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 JAINTIA HILLS DISTRICT, MEGHALAYA

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

REPORT
ON

"AQUIFER MAPPING AND MANAGEMENT PLAN OF WEST JAINTIA HILLS DISTRICT, MEGHALAYA"

(AAP 2017-18)

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Preface

Under National Aquifer Mapping and Management Plan (NAQUIM) program, Central Ground Water Board, State Unit Office, Shillong has carried out aquifer mapping and management plan in WestJaintia Hills district of Meghalaya. The objective was to understand the aquifer system down to the depth of 200 meters, decipher the aquifer geometry, its characteristics, quantity, quality and formulate a complete sustainable and effective management plan for ground water development in the study area.

A multi disciplinary approach of geology, geophysics, hydrology and chemistry was adopted to achieve the objectives of the study. A management plan was made with emphasis on irrigation for agricultural.

This report elaborates the different aquifer system prevailing in the study area, its characteristics and also provides the different scientific data which will help in proposing plans to achieve drinking water security, irrigation facilities etc. through sustainable ground water development.

The groundwater management plan was made with an emphasis in providing irrigation facilities through ground water development as agriculture is the main means of livelihood of the people in the district. To use the groundwater for irrigation purpose, a cropping plan has been designed for the district by using CROPWAT model developed by FAO.

The study of this Aquifer mapping and management plan of WestJaintia Hills district was carried out under the supervision of Shri Tapan Chakraborty, Officer In Charge & Nodal officer of NAQUIM, NER who has helped in all the aspects of field work, technical inputs, report preparation and moral support.

I hope this report will help the stake holders, planners, policy makers, professionals, academicians and researchers dealing with water resources or ground water resources management.

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I would like to acknowledge all the below mentioned for their untiring help and support in all aspects related to this work.

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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
GSI	Geological Survey of India
IMD	Indian Meteorological Department
LPM	Litres per minute
LPS	Litres per second
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
DGM	Directorate of Geology and Mining
DTW	Depth to water table
DW	Dug Well
BW	Bore well
EC	Electrical Conductivity
EW	Exploratory Well
GEC	Ground water Estimation Committee
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

EXECUTIVE SUMMARY

Aquifer Mapping studies and Management Plan has been carried out in WestJaintia Hills district, Meghalaya under National Aquifer Mapping and Management Plan (NAQUIM) program with an objective to know the different aquifer system prevailing in the study area, to decipher the vertical and lateral extend of the aquifer down to the depth of 200 m, its characteristic, quantity as well as quality so as to bring a complete sustainable and effective aquifer management plan for ground water resources development in the study area.These studies has been done through multi-disciplinary approach so as to achieve the said objectives.

The total coverage area of aquifer mapping and management plan is 997 sq.km out of 1693 sq.km of the district and is underlain by consolidated rocks ofQuartzite, Granite, Granite Gneiss, Sandstone, Limestone and Intrusive rock.

Occurrence of ground water in the study area is mainly of weathered and fracturedQuartzite, Granite, Granite Gneiss, Sandstone and Limestone. The different hydrogeological data are generated through intensive field data collection and testing. The aquifer system in this district can be dividedas a two aquifer systemviz., first aquifer (shallow) and second aquifer (deeper).Shallow or first aquifer consists of weathered residuum where ground water occurs under water table condition and is mainly developed by construction of dug wells or shallow bore wells as hand pump. The second aquifer is the deeper aquifer which tapped the fractured zone. Based on the study of litholog and analysis of depth of construction of dug wells and shallow bore wells, it is found that the first aquifer occur within 2 to 38 m bgl. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures zoneupto the maximum depth of 182.94 m bgl.

Ground water exploration has been carried out in different parts of the district to delineate the potential aquifers and their geometry and to determine the hydrogeological parameters of the aquifer systems. To know the different parameters of an aquifer, preliminary yield test and slug test were carried out during the course of study.Soil infiltration test wasalso conducted in different parts of the study area to know the infiltration rates at different soil conditions, topography, geology and environment and also to know its suitability and the amount of water recharging in the area and its rainfall infiltration factor.

Study of water level trend and its behavior both in phreatic and confined condition were carried out in the aquifer mapping area. Study of spring was also carried out in the study area.Most of these springs weredepression and topographic or fractured springs. It is

observed that the discharge of springs in this area ranges from dry to 36.6 litre/minute during pre-monsoon and 0.06 to 40.2litre/minute during post-monsoon season.

In order to study the chemical quality of ground water in the district, water samples from first aquifer (dug wells and springs) and second aquifer (CGWB Bore well) were collected during the course of field work. The samples were analyzed andwas found that all the elements are within permissible limit except pH value is low in almost all the springs and dug wells.

Surface Geophysical studies in the study area were carried out to delineate the subsurface geology. A total of 56 nos. of VESwere conducted in WestJaintia Hills district during AAP 2010-11.

Dynamic Groundwater Resources of the study area has been estimated based on the methodology recommended by Groundwater Estimation Committee (GEC'97). The net ground water availability was 16421 ham and the stage of ground water development was 0.36% which comes under safe category.

Finally, the aquifer map of the study area is generated based on the inputs from geological, hydrogeological, geophysical and hydrochemical studies and a management plan was made with an emphasis in providing irrigation facilities through ground water development as agriculture is the main means of livelihood of the people living in the district.

1. INTRODUCTION

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in WestJaintia Hills district, Meghalaya during AAP 2017-18 covering an entire area of 997sq.km. Under National Aquifer Mapping and Management (NAQUIM) program, combination of geologic, geophysical, hydrologic and hydro chemical information is applied to characterize the quantity, quality and sustainability of ground water aquifers. Systematic aquifer mapping will improve ourunderstanding of the geologic framework of aquifers, their hydrogeologic characteristics, quality and also 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 behaviors, 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 effectivemanagement plan for ground water development.

1.2 Scope of the Study: The activities of this Aquifer Mapping and management plan can be envisaged asfollows:

1.2.1 Data Compilation & Data Gap Analysis: One of the important aspect of aquifer mapping program 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 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; to bring out the efficacy of various

geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environs.

1.2.3. Aquifer Map Preparation: On the basis of integration of data generated from various studies of hydrogeology, 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 to aquifer extremities, quality, water level, potential and vulnerability (quality & quantity).

1.2.4. Aquifer Management Plan Formulation: Aquifer Maps and ground water regimescenario are being utilized to identify a suitable strategy for sustainable development of theaquifer in the area.

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

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

(ii) Exploratory drilling and construction of bore 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 of bore wells, soil infiltration test, slug tests for determination of ground water recharge scope, intensity and potentials and also to determine the characteristics and performances of existing aquifers at various depths.

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

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

(vii) Formulating a complete sustainable aquifer management plan for ground water development.

1.4 Area details: WestJaintia Hills district lies between E 92˚00’00” to E 92˚40’00” Longitude and N 25˚07’08” to N 25˚45’07” Latitude. The district is having an area of 1693 sq.km. Out of this, 997 sq.km of map able area was covered under NAQUIM program. The

district has threeC. &R.D. blocks and the details of the block along with their respective headquarters and population are given in Table 1.1.

Table 1.1 Administrative setup of WestJaintia Hills district

District/Block	Area(sq Km)	Population (2011 census)		
		Person	Male	Female
East Jaintia Hills	**1693**	**272185**	**135052**	**137133**
1. Thadlaskein C & R.D. block		137939	67905	70034
2. Laskein C & R.D. block		90402	45244	45158
3. AmlaremC& R.D. block		43844	21903	21941

This area falls partly or fully in the quadrants of Survey of India Toposheets bearing nos. 83 C/2, 83 C/3, 83 C/4, 83 C/6, 83 C/7, 83 C/10 and 83 C/11 and is bounded by North CacharHills district of Assam and East Jaintia Hills district in the East,Bangladesh in the south, East Khasi Hills district in the West and Assam in the North.The base map of the study area is shown in fig.1.1

