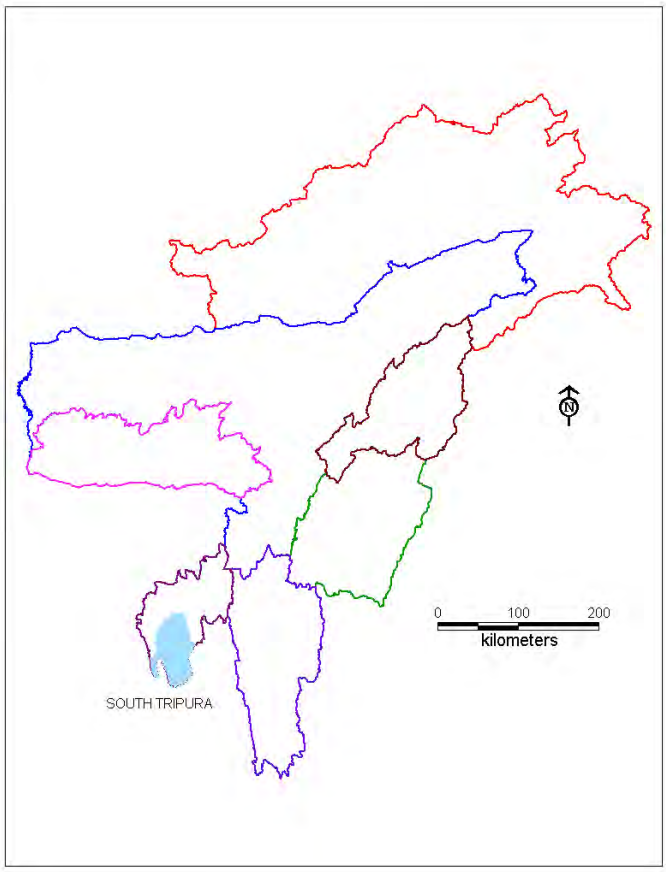
Technical Report Series: D

No: 55/2011-12

Ground Water Information Booklet
South Tripura District, Tripura



Central Ground Water Board

North Eastern Region

Ministry of Water Resources

Guwahati

March 2012

AT A GLANCE
South Tripura District, Tripura

SL. NO.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical Area (sq. km)	3074.78
	ii) Administrative Divisions (as on31.3.2008) No. of Blocks No. of Panchayats No of ADC villages	 11 153 167
	iii) Population (as per 2001 census)	7,67,440
	iv) Average Annual Rainfall (mm)	2055
2.	**GEOMORPHOLOGY**	
	Major Physiographic units	Hills-Baramura and Atharamura Valleys-Udaipur and Belonia
	Major Drainages	Gomti, Muhuri and Fenny
3.	**LAND USE (SQ. KM)(2007-08)**	
	a) Forest Area	2065.75 (67.18%)
	b) Net area sown	777.28 (25.27%)
	c) Cultivable area	1443.07
4.	**MAJOR SOIL TYPES**	Transported soil, residual soil and lateritic soil.
5.	**AREA UNDER PRINCIPAL CROPS (Ha) (2006-07)**	Rice 81457 ha Potato 2438 ha Total pulses 2188 ha Total oil seeds 1093 ha
6.	**Irrigation by Different Sources(2006-07) (Areas and Numbers of Structures)**	
	Dug wells	Nil
	Tubewells / borewells	850 ha
	Tanks / ponds	Nil
	Canals	Nil
	Other sources	Lift irrigation: 15704 ha /50 nos Diversion 921 ha/18 nos Medium irrigation 2886 ha
	Net Irrigated Area	18,325 ha
	Gross Irrigated Area	31,702 ha
7.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.03.08)**	
	No. of Dug wells	7
	No. of Piezometers	0
8.	**PREDOMINANT GEOLOGICAL FORMATION**	Recent formation of Quaternary age and Dupitila, Tipam and Surma formations of Upper Tertiary age.

