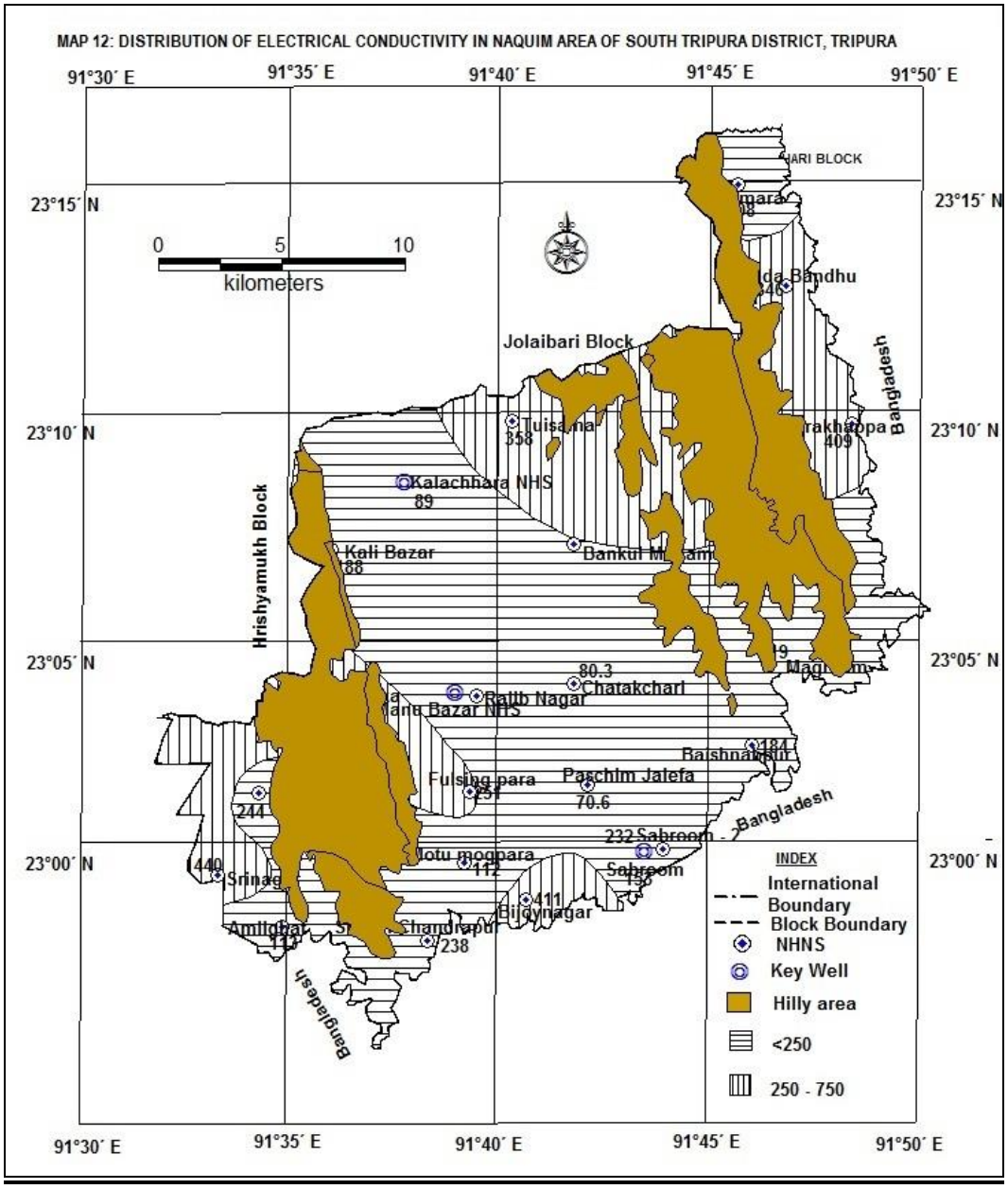
Enrichment of iron in water is due to ferruginous nature of Dupitila Formation and Tipam Sandstones, which form the major aquifers in the area. The iron concentration in water from open dug well is comparatively less than that of tube wells. This is due to the fact that the scope of aeration is more in open wells, which causes the precipitation of ferrous iron as ferric iron.

5.4 Wastage of Water from Overflowing Artesian Wells

There are hundreds of artesian overflowing wells which are mainly used for irrigation purpose and some for drinking & domestic purposes too. Water from these wells is flowing continuously. This water is going to Bangladesh through streams.


