केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

WEST TRIPURA DISTRICT, TRIPURA

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

REPORT
ON
"AQUIFER MAPPING AND MANAGEMENT PLAN OF WEST TRIPURA DISTRICT, TRIPURA"
(AAP 2017-18)

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ABBREVIATION

AAP	Annual Action Plan
CGWB	Central Ground Water Board
NER	North Eastern Region
NAQUIM	National Aquifer Mapping and Management Plan
GL	Ground Level
IMD	Indian Meteorological Department
LPM	Litres per minute
LPS	Litres per second
GSI	Geological Survey of India
m	Metre
mbgl	Meters below ground level
MCM	Million Cubic Meter
Mm	Milli meter
mg/l	milligram/litre
m amsl	Metre above mean sea level
Sq.Km	Square Kilometre
µS/cm	Microsimens/centimetre
AMP	Aquifer Management Plan
AQM	Aquifer Mapping
BIS	Bureau of Indian Standards
BDL	Below detectable level
BCM	Billion Cubic Metres
DTW	Depth to water table
DW	Dug Well
BW	Bore well
EC	Electrical Conductivity
EW	Exploratory Well
GEC	Ground water Estimation Commitee
Ha	Hectare
Ham	Hectare meter
Km	Kilometer
MP	Measuring Point
OW	Observation Well

°C	Degree Celsius
Ppm	Parts per million equivalents to mg/l
Pz	Piezometer
SWL	Static water level
TDS	Total dissolved solid
VES	Vertical Electrical Sounding
GWMW	Ground water monitoring well
PWD(WR)	Public Work Department (Water Resources)
PWD(DWS)	Public Work Department (Drinking Water & Sanitation)

1. INTRODUCTION

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in West Tripura district, Tripura during AAP 2017-18 covering **1170 sq.km** out of total geographical area of **2993** sq.km. Under National Aquifer Mapping and Management (NAQUIM) programme, combination of geologic, geophysical, hydrologic and hydro chemical information are applied to characterize the quantity, quality and sustainability of ground water aquifers. Systematic aquifer mapping will improve our understanding of the geologic framework of aquifers, their hydrogeologic characteristics, quality and also in quantifying the available ground water resources potential and proposing plans appropriate to the scale of demand and the institutional arrangements for management. Aquifer mapping at the appropriate scale can help to prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of our precious ground water resources, which, in turn, will help achieve drinking water security, improved irrigation facilities and sustainability in water resources development.

1.1 Objectives:

The objectives of this project are to understand the aquifer systems up to 200 m depth, to define the aquifer geometry, type of aquifers, ground water regime behaviours, hydraulic characteristics and to establish groundwater quantity, quality, and sustainability, and to estimate the dynamic and static resources accurately through a multidisciplinary scientific approach on 1:50,000 scale and finally formulate a complete, sustainable and effective management plan for ground water development.

1.2 Scope of the Study:

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

1.2.1. 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, analyzed, 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.

1.2.2. Data Generation: There was also a very 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, hydro-geochemical analysis, remote sensing, besides detailed hydrogeological surveys to delineate multi aquifer system.

1.2.3. 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).

1.2.4. 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 West Tripura district 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:

Aquifer mapping and management programme has been taken up during Annual Action Plan 2017–18 in West Tripura district for an area of 1170 sq. km covering the

following blocks. Khowai, Padmabil, Tulashikhar, Teliamura, Kalyanpur, Mungiakami, Jirania, Mandai, Mohanpur, Hezamara, Dukli, Agartala, Bishalgarh, Jampuijala, Melaghar, Kanthalia, boxanagar. The district headquarter of West Tripura District is Agartala. As per Census 2011, the total population of the district is 17, 29,451 dominated by SC, ST and OBCs.

The district lies in the Northwestern part of Tripura State and is bounded by North Latitudes 23°16′26.4″ and 24°14′16.8″ and East Longitudes 91°09′3.6″ : 91°47′34.8″ covering Survey of India Toposheet No. 78P/8, 78P/12, 79M/9,79M/5, 79M/1,79M/2,79M/6,7 9M/10, 79M/, 79M/3, 78P/16, 79M/13 & 79M/14 . The northern and western part of the study area are bounded by Bangladesh, while eastern and southern parts are bounded by Dhalai and West Tripura districts respectively. The base map of the NAQUIM area has been shown in Fig.1.1.

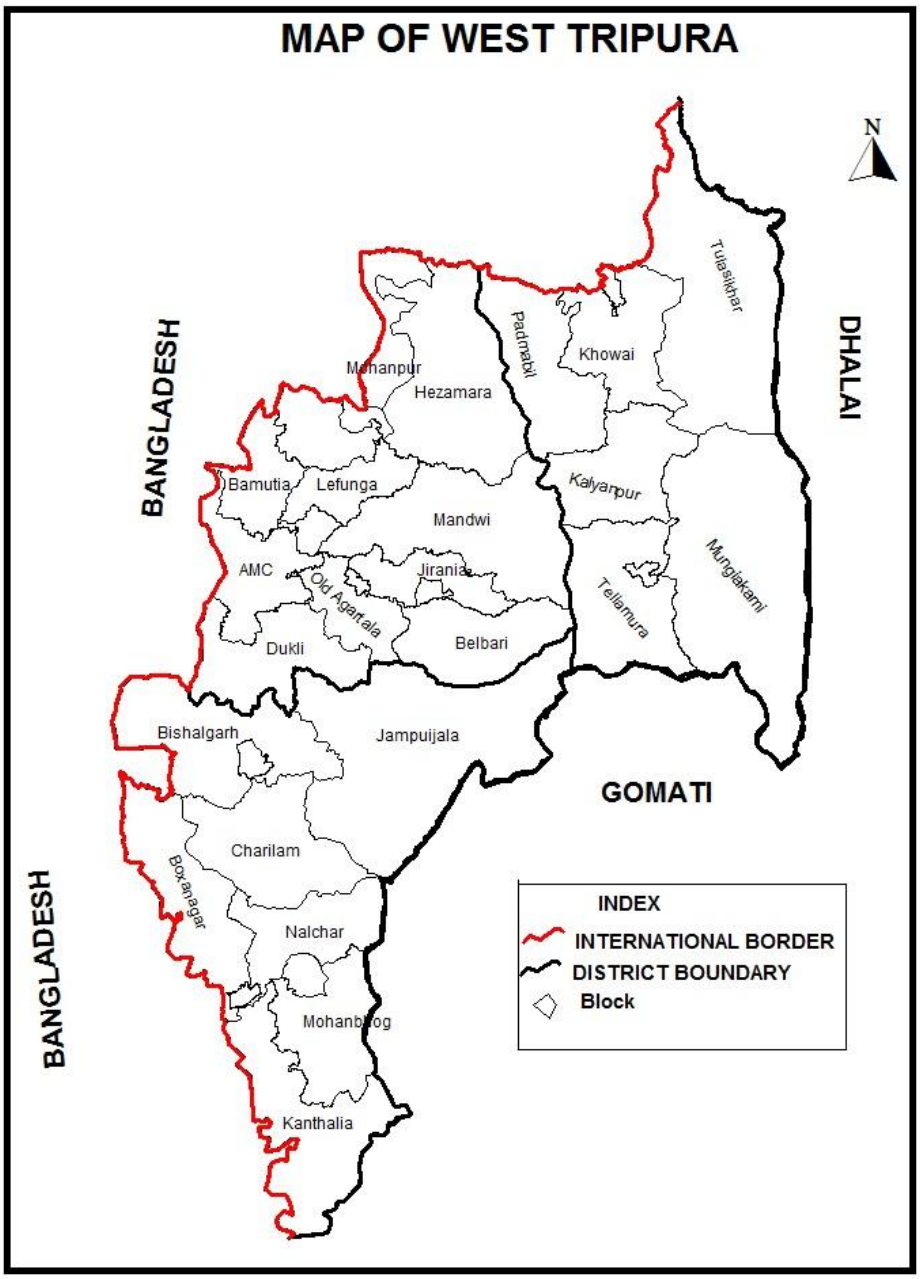

Fig.1.1: Base Map of West Tripura District, Tripura

1.5 Data Availability & Data Adequacy before conducting Aquifer Mapping:

Hydrogeological, geophysical and ground water exploration data available in the district are as follows:

- **Exploration Data**: CGWB has constructed 21 (Twenty One) exploratory wells in West Tripura district. Details of these drilling operations, aquifer parameters are furnished in the Annexure – 2. State govt. has also drilled about hundreds of tube wells in the district.

- **Geophysical Survey (VES) Data**: Neither CGWB nor the State Govt. Departments have conducted any VES survey in this district till 2015.

- **Ground Water Level Monitoring Data :** CGWB has 28 (Twenty Eight) GWM wells at Bishalgarh, Kenania, Golaghati, Tufaniamura, Gongrai, Dakshin Kalamcherra, Sonamura, Kanthalia Bazar, Khowai, Bagan Bazar, Kalyanpur, Pachim Howaibari, Tuimadhu, Chakmaghat EW, Chakmaghat OW, Mohanpur, Ishanpur, Simna, Subalsingh, Champak-nagar, Narsinghgarh DTW, Lichubagan STW, Badharghat DTW, Nagicherra EW – I, Nagicherra EW – II, Bodhjung-nagar DTW, Bodhjung-nagar STW where water levels are measured 4 times in a year. State ground water user departments, viz., PWD (WR), PWD (DWS) do not have any ground water monitoring station.

CGWB has 28 (Twenty Eight) GWM wells in the district which include 19 dugwells and 9 piezometers/observation wells. These wells are monitored four times a year. The details of Ground Water Monitoring wells are given in Table 1.1

Table 1.1: Details of GWMS in West Tripura District, Tripura.

Sl No	Location	Well Type	MP (mbgl)	Latitude	Longitude	R.L (amsl)
1	Bishalgarh	Dug	0.78	23°41'00"	91°17'00"	16.28
2	Kenania	Dug	0.84	23°44'00"	91°11'00"	20.72
3	Golaghati	Dug	0.85	23°40'38"	91°21'37"	
4	Tufaniamura	Dug	0.72	23°41'55"	91°24'25"	
5	Gongrai	Dug	0.55	23°39'24"	91°27'14"	
6	Dakshin Kalamcherra	Dug	0.96	23°34'25"	91°12'33"	
7	Sonamura	Dug	0.81	23°28'00"	91°16'30"	
8	Kathalia bazar	Dug	0.75	23°23'00"	91°19'00"	13.26
9	Khowai	Dug	0.72	24˚ 03' 50.8"	91˚ 36' 18.7"	3.12
10	Bagan Bazar	Dug	0.92	23˚ 58' 13.5"	91˚ 37' 4.5"	3.70
11	Kalyanpur	Dug	0.92	23˚ 55' 44"	91˚ 36' 34.7"	7.20
12	Pachim Howaibari	Dug	0.70	23˚ 48' 36"	91˚ 35' 31.5"	44.63
13	Tuimadhu	Dug	0.96	23˚ 50' 06"	91˚ 41' 11"	
14	Chakmaghat EW	DTW	0.75	23°50'6.13"	91°40'33.86''	54
15	Chakmaghat OW	DTW	0.75	23°50'6.095''	91°40'33.84''	54
16	Mohanpur	Dug	0.63	23˚ 58' 18.4"	91˚ 22' 22"	25.695
17	Ishanpur	Dug	0.63	24˚ 02' 43"	91˚ 23' 57"	25.695
18	Ishanpur	Dug	0.8	24˚ 02' 43"	91˚ 23' 57"	52
19	Simna	Dug	0.79	24˚ 05' 32"	91˚ 23' 36"	23.77
20	Subalsingh	Dug	0.64	24˚ 00' 17"	91˚ 27' 26"	56
21	Champak-nagar	Dug	0.80	23˚ 48' 31.9"	91˚ 28' 32.2"	47.16
22	Narsinghgarh DTW	DTW	0.70	23˚ 54' 15"	91˚ 14' 49"	12.8
23	Lichubagan STW	STW	0.58	23˚ 52' 16"	91˚ 17' 2.5"	11.865
24	Badharghat DTW	DTW	0.63	23˚ 48' 10"	91˚ 16' 16.3"	9.197
25	Nagicherra EW - I	DTW	0.55	23˚ 48' 13"	91˚ 19' 49"	25.87
26	Nagicherra EW - II	DTW	0.55	23˚ 48' 13"	91˚ 19' 48.5"	24.72
27	Bodhjung-nagar DTW	DTW	0.75	23˚ 52' 57"	91˚ 21' 55"	46.165
28	Bodhjung-nagar STW	STW	0.95	23˚ 52' 58"	91˚ 21' 55"	45.825

- **Ground Water Quality Monitoring Data**: CGWB collects water samples from 19 GWM wells and carried out chemical analysis in its regional laboratory at Guwahati.

1.6 Data Gap Analysis & Data Generation:

1.6.1 Data Gap Analysis:

- **Exploration Data Gap :**

CGWB, NER has constructed 18 (eighteen) exploratory wells and 3 (three) deposit wells in the said district. Based on this drilling work, hydrogeological data have been gathered. There is very small data gap for which 4 (four) new wells were suggested in Chakmaghat and Totabari (two EW and two OW)

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

Earlier there are 28 (Twenty Eight) GWM wells at Bishalgarh, Kenania, Golaghati, Tufaniamura, Gongrai, Dakshin Kalamcherra, Sonamura, Kanthalia Bazar, Khowai, Bagan Bazar, Kalyanpur, Pachim Howaibari, Tuimadhu, Mohanpur, Ishanpur, Simna, Subalsingh, Champak-nagar, Narsinghgarh DTW, Lichubagan STW, Badharghat DTW, Suryamani-nagar DTW, Nagicherra EW – I, Nagicherra EW – II, Bodhjung-nagar DTW, Bodhjung-nagar STW where water levels are measured 4 times in a year. Hence it may be concluded that there was no data gap or a very small data gap in the area. State ground water user departments, viz., PWD (WR), PWD (DWS) do not have any ground water monitoring station.

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

Generally, water samples were collected and analyzed from 11 (Eleven) GWM wells out of the 18 and 4 (Four) nos. of urban wells (Total Nos. of 15 nos.) (Annexure- 1) falling in the district. There was small gap in data in terms of ground water quality monitoring.

1.6.2 Recommendation on Data Generation:

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

- **Recommendation for Exploration :**

According to the data gap analysis, 4 nos. of DTW in Chakmaghat & Kalyanpur (piercing both Aquifer Group – I & Aquifer Group – II) was suggested. So the construction of a total 4 nos. of wells were recommended for further exploratory data generation in West Tripura district as per the existing norm in this regard.

1.7 Rainfall Distribution : The study area receives rainfall mainly from S–W monsoon which commences in the month of May and lasts till September. Rainfall data from 5 rain gauge stations viz, Agartala, Sonamura, Khowai, Teliamura, Jirania and Bishalgarh were collected.

The average annual rainfall of Agartala, Sonamura, Khowai, Teliamura, Jirania and Bishalgarh rain gauge stations for last 5 years are 1851 mm,2020 mm,1939 mm,1858 mm,1505mm and 1633 mm respectively & average no of rainy days are 87, 86,91,88,88 and 77 respectively.

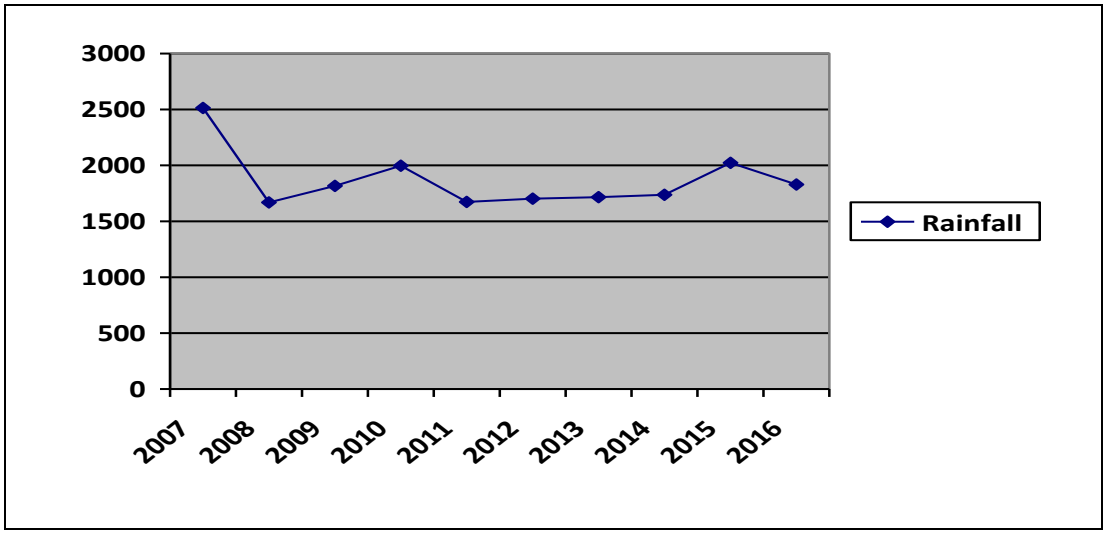

Fig 1.2: Average yearly rainfall variations in and around the study area for last 10 years

1.8 Physiography:

Physiographically, the area can be divided into two parts.

(1) Anticlinal Hill Ranges and

(2) Synclinal flat bottomed valleys.

The important hill ranges in the study area are Baramura and Atharamura. The hill ranges are tightly folded. The trend of the hill ranges is almost N – S. The height of the hill ranges increases from west to east. The altitude of the hill ranges in general varying from 150 – 445m above MSL. The broad synclinal valleys occurring in the study area are

(1) Agartala – Sonamura valley and

(2) Khowai valley

The major valley is Agartala – Sonamura (or simply Agartala valley) and is situated on the western part of Baramura hill ranges. The lowest altitude is in Bamutia area where the ground level is 8.91 m above M.S.L. The master slope of the valley is towards west. Khowai valley, named after river Khowai is small in arial extent. This valley is situated between Baramura and Atharamura hill ranges. Both the valleys are gently undulating with intermittent flood plains of rivers and streams. The undulation formed by 10 – 30 m high mounds with gullies in between them, locally called "loonga."

1.9 Geomorphology:

Geomorphologically, the area can be defined as a second order morpho-structural land system similar to that of "**Ridge and Valley Province**" 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 ('loonga') of Holocene terrace comprising stabilized, undissected, higher flood plains; **(3)** recent flood plains constituting the present-day flood-prone belts fringing the rivers. Three 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.

Block-wise land use details of the district is presented in Table 1.2.

Table 1.2: Block wise land utilization of the West Tripura District (as on 2013)

Name of Block	Geographical Area	Area under Forest	Land not Avail -able for Agri-cultural Use		Permanent Pasture & other Grazing Land	Land under Misc. Tree crops & Groves (Not included in Net Sown Area)	Culti vable Waste Land	Fallow Land other than Current Fallow	Current Fallow	Net Area Sown	Single Cropped Area	Double Cropped Area	Tripple Cropped Area	Total Cropped Area	Area Sown more than once	Total Cultivable Area	Cropping Intencity
			Land put to non-agri cultural use	Barren uncultivable Land													
WEST TRIPURA																	
Khowai	11048	2815	728	52	0	15	6	35	11	7700	2871	3345	1484	14013	4829	7767	182
Padmabil	12997	7449	923	61	0	30	15	27	13	4625	2422	1830	373	7201	2203	4710	156
Tulashikhar	23588	16752	1053	49	0	20	13	13	9	5940	4317	1425	198	7761	1623	5995	131
Teliamura	15589	8288	1283	141	0	12	12	12	3	6076	1625	2966	1485	12012	4451	6115	198
Kalyanpur	10712	4311	514	94	0	33	60	28	10	5666	2010	2485	1171	10493	3656	5797	185
Mungiakami	18071	14704	565	56	0	10	5	13	5	2858	1555	976	327	4488	1303	2891	157
Jirania	20415	4036	6083	29	0	48	10	12	9	10414	3019	6380	1015	18824	7395	10493	181
Mandawi	17188	11695	758	27	0	44	11	32	12	4700	2280	2027	393	7513	2420	4799	160
Bishalgarh	31849	5314	8352	187	0	615	123	46	75	17297	1990	11055	4252	36856	15307	18156	213
Jampuijala	22354	9232	7409	48	0	10	32	23	43	5672	1020	3917	735	11059	4652	5780	195
Mohanpur	26166	5555	7871	91	97	110	61	18	32	10659	4633	4352	1674	18359	6026	10977	172
Hezamara	15664	7422	1064	42	75	34	56	5	27	3727	1242	1990	495	6707	2485	3924	180
Melaghar	22300	4908	8284	147	0	163	122	30	31	8811	1348	3411	4052	20326	7463	9157	231
Kanthalia	14881	7310	745	56	9	33	18	15	2	6904	658	4133	2113	15263	6246	6981	221
Boxanagar	11696	4232	899	98	15	423	58	20	28	6093	934	3598	1561	12813	5159	6637	210
Dukli	19597	557	14164	228	0	387	95	36	58	4047	1242	1790	1015	7867	2805	4623	194
Agartala non-block	5566	0	5420	0	0	21	0	2	3	141	0	110	21	283	131	167	201
WT District Total	**299681**	**114580**	**66115**	**1406**	**196**	**2008**	**697**	**367**	**371**	**111330**	**33166**	**55790**	**22364**	**211838**	**78154**	**114969**	**190**

1.11 Soil:

In general, soils of the area are acidic in nature. The pH of soil ranges from 5.5 to 5.75. Nitrogen and phosphate is low, available potash is medium to high, calcium, magnesium and sulfur are deficient in these soils. The pH value of soil can be increased by applying calcium oxide or calcium carbonate which in turn increase the availability of nitrogen, phosphorus, calcium and magnesium in the acidic soils and can increase production of crops. In acidic soils calcium carbonate varies from 1.75 to 4.79 ton per ha. In the study area, presence of iron content in ground water is high. Iron content of the soils increases when ground water is used for irrigation. The high iron content decreases growth and production of crops. It can be minimised with the application of organic fertilizers.