9.	**HYDROGEOLOGY**	
	Major water bearing formation	Tipam sandstone
	Pre-monsoon depth to water level during 2008	1.42 – 5.82 m bgl
	Post-monsoon depth to water level during 2008	0.90 – 5.10 m bgl
	Long term trend for 10yrs (1999-2008) in m/ yr Pre-monsoon Rise- 3 stations Fall- 1 stations Post-monsoon Rise- 4 stations Fall- 4 stations	 **0.173 - 0.205** **0.0.011** **0.035 - 0.081** **0.059 - 0.205**
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31.03.08)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW = 16 nos. OW = 3 nos. PZ = 2 nos. Total = 21 nos.
	Depth Range (m)	197 – 215
	Discharge (lps)	3.33 to 44
	Storativity (S)	2.4×10^{-3} to 2.25×10^{-5}
	Transmissivity (m^2/ day)	47.4 to 1577
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limit (e.g., EC, F, As, Fe)	Iron up to 3.66 ppm (in deeper aquifer)
	Type of water	
12.	**DYNAMIC GROUND WATER RESOURCES (2004) in mcm**	
	Annual Replenishable Ground Water Resources	587.5
	Net Ground water Draft	41.86
	Projected demand for domestic and industrial uses up to year 2025	38.68
	Stage of ground water development	7.13 %
13.	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness programme organized	Nil
	Water Management Training Programme organized	Nil
14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Projects completed by CGWB (no. & amount spent)	Nil
	Projects under technical guidance of CGWB (nos.)	Nil
15.	**GROUND WATER CONTROL AND REGULATION**	
	No. of OE blocks	Nil
	No. of Critical blocks	Nil
	No. of blocks notified	Nil
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Ground water contains high iron concentration. In shallow aquifer conc. of iron varies from 0.08 to 0.65 ppm and in deeper aquifer it varies from 0.5 to 3.66 ppm.

1.0 INTRODUCTION

South Tripura district is situated between North Latitudes 22º58′00″ and 23º45′00″ and East Longitude 91º15′30″ and 91º58′30″ falling in the Survey of India degree sheet number **79M**. It is bounded by Bangladesh on south, east and west sides, by west Tripura district on north and northwestern sides and by Dhalai district on northeast side. The total geographical area of the district is **3074.78 sq.km**. Udaipur is the ditrict head quarters. Administratively, the district is divided into 4 nos. of sub–divisions which are in turn sub-divided into 11 nos. of blocks. There are **153 gram panchayats** and **167**Autonomous District Council (ADC) villages in the district.

Forests cover **2065.75 sq.km (67.18%)** of the total district. Land not available for agricultural use is **221.50sq.km** (**7.20%).** The net area sown is **77728 ha** which is only **25.27%** of the total geographical area.

As per 2001 census, the total population of the district is 767,440 persons with a density of 250 persons/ sq.km. The decadal growth rate is 6.78 (1991-2001).

Drainage

The anticlinal hill ranges forms the watersheds from which various drainage channels emerged. The district is drained by many perennial rivers. The major rivers are Gomti, Muhuri, Fenny etc (fig.1). These perennial rivers are a part of Gomti sub-basin which in turn forms a part of Meghna basin. The common drainage patterns are sub-parallel to parallel and dendritic. Up to 4^{th} order streams are found in the area.

Irrigation

There is no major irrigation project in the district. However there are two medium irrigation projects in the district namely 1.Gomati irrigation project and 2. Muhari irrigation project. The gross command area under the two projects is 5220 and 2600 ha respectively.

The total irrigation potential created so far (2006-07) is **20361 ha** only i.e., only about **26%** of the net sown area. Agriculture is mostly dependent on minor irrigation schemes apart from rainfall. The minor irrigation schemes found in the area are (1) lift irrigation schemes on perennial rivers and cherras, (2) diversions (3) weir (4) tanks, (5) deep tubewells (6) shallow tubewells and (7) artesian wells.

The major crops grown in the area are rice, pulses, oilseeds, potato and other crops. Cropping pattern in the area is paddy oriented. During the year 2006-07, rice is a major crop grown with **28,813 ha**. During Kharif season farmers cultivate Aman paddy, the main crop of the district. This crop rarely requires any irrigation due to abundant rainfall during the period.

Total irrigation potential created is **20361 ha.** The surface water schemes constitute **19511 ha (96%)** and the ground water irrigates only **850 ha** (**4%)** of the total irrigation potential created. This shows that the ground water utilization is in the primitive stage in the district.

Studies / Activities carried out by CGWB

The earlier work on the hydrogeological conditions of Tripura state was carried out by the officers of the Ground Water Division of Geological Survey of India and later by the officers of the Central Ground Water Board. Systematic hydrogeological investigations carried out in the district during 1972–75. Then the district is covered by Re-appraisal hydrogeological investigations. Under ground water exploration sixteen exploratory and three observation wells and piezometers constructed by the Board. During 2004–05, ground water management studies in the entire district except Dumburnagar block was carried out.