MAP 10: DISTRIBUTION OF IRON IN NAQUIM AREA OF SOUTH TRIPURA DISTRICT, TRIPURA
91°30' E
91°35' E
91°40' E
91°45' E
91°50' E
91°30' E - 23°15' N
91°50' E - 23°15' N
91°30' E - 23°10' N
91°50' E - 23°10' N
91°30' E - 23°05' N
91°50' E - 23°05' N
91°30' E - 23°00' N
91°50' E - 23°00' N
0
5
10
kilometers
SILACHHARI BLOCK
Jolaibari Block
Hrishyamukh Block
SATCHAND BLOCK
RUPAICHHARI
Kalachhara NHS
6.47
Kali Bazar
1.8
Tuisapa
0.28
Bangladesh
0.23
Bankul Maharani
0.74
Chatakchari
Rajib Nagar
Balisanappara
0.58
Paschim Jalefa
11.73
Fulsing para
4.16
POWAI
0.5
1.09
Sabroom - 2
Sabroom
0.45
Srinagar
0.74
0.17
Bijoynagar
0.27
Bangladesh
INDEX
International Boundary
Block Boundary
NHNS
Key Well
<0.3 mg/l
0.3 - 1 mg/l
>1 mg/l
Hilly area


MAP 11: DISTRIBUTION OF pH in NAQUIM AREA OF SOUTH TRIPURA DISTRICT, TRIPURA
91°30´ E
91°35´ E
91°40´ E
91°45´ E
91°50´ E
23°15´ N
23°10´ N
23°05´ N
23°00´ N
0 2.5 5
kilometres
Jolaibari Block
Hrishyamukh Block
Bangladesh
Ailmara
Ananda Bandhu Para
Tuisama
8.3
Ghorakhappa
7.8
7.4
Kalachhara NHS
Kali Bazar
7.7
Bankul Maharani
8.1
Chatakchari
Magroom
Purba Takka
8.3
Manu Bazar NHS
Rajiu Nagar
Baishnabpur
7.6
Fulsing para
8.4
Paschim Jalefa
7.3
Powang Bari
7.9
7.6 Sabroom -
Sabroom
7.3
Motu moopara
7.6
7.6
Srinagar
8.3
Bijoynagar
Amlighat
7.9
Shashi Chandrapur
7.9
INDEX
NHNS
Key Well
pH value more than 8
pH value from 6 to 8
pH value less than 6
Hilly area


MAP 12: DISTRIBUTION OF ELECTRICAL CONDUCTIVITY IN NAQUIM AREA OF SOUTH TRIPURA DISTRICT, TRIPURA
91°30´ E
91°35´ E
91°40´ E
91°45´ E
91°50´ E
23°15´ N
23°10´ N
23°05´ N
23°00´ N
0
5
10
kilometers
Jolaibari Block
Hrishyamukh Block
Bangladesh
Kalachhara NHS
89
Kali Bazar
88
Tuisama
358
Rakhtopa
409
Ratib Nagar
Chatakchari
80.3
Fusing para
257
Paschim Jalefa
70.6
Baishnabbir
184
Sabroom
232
Jotu mogpara
112
Srinagar
440
244
Bijoynagar
411
Chandrapur
238
INDEX
International Boundary
Block Boundary
NHNS
Key Well
Hilly area
<250
250 - 750

6. AQUIFER MANAGEMENT PLAN

1.1 MANAGEMENT STRATEGIES

1) Future Irrigation Schemes by Using Dynamic Ground Water Resources and Shallow Water Level

As per the report on dynamic ground water resources of Tripura as on March 2013, the Satchand aquifer mapping area is having balance net ground water availability for future irrigation use is 11500.55 ham (115 MCM). If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available 6900.33 ham (69 MCM) in the area for the future irrigation uses, then 2555 nos. of shallow tube wells (considering a unit draft of 2.7 ham/year) can be constructed in the aquifer mapping area.

It is proposed to bring 60% of the net sown area under paddy cultivation and 40% under non-paddy cultivation. Crop water requirement for paddy cultivation is 1.2 m and for non-paddy crops it is 0.3 m. It is proposed to use 80% of 6900.33 ham of ground water for paddy irrigation and 20% of 6900 ham of groundwater for non-paddy irrigation. This will bring an additional 9,200 ha (4600 ha for paddy and 4600 ha for non-paddy) un-irrigated land under assured irrigation in near future.

The aquifer mapping area does not have much irrigation facility. Out of net sown area of 14896 ha, only 4332 ha land has been brought under assured irrigation by both surface water and ground water. Thus a vast land of 10564 ha does not have any irrigation facility which can be easily brought under irrigation using the existing huge dynamic ground water resources available in the mapping area. It is proposed to bring 60% of residual un-irrigated (but irrigable) land under paddy and 40% of residual un-irrigated (but irrigable) land under non-paddy cultivation. Thus the irrigation water requirement for 6338 ha of paddy cultivation would be 7606 ham (76 MCM) while that for 4225 ha of non-paddy cultivation would be 1268 ham (13 MCM). Total irrigation water requirement to bring this entire 10564 ha of uncovered net sown area under irrigation is 8874 ham (89 MCM). To meet water requirement of 8874 ham 3287 shallow tube wells are required to be constructed. It is proposed to use 69 mcm of groundwater for future irrigation but extraction of 20 mcm more water from the aquifer will lower water level by 20 cm in the present un-irrigated area which will be easily replenished during monsoon (average annual rainfall more than 2000 mm).

Considering a distance between any two shallow tube well as 200m, 25 shallow tube wells can be constructed in 1 sq.km area. Hence, in 106 sq.km area, a total of 2650 shallow

tube wells can be constructed.

Considering 2.25 ha of command area creation for paddy from a shallow tube well and 9 ha of command area creation for non-paddy paddy from a shallow tube well, to bring 6338 ha of paddy and 4225 ha of non-paddy area under irrigation 3287 nos. of shallow tube wells are required.