1.12 Drainage:

The anticlinal hill ranges forms the watersheds from which various drainage channels emerged. The common drainage patterns are sub-parallel to parallel and dendritic. Upto 4^{th} order streams are found in the study area. In general, drainage pattern in the area is in conformity with the topography, which area structurally controlled. The drainage of the area is shown in Fig.1.3.

The major rivers in the study area are Khowai, Haora and Gomti and its tributaries which are perennial in nature. The Khowai river originates from Longtarai hill range and flows west and cut across Atharamura hills. Near Teliamura, it takes a right angle turn towards north. Khowai river and its tributaries constitutes the main drainage pattern of Khowai valley. Ultimately, it enters Bangladesh 1 km north of Khowai town. The length of river khowai in West Tripura district is 140 km and its catchment area is 1100 km^2.

Haora river originates from Baramura hill range, flows westward through Agartala – Sonamura valley and near Agartala it enters Bangladesh. Its length is 46 Km and catchment area is 414 Km^2.

Burinala or Bijoy river originates from Baramura hill range and flows westward through Agartala valley and near Boxanagar it enters Bangladesh. It traverses 54 km before entering Bangladesh.

Gomti river originates from Baramura hills and flows westward. Though it is the biggest river in the state but only a small part of its course is within the study area. This river also enters Bangladesh near Sonamura town.

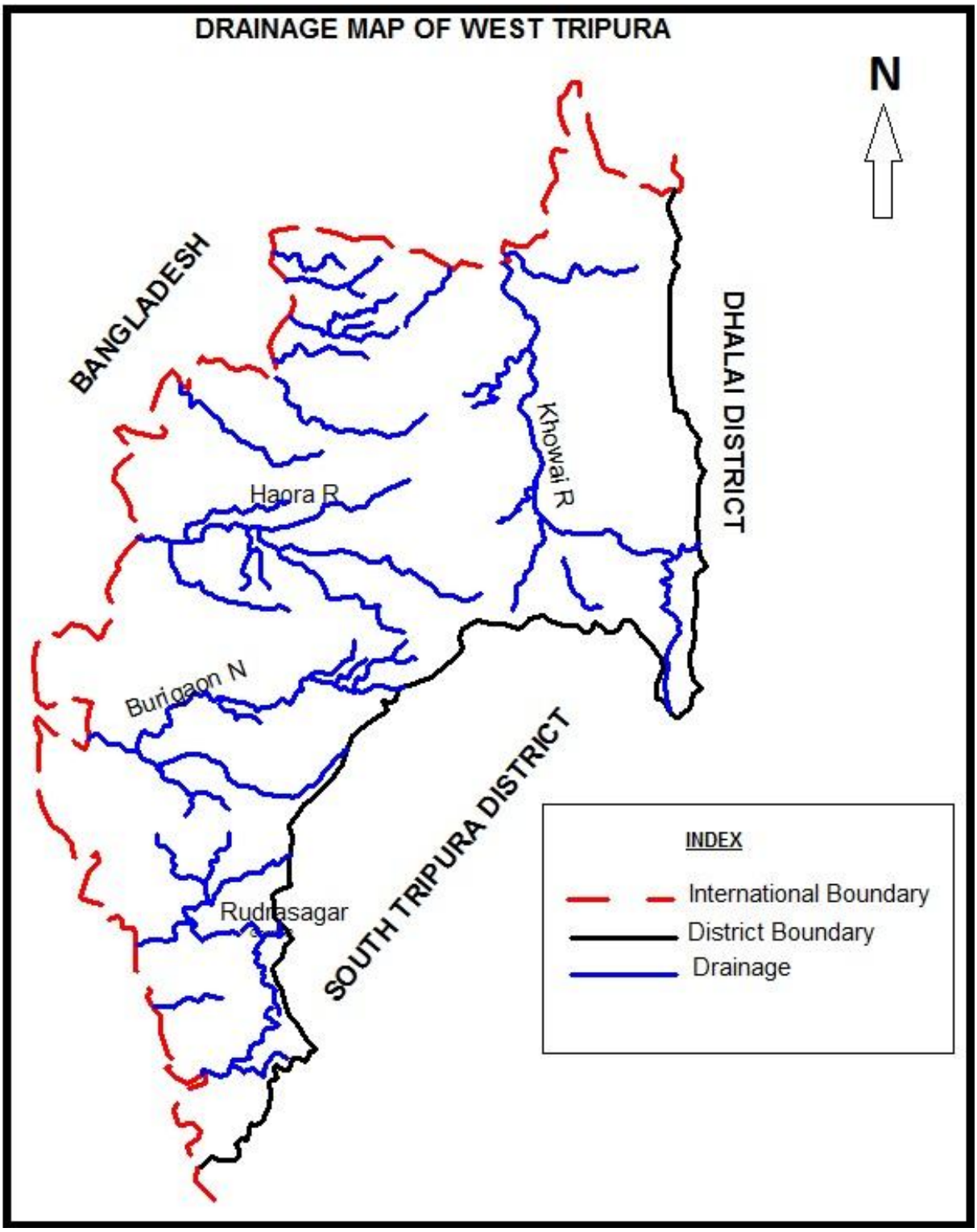

Fig.1.3: Drainage Map of West Tripura District, Tripura

1.13 Agriculture:

Agriculture in West Tripura district depends mainly on 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 **111330** ha (in 2013-14), which is 37.14 % of total geographical area (**299681**ha).

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 of West Tripura district. Favorable agro-climatic conditions, fertile soils, sub-tropical climate with pockets of temperate zones, large 'tilla' lands and high rainfall also promotes growing of horticultural plants like fruits, vegetables, spices, floriculture, medicinal and aromatic plants etc.

People cultivate on high hill slopes by practicing traditional '**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. Crop production in the district are presented in Table 1.3.

Table 1.3 : Principal Crop Area(Ha), Production (Met ton) & Yield (Kg/Ha or Bales/Ha), 2011-12 contd.

Agricultural Sub-Division	Aush Paddy		Aman Paddy		Boro Paddy		'Jhum' Paddy		Maize		Wheat		Khariff Pulses		Rabi Pulses	
	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y
Khowai	1106	2456	172	2753	2727	3101	175	56	178	3154	12	4	3348	65	6761	72
Tulashikhar	575	2089	0	2603	60	2817	510	181	72	398	2	5	477	28	981	34
Teliamura	1408	2717	50	2874	2779	3149	758	241	157	652	5	8	822	55	1698	58
Jirania	123	2276	71	2835	1952	2817	144	51	42	822	2	2	868	15	1751	18
Mandai	198	2056	35	2433	719	2524	472	187	144	770	0	0	914	59	1887	70
Mohanpur	592	2275	136	2613	2294	2704	114	42	118	2799	3	1	2921	45	5887	52
Dukli	125	2184	50	2791	1880	2900	307	106	267	2522	15	6	2810	96	5716	122
Bishalghar	780	2468	193	2992	10105	3014	9	3	4	1340	1	1	1345	1	2692	2
Melaghar	735	2442	150	2924	9264	2902	285	98	65	662	13	20	760	22	1541	27
Total	**5642**	**2441**	**857**	**2833**	**31780**	**2948**	**2774**	**941**	**1047**	**1113**	**53**	**48**	**14265**	**370**	**28914**	**429**

Table 1.3: Principal Crop Area(Ha), Production (Met ton) & Yield (Kg/Ha or Bales/Ha), 2011-12

Agricultural Sub-Division	Sesamum		Kharif Ground Nut		Rabi Ground Nut		Reap & Mustard		Jute (P :Bales) (Y : Bales/Ha)		Mesta(P:Bales) (Y : Bales/Ha)		Cotton (P : Bales) (Y : Bales/Ha)	
	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y
Khowai	33	515	3	6	9	1545	55	655	7	8.71	3	8.67	2	0.23
Tulashikhar	14	500	0	0	0	0	51	725	0	0	5	8.8	9	1.02
Teliamura	97	464	12	26	17	657	269	810	27	8.96	39	8.95	37	4.13
Jirania	24	542	1	2	5	2710	29	690	11	7.91	4	7.75	5	0.65
Mandai	40	625	0	0	0	0	0	0	7	7.43	0	0	0	0.00
Mohanpur	28	464	32	69	15	218	68	721	16	8	19	7	6	0.86
Dukli	117	607	4	7	4	607	87	782	12	8.92	4	7.25	4	0.55
Bishalghar	24	750	0	0	0	0	18	667	4	7.5	1	7	1	0.14
Melaghar	120	1025	5	5	7	1435	65	862	16	9.5	7	9	6	0.67
Total	**497**	**668**	**57**	**85**	**57**	**668**	**642**	**773**	**100**	**8.59**	**82**	**8.32**	**70**	**8.41**

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

1.14 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/cheras/streams; tank and ponds; water harvesting and watershed management works like seasonal and permanent bunds 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.

In 2013-14, total cultivable land of **114969** ha was brought under cultivation (net area sown) is **111330** ha. Irrigated area under different crops in West Tripura District (Area in Ha) is shown in Table 1.4.

Table 1.4: Irrigated area under different crops in West Tripura District, 2013-14

Rice	Wheat	Total Pulses	Fruits & Vegetables	Total	Non- Food Crops			Total Irrigation Area Under All Crops
					Total Oil Seed	Other Non- Food Crops	Total	
97985	25	2057	20849	120916	1514	158	1672	122588

1.15 Irrigation Projects: Major, Medium and Minor

Agriculture is dependent on minor irrigation schemes only. There is no major irrigation project in the district. Various types of minor irrigation projects present in the district area lift irrigation, diversion, sluice gates, pick up weirs, deep tube wells, shallow tube wells etc. Amongst them the most important is (river) lift irrigation projects. Farmers also construct permanent or seasonal bund across cherras / nalas/ streamlets to collect the water and cater for irrigation through pump sets. Details of Irrigation Potential Created, Block wise Nos. Irrigation Structures and area covered and irrigated area under different crops are presented in Table-1.5 Table-1.6 and Table-1.7 respectively.

Table 1.5: Structure wise Irrigation Potential Created by PWD (WR) and Potential Utilisation (as on March 2013)

Potential Created (ha)				Total Potential Created (ha)	Net Potential Utilised (ha)
Lift Irrigation (LI + HPLI)	DTW	Diversion	Low/High Pickup Weir		
22740	3481	1400	4515	32136	22495.20

Table 1.6: Block wise Nos. of different Irrigation Structures and Irrigation Coverage Area (as on March 2013)

Block	Lift Irrigation (LI)	High Power Lift Irrigation (HPLI)	Diversion	Low & Medium Pick-up Weir	Deep Tube Well	Small Bore TW/ Mini Deep TW (80 - 100 m)	Shallow Tube Well	Artesian Well
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mohanpur	44 (1847)	---	2 (265)		36 (859)	37 (95)	278	280 (00)
Hezamara	19 (773)	---			1 (20)	10 (28)	10	0 (00)
Padmabil	6 (274)	---			4 (99)	10 (26)	28	0 (00)
Khowai	42 (1828)	---	1 (290)		9 (344)	24 (70)	96	2114 (00)
Tulashikar	20 (771)	---			1 (25)	13 (37)	19	0 (00)
Kalyanpur	33 (1652)	---	1 (95)	Medium (1500)	5 (111)	20 (54)	59	0 (00)
Teliamura	25 (1323)	---	1 (150)	Medium (2900)	5 (123)	22 (58)	100	366 (185)

Mungiakami	9 (543)	---		Medium (115)	0 (00)	12 (30)	1	0 (00)
Mandai	20 (1093)	---	1 (240)		4 (117)	5 (14)	0	0 (00)
Jirania	59 (2524)	---			11 (218)	25 (69)	134	59 (45)
Dukli	21 (1249)	---			10 (271)	17 (46)	400	101 (36)
Jampuijala	24 (969)	---			3 (66)	13 (32)	20	0 (00)
Bishalgarh	56 (3047)	---			25 (541)	38 (98)	542	1000 (00)
Boxanagar	13 (538)	---			13 (321)	19 (48)	94	18 (7)
Melaghar	78 (2835)	---	1 (110)		6 (105)	21 (54)	83	250 (50)
Kanthalia	19 (711)	1 (300)	1 (180)		5 (122)	17 (42)	514	0 (00)
Agartala M.C.	13 (463)		1 (70)		7 (139)	2 (6)	0	(00)
West Tripura dist. Total	**501 (22440)**	**1 (300)**	**9 (1400)**	**3 (4515)**	**145 (3481)**	**305 (807)**	**2378 (23780)**	**4188 (323)**

Table 1.7: Irrigated area under different crops in West Tripura District, 2013-14

Rice	Wheat	Total Pulses	Fruits & Vegetables	Total	Non- Food Crops			Total Irrigation Area Under All Crops
					Total Oil Seed	Other Non- Food Crops	Total	
97985	25	2057	20849	120916	1514	158	1672	122588

1.16 Ponds, Tanks and other Water Conservation Structures

There are thousands of small ponds available in the district. These ponds are used mainly for fish cultivation and also used for domestic purpose like washing, bathing, water for cattle's etc. But rarely these ponds are used for irrigation purpose as these ponds do not have much water during summer periods. Farmers rarely use these ponds for irrigation.

1.17 Cropping Pattern:

The cropping pattern of the district 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 – (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, cashewnuts 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 district shows that among paddy varieties Aman paddy is cultivated in maximum area followed by Boro, 'Jhum' paddy (cultivated on the hill slopes) and Aush. After paddy, vegetables which includes potato followed by pulses are the major cultivated crops in the area.

1.18 Prevailing Water Conservation/Recharge Practices:

In the study area, there are two big natural lakes i.e. Rudrasagar in Melaghar block and Brahmabil in Teliamura block. The areal extent of the Rudrasagar Lake is around 10 sq. km. During winter season (rabi) when water level in the lake recedes vegetable and boro paddy are cultivated on its banks. There are thousands of small ponds available throughout the study area. These ponds are used mainly for fish cultivation and also used for domestic purposes like washing, bathing, water for cattle's etc. But rarely these ponds are used for irrigation purpose because these ponds do not have much water during dry periods. Farmers sometimes use pond water for cultivation of vegetables only.

In the study area agriculture is mainly dependent on minor irrigation schemes only apart from rainfall. There is no major irrigation project in the area. A medium irrigation project on Khowai river near Chakmaghat, Teliamura is under progress. Most of these minor irrigation projects distribute water from surface sources. Amongst all minor irrigation projects most important type is (river) lift irrigation project.

Rural Development Department, Govt. of Tripura constructs sluice gates, pick up weirs, permanent bund across cherras / streams to arrest water which is to be applied for irrigation. Farmers also construct permanent or seasonal bund across cherras / nalas/ streamlets to collect and cater water for irrigation through pump sets.

1.19 General Geology:

Geologically, the study area is occupied by Quaternary & Upper Tertiary groups of rocks. The geological succession of the area is given in table below.

Table 1.8: Geological Succession in the study area

Age	Group	Formation	Lithology
Quarternary	Recent	Recent	Alluvium, represented by unconsolidated pale to dirty gray, silt, sand, clay, silty clay, sandy clay etc and yellowish brown coarse river sand, gravels & concretions.
	---------- UNCONFORMITY----------		
Upper Tertiary	Dupitila	Dupitila	Brown to buff sandy clay with grayish sandy loam, clayey sandstone with ferruginous materials & laterites.
	---------- UNCONFORMITY----------		
	Tipam	Champaknagar	Massive medium to coarse sandstone with sandy shale.
		Manubazar	Fairly bedded fine to medium sub-arkosic sandstone with sandy shale and siltstone.
	---------- UNCONFORMITY----------		
	Surma	Bokabil	Thinly laminated, bedded sandstone and silt (repetition) with ferruginous material, medium to coarse micaceous sandstone with mudstone.
		Bhuban	Intruded, hard compact, both massive & well-bedded sandstone, dark to olive shale repeated.
Base not known			

The distribution of the geological formations (Fig.1.4) is described as under:

a) Surma Group: The Surma Group is represented by Upper Bhuban and Bokabil Formations. The rocks of Bhuban Formation, constituting compact sandstones and shales, which are exposed in the core of the anticlines of the district, viz SakhanTlang, Jampui hills and Longtarai etc. These formations usually form high hills with steep slopes and are conformably overlain by Bokabil Formation. The rocks of Bokabil Formation are predominantly of argillaceous composition and are exposed on both limbs of the anticlines.

b) Tipam Group: The Tipam Formations are conformable and transitional to the underlying Bokabil Formation. These Formations are arenaceous in nature and comprised of fine to medium grained, yellow to light buff and brownish yellow colour, friable sandstones, and occur along the outer flanks of the anticlinal hill ranges with moderate dip to near horizontal

disposition. The sequence of these formations shows variations due to facies changes within the group. The maximum thickness of these formations is estimated to be around 1400m, the minimum being 400m.

c) Dupitila Group: The Dupitila sediments consisting of earthy brown to buff sandy clay, mottled clay, clayey sandstone and coarse to gritty ferruginous sandstone unconformably overlie the Tipam Formation, and are well developed in central portion of the synclinal valleys. These formations occur in the form of disconnected mounds. The thickness of this formation varies from 10 – 30m.

d) Recent Group: Recent alluvium occurs along the streams and the flood plains of major rivers. It consists of coarse sand, sandy clay, silt, silty clay and clay etc.

1.20 Sub-Surface Geology

It has been interpreted on the basis of the lithological logs of boreholes drilled by Central Ground Water Board and various state government Agencies. The sub-surface configurations of different granular zones have been shown in two panel diagrams (Fig – 5.1 & 5.2). The granular zones encountered down to a depth of 300m belong to semi-consolidated Tipam and Dupitila groups and constitute medium to coarse grained, sub-rounded quartz, feldspathic material. The occurrence and thickness of these zones very laterally as well as vertically.

In Khowai valley, 30 to 45 m thick granular zone was encountered within 50 m depth. It thins down to 6 m towards Khowai-Baijalbari area. Four granular zones were encountered within a depth range of 50 to 300m bgl and the thickness of granular zones varies from 15 to 100m. These zones laterally grade into clay.

In Agartala valley, 40 – 100 m thick granular zone occur within 120 m depth. This zone is without any consistent clay capping, but in Veluarchar area, it is confined by 40 m thick clay horizon. In Jirania - Mohanpur area, the granular zone continues uninterruptedly down to a depth of 280 m. In Mohanpur - Sasubari area, within this granular zone a 20 – 40 m thick clay horizon is found at a depth range of 40 to 70 m bgl. In western half of Bishalgarh block three more granular zones occur. These are 20 – 70 m in thickness and laterally grade into massive plastic clays towards eastern part of Bishalgarh block.