2.0 RAINFALL AND CLIMATE

Rainfall

The district is having 4 nos. of rain gauge stations located at Udaipur, Belonia, Amarpur and Sabroom. The **average annual rainfall** for last 35 years (1971 – 2008) of the area is **2055** mm. The average monsoon rainfall for lat 10 years is 1710 mm. The average nos. of rainy days for last 5 years is 95. Maximum rainfall of 5900 mm (1993) recorded at Sabroom and minimum rainfall of 1352 mm (1994) recorded at Udaipur. The co-efficient of variation of rainfall in the area ranges from 6 – 32% suggested a low variability of annual rainfall.

Climate

The climate in the area is characterized by moderate temperature and is highly humid in nature. There are three prominent seasons summer, rainy and winter. The summer season spans from March to May and is followed by SW monsoon lasting till September. Winter season starts from November and lasts till the end of February.

Other Climatic features

The temperature in the area varies from 5.1^{o}C to 35.6^{o}C. The humidity is generally high throughout the year. In summer season the relative humidity varies between 50 to 90 percent and in rainy season, the relative humidity is over 85 percent in morning and in evening it varies between 70 to 80 percent.

3.0 GEOMORPHOLOGY AND SOIL TYPES

Geomorphology

Physiographically, the area can be divided into two parts, Anticlinal Hill Ranges and Synclinal flat-bottomed valleys. The major hill ranges are Baramura and Atharamura. The trend of the hill ranges is almost N – S. The height of the hill ranges increases from west to east. The broad synclinal valleys are Udaipur and Amarpur. The valleys are gently undulating with intermittent flood plains of rivers and streams. The undulations formed by 10 to 30 m high mounds with gullies in between them, locally called “loonga.”

Soils

In general, soils of the area are acidic in nature. The pH of soil ranges from 5.50 to 5.68. Nitrogen and phosphate is low, available potash is medium to high, calcium, magnesium and sulfur are deficient in these soils. In the area lateritic soil is found in tilla (hilly / small mounds) area, younger soils or river valley soils are found along all major river courses, clayey soils are found in paddy fields. Apart from these, sandy loam, clayey loam and loamy soils are also available.

4.0 HYDROGEOLOGY

Water Bearing Formations

There are three hydrogeological units / water bearing formations identified in the district are Alluvial formation, Dupitila formation and Tipam formation and are shown in fig.1. The details of the water bearing formations are as follows:

Alluvial formation: It occurs along the banks of main rivers and its thickness varies from 10 to 15 m. Ground water occurs under unconfined condition. Ground water development in the area has not been very significant because of high clay and sandy clay content. Ground water is developed through dug wells and ordinary hand pumps.

Dupitila formation: Dupitila formation is nearly horizontal in disposition and its thickness varies from 10 to 30m. The formation consists of mainly clay and silt with some intercalations of gritty and ferruginous sandstones. It is exposed in the central portion of Udaipur valley. In general, it has low permeability and low storage capacity due to high clay content. It has been developed through dug wells and hand pumps.

Tipam formation: This formation consists of sub-rounded, fine to medium grained, friable sandstone with intercalated clay. Tipam formation is found in the majority of the valley portion. Sandstone of Tipam formation constitutes the principal aquifer in the area. The permeability of this sandstone is much higher than that of Dupitila sandstone or Surma sandstone. The recharge area of the sandstone is in the anticlinal hills. Ground water occurs under semi-confined to confined conditions. This sandstone is developed by deep tubewells and shallow tubewells.

Occurrences of ground water

In shallow aquifer ground water occurs under unconfined and semi-confined to confined conditions. In major part of the area ground water occurs under unconfined condition in shallow depth. Ground water occurs under confined condition within shallow depths in small isolated zones, e.g., in central and eastern part of Matabari block, in central part of Kakraban block, in northern part (Rajapur – Kanchannagar area) of Bagafa block, in Srirampur area of Rajnagar block, in the southern part (Jalefa – Harina area) of Satchand block. In deeper aquifers ground water occurs under semi-confined to confined conditions. Ground water occurs under artesian condition in Tulamura, Dhuptali, Rajnagar, Muhuripur, Charakbai, East Pipariakhola, Fulkumari and Satchand area.

Nature and depth of Aquifer systems in the area

Aquifer system of the area is divided into two types, viz, shallow aquifer within 50 m bgl and deep aquifer between 50 to 300 m bgl.

Udaipur – Subroom valley:

This valley is a southern extension of Agartala valley. This valley is dominated by thick sandstone horizons with thin intervening shale / clay horizons particularly in the northern and southern part. In the central part around Baikhora and Satchand the sandstone is quite thick and forms almost a single aquifer system. In Rajapur – Tulamura – Udaipur area four aquifers can be identified. The first granular zone is encountered in the depth range of 25 to 56 m bgl. The thickness of the zone varies from 14 to 25 m. The second granular zone occurs between 60 – 140 m bgl. In Subroom – Manubazar area 60 – 90 m thick granular zone occur between 35 – 135 m bgl and second granular zone encountered at a depth of 150 – 195 m bgl. In the southern part of Belonia and eastern part of Manu Bhanga hill range (around Srinagar area) the sediment is more argillaceous.