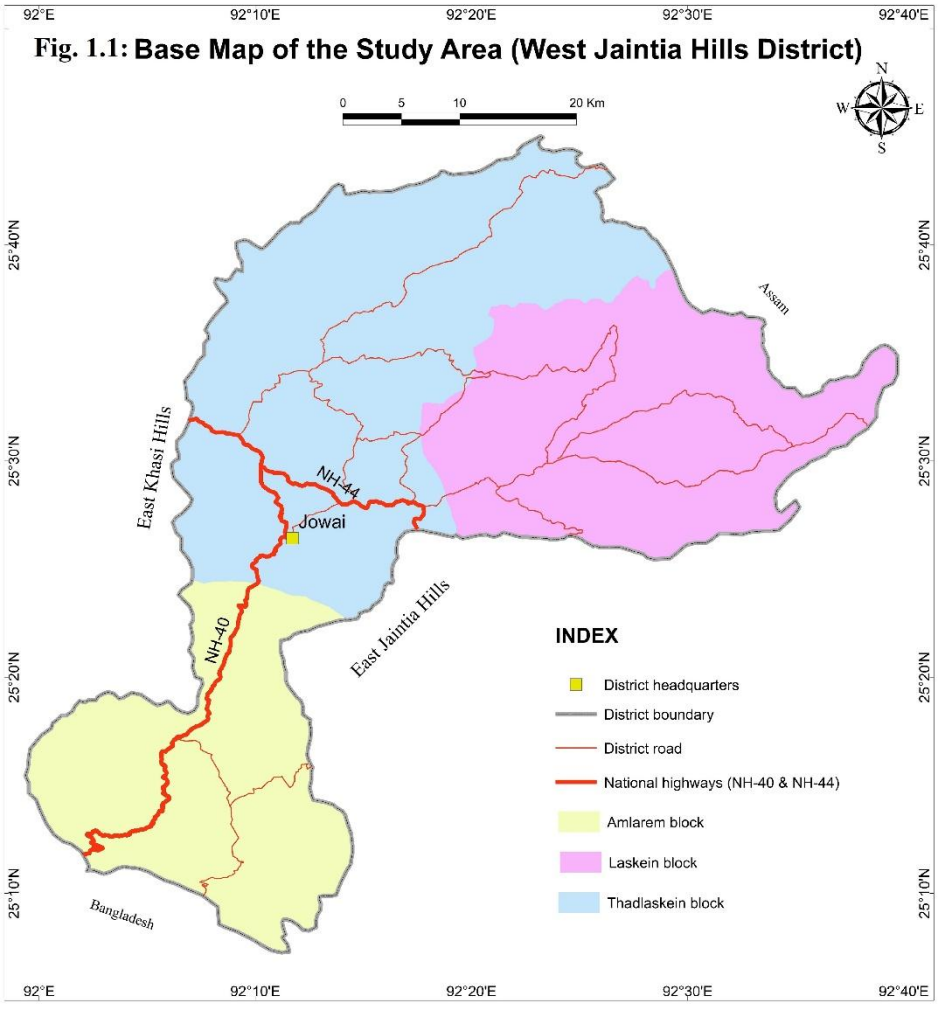


Fig. 1.1: Base Map of the Study Area (West Jaintia Hills District)

1.5 Data availability, data adequacy and data gap analysis:

Aquifer mapping and management plan is carried out through collaborative of different data. The required data on various attributes of the study are collected from the available literatures of Central Ground Water Board, State Water Resources Department of Meghalaya and various Central and State Government agencies. The Data Requirement, Data Availability and Data Gap Analysis are presented in table 1.2and annexure 9.

Table1.2 Data Availability and Data Gap Analysis in Aquifer Mapping Studies

Sl. No.	Items	Data Requirement	Data Availability	Data Gap
1	Ground Water Exploration Data	Both first aquifer and second aquifer	6 EW	I Aquifer : 19 nos. of EW & OW. II Aquifer : 18 nos.of EW and OW.
2	Geophysics	Geophysical data of the Study area	56 VES	54 nos.
3	Ground Water Monitoring Regime	Representative Monitoring Wells well distributed over the Study Area for both first and second aquifers.	2 Monitoring Well (DW)	I Aquifer : 28 nos. II Aquifer : 18 nos.
4	Ground Water Quality	Representative Monitoring Wells well distributed over the Study Area for both first and second aquifers.	Water quality data of 1 monitoring well	I Aquifer : 32 nos. II Aquifer : 18 nos.
5	Specific yield (Shallow and deeper aquifer)	Both aquifers	Nil	Entire study area
6	Climate	Season-wise Rainfall pattern	Annual Rainfall of 1 Meteorological Station	Time-series data on Rainfall
7	Soil	Soil map and Soil Infiltration Rate	Soil map	Soil Infiltration studies covering the entire study area
8	Land use	Latest Land Use pattern	Latest Land Use pattern	NA
9	Geomorphology	Detailed Information on Geomorphology of the area	District level information	NA
10	Recharge Parameters	Recharge parameters for different soil and aquifer types based on field studies	Recharge parameters given in Ground Water Resources Estimation	Entire study area

1.6 Demography: As per 2011 Census, WestJaintia Hillsdistrict has a population of 272185 out of which 135052 were male and 137133 were female respectively.

1.7 Communication: WestJaintia Hills district is well connected with the rest of the district by two National Highways(NH-40 &NH-44). The headquarter of the district is at Jowai which is located at 60 km away from the state capital Shillong and 159 km from Guwahati.Jowai town is well connected with the rest of the country by the STD and Internet facilities availed by the Telecom Company, BSNL and many mobile servicescompanies.

1.8 Climate: The Climate of West Jaintia Hills District is uniquely pleasant and caressing. The climate shows a variation from the warm, humid tropical in the plains in the eastern and southern part and temperate climate is experienced in the western part around the district headquarter Jowai. The climatic conditions vary substantially from place to place due to wide differences in altitude. Therefore, according to the prevailing weather condition over the years, the district can be grouped into four conspicuous seasons namely winter season, pre-monsoon season, monsoon season and retreating season. The rainfall profile is very high during the south west monsoon, which usually starts from the middle of May and declines towards the last part of September. The intensity of rainfall in the district during the last few years has registered a rising trend, due to the untimely vagary of monsoon coupled by the existence of fogs, mists and nimbus clouds which loom large during the rainy season. The Average Relative Humidity is the highest during the month of July while December records the lowest Relative Humidity.The total annual rainfall in the district during year 2015 was recorded 9793.8mm at Jowai. The district receives a fairly high rainfall throughout the year. Most of the precipitation occurs between April and September. The monthly maximum rainfall of 2864.4mm was recorded in June during year 2015 at the same rain gauge station. Average temperature in the district (at Jowai) varies from a minimum 13^0C (Jan) to a maximum 25^0C (Sep-Oct). During 2015, relative humidity in the district (at Jowai) varies from a minimum 45% (Dec) to a maximum 95% (June).

1.9 Land use: Land utilization statistics provide detailed information of the land use pattern in the area. Based on the land utilization, the total area is divided into various types of landforms such as forest, cultivable land, fallows lands, crops area etc. which in turn reflects the degree of development of agricultural activities and cultivation potential. The land utilization statistics of the West Jaintia Hills district is shown in the following Table1.3 and land use map is shown in Fig. 1.2.

Table 1.3: Land use pattern in West Jaintia Hills, 2015-16

Land Classifications	Area in hectares
A. Geogrphical Area	177900
B. Reporting Area	177760
1. Forests (classed & unclassed)	69886
2. Area not available for cultivation i) Area under non-agricultural uses	
a. Water logged land	
b. Social Forestry	2188
c. Land under still water	2627
d. Other land	5605
Total (a+b+c+d)	10420
ii. Barren and uncultivalble lands	6870
TOTAL = (i+ii)	17290
3. Other uncultivable lands a. Permanent pastures and other grazing lands	
b. Land under Misc. tree crops & grooves etc.	7934
c. Cultivable wastelands	44863
TOTAL = (a+b+c)	52797
4. Fallow lands a. Fallow lands other than current fallows	8006
b. Current fallows	4612
TOTAL = (a+b)	12618
5. Net area sown	25169
6. Area sown more than once	388
7. Total Croped area	25557

Source: Directorate of Economics & Statistics, Shillong, Govt. of Meghalaya.