Construction of thousands of shallow tube wells will definitely lower water level in the area and thereby will create space for more groundwater recharge during rainy periods.

Well Design: CGWB has established that aquifers in the mapping area are prolific in nature and this can be sustainably developed to irrigate a vast land. A shallow tube well in the valley or foot-hill zone yielding 15 m^3/hr, runs for 12 hrs/day for 150 days will create a draft of 2.7 ham. Tube wells can be designed with depth of 50 to 60 m and tapping 20 to 30 m of granular zone and constructed by using $8^{//}$ dia. casing pipe down to 30 m, $6^{//}$ dia. slot (0.5 to 1 mm) pipes for 20 to 30 m and $6^{//}$ dia. 10 m blank pipe, which are expected to yield 15 m^3/hr for a maximum drawdown of 10 m.

Though huge ground water resource is available but farmers in the area are poor and marginal farmer and so it may not be possible for them to construct tube wells at individual capacity. Community based irrigation schemes through harnessing ground water may be taken up by the Govt. departments, which will definitely and greatly boost the socio-economic conditions in the area.

Cost Estimates: One time expenditure to construct 2555 tube wells @ Rs. 2,00,000/- is Rs. 52 crores.

Cost of 5 HP submersible pumps @ Rs. 15,000/= is Rs. 4 crores. The electrical consumption for 5 HP submersible pumps will be 7 MW / per hour (@ 2.79 KW per hour per tube well).

Cost of 3 HP solar pump (auto tracking, 20 m head, avg daily discharge 1.5 lakh liter) @ 4.75 lakhs is 121 crores.

2) Increase Sustainability of Artesian Flowing Wells

It has been observed that in most of these wells piezometric head is up to 1 m agl only. So, if a pipe of 1.5 m is put on top of the wells, the water will stop flowing over and whenever water would be required, it can be collected through a tap with at the height of 1 m agl. In this way the ground water can be preserved in the aquifer, thus can be saved from wastage.

3) Rainwater Harvesting:

The area receives about 2000 mm annual rainfall. Most of it goes as surface runoff and within a short period enter Bangladesh. Rainwater harvesting structures like small sized check dams, nala bunds, gabions and check weirs etc. on the streams and gully plugging and contour bunds can also be constructed, especially in the foothill zones, so that rain water can be efficiently harvested and can be stored for future use. Already State Govt. has started constructing such rainwater harvesting structures in the foot hill areas.

4) High Concentration of Iron in Groundwater

Iron above permissible limit in groundwater may not cause any fatal health hazard, but high iron content renders ground water unsuitable for drinking and also creates aesthetic problems like odd water colour, reddish brown staining of laundry, porcelain, dishes, utensils and even glassware, which cannot be removed by any soap or detergent, foul smell etc. and other problems like bad taste, indigestion and accumulation/deposits in pipelines reducing the available quantity and pressure of water supply. Iron accumulations become an economic problem as it increases energy costs for pumping water through constricted pipes and as the water supply equipment frequently need replacement. The level of iron concentration should be brought down to the desirable limit before its use for drinking purpose, to avoid any health hazards.

6.2 Management Plan

By providing irrigation facilities 6338 ha of paddy land 190,000 quintal of food grains (@ 3000 kg/ha) can be produced. This will boost the economy by providing Rs. 42 crores per annum income (Recent minimum price of common paddy Rs. 2200/- per Quintal). Further by providing irrigation facilities to 4225 ha of non-paddy land 36,000 quintal of oilseeds can be produced. This will generate an income of Rs. 11 crores per annum (recent minimum price is Rs. 3000/ Qn of oilseeds). Total one time expenditure is Rs. 8.48 crores. Recurring income would be Rs. 4.445 to 5.258 crores per annum.

Ground water in the area is infested with iron, therefore before consumption aeration/filtering/installation of Iron Removal Plant is necessary. At present, PWD (WR), Govt. of Tripura is supplying treated drinking water in this aquifer mapping area. Apart from this, individual houses are also using indigenous and very efficient ôTripura Filterô for removing iron to a great extent. Farmerôs co-operative societies may also be formed at

the Gram Panchayet level, which will look after the operations and maintenances of the tube wells running for irrigation schemes at the community basis.

By putting a pipe of 1.5 m on top of the free flowing artesian wells, the free flow of water can be stopped and from each such well water in the tune of 1600 to 11000 m^3/ year can be saved and the process will increase sustainability of the aquifer also.