Amarpur valley:

In Amarpur valley, the disposition of sandstone horizons is more or less uniform in Amarpur – Ompinagar area where four prominent zones are discernible. The first aquifer occurring below 30 to 40 m having clay / shale bed is hardly 6 – 10 m thick. The second horizon is encountered at depth of 40 – 150 m is almost 30 – 40 m thick. Below 160 to 180 m depth the sediment is predominantly clayey down to the depth of 250m or more.

Depth to water level and seasonal fluctuation

The Board is monitoring water levels of observation wells four times in a year i.e., during January, March, August and November. There are seven observation wells in the district which are located at Manurmukh, Dhawajnagar-udaipur, Gaptalli, Gorjee bazaar, Hryshamukh, Santirbazar and Sabroom. During pre-monsoon period (March 2008), depth to water level in unconfined aquifer varies from 1.42 – 5.82 m bgl. During post-monsoon period (November 2008), depth to water level in unconfined aquifer varies from 0.90 – 5.10 mbgl. The seasonal fluctuation of water level (2008) varies between 0.20 to 1.04 m.

Long term Trend of Water Level

The Board is generating water level data over the years through monitoring of network stations. There are 7 nos. network stations in the district. The data generated was utilised for long-term trend of water levels

During pre-monsoon season, the trend of water level for the last decade (1999 – 2008) shows a **rise** of water level in 3 stations ranging from **0.173 to 0.205 m/yr** and **fall** of water level in 1 station in order of **0.011 m/yr.**

During post-monsoon season, the trend of water level for the last decade (1997 – 2008) shows a **rise** in 4 stations with **0.035 to 0.081 m/yr** and **fall** in 4 stations with **0.059 to 0.205 m/yr.**

Aquifer parameters of confined / deeper aquifers

Under GW Exploration programme CGWB has constructed 16 nos. of deep tubewells down to a depth of 215 mbgl tapping Tipam sandstone in the district, to determine the aquifer characteristics of the deeper aquifer.

In Udaipur – Sabroom valley, 11 Exploratory wells constructed in the depth range of 132 to 215 m. The discharge of the wells varies from 12 to151 m^3/hr (3 to 42 lps) and the drawdown varies from 5 to 25 m. The transmissivity of the wells varies from 47 to 1577 m^2/day, permeability varies from 1 to 28 m/day and storativity varies from $2.4x10^{-3}$ to $2.25x10^{-5}$.

Exploratory wells constructed at Tulamura, Dhuptali, Rajnagar and Satchand are found to be in flowing / artesian condition. The piezometric head measured varied from 0.18 to 2 magl .

In Amarpur valley, 5 Exploratory wells constructed in the depth ranges from 60 to 181 m. The discharge of the wells varies from 12 to 158 m^3/hr and the drawdown varies from 8 to25 m. The transmissivity of the wells varies from 325 to 794 m^2/day, and the permeability varies from 7 to 11 m/day. The hydrogeological details of exploratory wells constructed is given in Table-1.

Springs / seepage zones

Springs / seepage zones are available in the area. Traditionally tribal people living in the hilly areas are using spring water for drinking and domestic purposes. In the foothill areas people used to arrest the spring water by constructing seasonal / permanent bund on small streamlets / cherras and used this water for irrigation purpose and sometimes used for drinking and domestic purposes also. In Ishanchandranagar and Chittamara gram Panchayats, Rajnagar block, Jowalikhamar, Matabari block springs are available. In Satchand and Rupaichari blocks there are many such small seepage zones are present.

Artesian zones

Artesian zones occur in the district and are depicted in fig.5. These wells are mainly used for irrigation purposes but some of the wells are even used for drinking and domestic purposes. Artesian zones are found in Satchand, Bagafa Rajnagar, Matabari, Kakraban, Killa and Hrishyamukh blocks. The artesian zones found are discontinuous and are localized phenomenon. It is reported that the wells are constructed within a depth range of 6 to 171 mbgl. Discharge of the wells varies from 0.03 to 2 lps during pre-monsoon period and from 0.1 to 2.5 lps during post-monsoon period.