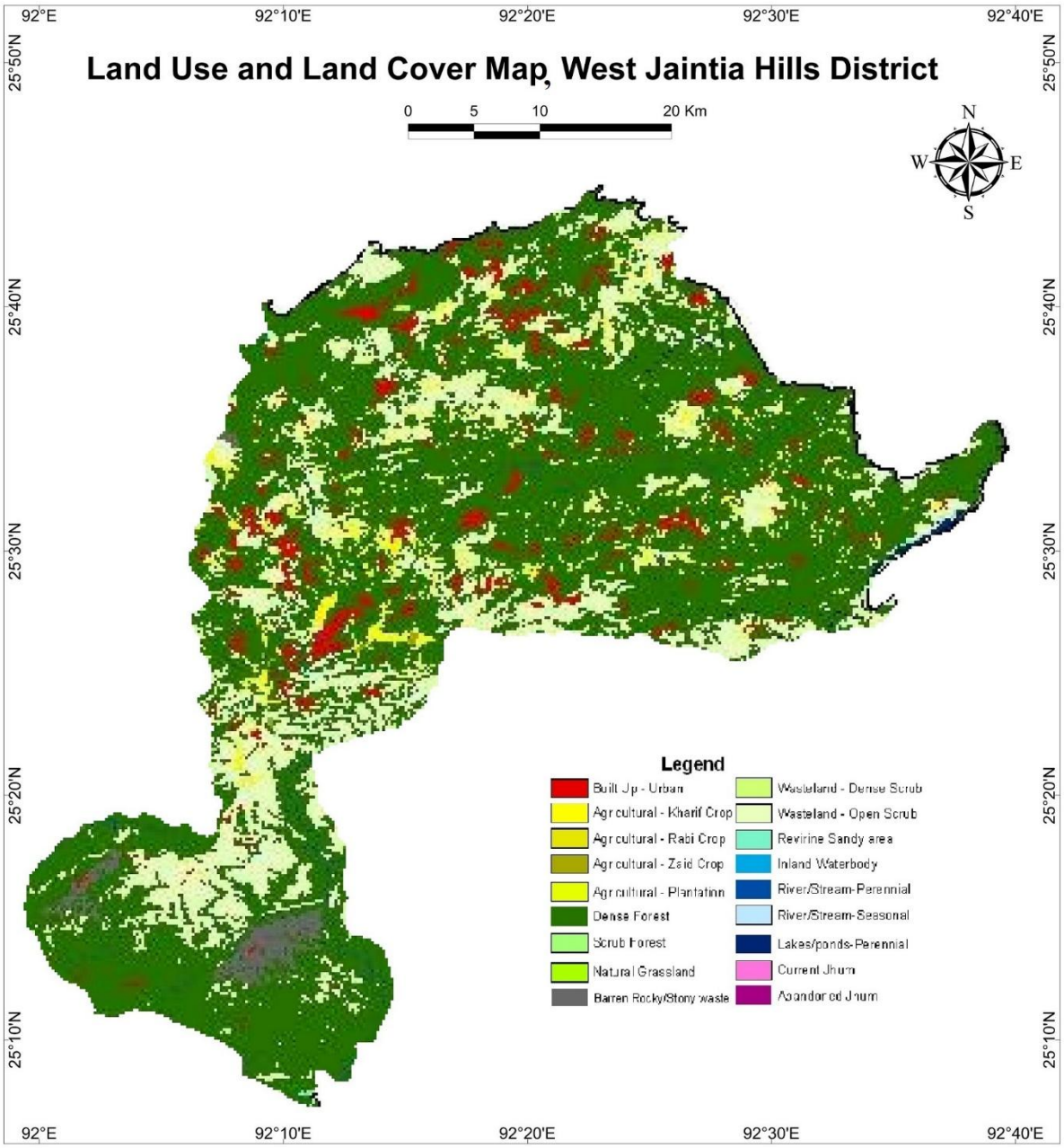


Fig 1.2: Land use map of West Jaintia Hills (*Source: NESAC*)

1.10Soil: High rainfall, humid subtropical climate and favorable topography have resulted in the formation of soil profile (1-10 m) in the study area. The soil in the study area is mostly deep brown, black soil, red soil, alluvial soil, sandy soil and acidic soil. The acidic character is due to leaching of bases caused by high rainfall. The district shows different types of soils as the provenance differs widely. The loamy soil is the most prevalent one. They vary from sandy to clayey-loam in JowaiandNongbah. Alluvial soil occurs in the southern periphery of the district e.g.,Dawki, Muktapur, Lakroh etc. The soil is acidic in nature, with low percentage of phosphorous and high organic carbons..The soil classification has been

conducted by the Regional Center of National Bureau of Soil Survey and Land Use Planning, for the State of Meghalaya. Soil map of the area is given in Fig 1.3.

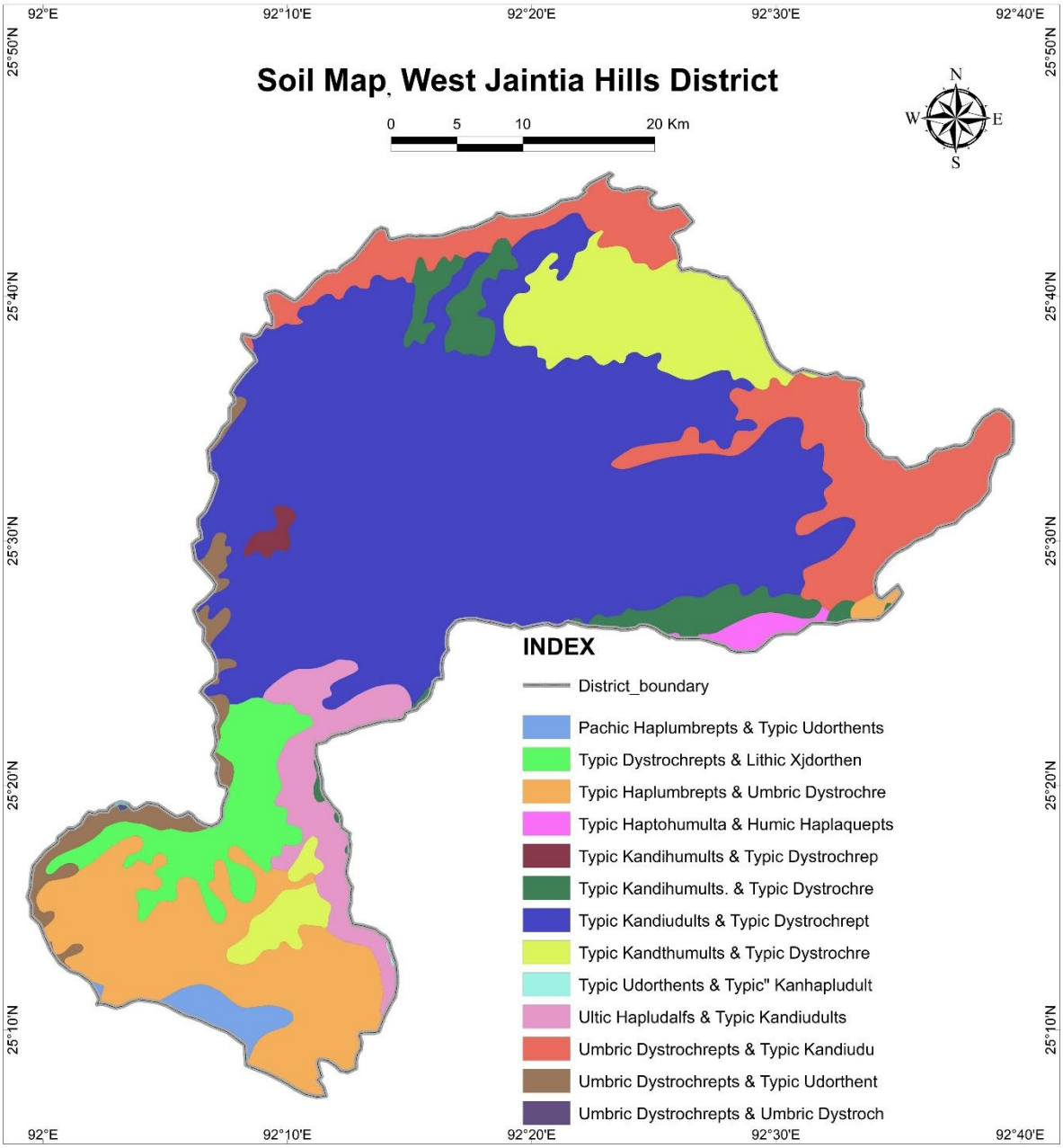


Fig. 1.3: Soil map of WestJaintiaHills (*source: Regional Center of National Bureau of Soil Survey and Land Use Planning*).

1.11 Agriculture: Agriculture is the main means of livelihood of the people in the district and majority of the population is dependent on agriculture. The area is endowed with diversified climatic condition thereby offering good scope for cultivation of temperate and subtropical crops. The principal crops of the study area are paddy, maize, potato, ginger, turmeric, pineapple, tapioca, citrus, banana etc. The season wise cropping pattern of WestJaintia Hills is shown in Table 1.4.

Table 1.4 Season wise cropping pattern of WestJaintia Hills district.

Name of the Crop	Kharif (May to Oct)	Rabi (Nov to April)
Paddy	Ploughing, transplanting inter culture nursery operation, sowing	Harvesting
Maize	Sowing, harvesting	Land preparation, inter culture sowing operation,
Tomato, potato, beans etc	-----do----	-----do-----

Source: Department of Agriculture Office, Govt. of Meghalaya.

Present area under different crops and their productivity is shown in table 1.5.

Table 1.5: Area under different crops and their productivity, West Jaintia Hills district (2015-16)

Crops	Area (ha)	Avg.Yield (kg/ha)
Autumn rice	80	2600
Winter rice	7938	2169
Spring rice	79	2316
Maize	4242	1876
Pulses	138	1159
Rape and mustard	80	891
Sesamum	29	862
Soyabean	593	1503
Small millets	207	1377
Tapioca	25	10440
Citruis fruits	925	5914
Pineapple	61	8000
Banana	257	3339
Papaya	16	3313
Potato	186	4957
Sweet potato	999	2985
Ginger	342	11149
Turmeric	1384	6377
Chillies	44	1023
Black pepper	7	1000
Tea	7	1000
Arecanut	1607	1653
Rubber	67	104
Sugarcane	7	1286
Total	19320	77293

Source: Agriculture Department, Govt. of Meghalaya.