Annexure I : AQUIFER WISE/ ZONE WISE WATER QUALITY DATA OF AQUIFER MAPPING AREA IN SATCHAND AREA, SOUTH TRIPURA DISTRICT

Sl. No.	Unique ID	Village/ Location	Taluka/ Block	District	Lat	Long	Year	Depth (mbgl)	Aquifer Type	p^H	EC (µS/cm)	TRBD (NTU)	TDS	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	NO_3	F	Fe
															(mg/lt)										
Group - I (Unconfined)																									
1.	79 M/12 – 2B	KALIR BAZAR	Satchand	South Tripura	23° 06.888'	91°35.99'	2014	5.38	(Unconfined)	7.7	188	0.5	93.5	80	16	9.71	19	13.9	BDL	68	17.87	1.33	0.4	0.18	2.18
2.	79M/12-2B	KALACHHARA	Satchand	South Tripura	23.141`	91.627°	2014	6.67	(Unconfined)	7.4	89	0.9	42	60	8	9.71	4.06	3.72	BDL	36	7.94	1.27	0.1	0.09	6.47
3.	79 M/12 – 3C	PASCHIM JALEFA	Satchand	South Tripura	23° 01.824'	91°42.002'	2014	5.72	(Unconfined)	7.3	70.6	0.3	34.1	60	4.8	11.7	4.12	12.82	BDL	36	13.9	1.36	BDL	0.08	11.73
4.	79M/12-3C	SABROOM	Satchand	South Tripura	23.006°	91.724°	2014	7.29	(Unconfined)	7.3	153	0.6	74.7	56	11.2	6.8	21	3.22	BDL	48	17.87	0.99	2.8	0.1	0.35
5.	79 M/12 – 3C	SABROOM -2	Satchand	South Tripura	23°00.417''	91°43.906''	2014	7.07	(Unconfined)	7.6	232	1.1	113	144	38.4	11.7	18.6	16.22	BDL	144	19.85	1.24	0.8	0.19	1.09
6.	79 M/16 – 3A	BAISHNABPUR	Rupaichhari	South Tripura	23°02.728'	91°45.965'	2014	13.00	(Unconfined)	7.6	184	1.7	88.6	88	14.4	12.6	18.3	4.54	BDL	40	13.9	3.53	0.9	0.1	0.58
7.	79 M/16 – 3A	MAGROOM	Rupaichhari	South Tripura	23°04.378'	91°46.531'	2014	10.31	(Unconfined)	7.8	219	1.3	107	84	19.2	8.74	29.2	1.88	BDL	72	27.79	1.19	0.2	0.15	0.88
8.	79 M/12 – 3C	BIJAYNAGAR	Satchand	South Tripura	22°59.319'	91°40.600'	2014	6.02	(Unconfined)	8.3	411	0.3	201	148	36.8	13.6	22.4	16.12	16	68	57.57	1.11	1.2	0.13	0.17
9.	79 M/12 – 3B	FULSINGPARA	Satchand	South Tripura	23°01.681'	91°39.223'	2014	6.12	(Unconfined)	8.4	251	0.2	122	180	38.4	20.4	3.26	18.5	24	84	15.88	1.19	1.2	0.18	14.18
10.	79 M/12 – 3B	MOTU MOGPARA	Satchand	South Tripura	23°00.170'	91°39.103'	2014	6.16	(Unconfined)	7.9	112	0.3	54.6	72	24	2.91	14.2	3	BDL	48	11.91	1.02	0.1	0.11	0.74
11.	79 M/12 – 3B	SHASHI-CHANDRAPUR	Satchand	South Tripura	22°58.389'	91°38.248'	2014	7.09	(Unconfined)	7.8	238	0.5	116	128	22.4	17.5	17.2	13.56	BDL	104	19.85	1.16	1.2	0.11	0.27

12.	**79 M/12 – 3A**	**AMLI GHAT**	**Poangbari**	**South Tripura**	**22°58.730'**	**91°34.747'**	**2014**	**6.43**	**(Uncon-fined)**	7.9	113	BDL	54.7	68	16	6.8	14.2	3.99	BDL	60	17.87	0.99	0.4	0.08	0.95
13.	**79 M/12 – 3A**	**SRINAGAR**	**Poangbari**	**South Tripura**	**22°59.931''**	**91°33.218''**	**2014**	**8.16**	**(Uncon-fined)**	7.6	440	0.2	215	220	27.2	36.9	46.1	16.2	BDL	68	83.37	1.05	0.2	0.09	0.45
14.	**79M/12 – 3A**	**POANGBARI**	**Poangbari**	**South Tripura**	**23°01.654'**	**91°34.206'**	**2014**	**7.15**	**(Uncon-fined)**	7.9	244	BDL	118	100	22.4	10.7	21.3	13.9	BDL	84	13.9	1.46	BDL	0.1	0.6
15.	**79 M/12 – 3B**	**PURBA TAKKA**	**Poangbari**	**South Tripura**	**23°03.598'**	**91°36.689'**	**2014**	**6.59**	**(Uncon-fined**	8.3	287	BDL	140	172	28.8	24.3	18	2.52	48	96	17.87	0.99	0.3	BDL	0.57
16.	**79 M/12 – 1C**	**TUISAMA**	**Satchand**	**South Tripura**	**23°09.796'**	**91°40.240'**	**2014**	**9.20**	**(Uncon-fined)**	8.3	358	.5	173	180	27.2	27.2	22.4	27.5	48	52	31.76	1.19	0.4	0.29	0.28
17.	**79 M/12 – 3C**	**CHATAKCHARI**	**Rupaichhari**	**South Tripura**	**23°04.070'**	**91°41.696'**	**2014**	**6.12**	**(Uncon-fined)**	8.1	80.3	BDL	39.3	88	4.8	18.4	2.73	3.92	BDL	44	11.91	0.99	0.1	0.24	0.74
18.	**79 M/16 – 2A**	**GHORAKHAPPA**	**Silachhari**	**South Tripura**	**23°09.726'**	**91°48.301'**	**2014**	**6.74**	**(Uncon-fined)**	7.8	409	.1	205	116	25.6	12.6	34.2	17.6	BDL	24	43.67	1.05	8.6	0.06	0.23
19.	**79 M/16 – 1A**	**ANANDA BANDHU PARA**	**Silachhari**	**South Tripura**	**23°12.839'**	**91°46.745'**	**2014**	**6.76**	**(Uncon-fined)**	8.32	346	.1	167	148	36.8	13.6	20.8	2.19	88	16	19.85	0.99	0.7	0.05	0.36
20.	**79 M/15 - 3A**	**AILMARA**	**Silachhari**	**South Tripura**	**23°15023'**	**91°45.615'**	**2014**	**6.62**	**(Uncon-fined)**	8.1	208	.9	101	68	11.2	9.71	21.4	3.06	BDL	52	11.91	1.47	0.4	0.15	1.03