5.0 GROUND WATER RESOURCES

Ground water resources for year 2004-05 were estimated by the GEC'97 methodology. During resource estimation, the smallest administrative unit i.e., Block is taken as the unit of computation. The main source of ground water recharge in the district is precipitation. Other sources of ground water recharge in the area are return flow from irrigation and seepage from ponds / tanks.

Recharge from rainfall in the area accounts for 90% of the total annual recharge. Comparison of monsoon and non-monsoon rainfall recharge shows that monsoon recharge accounts for 57% and non-monsoon recharge accounts for 43% of total rainfall recharge.

Ground water in the area is mostly used for domestic and irrigational purposes. Ground water draft for industrial purpose is negligible and has not been considered. Net ground water available in the district is 587.5 mcm and ground water draft for all uses is 41.86 mcm. Ground water draft for irrigation and drinking purposes accounts for 57% and 43% of total ground water draft respectively.

Block-wise net ground water availability, ground water draft, stage of development and balance ground water available for future irrigation purposes are shown table – 2. It is found that Bagafa block is having the highest available ground water while Karbuk block is having the lowest. In Bagafa block utilization of ground water is maximum i.e., 1399ham. **All the 10 blocks of the district falls under SAFE category.** Bagafa block has the highest stage of development i.e. 14.47% and Killa hill block has the lowest stage of development i.e., 1.54%. Block-wise net ground water availability, ground water draft and balance ground water available for future irrigation purposes are shown in fig.4.

Table – 2: Ground Water Resources of South Tripura district as on 31st March 2004 (in ha m)

Sl. No.	Block / District	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for All Uses	Allocation for domestic and industrial requirement upto next 25 years	Net Annual GW Availability for future irrigation development	Stage of ground water develop-ment (%)
1	Satchand	7565.66	282.32	424.49	7042.17	3.73
2	Rupaichari	4833.07	281.22	199.83	4579.24	5.82
3	Hrishyamukh	3657.03	135.52	323.82	3303.21	3.71
4	Rajnagar	7713.33	336.68	421.31	7172.02	4.36
5	Bokafa	9670.38	1399.39	614.66	7921.72	14.47
6	Matabari	8032.32	1081.24	741.65	6528.67	13.46
7	Kakraban	3245.73	198.60	334.88	2715.85	6.12
8	Killa	4414.39	68.16	157.89	4256.50	1.54
9	Karbook	2288.25	86.05	199.19	2089.06	3.76
10	Amarpur	7333.10	317.09	449.96	6760.14	4.32
Total		**58753.25**	**4186.27**	**3867.68**	**52368.57**	**7.13**

*** Data of Ompi block is clubbed with Amarpur block**

6.0 GROUND WATER QUALITY

The analytical results show that there is no considerable difference between quality of water from shallow and deeper aquifers.

Suitability of Ground Water for Drinking and 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 (1991), except iron. In phreatic aquifer p^H values of the ground water ranges from 6.94 to 7.01 and EC values ranges from 75 to 447. Fluoride content in ground water from phreatic aquifer ranges from BDL to 0.44 ppm. The content of iron in ground water from phreatic aquifer ranges from 0.08 to 0.65 ppm and in deeper aquifer it ranges from 0.50 to 3.66 ppm.

Suitability of Ground Water for Irrigation Use:

In general, ground water in the area is suitable for irrigation purpose, except concentration of iron is higher than permissible limit.

7.0 STATUS OF GROUND WATER DEVELOPMENT

Ground water is being developed mostly by construction of deep tube wells, shallow tube wells and RCC wells etc. for drinking, domestic and irrigation purposes. These structures are fitted with suitable pumps, Mark II/III or with ordinary hand pumps for withdrawing ground water. In addition to that, there are more 2000 shallow tube wells which are auto flow in nature drawing ground water in the districts.

Drinking water scenario

In urban areas water supply is done mainly from surface water sources, except in Amarpur. But in rural areas, deep tube wells and shallow tube wells fitted with suitable pumps provide drinking water to villagers.Water is being supplied directly from deep tubewells without any treatment and certain places water is supplied after iron removal where ever the iron concentration is beyond permissible limit

There are 309 deep tube wells, 38 shallow tube wells 1709 RCC wells in the district. In addition there are 2 surface water treatment plants in the district.

As on 31-03-2008, out of 2406 habitations, 971 are fully covered, 718 are partially covered and 717 are uncovered so for. The Block-wise no of existing sources and coverage is given in Table-3.

Irrigation scenario

Ground water is being developed for irrigation purposes through deep tubewells, shallow tubewells fitted with pump sets (both electric and diesel pumps) and artesian wells. The use of dug wells for irrigation purpose is negligible. In Bagafa, Satchand Matabari, Kakraban, Killa and

Rajnagar blocks some paddy fields are irrigated through artesian wells. The maximum use of ground water for irrigation purposes is in Bagafa block while in Karbook block the use of ground water for irrigation is nil.