1.12 Irrigation: In the district there are no major or medium irrigation projects, hence the agricultural development in the area is dependent on minor irrigation schemes. The existing irrigation schemes are based only on surface water and the source is mainly through non-monsoon base flow. Piped water supply schemes and spot source water schemes are the main source of water supply schemes and play a major role for the water requirement of the people especially in the rural areas. Piped water supply schemes are categorized into (i) Gravity Feed Schemes and (ii) River Pumping Schemes. Spot source water supply scheme are classified into (i) Hand pump, (ii) Spring tapped chamber and (iii) Well (dug, ring) maintained by Public Health Engineering Department, Meghalaya (PHED).

Table 1.6:Area under irrigation by different sources (as on 31.03.2017) are as follows:

Area irrigated by Ground Water (in Hectare)		**Area irrigated by surface water (in Hectare)**	
Open Wells (Community/Government)	11.30	Government Canal	5558.45
		Community/Private Canals	9825.89

(Source: DC office, West Jaintia Hills District)

1.13 Industries: The pace of industrialization in the district is still slow. However, there has been a steady increase in the number of registered small scale units which are mostly in the tiny sector covering servicing Industries, bakeries, furniture making, Iron and steel fabrication, tailoring, knitting, leather work, shoe making, Handicrafts, Tin-trunk making, stone crusher, betelnutpreservation, turmeric processing, fish fermentation, honey processing, auto servicing, car washing centre, electronic repairing, cartridge manufacturing and refilling centre.

1.14 Forest: The District is very rich in natural resources. The forest types of the District comprise of Sub-Tropical Pine Forest, Tropical Semi evergreen, Tropical Moist Dry deciduous, Tropical dry and Bamboo mixed. As per Directorate of Economics and Statistics, the forest cover area is about 69886 ha (2015-16). The district has good forest (over which is endowed with rich flora and fauna. One of the reasons that the district has a substantial forest cover is the presence of a large number of sacred groves which are maintained by the Raij. These sacred groves are found at Jowai, Raliang, Shallgpung, Mukhla, Nongtalang, Chyrmang and other village forest areas.

1.15 Drainage: The drainage system of the district is controlled by topography. The drainage pattern of dendritic, rectangular types is found in the area which indicates both

topographic and structural control. Broadly, there are mainly two watersheds in the district, one river flowing in the northern direction toward the Brahmaputra and the other in the south, towards the Surma valley in Bangladesh. The important rivers flowing to the Brahmaputra are Kopili, Myntang and Mynriang and the main rivers flowing to the Surma valley are Myngngot (Umngot), Myntdu, Wah Prang, WahLukhaandandWahSimlieng. The drainage pattern is sub parallel to parallel. It is being controlled by joints and faults as indicated by the straight courses of the rivers and streams with deep gorges. The drainage map is shown in Fig 1.4.

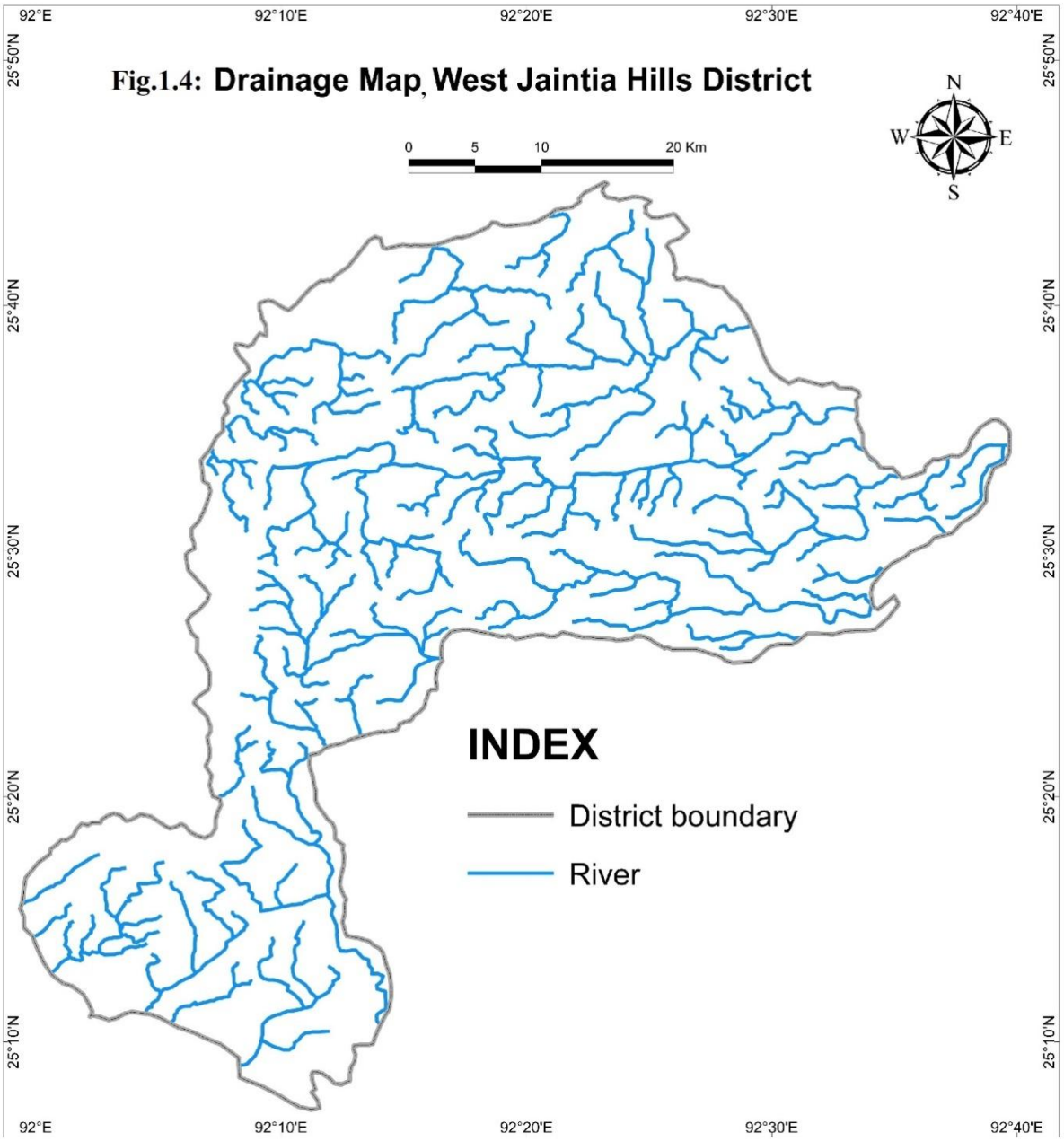


Fig.1.4: Drainage Map, West Jaintia Hills District

2. DATA COLLECTION AND GENERATION

One of the main objectives of the study was to collect various relevant technical data from the concerned State Government agencies and other Institutes dealing with ground water and incorporating these data along with CGWB data to generate strong data base. Based on the data availability and data gap analysis, the required sub-surface hydrogeological data, groundwater level data, groundwater quality data and Geophysical data were generated but the entire data required could not be generated due to unapproachable/inaccessible and difficult hilly terrain.

2.1 Hydrogeological: Occurrence of ground water in the study area is mainly of weathered and fractured Sandstone and Limestone formation. The different hydrogeological data are generated through intensive field data collection and testing.

2.1.1 Water level monitoring: In the study area, only 3 dug well, 1 bore wells and 25 springs were established askey wells to study the water level, quality, spring discharge and its behavior periodically. There was a huge data requirement, but due to lack of dug wells and bore wells structure in the study area only these were established.

Phreatic aquifer: A total of 3 dug well was established as key wells for periodical monitoring to know the water level trend and its behavior. The key observation wells details are presented in Annexure 3 and the pre and post monsoon Depth to Water Level in Fig 3.4 and 3.5.

Confined/Semi-confined aquifer: For study of piezometric head in the district, a total of 1bore well was monitored periodically. Details of these key observation wells are presented in Annexure 3 and the pre and post monsoon Depth to Water Level in Fig 3.6 and 3.7.

Springs: A total of 25 springs were established and monitored to know the type, discharge and their behavior. The locations of these springs are given in table 2.1.