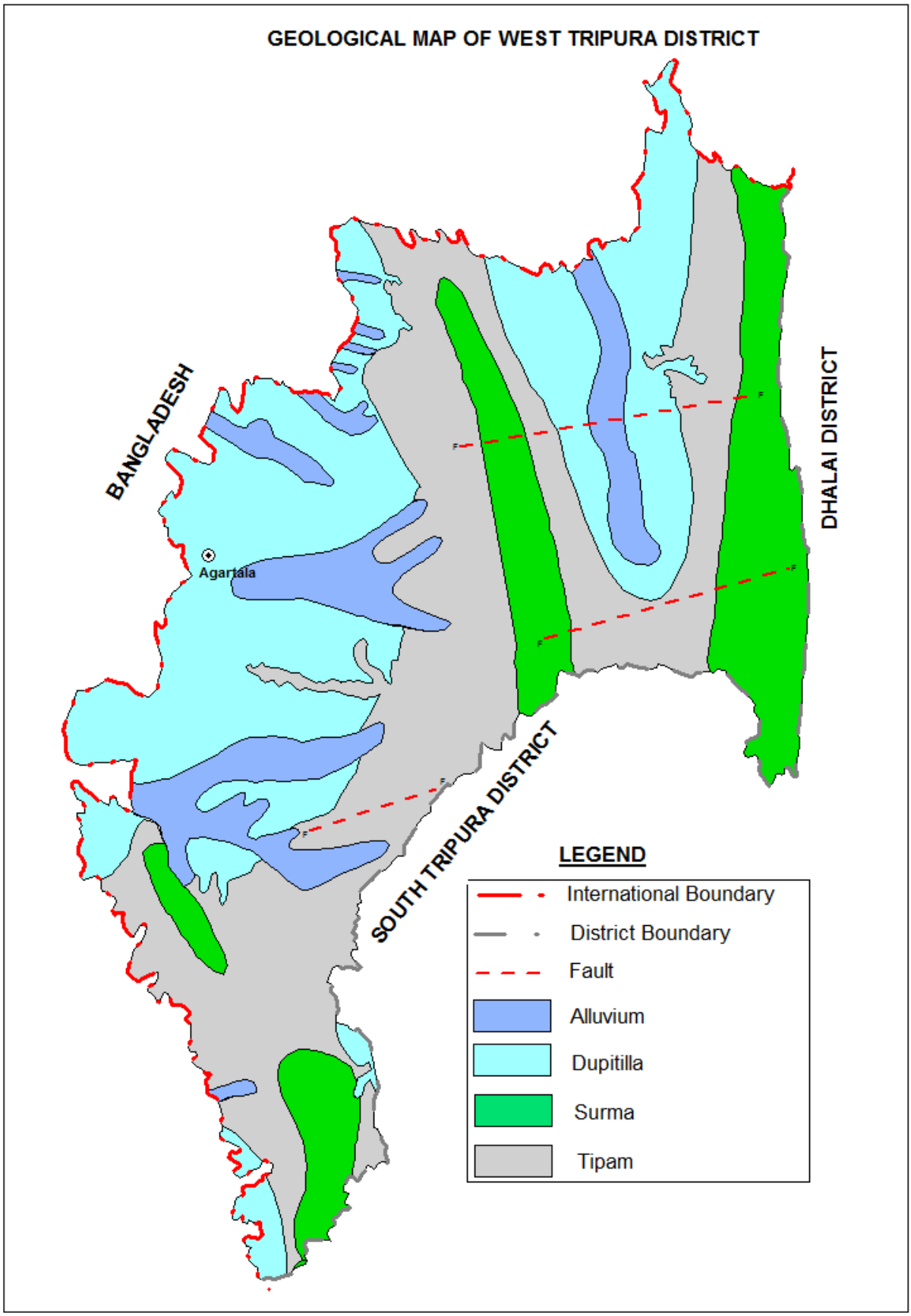

Fig.1.4: Geological map of West Tripura District, Tripura

2. DATA COLLECTION & GENERATION

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

Total 4 nos. of Deep Tube Wells (DTW) including 2 nos. of Exploratory Tube Wells (Production Well) and 2 nos. of Observation Wells (for Water Level Measuring only) were constructed in Teliamura and Kalyanpur under.

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

In addition to previously existing 19 nos. of dug wells & 9 no.s of Deep Tube Well under NHNS, 7 other dug wells have been established as NAQUIM keywells and since pre-monsoon of 2014-15. Also the 4 nos. of deep tubewells (DTW) have been added to the NHNS monitoring wells. Water levels from these total 29 nos. of wells are being monitored four times in a year.

The entire study area is covered by regular monitoring of existing GWMS and another 7 key wells have been established. Details of the keywells are given in Table 2.1

Table 2.1: Keywells location details in West Tripura District

Sl No.	Name of the Village	Latitude Longitude & RL	Well Inventory
1.	**Shiv Nagar** Block:- Nalchar Dist:- Sepahijala	23°32′ 58.12″ 91°16′ 57.82″ Rl- 35	Dia- 3.30 M.P.- 1.13 Total Depth-6.40 SLW- 3.10
2.	**Lalmaibari** Block :- Nalchar Dist:- Sepahijala	23°33′ 2.97″ 91°16′ 24.65″ Rl-	Dia- 3.15 M.P.- 1.12 Total Depth-10.05 SLW- 5.12
3.	**Bagbassa** Block:- Nalchar Dist: Sepahijala	23°33′ 7.836″ 91°23′ 30.654″ Rl- 18	Dia- 1.23 M.P.- 1.10 Total Depth-6.80 SLW- 5.09
4.	**Noabari-2** Block: Killa Dist: Gomati	23°35′ 28.2″ 91°31′ 10.824″ Rl-	Dia- 1.20 M.P.- 1.00 Total Depth-6.00 SLW- 3.90
5.	**Joingbari** Block:- Killa Dist: Gomati	23°36′ 4.2″ 91°31′ 30.2″ Rl- 49	Dia- 1.14 M.P.- 0.96 Total Depth-4.27 SLW- 1.33
6.	**Dewanbari** Block: Killa Dist:-Gomati	23°33′ 28.824″ 91°32′ 7.23″ Rl-57	Dia- 1.28 M.P.- 0.78 Total Depth-6.00 SLW- 2.40
7.	**Bagmabazar** Block: Matabari Dist:-Gomati 23°33′ 43.5″ 91°25′ 35″ **Rl- 16**		Dia- 1.16 M.P- 1.10 Total Depth-6.25 SLW- 3.25

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

In addition to previously existing 19 nos. of NHNS dug wells & 7 other dug wells have been established as NAQUIM Key Wells and since pre-monsoon of 2014-15, water samples from these 19 wells are being collected twice in a year during pre and post-monsoon period. And additional new key well's data were also collected for chemical analysis**.** Distribution of iron and EC in groundwater in the NAQUIM area is depicted in Map 11and Map 12 respectively.

- **Exploratory drilling**

Heavy duty deep tubewells with depth range of 100 – 300 m have been constructed tapping Tipam sandstones. CGWB has constructed deep tubewells in the study area under exploratory programme to determine the characteristics of the deeper aquifer (semi-confined to confined condition) and the details of exploration is shown in Annexure – 2. The discharge of the wells varies from 13 – 190 m^3/hr and the drawdown varies from 4.95 – 30.53 m. The transmissivity of the wells varies from 5 – 1689 m^2/day, permeability varies from 1.8 – 32.92 m/day and storativity varies from 4.4 X 10^{-4} to 5.71 X 10^{-3}.

4 Nos. of new tubewells (2 EW & 2 OW) were constructed at Chakmaghat & Kalyanpur. . Discharge of the wells at Chakmaghat is 15.93 m^3/hr & at Kalyanpur is 82.8 m^3/hr.

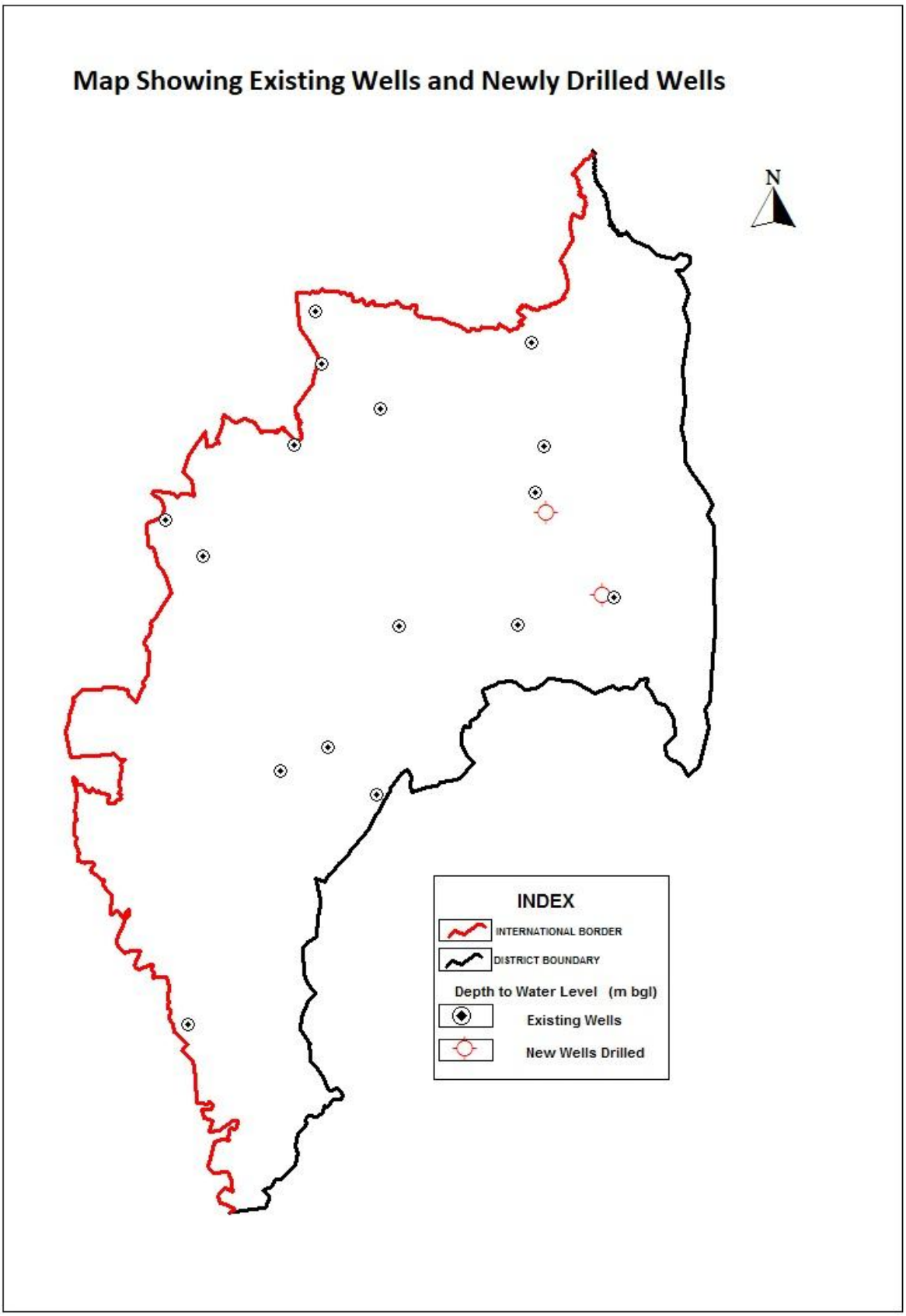

Fig 2.1: Map showing already existing wells and newly drilled well to cover up the data gap

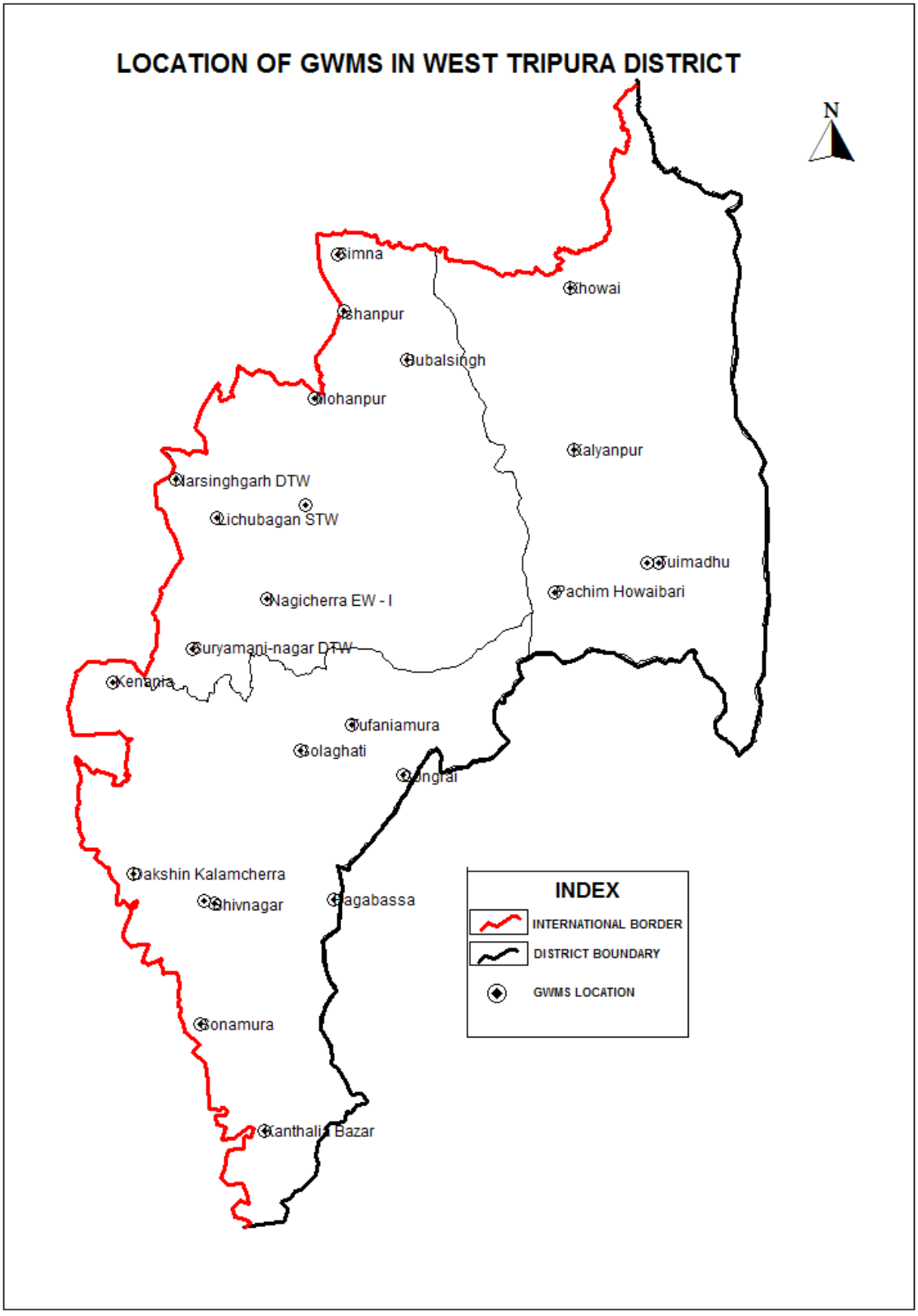

Fig 2.2: Location of Groundwater monitoring stations of West Tripura

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 Depth to water level:

The ground water occurs in unconfined condition in the shallow aquifer and in semi confined to confined condition in deeper aquifer. The main potential zone is formed by Tipam sandstone. Depth to water level during March, 2017 monitored from dug wells (first Aquifer) ranges from 1.63 to 10.30 m bgl while in Nov, 2017 depth to water level ranges from 0.22 to 6.64 m bgl. Depth to water level map in the district during March, 2017 and November, 2017 has been shown in Fig 3.1 and Fig 3.2.