There are 42 nos. deep tube wells, 660 shallow tube wells and 2138 artesian wells in the district for irrigation. The Block-wise number of sources as on 31-03-2008 is shown in Table 4.

8.0 GROUND WATER MANAGEMENT STRATEGY

Based on hydrogeological situation and yield - drawdown relation, the district has been divided into three sectors 'A', 'B' and 'C '. Sector 'A' coincides with the central parts of the valleys, where large yielding tubewells for moderate drawdowns are considered feasible, while sector 'B' forms the foothill areas where small yielding tubewells at high drawdown are considered feasible. Lastly, sector 'C' coincides with the hills of the district which are generally not suitable for tubewells except some intermontane valleys where some very small capacity tubewells may be constructed. Ground water development prospects of shallow tubewells and deep tubewells are depicted in fig 6 and7 respectively.

Shallow tubewells of small yield up to 50m depth can be constructed through 150/100mm diameter well assembly tapping 20 – 30m granular zones having 25m housing and 10m 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 tubewells in sector 'A' is expected to be 15–20m^3/hr at 5–10m drawdown and in sector 'B' the yield of such tubewells is expected to be 10–15m^3/hr at drawdown 5–10m.

Deep tubewells of large yield potentiality down to the depth of 300m can be constructed through 250/150mm diameter assembly tapping 30–50m granular zones with 45–50m housing length in sector 'A' and with 50–55m housing length in sector 'B'. The annular space between the borehole and the well assembly should be shrouded preferably with 100–120mm thick zone of pea gravels.

The nature of the aquifer materials shows that gravel packing is required for construction of good tubewells. The slot size is required to be in between 0.50 – 1.00mm and size of gravel between 2 – 4mm. Gravels for shrouding should be composed of quartz and should be sub-rounded to sub-angular.

9.0 WATER CONSERVATION AND ARTIFICIAL RECHARGE

In the area, the scope for artificial recharge is minimal because water level in the major part of the district lies between 2 – 5 mbgl. As the area receives about 2055mm of annual rainfall construction of rainwater harvesting structures are possible. Apart from roof top rainwater harvesting structures small and medium sized check dams can be constructed.

10.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Water Quality problems

Ground water from deeper aquifer of the area is characterized by a generally high iron content which ranges from 0.5 to 3.66 ppm. 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 tubewells. 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 forms the major aquifers. The high contents 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 district shallow tubewells are drilled manually. It is reported that construction of shallow tubewells is difficult mainly in the foot-hills and hilly areas of the district due to the presence of hard shale.

11.0 RECOMMENDATIONS

1. The stage of ground water development in the district is only about 7% which indicates that there is ample scope for ground water development in the area. However the high concentration of iron in ground water may be removed before its use.
2. The present rain gauge density is very low. Additional rain gauge stations may be established both on the wind ward and leeward side of mountains to know any variability in amount of rainfall in the district
3. Research may be taken up on the impact of high iron waters on the soil health and on the growth of various crops, plants etc and their yield because of continuous supply of iron rich ground water for irrigation.
4. Research may also be taken up on the mobility of iron in plants and crops and its concentration in the food grains, seeds, fruits etc, and its impact on human health.
5. More focus should be given to surface water utilization than to ground water because of its high concentration of iron.
6. Conjunctive use of surface and ground water should be taken up in the area for better utilization of waters.
7. The area annually receives nearly 2055mm 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.
8. Ground water contains high concentration of iron in the area. So, iron removal plants are required to be installed wherever necessary for water supply schemes.
9. Roof top rainwater harvesting may be taken up on a large scale for utilization of rainwater in both urban and rural areas for domestic purposes.