Table 2.1 Location of springs in WestJaintia Hills district

Sl. No.	Location	Block	District	Latitude	Longitude	RL (m)	Type	Lithology
1	Raliang	Laskein	West Jaintia Hills	25°30’05.4”	92°23’56.2”	1276	Depression	Granite Gneiss
2	Madanrwan	Laskein	West Jaintia Hills	25°32’23.1”	92°28’08.8”	1041	Depression	Granite Gneiss
3	Niawkmai	Laskein	West Jaintia Hills	25°32’58.2”	92°29’59.8”	981	Depression	Granite Gneiss
4	Banmuhur	Laskein	West Jaintia Hills	25°31’46.1”	92°32’33.7”	906	Depression	Sandstone
5	Nongringkoh	Laskein	West Jaintia Hills	25°29’11.0”	92°30’54.2”	1082	Depression	Granite Gneiss
6	Shangpung	Laskein	West Jaintia Hills	25°28’49.6”	92°21’11.3”	1260	Depression	Sandstone
7	Thadlaskien	Thadlaskein	West Jaintia Hills	25°29’42.6”	92°10’13.4”	1368	Depression	Quartzite
8	Tyrsang	Thadlaskein	West Jaintia Hills	25°32’04.7”	92°08’52.3”	1328	Fracture	Quartzite
9	Lad Mukhla	Thadlaskein	West Jaintia Hills	25°30’37.0”	92°09’52.6”	1344	Depression	Quartzite

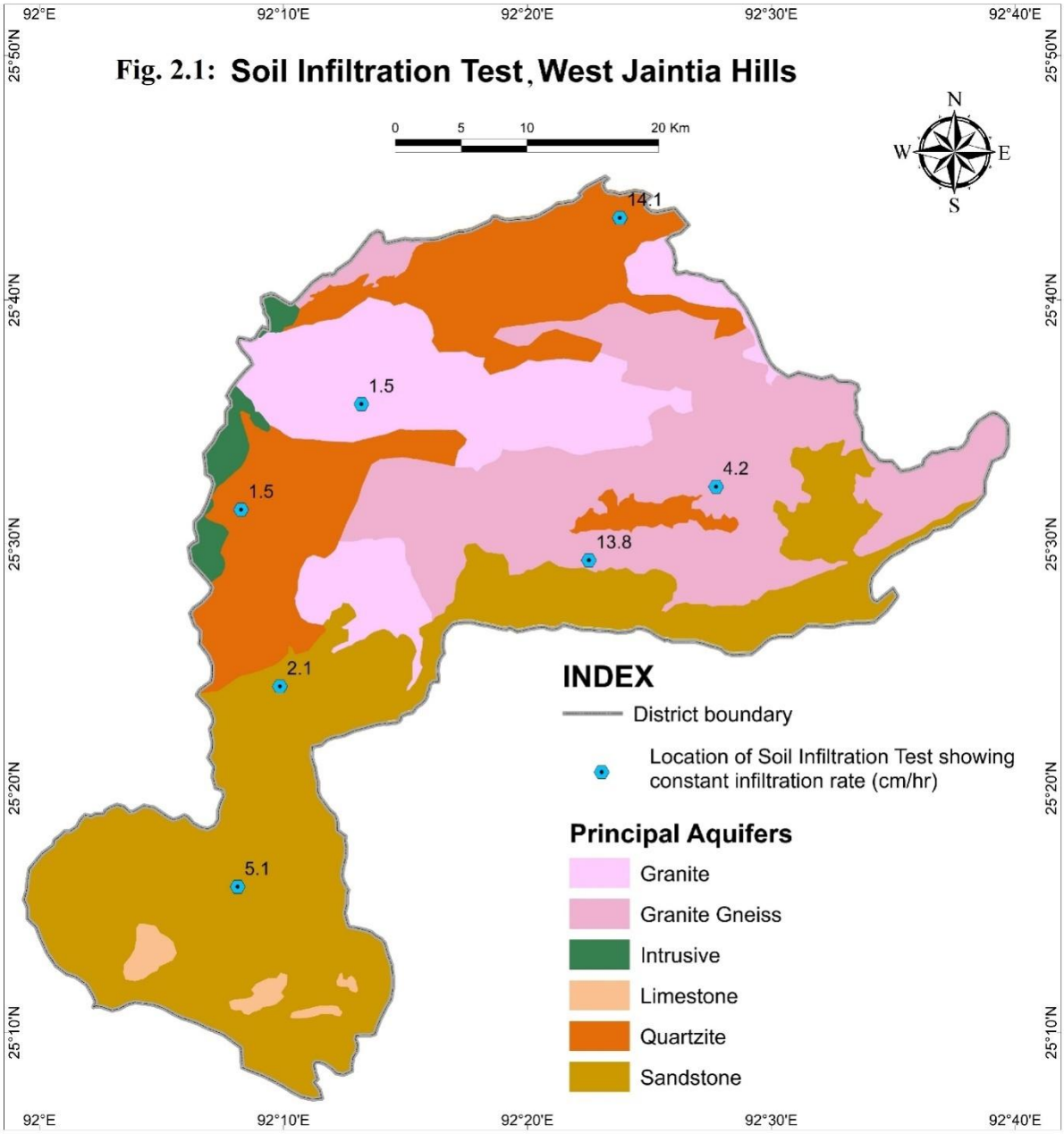
Sl. No.	Location	Block	District	Latitude	Longitude	RL (m)	Type	Lithology
10	Mukhla	Thadlaskein	West Jaintia Hills	25°30’20.5”	92°10’17.9”	1362	Depression	Quartzite
11	Nartiang	Thadlaskein	West Jaintia Hills	25°34’09.7”	92°12’23.5”	1204	Depression	Quartzite
12	Moobakhon	Thadlaskein	West Jaintia Hills	25°38'37.4”	92°17’12.6”	1045	Depression	Quartzite
13	Namdong	Thadlaskein	West Jaintia Hills	25°39'33.0”	92°19’36.4”	990	Depression	Quartzite
14	Khonsaro	Thadlaskein	West Jaintia Hills	25°41'09.2"	92°20’49.4”	963	Depression	Quartzite
15	Saitsama	Thadlaskein	West Jaintia Hills	25°43'15.2"	92°23’01.9”	891	Depression	Quartzite
16	Khanduli	Thadlaskein	West Jaintia Hills	25°43'11.5"	92°24’55.0”	859	Depression	Quartzite
17	UmsyneirSaitsama	Thadlaskein	West Jaintia Hills	25°43'21.1"	92°23’46.7”	878	Depression	Quartzite
18	Mukoh	Thadlaskein	West Jaintia Hills	25°40'25.5"	92°21’01.1”	960	Depression	Quartzite
19	Nongbah	Thadlaskein	West Jaintia Hills	25°31'22.0"	92°14’56.7”	1313	Fracture	Granite Gneiss
20	Jowai	Thadlaskein	West Jaintia Hills	25°26'30.37"	92°11’20.47”	1263	Depression	Quartzite
21	Mostam	Amlarem	West Jaintia Hills	25°24'42.5"	92°10’14.0”	1318	Depression	Sandstone
22	Shkendyrsit	Amlarem	West Jaintia Hills	25°21'49.2"	92°08’51.5”	1304	Fracture	Sandstone
23	Umjarang	Amlarem	West Jaintia Hills	25°18'52.38"	92°07’49.51”	1142	Fracture	Sandstone
24	Dawki	Amlarem	West Jaintia Hills	25°11'11.8"	92°01’08.6”	28	Fracture	Sandstone
25	Amlari	Amlarem	West Jaintia Hills	25°11'00.68"	92°08’59.83”	418	Fracture	Limestone

2.1.2 Preliminary Yield Test (PYT) and Slug test: A total of 1 preliminary yield test was carried out during NAQUIM program and 4PYT before NAQUIM in the study area to know the aquifer parameters. And 2 nos. slug tests were conducted during NAQUIM program using Ferri’s method to ascertain the transmissivity. The details are shown in Annexure 1.

2.1.3Soil Infiltration Studies: Soil infiltration test were conducted using double ring infiltrometer and the constant infiltration rates of different soils were calculated by double ring infiltrometer method. These studies were carried outin different locations to know the infiltration rates at different soil conditions, topography, geology and environment. This will provide a scientific approach of groundwater recharge, its suitability and the amount of water recharging in that area, rainfall infiltration factor and will help in calculating ground water resource estimation. The details are shown in table 2.2 and fig. 2.1.

Table 2.2 Details of Soil Infiltration Test studies results

Sl. No.	Location	Latitude	Longitude	RL (m)	Soil type	Soil thickness (m)	Colour	Infiltration rate (cm/hr)	Date of Test
1	Muphlang	25°24'09.97"	92°09'51.49"	1267	UlticHapludalfs& Typic Kandiudults	2 to 3	Red	2.1	18.12.2017
2	Pamdabuh	25°15'57.73"	92°08'07.44"	923	Typic Dystrochrepts & Lithic Xjdorthen	1 to 2	Brown	5.1	18.12.2017
3	Mynsngat	25°35'43.78"	92°13'11.99"	1158	Typic Kandiudults& Typic Dystrochrept	2 to 3	Red	1.5	19.12.2017
4	Saitsama	25°43'21.12"	92°23'47.66"	878	Umbric Dystrochrepts & Typic Kandiudu	2 to 3	Red	14.1	19.12.2017
5	Ummulong	25°31'24.29"	92°08'15.84"	1315	Typic Kandiudults& Typic Dystrochrept	3 to 4	Brown	1.5	20.12.2017
6	Raliang	25°29'19.96"	92°22'31.31"	1155	Typic Kandiudults& Typic Dystrochrept	2 to 3	Brown	13.8	21.03.2018
7	Mowkaiaw	25°32'20.56"	92°27'44.03"	1055	Typic Kandiudults& Typic Dystrochrept	1 to 2	Brown	4.2	21.03.2018



2.2 Hydrochemistry: The quality of ground water is as important as that of the quantity. In order to study the chemical quality of ground water in the district, water samples from first aquifer (dug wells and springs) and second aquifer (CGWB Bore well) were collected during the course of field work. Ground water samples were analyzed in the regional chemical laboratory, Central Ground Water Board, North Eastern Region, Guwahati for 16 parameters. The analytical data are given in Annexure 2.