Sl. No.	Unique ID	Village/ Location	Taluka/ Block	District	Lat	Long	Year	Depth (mbgl)	Aquifer Type	pH	EC (µS/cm)	TRBD (NTU)	TDS	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	NO_3	F	Fe	As
															(mg/lt)											
Group - II (Confined)																										
1.	ST-79M - 54	**Satchand EW**	Satchand	South Tripura	**23^0 07' 45"**	**91^0 38' 10"**	1979	200	Con-fined	7.1	130	-	-	70	14	8.5	-	-	Nil	92	9	-	-	-	0.4	-
2.	ST-79M - 55	**Manu Bazar (Deposit Well)**	Satchand	South Tripura	**23^0 04' 34"**	**91^0 38' 35"**	1979	208	Con-fined																	
3.	ST-79M - 56	**Paschim Jalefa EW**	Satchand	South Tripura	**23^0 02' 00"**	**91^0 41' 13"**	2015	151	Con-fined																	
		Paschim Jalefa OW	Satchand	South Tripura			2015	151	Con-fined																	
4.	ST-79M - 57	**Tuisama EW**	Satchand	South Tripura	**23^0 09' 24"**	**91^0 39' 42"**	2015	154	Con-fined																	
		Tuisama OW	Satchand	South Tripura			2015	154	Con-fined																	
5.	ST-79M - 58	**Rajib Nagar EW**	Satchand	South Tripura	**23^0 03' 28''**	**91^0 39' 21''**	2016	153	Con-fined																	
6.		**Rajib Nagar OW**	Satchand	South Tripura			2016	152	Con-fined																	

Annexure - II

HYDROGEOLOGICAL DETAILS OF TUBE WELLS CONSTRUCTED BY CGWB IN NAQUIM AREA South Tripura District																	
Sl No	Village	Type of well	Depth Drilled (m)	Assembly lowered (m)	Surface Elevation (m amsl)	Year of drilling	Position of slot (m)	Aquifer tapped (m)	SWL (m bgl)	Discharge		Draw down (m)	Specific Cap (lpm/mdd)	Transmissivity (m^2/day)	Permeability (m/day)	Storativity	Remarks
										m^3/hr	**lps**						
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
FENNY BASIN, SOUTH TRIPURA																	
1	Satchand N lat 23^{0}07'45ôô E long 91^{0}38'10"	EW	253	200	17.465	1979	60-63 83-88 93-99 117-120 130-133 147-153 168-180 183-189 192-198	50	0.42 m agl	91	25.25	12.5	121.4	887.7	17.7	-	Auto flow
2	Haripur	EW	202	187	25.972	1991	80-92 104-110 144-150 160-184	48	1.9	30	8.33	7.12	70	330	4.8	2.38x10^{-3}	
3	Haripur	OW	190	174	25.68	1991	105-111 144-150 165-171	18	4.5			0.68		470			

Annexure III : Vertical Electric Survey Details Prepared By Geo-physicist

Unique ID	VES 1TRPS	**Date/Year**	27/06/2014
Village	Ramgua	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.		**Depth Drilled**	
Lat	$23^0$07ô19.5ò	**Discharge (lps)**	
Long	$91^0$37ô30.5ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 1TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.26	1.26	1542	Top soil with pebbles etc
1.26	1.62	0.364	5734	Pebbles, boulders, sands etc
1.62	7.98	6.36	1299	Consolidated sands/sanstone
7.98	17	8.98	7	Clays etc
Below 17		-	1160	Weatherd rock etc.

Unique ID	VES 2 TRPS	**Date/Year**	27/06/2014
Village	Maninder Raiwazapara	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79M/12	**Depth Drilled**	
Lat	$23^0$09ô21.0ò	**Discharge (lps)**	
Long	$91^0$39ô44.7ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 2 TRPS

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	**To**			
0	4.77	4.77	1640	Top soil with sands etc
4.77	9.62	4.85	6000	Consolidated sands.
9.62	21.4	11.7	17	Clays etc. with sands
Below 21.4m		-	2456	Weathered rock etc

Unique ID	VES 3 TRPS	**Date/Year**	27/06/2014
Village	Guwachand	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$02ô53.2ò	**Discharge (lps)**	
Long	$91^0$39ô59.2ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 3 TRPS

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	**To**			
0	0.75	0.75	131	Top soil with sands etc
0.75	3.728	2.978	471	Pebbles, sands, boulders etc.
3.728	8.20	4.472	210	sands with clays etc.
8.20	18.11	9.906	8	Clays etc.
Below 18.11		-	70	Intercalations of Sands with clays etc