10. Safe distance of 500m between two deep tubewells and 150 m between two shallow tubewells should be maintained while constructing tubewells in the district.
11. While constructing deep tubewells or mini deep tubewells gravel packing is a must because the grain size of sandstones (granular zones) is very small. The slot size should be within 0.5 to 1 mm and size of gravel between 2 – 4mm. Gravels should be composed of quartz and should be sub-rounded to sub-angular.
12. Ground water regime including deeper aquifer should be monitored by the State Govt. in view of urbanization and ever increasing population
13. Ground water quality should be monitored both during pre-monsoon and post-monsoon period, especially for iron and arsenic content of ground water because ground water in the neighboring Bangladesh is arsenic infested.
14. In hilly areas springs should be developed. Near by springs, deforestation should be discouraged, spring mouth should remain clean / no clogging should occur to have good discharge.
15. In hilly areas people are facing water crisis during lean periods. Ground water can be developed through dug wells and shallow tubewells in intermountane valleys.
16. Rainwater harvesting should be encouraged, particularly in hilly terrains.
17. Public awareness should be created for proper use and conservation of water.
18. All existing farm ponds and community tanks may be renovated and integrated farming systems involving fisheries and live stock components along with crop production may be taken up to increase the income and water productivity.
19. Installation of low lift points may be intensified throughout the district at suitable locations.
20. Waterlogged areas may be converted into integrated farm ponds.
21. There are more than 2000 artesian wells in the district which are continuously discharging ground water. These wells are to be capped suitably so that ground water flow should be regulated according to the needs. It builds up the piezometric head and reduces the wastage of ground water.

Table-I Hydrogeological Details Of Ground Water Exploration In South Tripura District

Sl no	Site name /Block /Cordinates	Surface elevation (m.amsl)	Depth Drilled/ Assembly lowere(m)	Position of slot (m)	Thikness of aquifer tapped(m)	SWL (mbgl)	Discharge		Draw Down (m)	Specific capacity (lpm/mdd)	Transmi-Ssivity (m^2/day)	Permeability (m/day)	Storativity	Remarks
							m^3/hr	lps						
Amarpur Valley														
1	Amarpur N lat 23^{0}31'20" E long 91^{0}39'38"		255/178	35-42 72-83 62-115 125-140 153-176	79	9.93	158	44	9.8	133.6	794.7	10.43	-	ETW
2	Ompinagar N lat 23^{0}40'27" E long 91^{0}38'16"		250/153	53-73 111-130 140-150	51	0.7	158	44	24.3	181.0	362	7.1	1.77x10^{-3}	-do-
3	Nutan Bazar		250/60	30-56	27	2.53	12	3.33	8.5	23.5	-	-	-	-do-
4	Rangkhang		190/181	47-56 65-88 108-114 144-147 156-168 172-178	39	10.4	85.1	23.63	10.6	134.0	329.0	8.4	-	Deposite well
5	Duluma		208/158	63-75 86-98 12-121 142-151	42	10.5	96.5	26.80	14.4	112.0	325.2	7.76	-	-do-
Udaipur-Sabroom valley														
1	Bagma		201/162	64-70 115-133	36	4.5	48.6	13.5	20.3	30.8	330	9	-	Deposite well
2	Tulamura N lat 23^{0}27'35" E long 91^{0}27'10"		247/212.6	75-81 85-91 99-111 179-191 197-210	48	0.18 agl	112	31.21	24.0	8	246	5.1	-	ETW Auto flow
3	Dhupthali N lat 23^{0}13'25" E long 91^{0}23'20"		208/140.85	56-80 92-104 110-128	54	1.50 agl	36	10	6.80	88	263	4.8		-do
4	Rajapur		252/215	56-59 65-70 75-86 119-126 150-155 162-165 169-174 197-212	56	5.30	143	39.72	10.30	232	1577	28	-	ETW

5	Rajnagar N lat 23^{0}40’27” E long 91^{0}38’16”		252/186	51-93 113-125 136-148 157-163 171-183	54	2 agl	151	42.08	25.0	101	222	4.1	-	ETW Auto flow
6	Matai		232/200	64-82 140-152 161-173 183-195	54	3.6	12	3.33	17.6	11.4	47.4	0.87		ETW
7	Ghoshkhamar		220/206	52-58 79-97 130-142 154-166 186-192 197-203	60	1.48	12	3.33	11.3	17.7	164	2.70		-do-
8	Haripur Rajnagar block		202/187	80-92 104-110 144-150 160-184	48	1.9	30	8.33	7.12	70.2	440	4.8		ETW
9	Bagafa BSF Campus N lat 23^{0}40’27” E long 91^{0}03’03”		197.5/167	103-106 109-114 116-119 123-131 138-150 158-164	37	20.92	36.79	10.21	12.21	42.76	752.45	20.34	-	ETW
10	Satchand N lat 23^{0}07’45” E long 91^{0}38’10”		253/200	60-63 83-88 93-99 117-120 130-133 147-153 168-180 183-189 192-198	50	0.42 agl	91	25.25	12.47	121.2	887.7	17.75	-	ETW Auto flow
11	Manubazar		233/208	87-106 117-120 162-168 193-205	40	19.95	79.5	22.08	5.4	24.5	897	22.4	-	Deposit e well-

Hydrogeological Details Of Ground Water Exploration In Fenny basin, South Tripura District