2.3 Geophysicalstudies: Surface Geophysical studies in the study area were carried out to delineate the subsurface geology as well as supplement the data gap under the assignment of Aquifer Mapping. A total of 56 VES were conducted and HAK, HK, HKH, HAK, KQ, QH, A, K type VES curves were obtained. The inferences drawn on the basis of interpreted results could not be obtained for deeper formation due to the limitations of unavailability of large and straight stretch for current electrode separation. However, taking into account the interpreted results as well as the apparent resistivity, inferences have been approximated to shallow to deeper depth at fewplaces. The detail results are given in Annexure 6. The locations of the surveycarried out are tabulated below;

Table 2.3 Location of VES survey carried out in WestJaintia Hills

Sl. No.	VES No.	Village	Location	Coordinates
1	88	Nongbah	90 m N35°E of School	N25°30’54” E92°14’53”
2	89	Nongbah	Due east of red building on the main road(Smt.Jietthabru)	N25°30’38” E92°14’43”
3	90	Nongbah	200 m South of VES-89(opposite to green building Sri.Wanpadit)	N25°30’31” E92°14’41”
4	91	Nongbah	150 m South of VES-90	N25°30’26” E92°14’41”
5	92	Nongbah	Pynkai Colony play ground	N25°30’41” E92°15’07”
6	93	Nongbah(Mangkariang)	Centre of South western corner of the Bull fight ground	N25°30’16” E92°14’59”
7	94	Nongbah(Mangkariang)	100m N 65° E of VES-93.	N25°30’16” E92°14’59”
8	95	Nongbah(Mangkariang)	200m N 65° E of VES-93.	N25°30’16” E92°14’59”
9	96	Nongbah(Mangkariang)	70m N 25° W of VES-94.	
10	97	Nongbah(Mangkariang)	30m S 25° E of VES-94.	
11	98	Nongbah	60m North of culvert.	N25°30’29” E92°14’34”
12	99	Nongbah	300m North 0f VES- 98 and centre of the foot ball ground.	N25°30’41” E92°14’36”
13	100	Tharraumlong	200 m south of junction of the road leading to the village Tharra and Umlong	N25°30’04” E92°14’20”
14	101	Tharraumlong	180m South of VES-100 in the valley.	N25°31’00” E92°14’16”
15	102	Tharraumlong	200m South of VES-101 in the valley.	N25°30’54” E92°14’07”
16	103	Lower Umlong	In the farm house and the farm house is located at 150m South of VES-102.	N25°30’49” E92°14’16”
17	104	Lower Umlong	125m South of VES-103.	N25°30’45” E92°14’13”
18	115	Lumstong(Marwa)	70m South of the bridge.	N25°36’53” E92°16’54”
19	116	Lumstong(Marwa)	115m South of VES-115.	N25°36’48” E92°16’53”

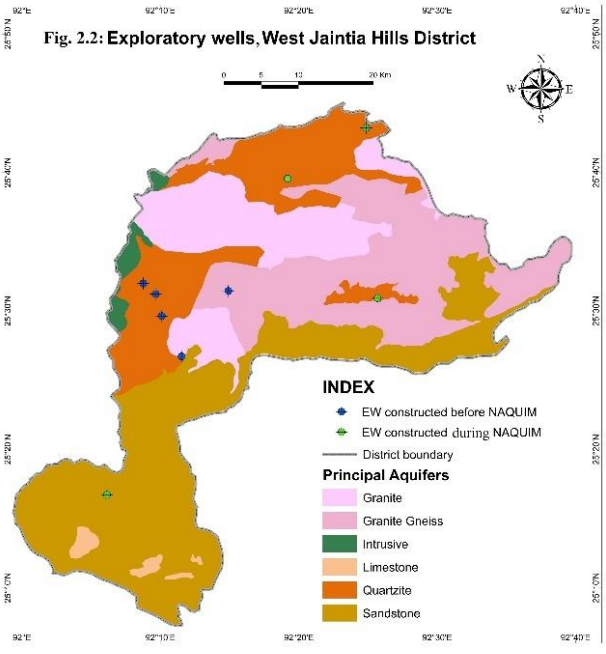
20	117	Lumstong(Marwa)	120m South of VES-116.	
Sl. No.	**VES No.**	**Village**	**Location**	**Coordinates**
21	118	Lumstong(Marwa)		
22	119	Mynriang (Upper)		
23	120	Kshehrynshung	In Nongseingfoot ball ground.	N 25°37’04” E 92°16’51”
24	121	Kshehrynshung	80m SE of VES-120 and 80 m north of the bridge.	
25	122	Kshehrynshung	80 m West of VES-121.	
26	123	Kshehrynshung	80 m West of VES-122.	
27	124	Kshehrynshung	25m West of the bridge on the main road in the valley.	N 25°36’57” E 92°16’44”
28	125	Kshehrynshung	90m West of VES-124.	
29	126	Ksherynshung	185m NW of the31 Km stone on Jowai road.	N 25°37’25” E 92°16’00”
30	127	Wahiajar. Maya club ground	Maya club ground. Adjecent to the road.	N 25°32’23” E 92°09’45”
31	128	Wahiajar. Maya club ground	80m East of VES-127 and 50 m west of cell tower.	
32	129	Wahjar bull fight ground	100m S30°E of the fencing which is adjacent to the road.	N 25°32’41” E 92°10’04”
33.	130	Wahjar bull fight ground	50m N 30°W of VES-129.	
34	131	Wahjar bull fight ground	50m East of VES-129.	
35	132	Wahijar (Bhadakha)	40m S30°W of VES-133	N 25°31’22” E 92°10’04”
36	133	Wahijar (Bhadakha)	70m S30°W of VES-134	N 25°31’21” 92°10’03”
37	134	Wahijar (Bhadakha)	Near the South Eastern side goal post in the foot ball ground.	N 25°31’23” E 92°10’00”
38	135	Umlong	80m South of VES-136	N 25°31’00” E 92°09’00”
39	136	Umlong	100m East of 1 km stone Tyrshang – Umlong road.	N 25°31’34” E 92°08’59”
40	137	Mukhla	80m west of VES-138	N 25°29’45” E 92°10’50”
41	138	Mukhla	25m SW of the Southern goal post of the foot ball ground.	N 25°29’45” E 92°10’48”
42	139	Mukhla	On the road leading to Thadlaskein lake	N 25°29’46” E 92°10’32”
43	140	Mukhla	-do-	N 25°29’50” E 92°10’33”
44	141	Umlong	In the school play ground and 80m NE corner of Little Flower Sec. school.	N 25°31’08” E 92°08’26”
45	142	Umlong	Opposite to the Little Flower Sec. School and on the other side of the road.	N 25°31’070” E92°08’31”
46	143	Phramear	80m South of St. Lawrence Primary School.	N 25°28’03” E 92°17’30”
47	144	Phramear	In the centre of the foot ball ground.	N 25°28’03” E 92°17’29”
48	145	Phramear	100m S30°E of the school.	N 25°28’03” E 92°17’34”
49	146	Ialong	Opp. To the cell tower and sign board on the Jowai-Silchar road.	N 25°27’58” E 92°14’48”
50	147	Amlarem	43m S60°E of VES-148.	N 25°16’57” E 92°06’13”
51	148	Amlarem	South of the village and 150m North of the check post on Dawki-Amlarem road.	N 25°16’57” E 92°06’11”
52	149	Amlarem	80m east of SD office. N20°W of DI office.	
53	150	Amlarem	50m N25°E of VEs-149	
54	151	Amlarem	Near Amlarem square, Dawki 27 Km.	N 25°17’11” E 92°06’10”
55	152	Amlarem	70m east of VES VES-151.	
56	153	Amlarem	In the premises of Amlarem Sec. School. Due north of School board.	