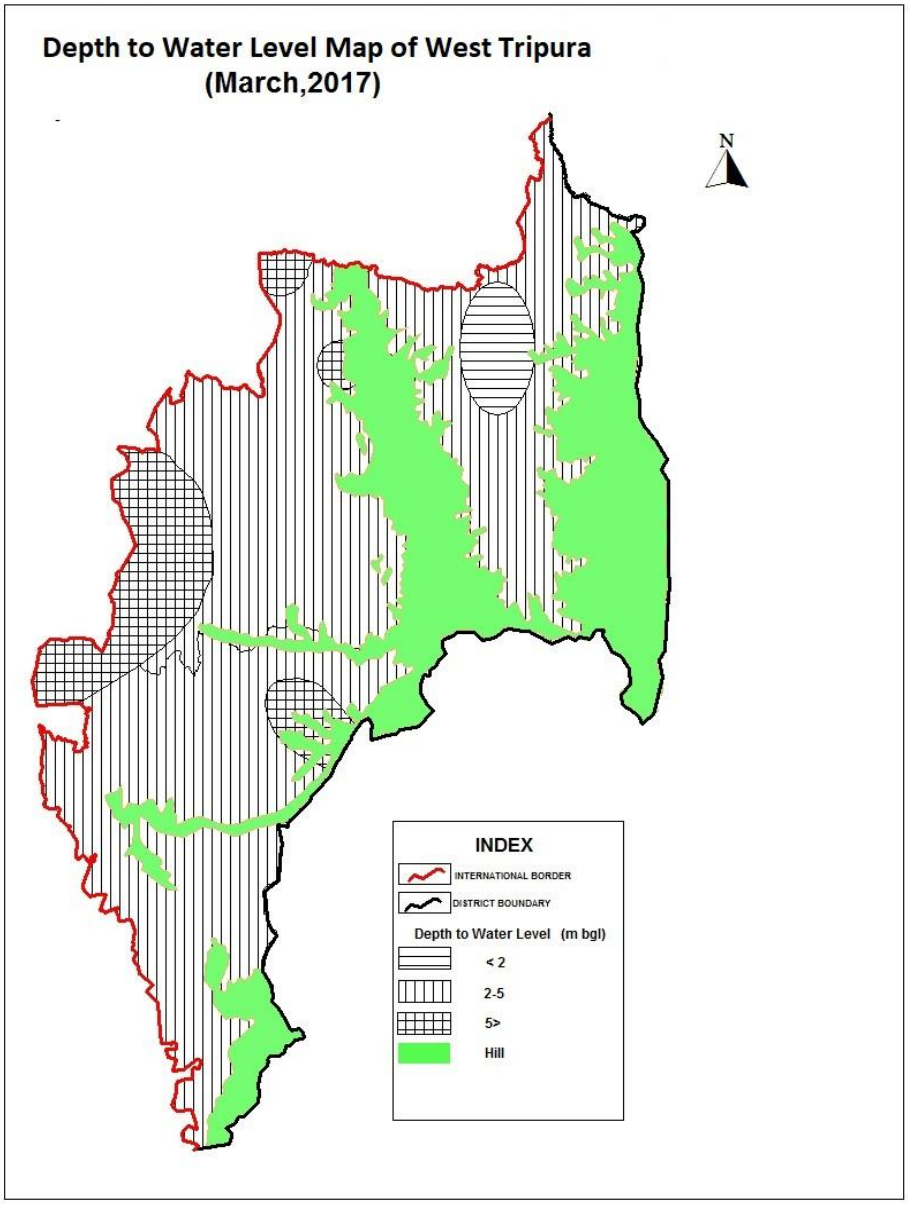

Fig.3.1: Depth to water level Map of West Tripura, March 2017

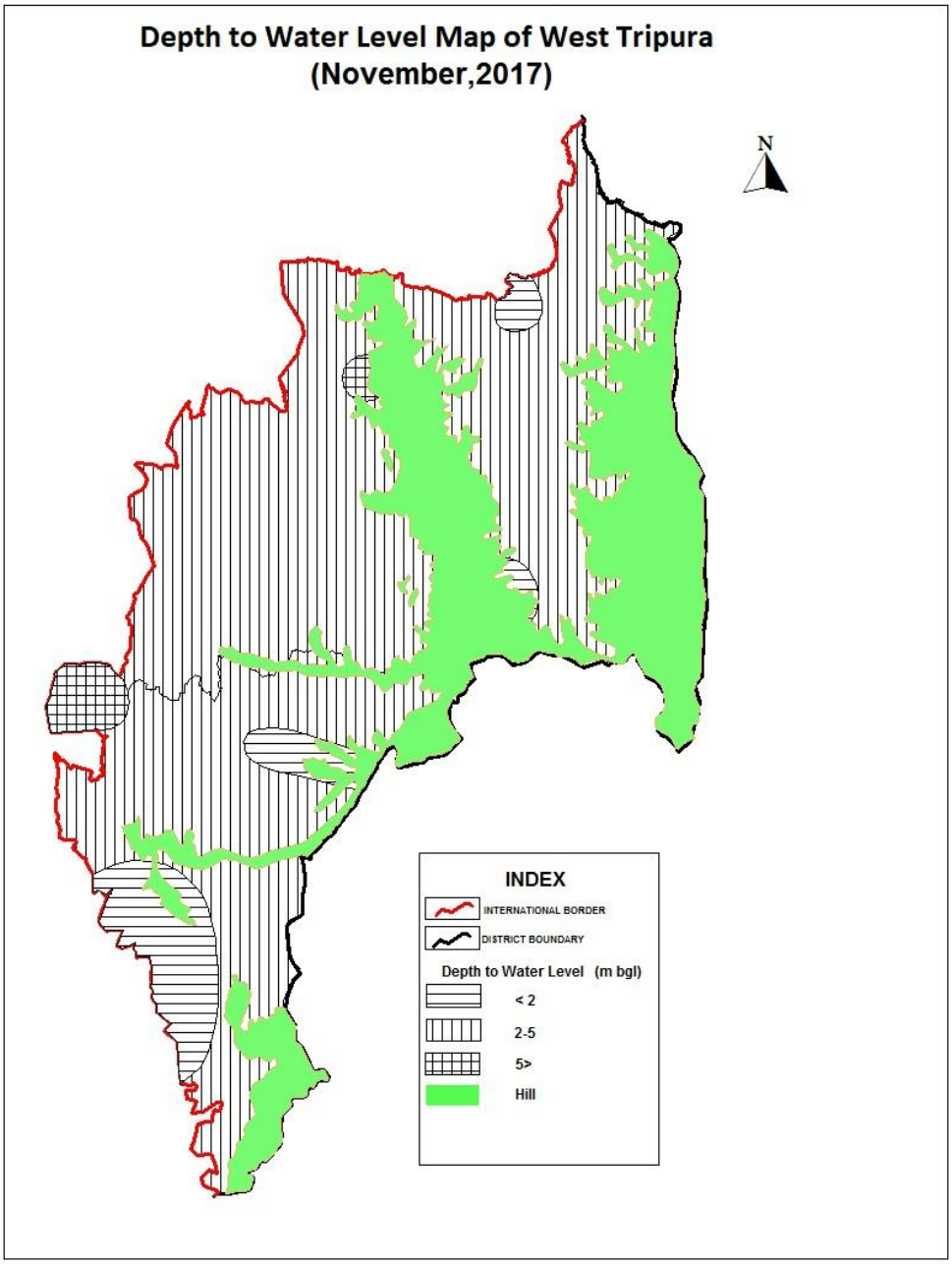

Fig.3.2: Depth to water Level Map of West Tripura, November 2017

3.2 Aquifer character:

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 abstraction 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 the study area. Permeability of this formation is much higher than that of Dupitila formation or Bokabil (Surma Group) formation. This formation consists of sub-rounded, fine to medium grained, friable sandstone with intercalated clay. The recharge area of these sandstones are 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.

3.3 Aquifer geometry

The aquifer system of the area is divided into two groups, viz, shallow aquifer and deep aquifer. Shallow aquifer occurs within depth of 50 m and deeper aquifer occurs from 50 to 300 m bgl.

- **Agartala Valley:**

Agartala valley is occupied by thick sandstone horizons with thin intervening shale / clay horizons particularly in the southern part. Except Simna area it is not possible to differentiate between shallow and deeper aquifer because the first granular zone is encountered in the depth range of 5 to 20 m and its thickness varies from 40 to 100 m and is persistent almost throughout the valley. In Jirania – Chanpur area this granular zone (1^{st} granular zone) continues uninterruptedly down to a depth of 280 m. In Mohanpur – Sasubari area within this granular zone 20 – 40 m thick clay horizon is found at a depth range of 40 – 70 m. In Bishalgarh and southern part of Agartala valley 2 to 3 granular zones were found. The second horizon occurs within depth of 100 m and thickness of this zone varies from 30 – 140 m. The third horizon found in the southern part of the valley at a depth range of 175 – 225 m and its thickness varies from 20 – 50 m.

- **Khowai valley:**

Northern part of Khowai valley is dominated by alluvial sediments comprising of clay, sand. In the southern part of the valley the first granular zone encountered at a depth range of 5 to 30 m and its thickness varies from 10 to 20m.

In Khowai valley, four aquifers were identified. The aquifer horizons are occurring in the range of 40 – 64 m bgl, 72 – 112 m bgl, 90 – 216 m bgl and 250 – 300 m bgl. The aquifers show a dip towards north. Thickness of the granular zones increases towards north.

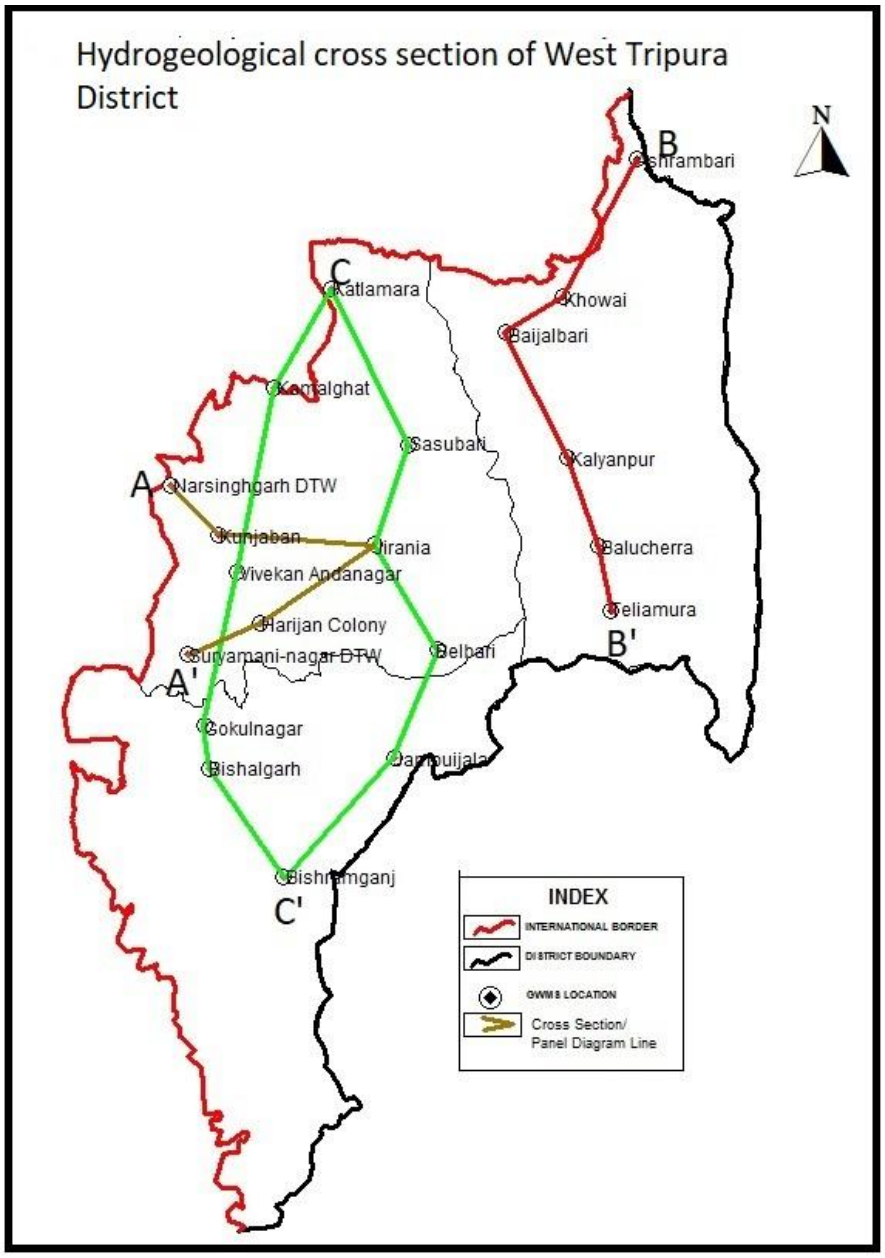

Fig 3.3: Map showing Hydrogeological cross section of West Tripura District

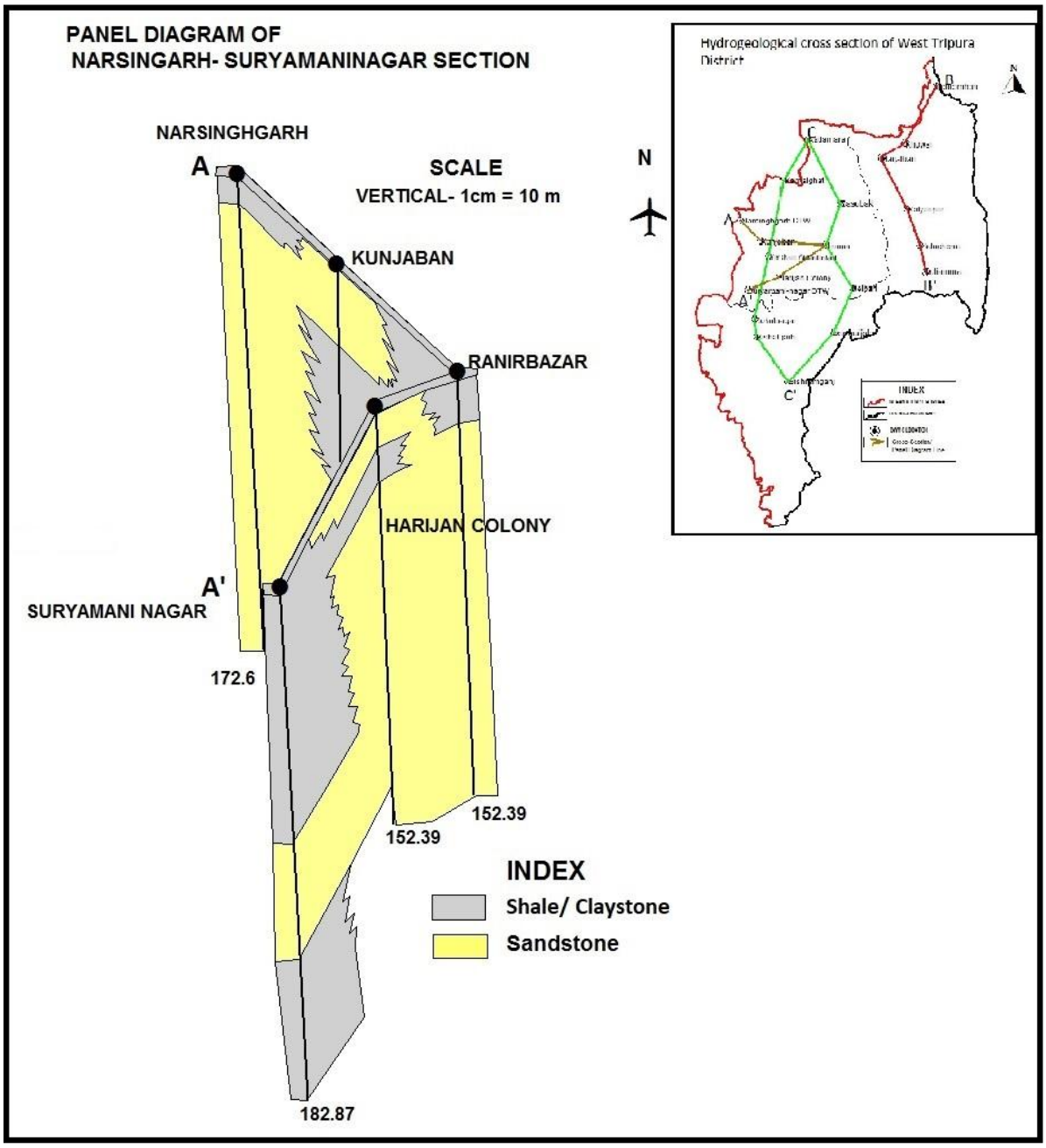

Fig 3.4: Panel Diagram AA’ of Narsingarh- Suryamaninagar Section

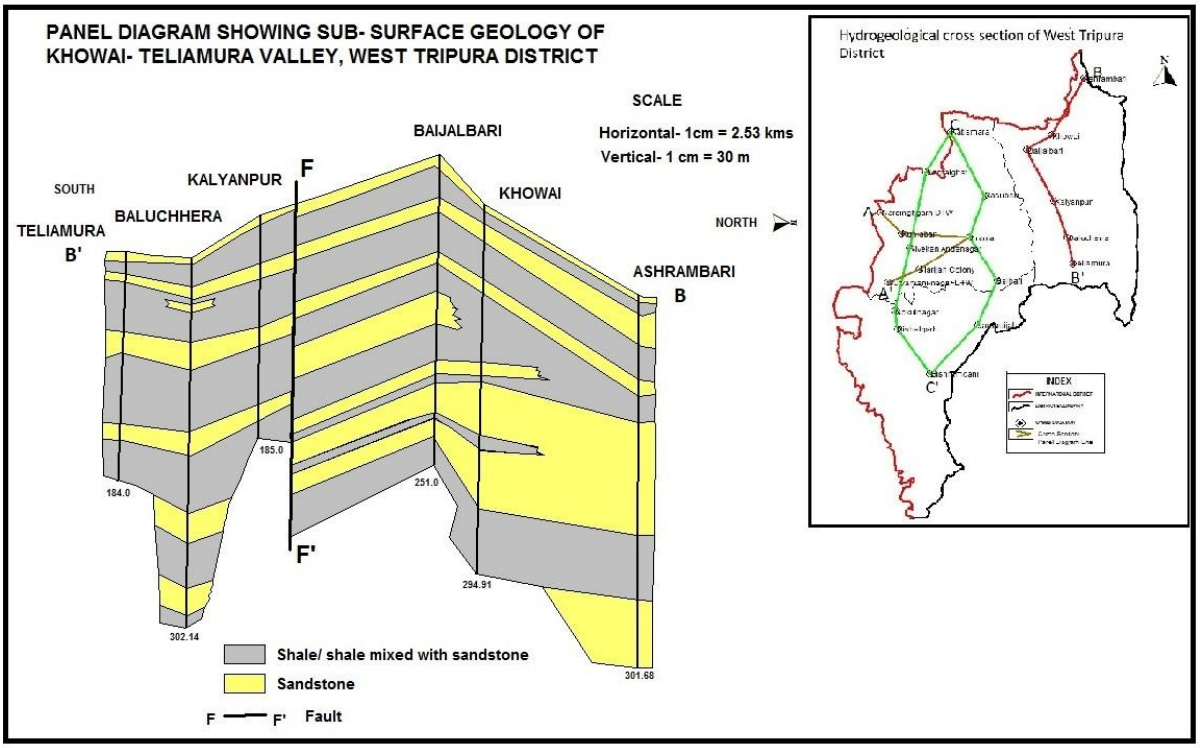

Fig 3.5: Panel diagram BB' showing Sub surface geology of Khowai -Teliamura Valley

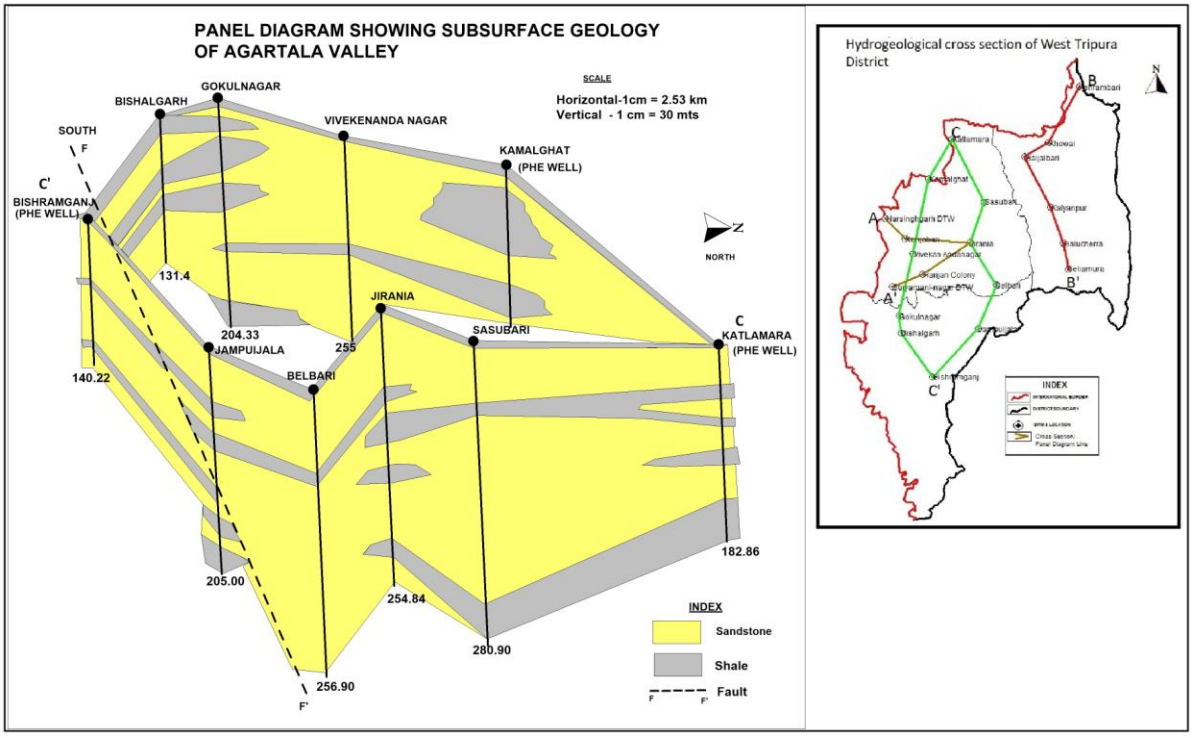

Fig 3.6: Panel diagram CC' showing Sub surface geology of Agartala Valley

3.4 Ground water quality:

Chemical analysis of ground water samples are carried out by regional chemical laboratory of Central Ground Water Board, North Eastern Region, Guwahati. The pH values of the ground water ranges from 6.52 to 8.35 for shallow aquifer. The BIS has recommended acceptable range of pH from 6.5 to 8.5 for domestic use. Ground water quality in the area is potable and range of all the chemical constituents are within the permissible limit set by BIS, except iron. In shallow aquifer EC values ranges from 107.30 to 688.70. Fluoride content in ground water from shallow aquifer ranges from 0 to 0.46 ppm. Ground water of the area is characterized by a generally high iron content which ranges from 0.00 to 4.99 ppm.

The details of chemical constituents in ground water has been shown in Annexure 1.