Sl no	Site name /Block / Cordinates	Surface elevation (m.amsl)	Depth Drilled/ Assembly lowere (m)	Year of construction	Position of slot (m)	Thickness of aquifer tapped (m)	SWL (mbgl)	Discharge		Draw Down (m)	Specific capacity (lpm/ mdd)	Transmi-Ssivity (m^2/day)	Permeability (m/day)	Storativity	Remarks
								m^3/hr	lps						
1	Satchand Satchand N lat $23^0$07'45" E long $91^0$38'10"	17.465	253/200	1979	60-63 83-88 93-99 117-120 130-133 147-153 168-180 183-189 192-198	50	**0.42 agl**	91	25.25	12.47	121.44	887.7	17.75	-	Auto flow
2	Haripur Rajnagar block	25.972	202/187	1991	80-92 104-110 144-150 160-184	48	1.90	30	8.33	7.12	70.2	440	4.8	$2.38x10^{-3}$	

Table- 3 Block- wise drinking water sources in South Tripura district as on 31.03.08

Sl no	**Name of Block**	**No. of GP**	**Total No. of Habita-tions**	**Habitations covered by water supply**				No. of existing source of water					
				FC	PC	NC	% of coverage	DTW	SBTW	IRPatta-ched to DTW	Irp attached to SBTW	SWTP	M.Well/ RCC Well/ Innovative
1	Matabari	43	240	158	49	33	86.25	41	0	18	0	1	107
2	Killa	17	111	14	18	79	28.83	13	2	6	0	0	167
3	Kakraban	25	138	84	47	7	94.33	32	5	8	0	0	88
4	Amrpur	28	170	50	46	74	56.47	27	4	11	0	0	137
5	Ompi	21	155	8	85	62	60.00	10	2	4	0	0	117
6	Karbook	17	207	38	67	102	50.72	17	0	6	0	0	104
7	Rupaichari	26	197	151	45	1	99.49	13	6	3	0	0	64
8	Satchand	49	321	101	51	169	47.35	40	8	10	0	0	199
9	Bokafa	45	458	226	149	83	81.88	58	2	12	0	1	290
10	Ramnagar	27	247	84	127	36	85.43	38	9	6	0	0	320
11	Hrishamukh	22	162	57	34	71	56.17	20	0	3	0	0	116
	Total	320	2406	971	718	717	70.20	309	38	87	0	2	1709

DTW= Deep Tubewell **SBTW=**Small Bore Tubewell **IRP=** Iron Removal Plant
SWTP=Surface Water Treatment Plant **M.Well=**Masonry Well
FC- Fully covered **PC**- Partially Covered **NC**- Not Covered

Table- 4 Block-wise number of Irrigation sources in South Tripura Distt as on 31.03.2008.

S.no	Block	No.of GP	Cultivable Land (ha)	Irrigable land (ha)	Present Irrigated land (ha)	No of existing structures									
						L.I	DTW	Div	Sto	STW	Art	Canal	Weir	WSM	Tank
1	Satchand	49	7115	4235.97	3619.90	63	11	2	0	96	768	0	27	0	0
2	Rupaichari	26	4296	1461.08	999.87	19	1	1	0	0	0	0	3	0	0
3	Hrishyamukh	22	4745	2513.01	2184.76	22	2	5	0	5	11	0	17	0	0
4	Rajnagar	27	7594	4130.60	3819.39	40	8	2	0	199	250	0	10	0	0
5	Bogafa	45	11528	6960.00	5220.21	74	3	3	0	295	674	0	40	0	0
6	Ompi	21	4635	1324.96	1132.13	45	0	0	0	0	0	0	1	0	0
7	Karbook	17	5018	1402.96	1064.40	36	0	0	0	0	0	0	0	0	0
8	Amarpur	28	8467	3318.18	2553.95	78	0	1	0	0	0	0	0	0	0
9	Killa	17	4649	1706.37	1352.17	20	1	1	0	6	41	0	0	0	34
10	Kakraban	25	6470	5937.04	5015.97	53	7	1	0	45	183	0	2	0	1
11	Matabari	43	7981	6416.10	5813.23	56	9	2	0	14	211	0	24	0	0
	Total	320	72498	39406.27	32776.00	506	42	18	0	660	2138	0	124	0	35

Note: **LI**= Lift Irrigation, **DTW**= Deep Tube well, **Div**= Diversion, **Sto**= Storage, **STW**= Shallow tube well
Art= Artesian well, **WSM**= Water shed management, **GP**= Gram panchayat

Fig 1: Hydrogeology map, South Tripura district