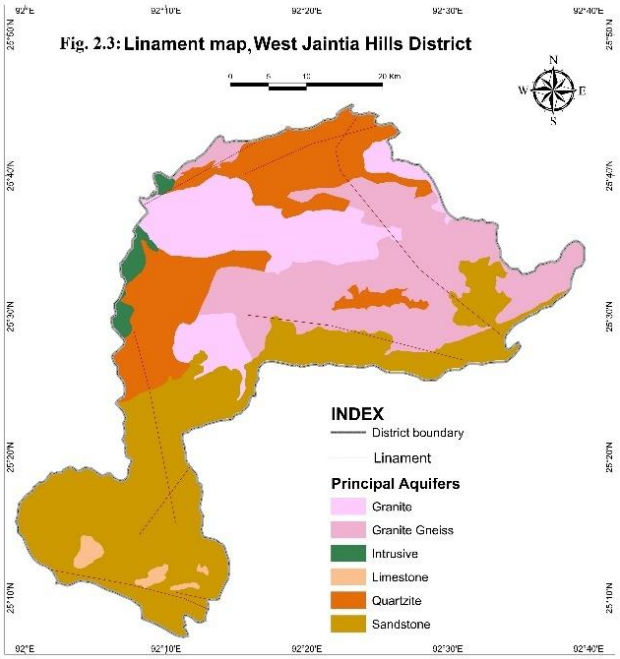
2.4 Ground water Exploration studies: Ground water exploration has been carried out in different parts of the district to delineate the potential aquifers and their geometry and to determine the hydrogeological parameters of the aquifer systems.Before NAQUIM programmestartedin the district, 5 EW and 1 OW were constructed and as a part of data gap generation5 EW were constructed during the course of study. Details of the exploratory wells are presented below in the table 2.4.

Table 2.4 Exploratory wells constructed in WestJaintia Hills district

Sl. No.	Village/ Location	Taluka/ Block	District	Toposheet No.	Longitude	Latitude	Type of well (DW/BW/TW)	Depth (m bgl)
1	Jowai	Thadlaskein	West Jaintia Hills	83 C/3	92°11'32"	25°26'43"	BW	80.19
2	Nongbah	Thadlaskein	West Jaintia Hills	83 C/2	92°14'55"	25°31'27"	BW	74.2
3	Tyrsang	Thadlaskein	West Jaintia Hills	84 C/2	92°08'15"	25°32'01"	BW	82.35
4	Wahiajer	Thadlaskein	West Jaintia Hills	85 C/2	92°09'45"	25°31'47"	BW	88
5	DIET Thadlaskein	Thadlaskein	West Jaintia Hills	83 C/3	92°10'6"	25°29'37"	BW	120.4
6	Amlarem	Amlarem	West Jaintia Hills	83 C/3	92°06'08"	25°16'43"	BW	92.7
7	Laskein	Laskein	West Jaintia Hills	83 C/6	92°25'40"	25°30'55"	BW	201.9
8	Khanduli	Thadlaskein	West Jaintia Hills	84 C/6	92°24'51"	25°43'13"	BW	184
9	Namdong-A	Thadlaskein	West Jaintia Hills	85 C/6	92°19'11"	25°39'33"	BW	202.5

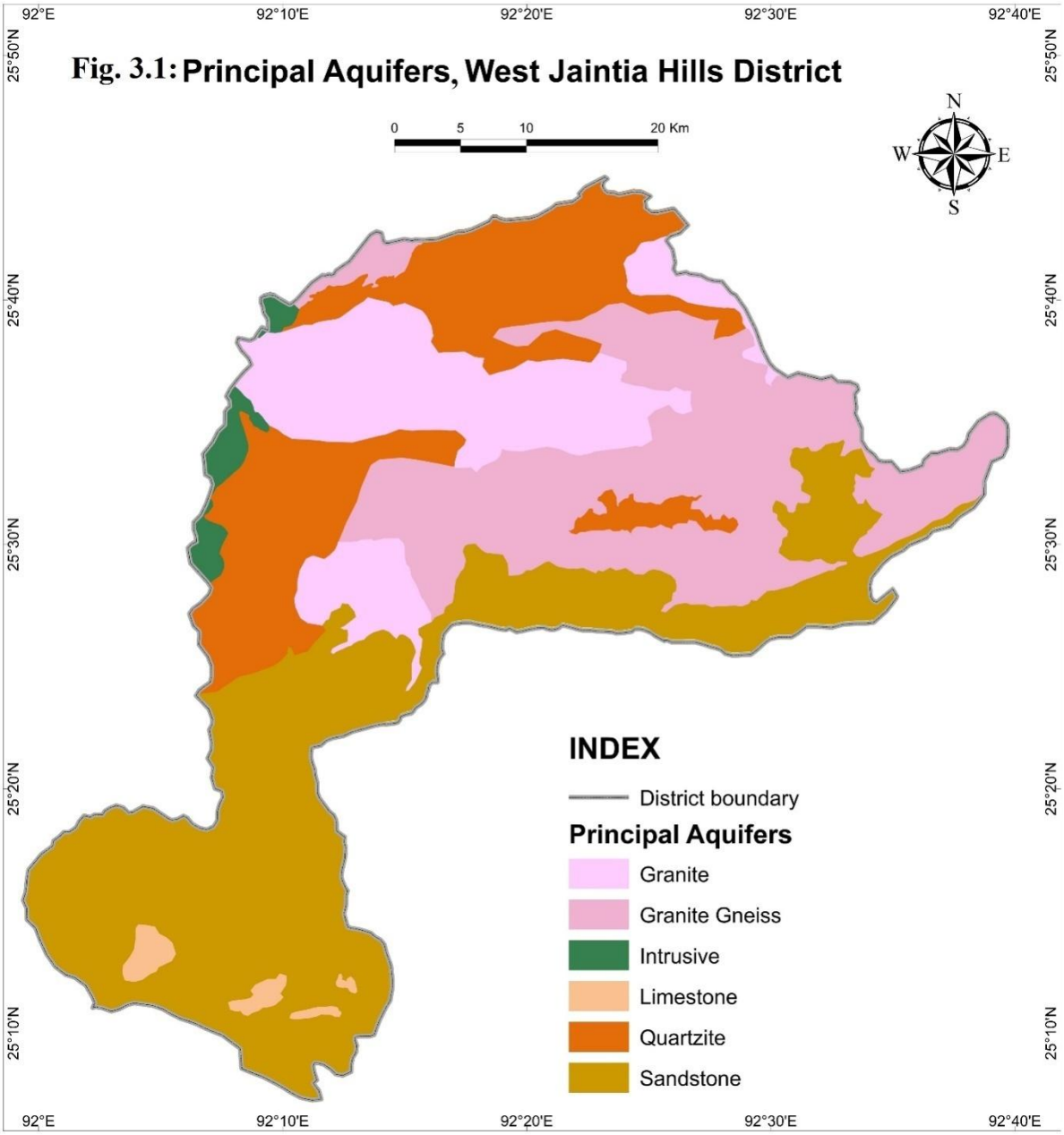
The exploratory wells which were constructed before and during NAQUIM is shown in fig 2.2 and lineament map is shown in fig. 2.3.





3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 General hydrogeology and occurrence of ground water: Thehydrogeological formation of the study area comprised of Granite Gneiss and intrusive of Archean-Proterozoic, Quartzite of Paleo-Meso-Proterozoic of Shillong group, Granite of Neo Proterozoic- early Proterozoic, Sandstone and Limestone of Paleocene-Eocene age. The presence of weak planes like fractures and joints in these hard rock formation forms the principal aquifer in the area. The ground water in the district occurs under unconfined, semi-confined to confined conditions. Study of dug wells and exploration data reveals the presence of phreatic/shallow and deep fractured aquifers in the district. The principal aquifer of the study area is shown in fig 3.1.



3.1.1 Occurrence of ground water in shallow aquifers: The depth of shallow aquifer in the district ranges from 2 to 40 meters. This shallow aquifer occurs under unconfined to semi confined condition. Ground water from shallow aquifer is exploited through different types of ground water extraction structures such as dug wells (Kachha dug wells and ring well). This dug well tapped the unconfined aquifer generally down to 2 to 6 meters. This unconfined aquifer extendsupto40 meters which is the weathered portion.

3.1.2 Occurrence of ground water in deeper aquifers: The deeper aquifer occurs as semi-confined to confined condition where ground water is found in the fractured zone of consolidated Quartzite, Granite, Granite Gneiss, Intrusive rock, Sandstone and Limestone. The drilled depth of exploratory wells tapping this aquifer ranges from 74.2 to 202.5m bgl.

The number of fractures and its zones encountered varies in all the places which show the complexity of the hydrogeology of consolidated hard rock formation.

3.1.3 Springs: Spring is defined as a localized natural discharge of ground water appearing at the ground surface as a current of flowing water through well-defined outlets. The discharge may vary from a trickle to a stream. Groundwater flow from springs is governed mainly by three inter-related factors: geology (type, distribution and permeability characteristics of geologic units), topography (landforms and relief), and climate (timing and amount of precipitation). Topography drives the groundwater flow downhill and largely dictates the occurrence of the spring itself. Climate would influence the timing and amount of recharge to the flow system and the volume and variability of discharge. Groundwater obtained from springs is similar to water pumped from shallow wells. The study of spring has been carried out in the aquifer mapping area and it was found that the location of the spring is mainly restricted to foothills and intermontane valleys. Most of the villagers are highly depended on the springs for their drinking and domestic purposes. A total of 25 springs were established and monitored periodically during the course of study. Most of these springs are depression and topographic or fractured springs. It is observed that the discharge of springs in this area ranges from dry to 36.6 litre/minute during pre-monsoon and 0.06 to 40.2litre/minute during post-monsoon seasonwhichis shown in fig 3.2 and fig 3.3. It has also been observed that the discharge of springs hasbeen increased during monsoon season and gradually decreases in post-monsoon and pre-monsoon.