Unique ID	VES 4 TRPS	**Date/Year**	28/06/2014
Village	Madhab Nagar	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Powangbari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	

Toposheet No.	79M/12	**Depth Drilled**	
Lat	$23^0$03ô19.3ò	**Discharge (lps)**	
Long	$91^0$32ô20.4ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 4 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.87	1.87	83	Top soil with clays and sands
1.87	11.6	9.76	26	clays with sand etc.
11.6	60.3	48.7	11	Clays etc
Below 60.3		-	20	Intercalations of Sands with clays etc

Unique ID	VES 5 TRPS	**Date/Year**	28/06/2014
Village	Kalyan Nagar	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 N/9	**Depth Drilled**	
Lat	$22^0$59ô20.5ò	**Discharge (lps)**	
Long	$91^0$40ô10.4ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 5 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.221	1.221	128	Top soil with pebbles, sand etc
1.221	3.038	1.817	35	Clays with sand etc
3.038	6.513	3.475	360	Sands etc
6.513	27.75	21.21	37	Clays with sand etc
27.75	48.65	20.93	313	Sands etc
Below 48.65		-	69	Intercalations of Sands with clays etc

Unique ID	VES 6 TRPS	**Date/Year**	28/06/2014
Village	Sabroom	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$00ô10.5ò	**Discharge (lps)**	
Long	$91^0$43ô53.9ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 6 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	4.55	4.55	140	Top soil with pebbles, clays
4.55	6.8	2.25	1566	Sands, boulders, clays etc
Below 6.80		-	143	Intercalations of Sands with clays etc.

Unique ID	VES 7 TRPS	**Date/Year**	28/06/2014
Village	Manu Bankul	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Rupaichari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$07ô07.4ò	**Discharge (lps)**	
Long	$91^0$42ô41.4ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 7 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.2	1.2	431	Top soil with pebbles, boulders, sand etc
1.2	11.3	10.1	359	Sand etc

11.3	23.7	12.5	866	Consolidated sands etc
23.7	50	26.3	25	Clays with sand etc
Below 50		-	3680	Sandstone / shale etc

Unique ID	VES 8 TRPS	**Date/Year**	30/06/2014
Village	Kathalcheri	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$01ô20.6ò	**Discharge (lps)**	
Long	$91^0$44ô15.3ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 8 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.475	0.475	290	Top soil with pebbles, sand etc
0.475	1	0.525	5816	Boulders, pebbles with sands etc
1	14.7	13.7	858	Shale / dry sands etc
14.7	33	18.3	56	Sands etc
Below 33		-	16108	Sandstone / shale

Unique ID	VES 9 TRPS	**Date/Year**	28/06/2014
Village	Vaishnavpur	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Rupaichari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/16	**Depth Drilled**	
Lat	$23^0$03ô27.8ò	**Discharge (lps)**	
Long	$91^0$46ô00.0ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 9 TRPS

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	**To**			
0	1.54	1.54	109	Top soil with pebbles, sand etc
1.54	11.2	9.65	72	Sand etc
11.2	15.9	4.71	11	Clays etc
Below 15.9		-	49	Intercalations of Sands with clays etc

Unique ID	VES 10 TRPS	**Date/Year**	30/06/2014
Village	Bakmara	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Korbook	**Yield / discharge**	
District	Gomati	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/16	**Depth Drilled**	
Lat	$23^0$06ô19.5ò	**Discharge (lps)**	
Long	$91^0$48ô55.6ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 10 TRPS

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	**To**			
0	0.789	0.789	186	Top soil with pebbles, sand etc
0.789	2.6	1.81	363	Sands, pebbles, boulders, clays etc
2.6	14.4	11.8	263	Sands / Consolidated sands etc
14.4	31.3	16.9	416	Sands (dry)
Below 31.3		-	2	Predominantly clays etc

Unique ID	VES 11 TRPS	**Date/Year**	02/07/2014
Village	Sukantapalli	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	

District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$04ô01.9ò	**Discharge (lps)**	
Long	$91^0$38ô19.0ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 11 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.627	0.627	130	Top soil with pebbles, sand etc
0.627	0.854	0.227	12490	Boulders, pebbles, clays with sand etc
0.854	25.7	24.8	752	Sands etc
25.7	60.5	34.8	32	Clays with sand etc
Below 60.5		-	3924	Shale / Sandstone etc

Unique ID	VES 12 TRPS	**Date/Year**	28/06/2014
Village	Sankartilla	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Powangbari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$03ô18.7ò	**Discharge (lps)**	
Long	$91^0$36ô08.4ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 12 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.218	0.218	168	Top soil with pebbles, sand etc
0.218	5.96	5.74	310	Pebbles with sand etc
5.96	14	8.05	622	Dry sands etc
14	115	101	139	Sands, shale etc
Below 115		-	367	Consolidated sands etc

Unique ID	VES 13 TRPS	**Date/Year**	04/07/2015
Village	Sakbari	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$10ô02.6ò	**Discharge (lps)**	
Long	$91^0$38ô24.5ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 13 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.224	0.224	512	Top soil with pebbles, sand etc
0.224	5.38	5.16	1159	Shale/dry sand
5.38	21.8	16.4	511	Dry sands etc
Below 21.8		-	89.2	Intercalations of Sands with water etc