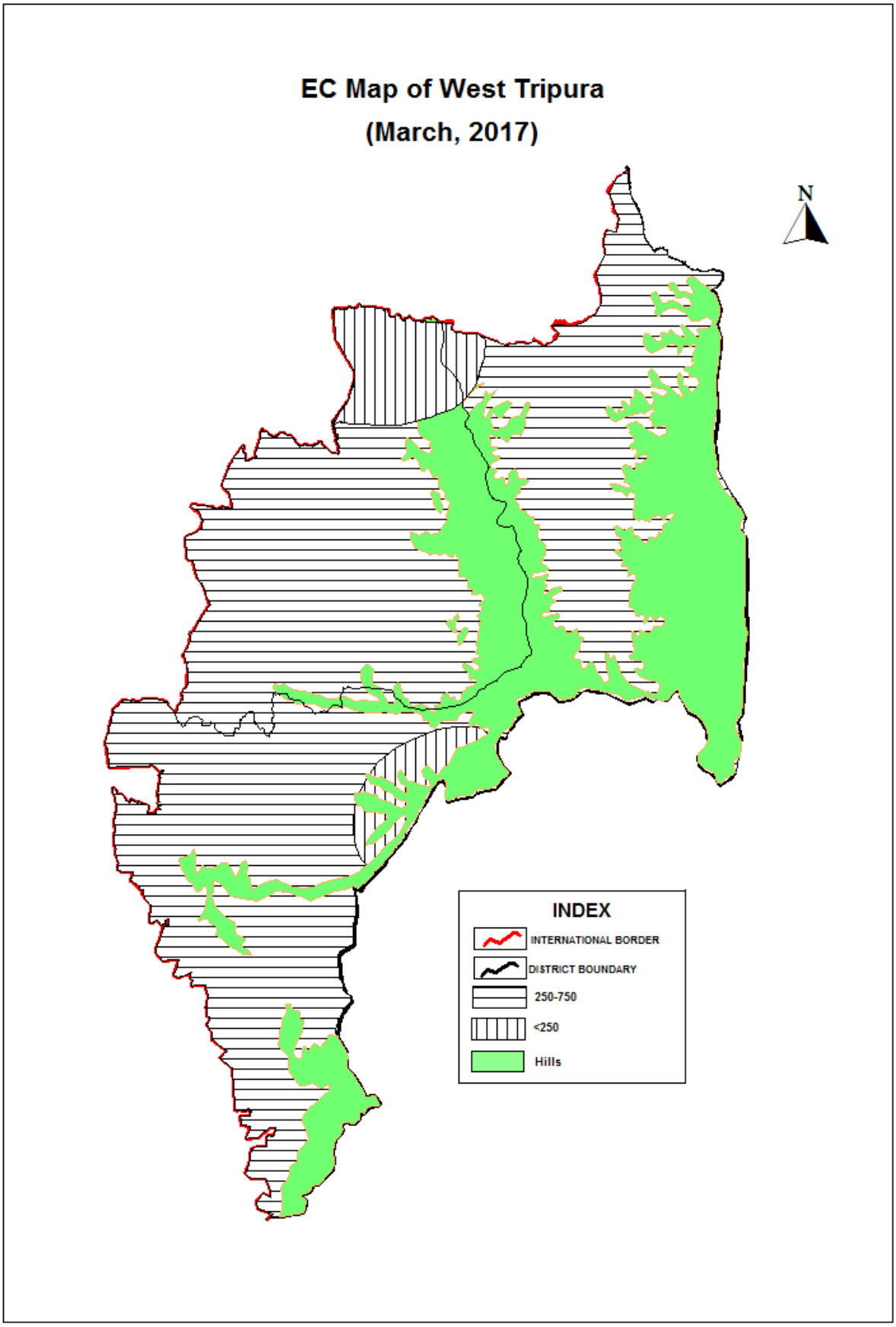

Fig 3.7: EC Map of West Tripura district

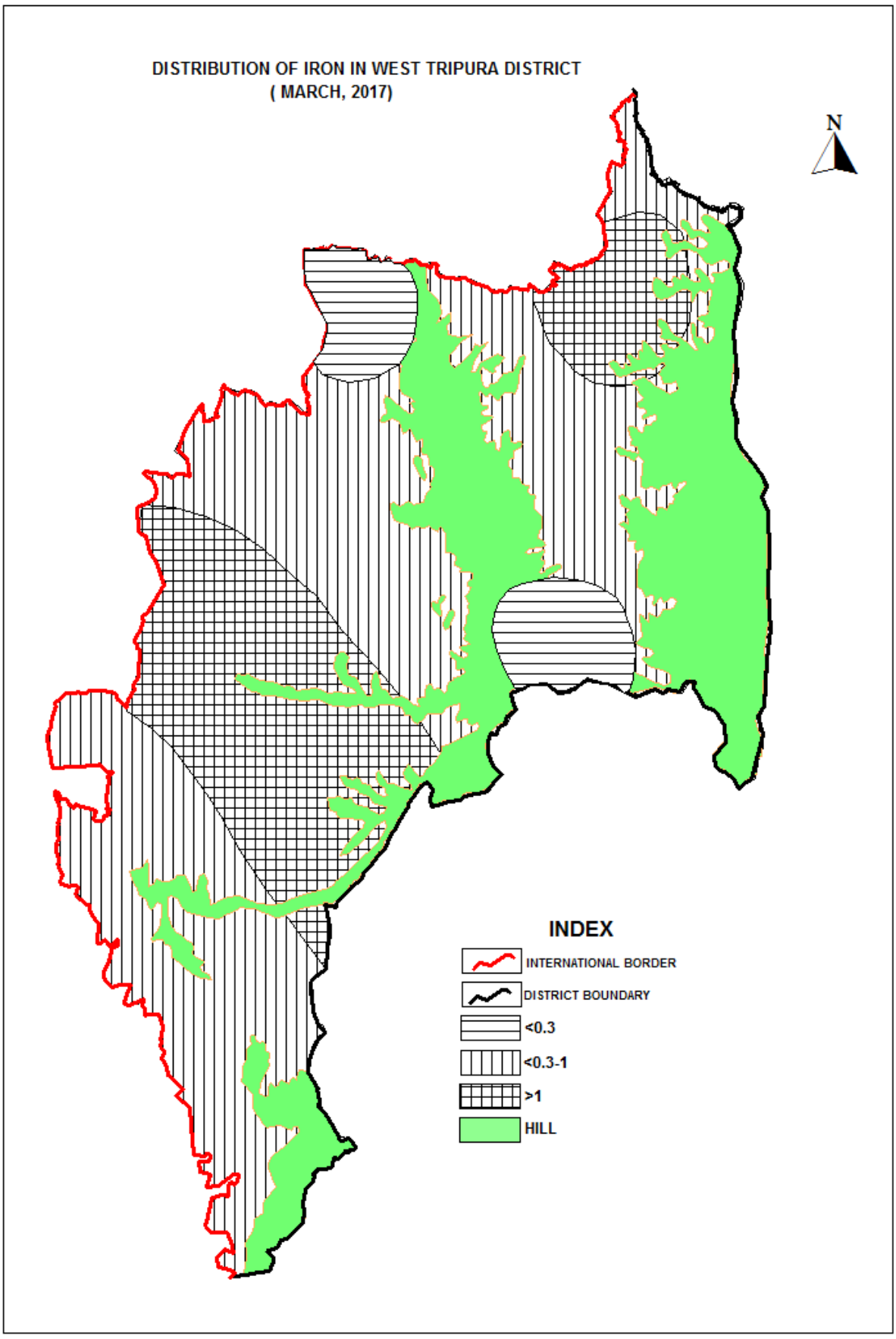

Fig 3.8: Distribution of Iron Map of West Tripura district

4. GROUND WATER RESOURCES

Estimation of Ground Water Resources in the West Tripura district 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 West Tripura district 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 West Tripura district 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 West Tripura district has been considered as a non-command area. Block-wise ground water availability estimated in the district, stage of ground water development etc. have been presented in Table 4.1 and Table 4.2 respectively.

Table 4.1: Groundwater Resource of West Tripura district as on 2012-13

Assessment unit	Stage of Ground Water development (%)	Net GW Availability (ham)	Existing Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for All Uses	Provision for Domestic & Industrial requirement for upto 2025	GW Availability for Future Irrigation@ 60% Net GW Availability (ham)
Bishalgarh	18.50	8180.92	1626.00	2004.58	1028.95	8180.92
Mohanpur	12.38	7677.98	834.00	1164.69	898.88	7677.98
Jirania	10.69	5445.80	402.00	715.99	852.53	5445.80
Dukli	28.81	3144.88	1200.00	1440.25	654.05	3144.88
Mandai	1.96	4357.39	0.00	90.27	245.62	4357.39
Jampaijala	2.69	5352.70	60.00	152.32	251.06	5352.70
Hezamara	2.55	3770.79	30.00	102.00	195.83	3770.79
Padmabil	7.12	1910.76	84.00	155.81	194.97	1910.76
Kalyanpur	7.43	3216.06	177.00	271.13	257.56	3216.06
Tulashikar	3.46	3887.42	57.00	144.82	238.71	3887.42
Khowai	9.60	4012.06	288.00	456.79	459.02	4012.06
Teliamura & Mungiakami	8.93	5118.30	303.00	542.41	651.09	5118.30
Boxanagar	11.59	2767.41	282.00	386.49	284.14	2767.41
Melaghar	5.93	7419.68	249.00	494.48	667.62	7419.68
Kathalia	39.68	2314.08	1542.00	1691.09	405.40	2314.08
Agartala (non-block)	42.44	13.30	0.00	505.22	1177.14	13.30
W. Tripura	**12.26**	**68589.51**	**7134.00**	**10318.35**	**8462.55**	**68589.51**

Table 4.2: Assessment of Dynamic Ground Water Resources of West Tripura District Unit-wise Categorization (2012-13)

Sl. No.	Assessment Unit	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)	
1	Bishalgarh	18.50	Rising	No	Rising	No	Safe
2	Mohanpur	12.38	Rising	No	Rising	No	Safe
3	Jirania	10.69	Rising	No	Rising	No	Safe
4	Dukli	28.81	Rising	No	Rising	No	Safe
4	Mandai	1.96	Rising	No	Rising	No	Safe
6	Jampaijala	2.69	Rising	No	Rising	No	Safe

7	Hezamara	2.55	Rising	No	Rising	No	Safe
8	Padmabil	7.12	Rising	No	Rising	No	Safe
9	Kalyanpur	7.43	Rising	No	Rising	No	Safe
10	Tulashikar	3.46	Rising	No	Rising	No	Safe
11	Khowai	9.60	Rising	No	Rising	No	Safe
12	Teliamura& Mungiakami	8.93	Rising	No	Rising	No	Safe
13	Boxanagar	11.59	Rising	No	Rising	No	Safe
14	Melaghar	5.93	Rising	No	Rising	No	Safe
15	Kathalia	39.68	Rising	No	Rising	No	Safe
16	Agartala (non-block)	42.44	Rising	No	Rising	No	Safe
West Tripura district		**5.90**	**12.26**	Rising	No	Rising	No

5. GROUNDWATER ISSUES

- **Water Quality problems**

The concentration of iron in ground water is generally much above the prescribed desirable limit of 0.3 ppm and maximum permissible of 1 ppm. The iron concentration in water from open 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 allowing the precipitation of ferrous iron as ferric iron. The enrichment of iron in water of the area is due to the ferruginous nature of Tipam sandstones, which form the major aquifers. The high content of iron renders ground water unsuitable for drinking purpose, hence the level of concentration should be brought down to the desirable limit before use for drinking purpose, to avoid any health hazards.

- **Drilling Problems**

In the area shallow tube wells are drilled manually. It is reported that construction of shallow tube wells is difficult in the foothills and hilly areas of the district due to the presence of hard shale.

As per dynamic ground water resource estimation 2013, by CGWB, the stage of ground water development is only **12.26** % for West Tripura District. Therefore, there is enough scope for future development of ground water in the study area to bring more area under irrigation practice. Though there is enough ground water resources available in the study area and CGWB has constructed a few successful bore wells in valley areas that does not mean that the above bore holes constructed anywhere will yield required ground water. Before construction of bore wells sites are to be selected scientifically.

The area annually receives nearly 1642.9 mm of rainfall yet people suffer for drinking water during lean periods. It has been observed that 70 to 80 percent of rainfall occur between May to September and within a few hours most of the rainwater goes as run off and finally enters Bangladesh. Suitable water storage structures may be constructed for utilization of water during lean periods.

Major ground water related issues can be summarized as under:

- Low stage of groundwater development (**12.26** %).
- Less Tube well / bore well /irrigation wells in the entire area
- Higher concentration of iron both in shallow and deeper aquifer

6. MANAGEMENT STRATEGY

As per dynamic ground water resource estimation of West Tripura district for 2012-13, net ground water availability is 84186 ham and stage of development is only 12%. The district is having balance net ground water availability for future irrigation use in the tune of 68590ham. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then 41154 ham of groundwater resources is available in the district for the future irrigation uses. From this available resource (planned for future development) 17147 nos. of shallow tube wells (considering a unit draft of 2.4 ham/year) can be constructed. Therefore, there is enough scope for future development of ground water in the district to bring more area under irrigation practice.

During Kharif season, land under cultivation (field crops only) in the district is 67,386 ha. Land use data for 2014-15 shows that cropping intensity in the district is 181%. During Rabi season, land under cultivation (field crops only) in the district is 51,532 ha. Irrigation potential created in the district is 47,296 ha. It can be seen that land cultivated during rabi season is more than the irrigation potential created. This may due to the fact that apart from the assured minor irrigation projects farmers use pump sets to collect water directly from rivers and some artesian wells; in some narrow valleys during dry season also water seeps from hills, some temporary bunds are constructed on small rivers / streamlets for irrigation in the district, which were not accounted.

After Kharif crops are over, a part of this cultivable area remains fallow during Rabi season. Gap between area cultivated during Kharif season and Rabi season is 15,854 ha. The intention of this plan is to utilize this fallow land of about 15854 ha under assured irrigation during Rabi season which will help to increase gross cropped area to 31,708ha. This will help to increase gross cropped area and thereby increase cropping intensity up to 200%. Since

stage of dynamic ground water is only about 12%, this area of 15,854 ha can easily be covered by constructing ground water based irrigation projects. To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. A suitable cropping plan for the district was prepared and is presented in Table 6.1.

In rice fallow, potato, mustard, pulses and rabi vegetables can be grown with the support of irrigation. Present cropping pattern, proposed cropping pattern, targeted increase in cropping intensity were shown in Table 6.2a and 6.2b.

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been estimated from CROPWAT after giving necessary meteorological, soil, crop plan inputs and the same has been shown in Table 6.3. Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in Table 6.4.

Table 6.1: Cropping pattern data of West Tripura District.

CROPPING PATTERN DATA
(File: C:\ProgramData\CROPWAT\data\sessions\Agartala.PAT)

Cropping pattern name: Agartala

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...Data\CROPWAT\data	Rice	04/06	01/10	10
2	...Data\CROPWAT\data	Rice	11/06	08/10	15
3	...Data\CROPWAT\data	Rice	18/06	15/10	15
4	...Data\CROPWAT\data	Rice	25/06	22/10	10
5	...a\CROPWAT\data\cr	Pulses	15/11	04/03	12
6	rape___mustard.CRO	Mustard	25/11	08/04	13
7	...\CROPWAT\data\cro	Potato	05/12	13/04	12
8	...CROPWAT\data\crop	Small Vegetables	13/12	17/03	13

Source: CROPWAT

Table 6.2a: Proposed cropping pattern with water deficit months and IWR, West Tripura district

Crop	**Growing period (Months)**	**Periods/months of water deficit**	**Irrigation requirement (ha m)**
Rice	4	2 – 3	2754.5
Potato	5	4	648.0
Mustard	6	5	738.7
Vegetables	4	4	830.2
Pulses	4	4	716.0

The total area of rice cultivation is comprised of (15854 ha). During kharif season, rice is cultivated from June to mid-July. Since this huge area cannot be cultivated in a single day (one planting date), so it is considered/ planned to cultivate rice in two to four stages during this period.

It is planned to utilize rice fallow of 15,854 ha for the cultivation of pulses, potato, mustard and vegetables. It is considered to cultivate the proposed crops 3963.5 ha each.

The peak water requirement for irrigation for rice is in the months of May-June, for mustard and pulses it is in the month of January, for potato it is in the month of March and for vegetables it is during February.

Table 6.2b. Cropping pattern, proposed cropping pattern, intended cropping intensity, for mono-cropped un-irrigated area in West Tripura district.

Mono-cropped Un-irrigated area in West Tripura district (new)				
Rice based cropping pattern				
1. Rice-Potato 2. Rice-Mustard 3. Rice-Vegetables 4. Rice-Pulses	Present Cultivated area (**ha**)	Area to be cultivated (**%**)	Area to be cultivated (**ha**)	Irrigation requirement (**ha m**)
	1	**2**	**3(= % of 1)**	**4**
Rice (main crop)	15,854	15,854		2754.5
Vegetables	0	3963	25	648.0
Mustard	0	3963	25	738.7
Pulses	0	3964	25	830.2
Potato		3964	25	716.0
Net cultivated area	15,854	**15,854**		
Gross cultivated area (1+potato/+mustard/+Veg/+Pulses)	15,854	**31,708**		
Total irrigation requirement				**5687**
Cropping intensity	**100% (Present)**	**200% (Intended)**		

Table 6.3: Crop-wise and month-wise precipitation deficit (mm) using CROPWAT 8 for West Tripura District.

Crops	Precipitation deficit (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Rice	0	0	0	0	147.6	62.7	0	0	0	3.1	0	0
2. Rice	0	0	0	0	49.5	98	0	0	0	0	0	0
3. Rice	0	0	0	0	61.8	125.3	0	0	0	0	0	0
4. Rice	0	0	0	0	0	147.4	0	0	0	6	0	0
5. Pulses	68.4	53.2	0	0	0	0	0	0	0	0	7.4	41.3
6. Mustard	53.4	51.9	35.2	0	0	0	0	0	0	0	3.3	35.4
7. Potato	51.5	68.1	72.3	0	0	0	0	0	0	0	0	26.3
8. Small Vegetables	51.5	61.2	33.8	0	0	0	0	0	0	0	0	27.2

Table 6.4: Irrigation water requirement (ham) of West Tripura district

Crops	% of total area of 31708 ha	Precipitation deficit												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1. Rice	10	0.0	0.0	0.0	0.0	468.0	198.8	0.0	0.0	0.0	9.8	0.0	0.0	676.6
2. Rice	15	0.0	0.0	0.0	0.0	235.4	466.1	0.0	0.0	0.0	0.0	0.0	0.0	701.5
3. Rice	15	0.0	0.0	0.0	0.0	293.9	596.0	0.0	0.0	0.0	0.0	0.0	0.0	889.9
4. Rice	10	0.0	0.0	0.0	0.0	0.0	467.4	0.0	0.0	0.0	19.0	0.0	0.0	486.4
5. Pulses	12	260.3	202.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.2	157.1	648.0
6. Mustard	13	220.1	213.9	145.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	145.9	738.7
7. Potato	12	196.0	259.1	275.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.1	830.2
8. Small Vegetables	13	212.3	252.3	139.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.1	716.0
		888.6	927.7	559.5	0.0	997.4	1728.2	0.0	0.0	0.0	28.9	41.8	515.3	5687.4

Under ground water exploration programme, CGWB has drilled 24 nos. of exploratory (including observation wells) tube wells in the district down to the depth of 300 m bgl. It has established that the aquifer in most part of the valleys in the district is having moderate to high potentiality, having an average discharge of about 47 m^3/hr and can be sustainably developed and use for irrigation purpose. Shallow tube wells within 50m depth can be constructed through 150/100mm diameter well assembly tapping 20 – 30m granular zones having 25m housing and 12-15m slotted portion. The annular space between the borehole and the well assembly should be shrouded preferably with 100mm thick zone of pea gravels. The yield of such tube wells in central part of the valleys is expected to be 15 – 20 m^3/hr at 5 to 10 m drawdown and in foothills yield of such tube wells is expected to be 10 – 15 m3/hr at draw down 5 – 10m. Shallow tube wells in valley portions where draw down is less than 5m and where non-pumping water level is less than 2 m bgl, enable the use of centrifugal pumps.

A shallow tube well in the district is expected to yield 20 m^3/hr. If such a tube well runs for 10hrs/day for 120 days, then it will create a draft of 2.4ham.

In the considered area of 15,854 ha, 3950 nos. of shallow tube wells can be constructed (considering 200m distance between any two shallow bore well). 3950 nos. of tube wells can extract 9480ham of water annually.

Annual irrigation water requirement is 5687 ham while irrigation water requirement during dry season spanning from October to March it is 2962 ham. However, proportionate dynamic groundwater resources available for future irrigation use (proposed to use 60% of availability) in 15,854 ha in the district is 6301 ham. Therefore, this rice fallow area can be irrigated by constructing ground water abstraction structures and can bring under double cropped area. This amount of groundwater resources can be harnessed by constructing 1250 tube wells. It is also proposed to construct water harvesting structures at suitable places. As per available ground water resources (60% availability) 17147 nos. of tube wells can be constructed and State Govt. has already constructed 23 deep tube wells, 150 mini deep tube wells and 58 shallow tube wells for irrigation purpose. For drinking purposes also there is thousands of shallow tube wells drilled by State Govt. and by public/private. Still there is scope for further drilling of 1250 tube wells.