Unique ID	VES 14 TRPS	**Date/Year**	04/07/2014
Village	Pilak	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Santir bazar	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$11ô13.0ò	**Discharge (lps)**	
Long	$91^0$42ô21.9ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 14 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	4.78	4.78	1252	Top soil with pebbles,

				boulders, sand etc
4.78	8.53	3.76	273	Sands etc
8.53	19.1	10.6	3022	Sandstone/Consolidated shale etc
Below 19.1		-	8	Clays with sand etc

Unique ID	VES 15 TRPS	**Date/Year**	05/07/2015
Village	Tulamura	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Korbook(Silachari)	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$14ô16.9ò	**Discharge (lps)**	
Long	$91^0$44ô38.0ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 15 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.3	1.3	223	Top soil with pebbles, sand etc
1.3	3.49	2.19	77	Coarse sands etc
3.49	16.2	12.7	42	Medium sands etc
Below 16.2		-	87	Coarse sands etc

Unique ID	VES 16 TRPS	**Date/Year**	05/07/2014
Village	Ailmara	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Silachari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$15ô49.3ò	**Discharge (lps)**	
Long	$91^0$45ô10.6ò	**Transmissivity (m^2 /day)**	

RL (m amsl)		Storativity	
Unique ID: VES 16 TRPS			
Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.637	0.637	47	Top soil with sand etc
0.637	1.019	0.383	177	Sands, pebbles etc
1.019	13.36	12.34	65	Sands etc
Below 13.36		-	29	Intercalations of Sands with clays etc

Unique ID	VES 17 TRPS	**Date/Year**	05/07/2014
Village	Kajoshikmokpara	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Korbook(Silachari)	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/16	**Depth Drilled**	
Lat	$23^0$14ô40.9ò	**Discharge (lps)**	
Long	$91^0$45ô52.1ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	
Unique ID: VES 17 TRPS			
Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.749	0.749	77	Top soil with sand etc
0.749	1.58	0.831	897	Sand with pebbles, boulders etc
1.58	3.8	2.22	52	Sands etc
3.8	14.7	10.9	871	Dry sands etc
14.7	46.1	31.4	25	Sands with clays etc
Below 46.1		-	4479	Consolidated shale/sandstone

Unique ID	VES 18 TRPS	**Date/Year**	05/07/2014

Village	Suknachari	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Korbook	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$11ô20.7ò	**Discharge (lps)**	
Long	$91^0$47ô11.7ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 18 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.47	1.47	527	Top soil with pebbles, boulders, sand etc
1.47	15.5	14	197	Sand with pebbles etc
15.5	41.1	25.6	39	Sands etc
Below 41.1		-	11726	Consolidated shale / sandstone etc

Unique ID	VES 19 TRPS	**Date/Year**	06/07/2014
Village	Powangbari	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Powanbari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$01ô22.7ò	**Discharge (lps)**	
Long	$91^0$34ô02.6ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 19 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.535	0.535	54	Top soil with sand etc
0.535	0.874	0.339	1505	Sand with pebbles, boulders etc

0.874	19.4	272	272	Sands etc
19.4	37.4	18	32	Fine sand with clays etc
Below 37.4		-	43313	Consolidated shale sandstone etc

Unique ID	VES 20 TRPS	**Date/Year**	06/07/2014
Village	Sukanta Colony	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Powangbari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 N/9	**Depth Drilled**	
Lat	$22^0$59ô49.2ò	**Discharge (lps)**	
Long	$91^0$33ô30.7ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 20 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.89	1.89	181	Top soil with pebbles, sand etc
1.89	2.94	1.05	1094	Sand with pebbles, boulders etc
Below 2.94		-	59	Intercalations of Sands with clays etc

Unique ID	VES 21 TRPS	**Date/Year**	06/07/2014
Village	Kalirbazar/Nabagram	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 N/9	**Depth Drilled**	
Lat	$22^0$59ô35.0ò	**Discharge (lps)**	
Long	$91^0$36ô56.8ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 21 TRPS				
Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.465	0.465	212	Top soil with gravel, sand etc
0.465	1.25	0.78	1243	Sand with pebbles, boulders etc
1.25	2.61	1.37	113	Sands with clay etc
2.61	7.07	4.46	714	Dry sand /Consolidated shale etc
7.07	14.2	7.13	83	Sands etc
Below 14.2		-	808	Dry/Consolidated sand

Unique ID	VES 22 TRPS	**Date/Year**	07/07/2014
Village	Silpara	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Rupaichari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$03ô23.3ò	**Discharge (lps)**	
Long	$91^0$41ô19.7ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 22 TRPS				
Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.03	1.03	823	Top soil with pebbles, sand etc
1.03	2.34	1.31	4000	Sand with pebbles, boulders etc
2.34	4.42	2.08	622	Sands etc
4.42	8.72	4.3	3947	Consolidated shale / sandstone etc
8.72	20.9	12.2	52	Sands with clays etc
20.9	89	68.1	236	Sandstone/dry sand
Below 89		-	6	Sheared/Fractured rock