Groundwater in the area is infested with iron, therefore before consumption aeration/ filtering/ installation of Iron Removal Plant is necessary.

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ANNEXURE 1: WATER QUALITY DATA OF WEST TRIPURA DISTRICT FOR THE YEAR 2016

Sl.No	Location	Block	Source	NHNS/Exploratory/Aquifer mapping/short term/Pollution	pH	EC µS/cm at 25°C	Turbidity(NTU)	TDS	CO_3	HCO_3	TA	Cl^-	SO_4^{-2}	NO_3^{-1}	F^-	Ca^{+2}	Mg^{+2}	TH	Na^+	K^+	Fe
									mg/l												
1	Mohanpur	Mohanpur	DW	NHNS	6.52	425.10	BDL	210.80	0.00	105.00	105.00	42.49	21.47	2.50	0.17	20.00	2.43	60	45.03	19.74	0.38
2	Ishanpur	Mohanpur	DW	NHNS	7.42	162.30	BDL	76.56	0.00	55.00	55.00	17.49	10.04	1.10	0.13	10.00	10.92	70	5.62	3.04	2.05
3	Simna	Mohanpur	DW	NHNS	7.09	199.56	BDL	95.73	0.00	50.00	50.00	52.49	31.24	0.70	0.19	26.00	12.14	115	18.48	3.58	0.06
4	Subalsingh	Heza-mara	DW	NHNS	8.05	458.60	BDL	227.30	0.00	80.00	80.00	24.99	19.40	5.60	0.00	24.00	2.43	70	25.45	4.84	0.89
5	Khowai	Khowai	DW	NHNS	7.83	285.60	BDL	142.00	0.00	60.00	60.00	52.48	9.72	0.10	1.01	28.00	9.71	110	8.10	12.26	1.06
6	Bagan Bazar	Khowai	DW	NHNS	7.48	201.00	0.50	45.87	0.00	120.00	120.00	10.00	26.48	0.10	0.38	18.00	13.35	100	20.56	2.98	3.61
7	Kalyanpur	Kalyanpur	DW	NHNS	8.35	688.70	BDL	383.20	20.00	5.00	25.00	82.47	16.42	0.20	0.37	42.00	1.21	110	23.96	3.35	0.64
8	Paschim Hawaibari	Teliamura	DW	NHNS	7.50	493.60	BDL	426.40	0.00	65.00	65.00	57.48	64.21	3.90	0.46	16.00	36.41	190	12.18	7.57	0.00
9	Tufaniamura	Jampuijala	DW	NHNS	8.24	533.30	0.30	273.70	10.00	120.00	130.00	69.98	52.91	0.20	0.26	28.00	20.63	155	55.69	13.29	1.16
10	Gongrai	Jampuijala	DW	NHNS	6.60	107.30	0.60	54.40	0.00	50.00	50.00	10.00	7.77	0.00	0.33	10.00	3.64	40	9.54	3.97	1.55
11	A. D. Nagar	Agartala	DW	Urban Key well	7.85	151.20	BDL	81.52	0.00	70.00	70.00	19.99	7.93	1.10	0.18	20.00	6.07	75	8.59	1.99	1.38
12	R. K. Nagar	Agartala	DW	Urban Key well	7.70	167.60	BDL	90.77	0.00	65.00	65.00	17.49	39.46	7.00	0.29	24.00	7.28	90	12.52	7.76	4.99
13	Nath Para	Old Agartala	DW	Urban Key well	8.30	429.20	BDL	232.00	40.00	155.00	195.00	22.49	2.67	9.80	0.34	46.00	15.78	180	23.32	11.53	0.24
14	Madhuban	Dukli	DW	Urban Key well	7.90	109.80	BDL	59.37	0.00	35.00	35.00	15.00	13.26	2.40	0.35	8.00	6.07	45	9.70	2.39	0.05
15	S.M. Nagar	Agartala	DW	Urban Key well	8.39	270.40	BDL	148.10	40.00	30.00	70.00	39.99	9.09	4.00	0.13	18.00	15.78	110	16.61	3.35	1.99

ANNEXURE 2 : DETAILS OF EXPLORATORY WELLS DRILLED BY CGWB AGARTALA VALLEY

Sl. No.	Well Location	Depth Drilled/ Assembly lowered (m)	Position of slot (m)	Thickness of aquifer tapped (m)	Discharge (m^3/h)	SWL/ Draw down (m)	Specific Capacity (lpm/m)	Transmissivity (m^2/day)	Permeability (m/day)	Storativity	Remark
1	Jirania BDO Office	254.8	50-73 105-115 127-136 185-195 230-245	64	168	1.47/14.97	123.5	1100	17.0	-	ETW
2	Belbari	257	-	59	35	2.78/30.53	19.4	5.19	8.8	-	-do-
3	Jirania Coconut Farm	232	86-92 110-122 134-146 152-170	48	99	9.30/5.00	329.3	829.5	18.6	-	Deposit well
4	Champaknagar	261.3	41-52 124-136 147-188	64	13	NA/20.92	10.3	-	-	-	ETW
5	Sasubari	281/182	98-110 116-122 128-143 153-162 165-79	56.9	-	-	-	-	-	-	ETW Yet to be tested
6	Salbagan BSF	203.2	64-68 72-81 94-100 120-134 144-150 156-160	41	42	14.0/17.26	40.9				Deposit well
7	GPA, Agartala	190	60-84 90-96 140-146 166-184	54	164.8	9.8/12.6	217.6	1449	26.8	-	Deposit well
8	Bishalgarh	235	47-92	45	172	NA/13.65	210.0	1438	28.3	1.28×10^{-4}	ETW

9	Jampaijala	205	69-80 98-110 116-128 140-153 171-177	53	62.8	0.05/4.95	211.7	709	11.9	-	ETW
10	Golaghati	270	65-77 88-100 119-125 131-137	50	20	0.80/10.75	32.1	90.9	1.8	4.4×10^{-4}	ETW
11	Gokulnagar BSF Campus	200	57 – 61 69 – 73 82 – 91 109 – 111 115 – 119 125 – 127 145 - 160	40	35	11.14/6.03	98.33	1302.03	32.92	2.06×10^{-3}	ETW
12	Fatikcherra BSF Campus	200.50	94 – 103 120 – 126 145 - 169	39	50	1.95/8.92	98.02	934.43	23.96	5.71×10^{-3}	ETW
13	Gokulnagar	204	63-70 99-109 118-128 134-173	66	113	7.90/19.40	97.1	904.8	13.7	-	Deposit well
14	Vivekananda Nagar	255/155	43-89 95-98 105-111	55	66	NA/10.5	104.7	161.4	2.4	-	-do-
15	Konaban	280	-	-	-	-	-	-	-	-	Slim hole

KHOWAI VALLEY

Sl No	Well Location	Depth Drilled/ Assembly lowered (m)	Position of slot (m)	Thickness of aquifer tapped (m)	Discharge (m^3/h)	SWL/ Draw down (m)	Specific Capacity (lpm/m)	Transmissivity (m^2/day)	Permeability (m/day)	Storativity	Remark
1	Bonbazar	256	52-61 85-100	24	-	Flowing/NA	-	-	-	-	Sand flow
2	Asharambari	301.6	51-62 107-112 120-146 155-157	54	28	0.5 agl/10.45	44.6	-	-	-	-do-
3	Badlabari	250	60-78 84-96 120-126 162-180 216-222	60	-	0.80/NA	-	-	-	-	Not tested
4	Khowai	295	132-137 153-188 236-255	59	190	7.0 agl/13.6	207.5	1689	28.4	-	ETW
5	Baijalbari	256.7/231	76-80 86-92 110-134 168-180 195-208 217-229	71	74	10.4/5.68	217.0	1102	15.7	-	ETW
6	Balucherra	320	56-70 75-79 92-107 126-141 205-217 231-237	66	91	6.40/6.83	197.8	1047	15.9	-	ETW

ANNEXURE 3: WATER LEVEL DATA OF GROUND WATER MONITORING STATIONS OF WEST TRIPURA (March, 2017)

S.N	District*	Block*	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Dia*	Water Level (m bgl) Jan-2017	Water Level (mbgl) Mar-17*
STATE : TRIPURA												
1	Sipahi-jala	Bishal-garh	Kenania	23˚ 44' 0.9"	91˚ 11' 25.7"	DUG	0.84	20.73			**7.21**	6.37
2	Sipahi-jala	Bishal-garh	Golaghati	23˚ 40' 37"	91˚ 21' 37"	DUG	0.85		5.2	1.2	**3.12**	2.27
3	Sipahi-jala	Jampui-jala	Tufaniamura	23˚ 41' 55.5"	91˚ 24' 25.5"	DUG	0.72		5.43	1.4	**7.03**	6.31
4	Sipahi-jala	Jampui-jala	Gongrai	23˚ 39' 24"	91˚ 27' 14.4"	DUG	0.55		7.25	1.97	**6.00**	5.45
5	Sipahi-jala	Boxnagar	Dakshin Kalamcherra	23˚ 34' 25"	91˚ 12' 33"	DUG	0.96				**6.23**	5.27
6	Sipahi-jala	Kanthalia	Sonamura	23˚ 26' 55"	91˚ 16' 13"	DUG	0.81				**4.57**	3.76
7	Sipahi-jala	Kanthalia	Kanthalia Bazar	23˚ 21' 31"	91˚ 19' 47"	DUG	0.75	13.755			**5.07**	4.32
8	Khowai	Khowai	Khowai	24˚ 03' 50.8"	91˚ 36' 18.7"	DUG	0.72				**2.71**	1.99
9	Khowai	Khowai	Bagan Bazar	23˚ 58' 13.5"	91˚ 37' 4.5"	DUG	0.92		3.7	1.15	**2.82**	1.9
10	Khowai	Kalyanpur	Kalyanpur	23˚ 55' 44"	91˚ 36' 34.7"	DUG	0.92	41.69			**5.20**	4.28
11	Khowai	Telia-mura	Pachim Howaibari	23˚ 48' 36"	91˚ 35' 31.5"	DUG	0.7	44.63	6.2	1.24	**3.44**	2.74
12	Khowai	Mungia-kami	Tuimadhu	23˚ 50' 06"	91˚ 41' 11"	DUG	0.96		6.31	1.15	**5.18**	4.22
13	Khowai	Mungia-kami	45 Miles	23˚ 57' 09"	91˚ 57' 38"	DUG	0.77		8.44	1.12	**4.60**	3.83
14	W.Tripura	Mohan-pur	Mohanpur	23˚ 58' 18.4"	91˚ 22' 22"	DUG	0.63	25.695	5.51	1.25	**3.56**	2.93
15	W.Tripura	Mohan-pur	Ishanpur	24˚ 02' 43"	91˚ 23' 57"	DUG	0.8		8.13	1.2	**4.71**	3.91
16	W.Tripura	Mohan-pur	Simna	24˚ 05' 32"	91˚ 23' 36"	DUG	0.79	23.77			**6.74**	5.95
17	W.Tripura	Heza-mara	Subalsingh	24˚ 00' 17"	91˚ 27' 26"	DUG	0.64		9.84	1.15	**8.54**	7.9
18	W.Tripura	Jirania	Champak-nagar	23˚ 48' 31.9"	91˚ 28' 32.2"	DUG	0.8	47.16	5.15	1.8	**2.43**	1.63
19	W.Tripura	Mohan-pur	Narsinghgarh DTW	23˚ 54' 15"	91˚ 14' 49"	PZ	0.7	12.8	186	0.203	**6.70**	6
20	W.Tripura	Agartala M. C.	Lichubagan STW	23˚ 52' 16"	91˚ 17' 2.5"	PZ	0.58	11.865	179	0.102	**5.87**	5.29
21	Sipahi-jala	Bishal-garh	Kenania	23˚ 44' 0.9"	91˚ 11' 25.7"	DUG	0.84	20.73			**7.21**	6.37

ANNEXURE 4: SAMPLES COLLECTED DURING NOVEMBER,2017

Sl No.	Location	Co-Ordinates		Type (EW or DW)	Date of Collection	NHNS/Exploratory/ Aquifer Mapping/ Short Term/Pollution	No. of samples to be Analysed		
							Basic	Iron	Heavy Metal
1	Gongrai	23˚ 39' 24"	91˚ 27' 14.4"	Dug	15.11.17	NHNS	1 Litre	250 ml	500 ml
2	A.D Nagar			Dug	21.11.17	Urban Well/NHNS	1 Litre	250 ml	500 ml
3	Dukli	23˚ 47' 19" N	91˚ 17' 09" E	Dug	21.11.17	Urban Well/ NHNS	1 Litre	250 ml	500 ml
4	Lalmaibari	23°33′ 2.97″	91°16′ 24.65″	Dug	18.11.17	Aquifer Mapping	1 Litre	250 ml	500 ml
5	Kenania	23˚ 44' 0.9"	91˚ 11' 25.7"	Dug	13.11.17	NHNS	1 Litre	250 ml	500 ml
6	Bagbassa	23°33′7.836″	91°23′30.654″	Dug	18.11.17	Aquifer Mapping	1 Litre	250 ml	500 ml
7	Paschim Hawaibari	23˚ 48' 36"	91˚ 35' 31.5"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
8	Subalsing	24˚ 00' 17"	91˚ 27' 26"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
9	Simna	24˚ 05' 32"	91˚ 23' 36"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
10	Mohanpur	23˚ 58' 18.4"	91˚ 22' 22"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
11	Ishanpur	24˚ 02' 43"	91˚ 23' 57"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
12	D.Kalamcharra	23˚ 34' 25"	91˚ 12' 33"	Dug	16.11.17	NHNS	1 Litre	250 ml	500 ml
13	Sivnagar	23°32′58.12″	91°16′ 57.82″	Dug	18.11.17	Aquifer Mapping	1 Litre	250 ml	500 ml
14	Kathaliabazar	23˚ 21' 31"	91˚ 19' 47"	Dug	16.11.17	NHNS	1 Litre	250 ml	500 ml
15	Sonamura	23˚ 26' 55"	91˚ 16' 13"	Dug	18.11.17	NHNS	1 Litre	250 ml	500 ml
16	Khowai	24˚ 03' 50.8"	91˚ 36' 18.7"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
17	Kalyanpur	23˚ 55' 44"	91˚ 36' 34.7"	Dug	14.11.17	NHNS	1 Litre	250 ml	500 ml
	Isotope Analysis								
18	Subalsing	24˚ 00' 17"	91˚ 27' 26"	Dug	14.11.17	NHNS			500 ml+500 ml
19	A.D Nagar			Dug	21.11.17	Urban Well/NHNS			500 ml+500 ml

ANNEXURE 5: LITHOLOG

1. Lithological log of Exploratory well at P&T Colony, Arundhutinagar, Agartala. West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-7.00	7.00	**Shale:** Fine grained, grey
7.00-13.30	6.30	**Sandstone:** Fine gained with piece of shale
13.30-19.20	5.9	**Shale:** Fine grained
19.20-52.70	33.50	**Sandstone:** Fine gained
52.70-64.66	11.96	**Shale:** Fine grained
64.66-69.54	4.88	**Sandstone:** Fine gained
69.54-71.06	1.52	**Shale:** Fine grained
71.06-78.69	7.63	**Sandstone:** Fine gained
78.69-88.45	9.76	**Shale:** Fine grained
85.45-92.11	6.66	**Sandstone:** Fine gained
92.11-95.16	3.05	**Sandstone:** Fine gained with intermixing of shale
95.16-99.43	4.27	**Sandstone:** Fine gained
99.43-109.83	10.4	**Shale:** Fine grained
109.83-148.84	39.01	**Sandstone:** Fine gained
148.84-153.11	4.27	**Shale:** Fine grained
153.11-162.26	9.15	**Sandstone:** Fine gained
162.26-163.17	0.91	**Shale:** Fine grained
163.17-171.10	7.93	**Sandstone:** Fine gained
171.10-186.05	14.95	**Shale:** Fine grained
186.05-205.20	19.15	**Sandstone:** Fine gained
205.20-208.30	3.10	**Shale:** Fine grained
208.30-211.30	3.00	**Sandstone:** Fine gained
211.30-214.40	3.10	**Shale:** Fine grained
214.40-226.60	12.20	**Sandstone:** Fine gained

2. Lithological log of Exploratory well at Belbari, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-10.00	10.00	**Sandy clay:** Yellowish brown, fine to medium grained.
10.00-19.00	9.00	**Sandstone:** Light yellow, fine to medium grained.
19.00-40.00	21.00	**Sand:** Light yellow, fine to medium grained, slightly micaceous with a few ferruginous materials.
40.00-74.00	34.00	**Sand:** Yellowish grey, medium to fine, micaceous and the percentage ferruginous materials are higher than above.
74.00-77.00	3.00	**Sand:** Yellowish grey, fine to medium micaceous with a few intercalation of shale, bluish.
77.00-86.00	9.00	**Sand:** As above, but the percentage of shale is high.
86.00-100.00	14.00	**Sand:** Yellowish grey, medium to fine micaceous
100.00-107.00	7.00	**Sand:** Yellowish grey, fine to medium with a few intercalation of shale, bluish
107.00-110.00	3.00	**Sandy clay:** Bluish, sticky,
110.00-120.00	10.00	**Sand:** Light grey, fine to medium with little clay,
120.00-150.00	30.00	**Sand:** Light grey, fine to medium with a few chips of shale.

150.00-225.00	75.00	**Sand:** Yellowish grey, medium to fine
225.00-233.00	8.00	**Sand:** Yellowish grey, fine to medium with little clay sticky.
233.00-257.00	24.00	**Sand:** Yellowish grey, medium to fine

3. Lithological log of Exploratory well at Gokulnagar BSF Camp (2002), West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0-6.80	6.80	**Clayey sand:** Brown in colour mixed with particles of ferruginous materials of lateritic origin, angular to sub angular in shape and grains of quartz and feldspar in less quantity present
6.80-16.80	9.30	**Sand:** Fine grained, light brown in colour, mixed with little ironaceous compound
16.80-46.85	30.75	**Sand:** Medium to fine gained, light brownish in colour with quartz, feldspar and ironaceous martial of lateritic origin
46.85-49.85	3.00	**Sand:** Fine gained, light brownish in colour
49.85-62.15	12.30	**Sand:** Medium to fine gained, light brownish in colour with quartz, Feldspar and ferruginous materials and occasional particles of lateritic origin
62.15-68.30	6.15	**Sand:** Medium to fine grained, light brownish in colour with occasional lateritic material.
68.30-99.05	30.75	**Sand:** Medium to fine grained, light brownish in colour with quartz, feldspar and ferruginous nodules.
99.05-102.20	3.15	**Clay:** Light brown in colour with little amount of fine sand
102.20-105.20	3.00	**Clayey sand:** Sand medium to fine grained creamish in colour
105.20-108.20	3.00	**Sand:** Medium grained, white with light brownish tint in colour with angular to sub angular particles of quartz, feldspar and ferruginous material.
108.20-114.50	6.30	**Sand:** Medium to fine gained, dirty white in color
114.50-126.80	12.30	**Sand:** Medium to fine gained, dirty white in color with very little clay
126.80-142.10	15.30	**Clayey sand:** Grayish white in colour with little ferruginous particle.
142.10-154.40	12.30	**Sand:** Medium to fine gained, grayish white in color with quartz, feldspar and ferruginous material.
154.40-160.35	6.15	**Sand:** Medium to fine grained with negligible amount of clay.
160.55-163.70	3.15	**Sand:** Medium to fine grained, grayish white in colour with clay admixture
163.70-200.00	36.30	**Clayey sand:** Sand fine grained, grayish white in colour.