Unique ID	VES 23 TRPS	**Date/Year**	07/07/2014
Village	Ghorakappa	**Nearby DW/DCBW/BWDepth**	
Taluka/Block	Silachari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point?**	
Toposheet No.	79 M/16	**Depth Drilled**	
Lat	$23^0$10ô04.5ò	**Discharge (lps)**	
Long	$91^0$47ô57.6ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 23 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.75	0.75	82	Top soil with gravel, sand etc
0.75	1.74	0.987	1055	Sand with pebbles, boulders etc
1.74	9.66	7.92	265	Sands etc
9.66	21.9	12.3	714	Consolidated shale / sands etc
Below 21.9		-	2	Sheared/fractured rock/ clay etc

Unique ID	VES 24 TRPS	**Date/Year**	08/07/2014
Village	Chalitabankul	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Rupaichari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$08ô45.8ò	**Discharge (lps)**	
Long	$91^0$41ô53.4ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 24 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.664	0.664	145	Top soil with gravel, sand etc
0.664	2.73	2.07	2648	Sands with pebbles, boulders etc

2.73	38.1	35.4	419	Dry sands / consolidated shale
Below 38.1		-	92	Weathered rock

Unique ID	VES 25 TRPS	**Date/Year**	08/07/2014
Village	Sakbari	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point?**	
Toposheet No.	79 M/12	**Depth Drilled**	
Lat	$23^0$09ô10.9ò	**Discharge (lps)**	
Long	$91^0$37ô05.9ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 25 TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.75	0.75	634	Top soil with pebbles, sand etc
0.75	3.49	2.74	426	Clays with sand etc
3.49	7.51	4.02	644	Sands (dry)
7.51	16.2	8.66	157	Sand (consolidated) etc
16.2	34.8	18.7	10	Clays etc
Below 34.8		-	56	Intercalations of Sands with clays etc

Unique ID	VES 26TRPS	**Date/Year**	15/09/2015
Village	Bhuratalli	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.		**Depth Drilled**	
Lat	$23^0$07ô00.6ò	**Discharge (lps)**	
Long	$91^0$38ô10.7ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 26TRPS

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	0.85	0.85	69	Top soil with clay, sands etc
0.85	8.585	7.735	55.2	Sands etc
Below 8.585		-	1100	Weathered formation etc.

Unique ID	VES 27TRPS	**Date/Year**	16/09/2015
Village	Srinagar	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Powangbari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.		**Depth Drilled**	
Lat	$23^0$00ô49.2ò	**Discharge (lps)**	
Long	$91^0$33ô13.2ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 27TRPS

Depth range (m bgl)		Thickness (m)	Resistivity (ohm-m)	Inferred Lithology
From	To			
0	1.6	1.6	1400	Top hard soil with pebbles etc
1.6	7.68	6.08	280	Dry sands/shale
7.68	29.44	21.76	120	Sands etc
Below 29.44		-	24	Clay with intercalation of sand etc

Unique ID	VES 28TRPS	**Date/Year**	17/09/2015
Village	Amlighat	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Powangbari	**Yield / discharge**	
District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.		**Depth Drilled**	
Lat	$22^0$58ô15.9ò	**Discharge (lps)**	

Long	91^{0}34ô43.3ò	**Transmissivity (m^2 /day)**		
RL (m amsl)		**Storativity**		
Unique ID: VES 28TRPS				
Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	0.8	0.8	1555	Top soil with pebbles, bricks etc
0.8	1.36	0.56	582	Consolidated sands etc
1.36	6.376	5.016	1320	Consolidated shale/ dry sand etc
6.376	40.546	34.17	590	Consolidated sands etc
Below 34.17		-	189	Sands/weathered formation

Unique ID	VES 29TRPS	**Date/Year**		19/09/2015
Village	Motu Mogpara	**Nearby DW/DCBW/BW Depth**		
Taluka/Block	Satchand	**Yield / discharge**		
District	South Tripura	**Whether borehole was drilled at this point? If yes,**		
Toposheet No.		**Depth Drilled**		
Lat	23^{0}02ô47.8ò	**Discharge (lps)**		
Long	91^{0}40ô12.5ò	**Transmissivity (m^2 /day)**		
RL (m amsl)		**Storativity**		
Unique ID: VES 29TRPS				
Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.76	1.76	2386	Top soil with roots etc
1.76	15.6	13.8	1246	Consolidated shale/weathered formation
Below 15.6		-	190	Consolidated sands etc

Unique ID	VES 30TRPS	**Date/Year**	30/09/2015
Village	Harina	**Nearby DW/DCBW/BW Depth**	
Taluka/Block	Satchand	**Yield / discharge**	

District	South Tripura	**Whether borehole was drilled at this point? If yes,**	
Toposheet No.		**Depth Drilled**	
Lat	$23^0$02ô47.8ò	**Discharge (lps)**	
Long	$91^0$40ô12.5ò	**Transmissivity (m^2 /day)**	
RL (m amsl)		**Storativity**	

Unique ID: VES 30TRPS

Depth range (m bgl)		**Thickness (m)**	**Resistivity (ohm-m)**	**Inferred Lithology**
From	**To**			
0	1.10	1.10	240	Top soil with small plants etc
1.10	11	9.90	1200	Consolidated shale etc
Below 11		-	180	Consolidated sands etc