4. Lithological log of Exploratory well at Gokulnagar, BSF Camp (1976), West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-3.00	3.00	**Clay**: Dark, reddish brown with little fine grained sand and mica.
3.00-6.55	3.55	**Sandy clay**: Reddish brown, sand fine to medium grained, clay sticky and soft sand content is about 30%
6.55-15.93	9.38	**Sand**: Reddish brown, fine to medium grained, little micaceous clay (about 10%)
15.93-19.31	3.38	**Clay:** Reddish brown, sticky, hard and micaceous with 10.15% fine grained sand.
19.31-28.69	9.38	**Sandy clay**: Reddish brown to dirty brown, fine to medium grained and occasionally coarse grained sand (Feldspar and quartz pieces of kankar are also noticed.
28.69-32.07	3.38	**Clay:** Reddish brown, slightly micaceous with patches of dark brown, lateritic formation and 5% sand.
32.07-63.92	31.85	**Sandy clay:** Reddish brown to dirty brown, fine to medium grained and occasionally coarse grained sand (Feldspar and quartz pieces of kankar are also noticed.
63.92-70.35	6.43	**Sand:** Brownish gray, fine to medium grained, micaceous with little dark gray.
70.35-95.87	25.52	**Clay:** Dark grey to reddish brown with patches of lateritic material, sticky, hard with 20 to 30% of fine grained sand.
95.87-99.25	3.38	**Clay:** Reddish brown to brown micaceous with patches of dark grey clay, fine grained sand is about 15%.
99.25-108.63	9.38	**Sand:** Reddish brown, fine to medium grained, micaceous with little admixture of clay, sand is occasionally coarse grained.
108.63-15.01	6.38	**Sand:** Reddish brown, fine to medium grained, and micaceous with dark grey, coloured clay (about 20-30%).
115.01-118.39	3.38	**Sandy clay:** Reddish brown, fine to medium grained, and micaceous with pieces of kankar, brown to grey coloured clay portion, sticky and hard sand.
118.39-127.97	9.58	**Sand:** Reddish brown, fine to medium grained with patches of lateritic material, silt content is about 10%, with grey clay.
127.97-134.15	6.38	**Sandy clay:** Reddish brown, fine to medium grained, and micaceous with pieces of kankar, clay is sticky, hard, dirty grey and 30% of the total volume.
134.15-175.81	41.66	**Sand:** Grey to brownish grey, fine to medium grained, micaceous, with pieces of kankar, silt content is about 10%.

175.81-182.19	6.38	**Clayey sand**: Grey to dark grey, miceceous sand, fine grained with pieces of kankar and clay(about 30-40%).
182.19-204.33	22.14	**Clay**: Grey to dark grey, sticky, with medium and fine grained micaceous sand, sand is about 30%.

5. Lithological log of Exploratory well at Gokulnagar BSF Camp (2002), West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0-6.80	6.80	**Clayey sand**: Brown in colour mixed with particles of ferruginous materials of lateritic origin, angular to sub angular in shape and grains of quartz and feldspar in less quantity present
6.80-16.80	9.30	**Sand**: Fine grained, light brown in colour, mixed with little ferruginous compound
16.80-46.85	30.75	**Sand:** Medium to fine gained, light brownish in colour with quartz, feldspar and ironaceous martial of lateritic origin
46.85-49.85	3.00	**Sand:** Fine gained, light brownish in colour
49.85-62.15	12.30	**Sand:** Medium to fine gained, light brownish in colour with quartz, feldspar and ferruginous materials and occasional particles of lateritic origin
62.15-68.30	6.15	**Sand:** Medium to fine grained, light brownish in colour with occasional lateritic material.
68.30-99.05	30.75	**Sand**: Medium to fine grained, light brownish in colour with quartz, feldspar and ferruginous nodules.
99.05-102.20	3.15	**Clay:** Light brown in colour with little amount of fine sand
102.20-105.20	3.00	**Clayey sand:** Sand medium to fine grained creamish in colour
105.20-108.20	3.00	**Sand**: Medium grained, white with light brownish tint in colour with angular to sub angular particles of quartz, feldspar and ferruginous material.
108.20-114.50	6.30	**Sand:** Medium to fine gained, dirty white in color
114.50-126.80	12.30	**Sand:** Medium to fine gained, dirty white in color with very little clay
126.80-142.10	15.30	**Clayey sand:** Grayish white in colour with little ferruginous particle.
142.10-154.40	12.30	**Sand:** Medium to fine gained, grayish white in color with quartz, feldspar and ferruginous material.
154.40-160.35	6.15	**Sand:** Medium to fine grained with negligible amount of clay.
160.55-163.70	3.15	**Sand:** Medium to fine grained, grayish white in colour with clay admixture
163.70-200.00	36.30	**Clayey sand:** Sand fine grained, grayish white in colour.

6. Lithological log of Exploratory well at Khowai, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-3.60	3.60	**Clay**: Dirty brown to yellowish coloured with 5 to 10% fine micaceous sand.
3.60-16.36	12.76	**Clay:** Grey to yellowish brown coloured and sticky, with little admixture of sand.
16.36-19.36	3.00	**Sandy clay**: Gray do yellowish brown, sticky, with 40% fine to medium grained sand.
19.36-22.74	3.38	**Sandy clay:** Grey coloured, sticky, micaceous with 50% fine do medium grained sand.
22.74-32.12	9.38	**Clay:** Deep grey coloured, sticky, micaceous, about 5 to 10% sand is also present.
32.12-35.50	3.38	**Clay**: Grey coloured, sticky, hard, little micaceous, with occasional brown coloured clay, lumps
35.50-61.02	25.48	**Sandy clay:** Grey to brown coloured, sticky, hard, micaceous, fine to medium grained sand content varies from 30-60%.
61.02-67.40	6.38	**Clay:** Grey to brown coloured, sticky with compact, micaceous with pieces of carbonaceous material.
67.40-99.30	31.90	**Sandy clay**: Grey to brownish in colour, sticky compact with 40% fine to medium grained sand of carbonaceous material and peat are seldom seen.
99.30-112.06	12.76	**Clay:** Deep grey coloured, sticky and hard, micaceous with 5 to 10% sand.
112.06-131.20	19.14	**Sandy clay:** Grey coloured, micaceous and sticky, fine to medium grained sand content varying from 20-50%.
131.20-140.58	9.38	**Sand**: Light to grey coloured, micaceous, fine to medium grained with little silt.
140.58-153.34	12.76	**Sandy clay**: Grey to light grey coloured, sticky with fine to medium grained.
153.34-191.62	38.28	**Sand:** Light grey, occasionally brown coloured medium to coarse grained, micaceous, with occasional pieces of shale and quartz between 182.24-185.34m.
191.62-233.28	41.66	**Sandy clay**: Grey to yellowish brown coloured, sticky, micaceous. Fine to medium grained sand is about 40% grained sand is about 40%.
233.28-255.42	22.14	**Sandy clay**: Grey coloured, medium to coarse grained, micaceous.
255.42-294.92	39.50	**Sandy clay:** Grey to light brown in colour, sticky and soft, little micaceous clay with fine to medium grained sand which varies from 10-40%.

7. Lithological log of Exploratory well at Baijalbari West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-6.60	6.60	**Clay:** Brown sticky clay with little sand (20%).
6.60-12.70	6.10	**Sand:** Fine to medium grained light brown, micaceous.
12.70-15.80	3.10	**Clay sandy:** Brownish sticky withy fine to medium grained sand.
15.80-40.20	24.40	**Clay:** Grayish mixed with fine sand.
40.20-55.40	15.20	**Clay sandy:** Grayish with fine to medium grained sand, sand % increase downward.
55.40-76.80	21.40	**Clay:** Grey, very little sand 10-20% few weathered pieces of fine sandstone
76.80-79.80	3.00	**Sand:** Grey, angular, micaceous medium grained with mafics minerals and grayish clay 20%.
79.80-85.90	6.10	Clay sandy, grey with fine grained sand.
85.90-101.20	15.30	Sand grey fine to medium with little grey clay.
101.20-110.30	9.10	**Clay sand:** Grey, fine to medium grained sand.
110.30-134.80	24.50	**Sand:** Grey, fine to medium occasionally coarse with mafics clay content about 20% sticky soft, few pieces of quartz and feldspar
134.80-168.30	33.50	**Clay:** Grey, sticky, hard
168.30-180.50	12.20	**Sand:** Grey fine grained micaceous, with little clay
180.50-186.60	6.10	**Clay:** Grey, hard with fine grained sand
186.60-192.70	6.10	**Sand:** Grey micaceous, fine to medium sand with little clay
192.70-195.80	3.10	**Clay:** Grey, hard with fine grained sand
195.80-204.90	9.10	**Sand:** Grey fine grained micaceous with pieces of shale.
204.90-208.00	3.10	**Sand:** Fine grained grey Micaceous sand with little clay,
208.00-211.00	3.00	**Clay:** Grey hard with little sand.
211.00-223.20	12.20	**Sand:** Grey, mostly fine grained with sticky and hard pieces of shale.
223.20-226.30	3.10	**Sandy:** Clay, grey hard with fine grained sand.
226.30-229.30	3.00	**Sand:** Grey, very fine grained, micaceous with clay 30% sand
229.30-256.70	27.40	**Clay:** Grey, hard, sticky with little sand (20%).

8. Lithological log of Exploratory well (S.H) at Konaban, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-48.80	48.80	**Sand:** Fine to medium light yellowish brown
48.80-67.10	18.30	**Sand:** Fine to medium yellowish brown with few chips of shales
67.10-91.50	24.40	**Sand:** Fine to medium light grey with few chips of shales

91.50-179.90	88.40	**Shale:** With minor fine grained sand, grey sand percentage gradually decreasing with depth.
179.90-280.60	100.70	**Clay**: Grey sticky.

9. Lithological log of Exploratory well at GPA, Agartala, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-2.70	2.70	**Sandstone:** Reddish, yellow fine grained.
2.70-5.70	3.00	Sandstone: Reddish, yellow fine grained.
5.70-28.40	22.70	**Sandstone:** Yellow, fine to coarse grained.
28.40-31.40	3.00	**Sandstone:** Yellow, medium coarse grained with quartz grains.
31.40-95.50	64.10	**Sandstone:** Yellow, fine to coarse to very coarse grained
95.50-98.50	3.00	**Sandstone:** Grey, fine to coarse grained with shale.
98.50-104.60	6.10	**Shale:** Grey coloured, with fine gained sandstone.
104.60-110.70	6.10	**Sandstone:** Grey, fine grained with shale pieces.
110.70-129.00	18.30	**Sandstone**: Grey coloured, fine gained sandstone.
129.00-135.10	6.10	**Sandstone**: Grey coloured, fine grained with shale.
135.10-147.30	12.20	**Sandstone:** Grey coloured, fine grained, sandstone friable.
147.30-150.40	3.10	**Sandstone:** Grey coloured, fine grained with shale pieces.
150.40-153.40	3.00	**Sandstone:** Grey coloured, fine gained.
153.40-159.40	6.00	**Shale:** Grey coloured, with fine grained sandstone.
159.40-187.00	27.60	**Sandstone:** Grey, fine to medium grained.
187.00-190.00	3.00	**Shale:** Grey coloured, with fine grained sandstone.

10. Lithological log of Exploratory well at Jirania Coconut seed firm, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-3.00	3.00	Surface soil
3.00-18.00	15.00	**Sand:** Fine to medium, brownish yellow with quartz and feldspar and a few ferruginous materials.
18.00-45.70	27.70	**Sand:** Fine to medium, light brownish yellow mostly composed of quartz and feldspar.
45.70-67.00	21.30	**Sand**: Fine to medium, yellowish mostly composed of quartz and feldspar with a few mafic minerals.
67.00-73.00	6.00	**Sand:** Fine to medium, buff coloured, mostly composed of quartz and feldspar with significant quantity of micaceous and a few ferruginous material.
73.00-94.00	21.00	**Sand:** Fine to medium, yellowish with quartz and feldspar.
94.00-103.00	9.00	**Sand:** Fine to medium grained, buff coloured, mostly composed of quartz and feldspar with ferruginous material.
103.00-122.00	19.00	**Sand:** Fine to medium, yellowish mainly composed of quartz and feldspar.
122.00-219.60	97.60	**Sand:** Fine to medium, grayish mostly composed of quartz

		and feldspar with a few mafic minerals.
219.60-231.80	12.20	**Sand:** Fine to medium, grayish white, mostly composed of quartz and feldspar with a few mafic minerals

11. Lithological log of Exploratory well at Golaghati, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-14.00	14.00	**Sand:** Fine to medium yellowish white.
14.00-62.00	40.00	**Sand:** Fine to medium light brown.
62.00-72.00	9.20	**Sand:** Fine to medium light gray, micaceous with little quartz and a few ferruginous material
72.00-81.00	9.00	**Sand:** Fine to medium dark gray, micaceous with quartz and a few ferruginous material
81.00-84.20	3.20	**Sand:** Fine to medium dark gray, with little sticky clay.
84.20-108.60	24.40	**Sand:** Fine to medium, gray, micaceous with quartz and a few ferruginous material.
108.60-114.60	60.00	**Sand:** Fine to medium dark gray, with chips of shale.
114.60-142.10	27.50	**Sand:** Fine to medium, gray, micaceous.
142.10-151.20	9.10	**Sand:** Fine to medium gray, with chips of shale.
151.20-186.20	35.00	**Sand:** Fine to medium, gray, micaceous.
186.20-222.80	36.60	**Sandy clay:** Light yellow, sticky.
222.80-270.00	47.20	**Sand:** Fine to medium gray.

12. Lithological log of Exploratory well at 19 BSF camp Salbagan, Agartala (1979) West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
0.00-3.00	3.00	**Sandy loam:** Brown colour, fine grained with little clay.
3.00-13.10	10.10	**Sand:** Brown, fine grained with occasional medium grained sand and little mafic minerals.
13.10-19.20	6.10	**Sand:** Brown, fine to medium grained with occasional mafic minerals.
19.20-31.40	12.20	**Sandy clay:** Brown, fine grained sand with admixture of clay and mafic minerals.
31.40-83.30	51.90	**Sand:** Brown fine to medium grained with very little clay content.
83.30-89.40	6.10	**Sand:** Brown, medium grained with little clay and mafic minerals.
89.40-92.40	3.00	**Sandy clay:** Sand, fine grained with clay admixture and mafic minerals.
92.42-101.60	9.20	**Sand:** Gray fine grained with little clay admixture in the top portion, clay content decreases downward.
101.60-116.80	15.00	**Clayey sand:** Gray sticky with fine grained sand.
116.80-135.00	18.20	**Sand:** Gray, fine to medium grained with very little clay and mafic minerals.
135.00-142.20	7.20	**Clayey sand**: Gray sticky with fine grained sand, clay content increases in the middle.
142.20-166.60	24.40	**Sand:** Grayish fine grained with very little clay admixture and becomes medium grains toward downward portion.
166.60-172.70	6.10	**Clayey sand**: Grayish sticky with fine grained sand.
172.70-182.90	9.20	**Sand:** Gray, fine grained with mafics minerals.

182.90-184.90	3.00	**Clay sand:** Grayish sticky with fine grained sand.
184.90-203.20	18.30	**Sand:** Grayish fine to medium grained with very little clay content, clay portion decrees downwards.

13. Lithological log of Exploratory well at 19 BSF camp Salbagan, Agartala (2003) West Tripura District

Depth Range (mbgl)	Thickness (m)	Lithology
00.00-6.80	6.80	**Surface soil**: Reddish brown with lateritic fragments mixed with brownish sand.
6.80-12.95	6.15	**Shale**: Mixed with fine grained sandstone, brown.
12.95-34.55	21.60	**Sandstone:** Fine grained ferruginous with very little amount of reddish shale.
34.55-49.85	15.30	**Sandstone:** Very fine grained light yellowish in colour.
49.85-71.45	21.60	**Sandstone:** Fine grained grayish brown in colour.
71.45-77.60	6.15	**Sandstone:** Fine grained brownish in colour.
77.60-99.05	21.45	**Sandstone:** Fine grained creamish in colour.
99.05-105.20	6.15	**Sandstone**: Fine grained grayish brown in colour.
105.20-114.50	9.30	**Sand stone**: Fine grained mixed with grey shale.
114.50-142.10	27.60	**Sandstone:** Fine grained light brownish in colour.
142.10-148.25	6.15	**Sandstone**: Fine grained grayish in colour.
148.25-154.40	6.15	**Shale**: Grey in colour.
154.40-172.85	18.45	**Sandstone**: Fine grained grayish in colour.
172.85-185.15	12.30	**Sandstone: F**ine to medium grained grayish in colour.
185.15-200.75	15.60	**Sandstone: F**ine to medium grained mixed with silt stone.

14. Lithological log of Exploratory well at Fatikcherra BSF camp West Tripura District

Depth Range (m bgl)	Thickness (m)	Lithology
00.00-3.00	3.00	**Surface soil**: Gray.
3.00-6.80	3.80	**Clay stone**: Light gray.
6.80-16.10	9.30	**Clay stone:** Dark gray in colour.
16.10-25.25	9.15	**Clay stone**: Dark gray mixed with fine grained sandstone.
25.25-46.75	21.50	**Clay stone**: Dark gray in colour.
46.75-55.90	9.15	**Clay stone**: Mixed with fine grained sandstone.
55.90-83.80	27.90	**Sandstone:** Medium to fine grained mixed with clay stone.
83.80-92.95	9.15	**Sandstone**: Medium grained with little clay stone.
92.95-96.10	3.15	**Sand stone**: Coarse grained with feldspar and quartz particles.
96.10-105.25	9.15	**Sandstone:** Light brownish medium to fine grained with feldspathic particles.
105.25-114.55	9.3	**Sandstone**: Light brownish, medium to coarse grained with gray shale.
114.55-142.15	27.6	**Sandstone**: Light brownish fine to medium grained with quartz, feldspar and micaceous minerals.
142.15-169.75	27.6	**Sandstone**: Whitish, fine to medium grained with quartz and feldspar
169.75-200.50	30.75	**Sandstone:** Very fine grained with silt stone.

15. Lithological log of Exploratory well at Ashrambari, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
00-5.24	5.24	**Top soil**: Sandy loam, light brown, fine to medium grained with little admixture of clay and laterites.
5.24-10.43	5.19	**Sandy clay:** Yellowish brown clay with admixture of fine to medium grained sand.
10.43-13.43	3.00	**Sand clayey:** Yellowish brown, fine to medium grained sand with little admixture of brown clay and pieces.
13.43-16.45	3.02	**Clay sandy:** Grayish brown sand fine grained.
16.45-28.50	12.05	**Sand:** Pink mostly fine grained.
28.50-34.55	6.05	**Sand:** Grey fine to medium grained with micaceous minerals and sandstone pieces.
34.55-49.57	15.02	**Sand:** Brownish yellow, fine to medium grained sub-rounded.
49.57-52.62	3.02	**Sand:** Light grayish white, fine to medium grained sub-rounded with ferromagnesian minerals and grey clay.
52.62-55.362	3.00	**Gravelly sand:** Light brown fine to coarse sand with gravel (1mm-3mm) with sub angular quartz gravel and well rounded brown ferruginous sandstone gravel and few pieces of feldspar.
55.62-64.70	9.08	**Sand:** Light yellow, fine to medium grained sub-rounded.
64.70-67.70	3.00	**Sand:** Light brown, fine to medium grained sub-rounded.
67.70-73.74	6.04	**Sand clayey:** Dark grey light yellow fine to medium gained sand mostly sub-rounded along with little clay and coarse pieces of ferruginous minerals.
73.24-79.39	5.95	**Sand:** Light grayish yellow, fine to medium grained sub-rounded along with fragments of shale and decayed wood.
79.69-82.77	3.08	**Clay,** Mottled, plastic and sticky with admixture of fine grained sand.
82.77-85.77	3.00	**Sand:** Grey fine to medium grained with a little brownish clay.
85.77-106.65	18.88	**Clay sandy:** Mottle grey, plastic and sticky with admixture of fine-grained sand and broken pieces of ferruginous sandstone.
106.65-112.67	6.02	**Sand:** Light brownish grey, medium grained, sub-rounded with small pieces of weathered feldspar quartz grains and mafic minerals.
112.67-118.69	6.02	**Sand clayey:** Grey and yellowish brown medium grained sand with admixture of mottled clay.
118.69-124.73	6.04	**Sand:** Brown medium grained sub-rounded with weathered feldspar, quartz, mafic minerals and pieces of ferruginous sandstone.
124.73-148.73	8.99	**Sand:** Grey, medium grained with occasional coarse sand, sub-rounded with pieces of shale and ferruginous sandstone.
148.73-151.73	3.00	**Sand clayey:** Grey fine to medium grained with admixture of grey clay.
151.73-169.74	18.01	**Sand:** Grey and light yellowish brown, fine to medium

		grained sub-rounded with admixture of shale pieces, hard sandstone and little clay.
169.74-196.88	27.14	**Sand:** Grayish black fine to medium grained, sub-rounded with pieces of sandstone, decayed wood, peat and clay.
196.88-199.88	3.00	**Clay sandy:** Grayish and scanty violet colour clay, silty with rounded pieces of weathered ferruginous sandstone and little sand.
199.88-202.86	2.96	**Clay:** Dark grey, sticky with broken pieces of sandstone and quartz with occasional red colour clay.
202.86-232.85	29.99	**Sand clayey:** Grey grayish black and brownish yellow fine to medium grained, along with pieces of grey micaceous shale, ferruginous sandstone, quartz, decomposed feldspar, ferruginous sandstones.
232.85-232.76	5.91	**Sand:** Brownish yellow, mostly medium grained along with coarse pieces of quartz, weathered ferruginous sandstone, decomposed feldspar and biotite grains and a little variegated clay.
238.76-250.72	11.96	**Clay sandy:** Grayish brown and grey fine to medium grained sand with ferruginous sandstone, weathered feldspar, quartz clay plastic.
250.72-262.78	12.06	**Sand:** Light brown to grey, fine grained, sub-rounded, micaceous with pieces of quartz (angular grains) and little grey clay.
262.78-268.78	6.00	**Sand clayey:** Grey fine grained, micaceous with pieces of ferruginous sandstone and grey clay and weathered feldspar.
268.78-301.68	32.90	**Sand:** Light grey to grey, fine grained micaceous along with silt, ferruginous substances and decomposed feldspar and occasional white quartz pieces.

16. Lithological log of Observation well at Ashrambari, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
G.L-4.00	4.00	Sand, brown, fine grained.
4.00-16.95	12.95	Sand, brown, fine to medium grained with pieces of quartz, mica and mafic minerals..
16.95-26.95	9.10	Sand, White, fine to medium grained.
26.95-35.25	9.20	Clay, sandy brown sticky along with fine to medium grained sand.
35.25-38.025	3.00	Sand, brown fine grained with little clay.
38.25-45.35	6.10	Sand, brown to grayish brown, medium grained.
44.35-47.45	3.10	Sand, brown, fine grained.
47.45-59.65	12.20	Clay, sandy brown plastic along with fine to medium grained sand.
59.65-105.35	45.70	Clay, grayish brown plastic
105.35-108.45	3.10	Sand, grayish brown fine grained with little clay
108.45-114.55	6.10	Clay, brown plastic
108.45-114.55	12.20	Clay sandy, brown plastic along with fine to medium grained sand.
126.75-135.85	9.10	Sand, mottled (brownish) fine grained with little clay.
135.85-151.15	15.30	Clay, grey and sticky
151.15-154.15	3.00	Sand, grey fine to medium grained with little clay.
154.15-178.55	24.40	Clay, grey sticky with little admixture of fine-grained sand.

17. Lithological log of Exploratory well at Suryamaninagar (Tripura University Campus), Agartala, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
00.00-9.95	9.95	**Surface soil**: Brown, sandy
9.95-16.10	6.15	**Sandstone**: Fine grained, brown, with lateritic particles
16.10-22.25	6.15	**Sandstone**, Medium grained, brownish, with lateritic material; quartz and feldspar grains common.
22.25-34.55	12.30	**Sandstone**: Coarse grained, brown, with lateritic gravel and angular to sub-angular grains of quartz and feldspar.
34.55-43.70	9.15	**Sandstone**: Medium to coarse grained, lateritic particles, quartz and feldspar.
43.70-62.15	18.45	**Sandstone**: Medium grained, light brownish, with ironaceous compound, quartz, feldspar and little micaceous mineral.
62.15-65.30	3.15	**Sandstone**: Fine to medium grained, whitish, with quartz, feldspar and ironaceous material.
65.30-71.45	6.15	**Sandstone**: Fine grained with ironaceous particles.
71.45-74.45	3.00	**Sandstone**: Fine grained, whitish
74.45-96.05	21.60	**Sandstone**: Fine grained with shale grey
96.05-102.20	6.15	**Sandstone**, fine to medium grained, creamish in colour with quartz, feldspar and micaceous mineral.
102.20-108.35	6.15	**Sandstone**: Very fine grained.
108.35-114.50	6.15	**Sandstone**: Fine to medium grained with shale, grey
114.50-123.65	9.15	**Sandstone**: Fine to medium grained with particles of quartz and feldspar.
123.65-126.80	3.15	**Sandstone**: Fine to medium grained with shale, grey
126.80-135.95	9.15	**Sandstone**: Fine to medium grained with particles of quartz, feldspar and little micaceous mineral
135.95-154.40	18.45	**Sandstone**: Medium to fine grained with particles of quartz, feldspar and micaceous mineral.
154.40-176.00	21.60	**Sandstone**: Fine grained with shale, grey
176.00-179.00	3.00	**Sandstone**: Medium to fine grained with particles of quartz, feldspar and micaceous mineral
179.00-185.15	6.15	**Sandstone:** Fine grained creamish in colour with shale, grey
185.15-191.30	6.15	**Sandstone**: Fine to medium grained with quartz, feldspar ,little micaceous mineral and shale, grey
191.30 -200.60	9.30	**Sandstone:** Fine grained creamish with shale, grey

18. **Lithological log of Observation well at Suryamaninagar (Tripura University Campus). Agartala, West Tripura District**

Depth range (m bgl)	Thickness (m)	Lithology
00.00-6.80	6.80	**Surface soil**: Brown, sandy
6.80-12.95	6.15	**Sandstone**: Fine grained, brown
12.95-25.25	12.30	**Sandstone**: Medium grained, brownish, with lateritic material, quartz and feldspar grains.
22.25-37.55	15.30	**Sandstone**: Medium to coarse grained, brown, with lateritic material and angular to sub-angular grains of quartz and feldspar.
37.55-49.85	12.30	**Sandstone**: Coarse grained, brownish, with lateritic material, quartz and feldspar.
49.85-62.15	12.30	**Sandstone**: Medium to coarse grained, brownish, with quartz, feldspar and ironaceous material.
62.15-71.45	9.30	**Sandstone**: Fine to medium grained, whitish
71.45-77.60	6.15	**Sandstone**: Fine to medium grained.
77.60-100.00	22.40	**Sandstone**: Fine to medium grained, with shale grey

19. Lithological Log of Exploratory Well at Horticulture Research Centre Nagicherra, Agartala, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
00.00-6.80	6.80	**Surface soil**: Reddish
6.80-9.95	3.15	**Sandstone**: Fine to medium grained, brownish mixed with little clay, white. Abundant lateritic pieces present.
9.95-16.10	6.15	**Sandstone**: Fine to medium grained, brownish. Abundant lateritic pieces present.
16.10-19.10	3.00	**Sandstone**: Fine grained, brownish mixed with little clay, lateritic pieces present
19.10-22.25	3.15	**Sandstone**: Fine to medium grained, brownish
22.25-25.25	3.00	**Sandstone**: Fine grained, brownish mixed with little clay.
25.25-31.40	6.15	**Sandstone**: Fine to medium grained, brownish. Abundant lateritic pieces present.
31.40-34.55	3.15	**Shale,** grey mixed with sandstone, fine grained, brownish
34.55-43.70	9.15	**Sandstone**: Fine grained, brownish mixed with little clay.
43.70-56.00	12.30	**Sandstone**: Fine to medium grained, whitish.
56.00-59.15	3.15	**Sandstone**: Fine to medium grained, whitish mixed with little clay
59.15-62.15	3.00	**Sandstone**: Fine grained whitish.
62.15-65.30	3.15	**Sandstone**: Fine grained, whitish mixed with little shale, grey
65.30-68.30	3.00	**Shale:** Grey mixed with sandstone, fine grained, whitish
68.30-71.45	3.15	**Sandstone**: Fine grained, whitish mixed with little gray shale. Pieces of iron bearing minerals are present.
74.45-92.90	18.45	**Sandstone**: Fine to medium grained, whitish mixed with shale, grey. Pieces of iron bearing minerals are present.
92.90-96.05	3.15	**Sandstone**: Fine grained, light brownish. Pieces of iron bearing minerals are present.
96.05-111.35	15.30	**Sandstone**: Fine grained, light brownish mixed with shale, grey. Pieces of iron bearing minerals are present.
111.35-139.10	27.75	**Sandstone**: Fine grained, light brownish.
139.10-142.10	3.00	**Sandstone**: Fine to medium grained, light brownish. Pieces of iron bearing minerals are present.
142.10-160.55	18.45	**Sandstone**: Fine grained, light brownish mixed with little shale, grey. Pieces of iron bearing minerals are present.
160.55-179.00	18.45	**Sandstone**: Fine to medium grained, light brownish. Pieces of iron bearing minerals are present.
179.00-185.15	6.15	**Shale:** Grey mixed with sandstone, fine grained, light brownish.
185.15-197.45	12.30	**Sandstone**: Fine grained, light brownish mixed with shale.

20. Lithological Log of Observation Well at Horticulture Research Centre Nagicherra, Agartala, West Tripura District.

Depth Range (m bgl)	Thickness (m)	Description
0.00-6.80	6.80	**Surface soil:** Reddish
6.80-37.55	30.75	**Sandstone:** Fine to medium grained, brownish with lateritic pieces
37.55-52.85	15.30	**Sandstone:** Fine grained, light brownish
52.85-68.30	15.45	Sandstone: Fine grained, brownish mixed with shale, grey
68.30-117.30	49.00	**Sandstone:** Fine grained, light brownish
117.30-129.80	12.50	**Sandstone:** Fine to medium grained, light brownish
129.80-135.95	6.15	**Shale:** Grey sandstone, fine grained, brownish
135.95-139.10	3.15	**Sandstone:** Fine grained, brownish mixed with shale, grey
139.10-142.10	3.00	**Sandstone:** Fine grained, brownish
142.10-148.25	6.15	**Sandstone:** Fine grained, brownish mixed with shale, grey
148.25-157.55	9.30	**Sandstone:** Fine to medium grained, light brownish
157.55-166.70	9.15	**Sandstone:** Fine grained, brownish
166.70-169.85	3.15	**Sandstone:** Fine to medium grained, brownish
169.85-179.00	9.15	**Sandstone:** Fine grained, brownish mixed with little shale,
179.00-200.45	21.85	**Sandstone:** Fine grained, grayish

21. Lithological Log of Exploratory Well at Badharghat, Agartala, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
00.00-9.95	9.95	**Sandstone:** Medium to coarse grained, light brownish
9.95-16.10	6.15	**Shale**, grey
16.10-22.25	6.15	**Sandstone**: Medium grained, mixed with shale brownish.
22.25-37.55	15.30	**Sandstone**: Fine grained, brownish
37.55-43.70	6.15	**Sandstone**: Very fine grained, brownish
43.70-49.85	6.15	**Sandstone**: Fine to medium grained, grayish
49.85-74.45	24.60	**Sandstone**: Fine to medium grained, mixed with shale
74.45-77.60	3.15	**Sandstone**: Coarse grained with quartz, feldspar and mica
77.60-111.35	33.75	**Sandstone**: Fine grained, mixed with shale, grey
111.35-123.65	12.30	**Sandstone**: Medium to fine grained, whitish with grey shale
123.65-129.80	6.15	**Shale**: Grey
129.80-142.10	12.30	**Sandstone**: Fine to medium grained, whitish with shale, grey.
142.10-154.40	12.30	**Sandstone**: Medium to fine grained, whitish.
154.40-157.55	3.15	**Sandstone**: Fine to medium grained with shale, grey.
157.45 -166.70	9.25	**Sandstone**: Medium to fine grained, whitish.
166.70-172.85	6.15	**Sandstone:** Fine to medium grained, creamish with shale, grey.
172.85-179.00	6.15	**Sandstone:** Fine grained, creamish, with shale, grey.
179.00-182.15	3.15	**Sandstone:** Fine to medium grained, creamish with shale, grey.
182.15-188.30	6.15	**Sandstone:** Medium to fine grained, creamish.
188.30-194.45	6.15	**Sandstone:** Fine to medium grained, creamish with shale, grey.
194.45-200.60	6.15	**Sandstone:** Fine grained, creamish.

22. Lithological Log of Observation Well at Badharghat, Agartala West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
00.00-6.80	6.80	**Sandstone**: Medium to coarse grained, brown.
6.80-12.95	6.15	**Shale**, brown.
12.95-25.25	12.30	**Sandstone**: Medium grained, brownish, mixed with shale.
22.25-37.55	15.30	**Sandstone**: Fine to medium grained, brown, with lateritic material.
37.55-49.85	12.30	**Sandstone**: Fine grained, brownish.
49.85-71.45	21.60	**Sandstone**: Fine to medium grained, grayish, mixed with shale.
71.45-77.60	6.15	**Sandstone**: Coarse grained, whitish.
77.60-92.90	15.30	**Sandstone**: Fine grained mixed with shale.

23. Lithological log Exploratory Well at Bodhjungnagar (Industrial Growth Center premise) Agartala, West Tripura District.

Depth range (m bgl)	Thickness (m)	Lithology
00.00-6.80	6.80	**Surface soil**: Clay mixed with fine sand, reddish
6.80-12.95	6.15	**Sandstone**: Medium to fine grained, reddish brown, angular grains of quartz, feldspar and ironaceous material
12.95-22.10	9.15	**Shale:** Grayish brown
22.10-31.40	9.30	**Sandstone**: Medium to fine grained, brown, angular grains of quartz, feldspar and ironaceous material mixed with shale and lateritic material
31.40-43.70	12.30	**Sandstone**: Fine to medium grained, brownish
43.70-56.00	12.30	**Sandstone**: Fine to medium grained, brownish mixed with shale, grey
56.00-74.45	18.45	**Sandstone**: Fine to medium grained, brownish
74.45-86.75	12.30	**Sandstone**: Fine to medium grained, brownish, with lateritic material
86.75-105.20	18.45	**Sandstone**: Fine to medium grained, brownish
105.20-120.50	15.30	**Shale:** Grayish brown
120.50-123.65	3.15	**Sandstone**: Fine to medium grained, brownish mixed with shale, grey
123.65-126.65	3.00	**Sandstone**: Fine to medium grained, brownish
126.65-132.80	6.15	**Sandstone**: Fine to medium grained, brownish mixed with shale, grey
132.80-154.40	21.60	**Sandstone**: Fine grained, brownish
154.40-182.00	27.60	**Sandstone**: Fine to medium grained, light grey
182.00-200.45	18.45	**Sandstone**: Fine to medium grained, light grey mixed with shale, grey

24. Lithological log of Exploratory Well at Lichubagan, Agartala West Tripura District.

Depth Range (m bgl)	Thickness (m)	Lithology
00.00-6.80	6.80	**Surface soil:** Brown, sandy
6.80-12.95	6.15	**Sandstone:** Medium to coarse grained, brownish
12.95-43.70	30.75	**Sandstone:** Medium to fine grained, brownish
43.70-56.00	12.30	**Sandstone:** Fine grained, brownish
56.00-62.15	6.15	**Sandstone:** Medium to fine grained, brownish
62.15-65.30	3.15	**Sandstone:** Very fine grained, brownish,
65.30-92.90	27.6	**Sandstone:** Medium to fine grained, brownish
92.90-99.05	6.15	**Sandstone:** Medium to fine grained, mixed with little shale
99.05-105.20	6.15	**Sandstone:** Medium to fine grained, brownish
105.20-123.65	18.45	**Sandstone:** Medium to coarse grained, creamish
123.65-129.80	6.15	**Sandstone:** Medium to fine grained, mixed with shale
129.80-151.40	21.6	**Sandstone:** Medium to fine grained, grayish
151.40-157.55	6.15	**Sandstone:** Medium to fine grained, mixed with shale
157.55-182.15	24.60	**Sandstone:** Medium to fine grained, grayish
182.15-185.15	12.30	**Sandstone:** Fine grained, mixed with shale
185.15-197.45	12.30	**Sandstone:** Medium to fine grained, mixed with shale

25. Lithological log of Exploratory Well at Narsingarh, Agartala West Tripura District.

Depth Range (m)	Thickness (m)	Lithology
00.00-6.80	6.80	**Surface soil**: Reddish
6.80-28.40	21.60	**Clay:** Brownish
28.40-49.85	21.45	**Shale:** Gray
49.85-59.15	9.30	**Shale:** Gray, mixed with sandstone, fine grained
59.15-71.45	12.30	**Sandstone**: Fine grained, brownish mixed with shale, pieces of quartz and feldspar present
71.45-80.60	9.15	**Sandstone**: Fine grained, whitish, mixed with shale, gray
80.60-108.35	27.75	**Sandstone**: Fine to medium grained, grayish.
108.35-111.35	3.00	**Sandstone**: Fine grained, whitish, mixed with shale, gray
111.35-117.50	6.15	**Sandstone**: Fine to medium grained, grayish
117.50-139.10	21.60	**Sandstone**: Fine grained, grayish, mixed with shale, gray
139.10-142.10	3.00	**Shale:** Mixed with sandstone, fine grained, grayish
142.10-145.25	3.15	**Sandstone**: Medium to fine grained, grayish.
145.25-151.40	6.15	**Sandstone**: Fine grained, grayish
151.40-154.40	3.00	**Sandstone**: Fine grained, grayish mixed with shale, grey
154.40-169.85	15.45	**Sandstone**: Fine to medium grained, grayish.
169.85-179.00	9.15	**Sandstone**: Fine grained, grayish mixed with shale, grey
179.00-185.30	6.30	**Sandstone**: Fine grained, grayish
185.30-200.55	16.25	**Shale:** Mixed with sandstone, fine grained, grayish

26. Lithological log of Exploratory well at Balucherra, West Tripura District

Depth range (m bgl)	Thickness (m)	Lithology
00-6.35	6.35	**Top soil**: Sandy clay, brownish gray with mafic minerals.
6.35-19.15	12.80	**Sandy clay:** Yellowish brown clay with admixture of fine to medium grained sand.
19.15-28.41	9.26	**Sandstone:** Brownish yellow, coarse grained sub rounded with quartz and laterite pieces.
28.41-31.41	3.00	**Shale:** Greenish gray with coarse grained sandstone and mafic minerals.
31.41-36.54	5.13	**Sandstone:** Brownish gray, fine to course grained, subrounded with mafic minerals.
36.54-42.62	11.08	**Shale:** Greenish mixed with fine grained sandstone.
42.62-52.50	9.88	**Sandstone:** Grayish, fine to medium grained sub-rounded with mafic minerals.
52.50-55.50	3.00	**Shale:** Grayish with sandstone.
55.50-79.43	23.93	**Sandstone:** Gray, fine to medium grained sub-rounded to rounded.
79.43-88.54	9.11	**Sandstone:** Fine to medium grained, sub-rounded, micaceous with shale.
88.54-142.84	54.30	**Sandstone:** Grey, medium gained, sub-rounded with gray shale and mafic minerals.
142.84-151.86	9.02	**Sandstone:** Mixed with claystone, medium grained greenish gray shale.
151.86-157.78	5.92	**Shale:** Mixed with sandstone, sticky, greyish.
157.78-160.68	2.90	**Sandstone:** Grey, fine to medium grained subrounded, with mafic minerals and little shale.
160.68-166.69	6.01	**Sandstone:** Grayish, medium grained mixed with shale.
166.69-175.71	9.02	**Shale:** Mixed with sandstone, greyish.
175.71-181.61	5.90	**Shale:** Mixed with sandstone fine to medium grained, grayish.
181.61-202.74	21.13	**Shale:** With sandstone, brownish gray and sticky.
202.74-217.72	14.98	**Sandstone:** Grey, medium grained, sub rounded to rounded with mafic minerals and brown shale.
217.72-226.76	9.04	**Shale:** Gray, mixed with sand.
226.76-229.76	3.00	Sandstone: Medium grained, grey, with little sticky clay.
229.76-262.88	33.12	**Sandstone:** Grey, medium grained, sub rounded with greenish brown shale.
262.88-265.88	3.00	Shaly sandstone: Grey, sticky with fine to medium grained sandstone.
265.88-271.97	6.09	Shale: Grey, sticky with a little amount of fine to medium grained sandstone.
271.97-277.99	6.02	**Shale:** Grey, sticky with fine to medium grained sandstone.
277.99-280.03	2.04	**Sandstone: L**ight yellowish brown, fine grained with laterite and shale.
280.03-302.14	22.11	**Shale:** Light yellowish brown, sticky with fine grained sandstone.