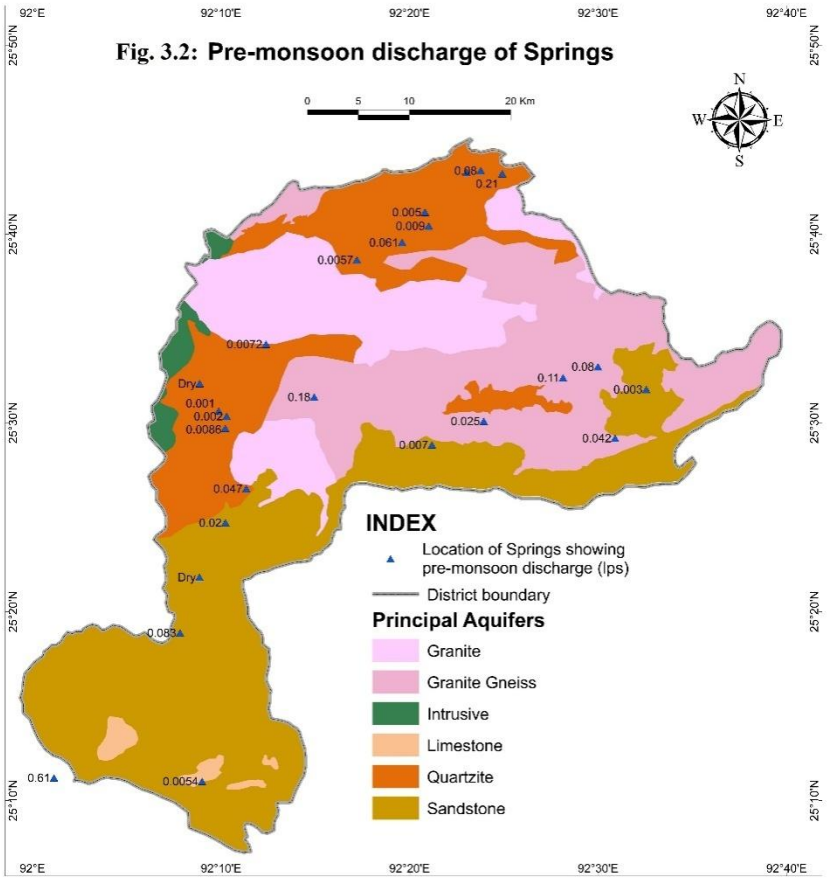


Fig. 3.2: Pre-monsoon discharge of Springs

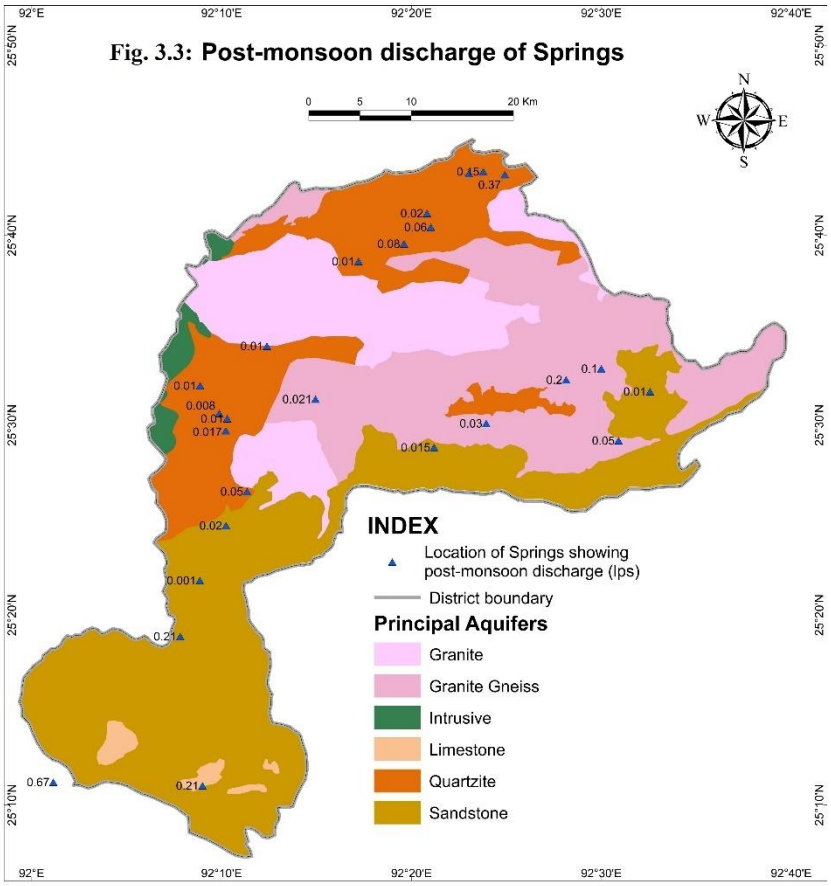
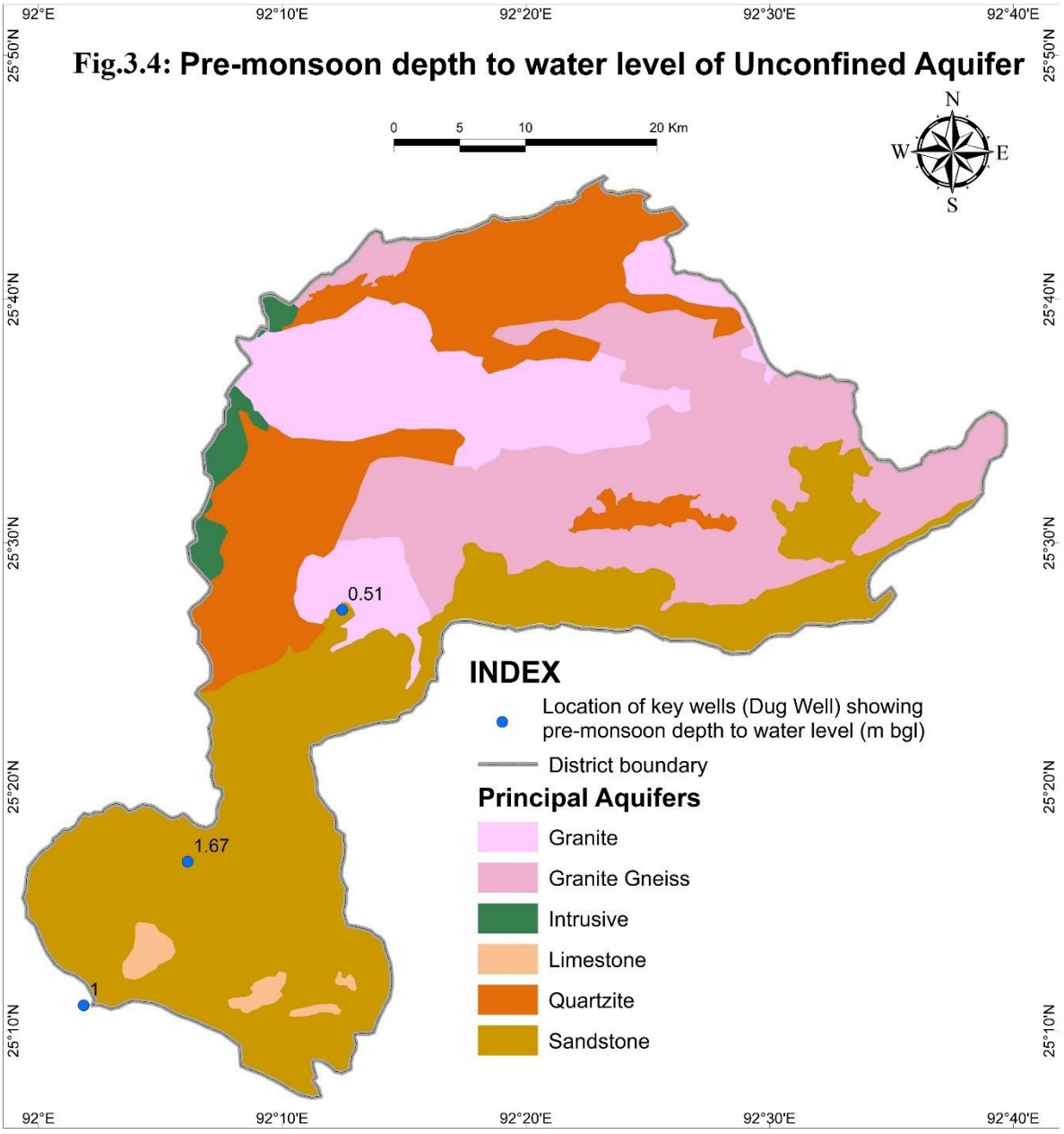
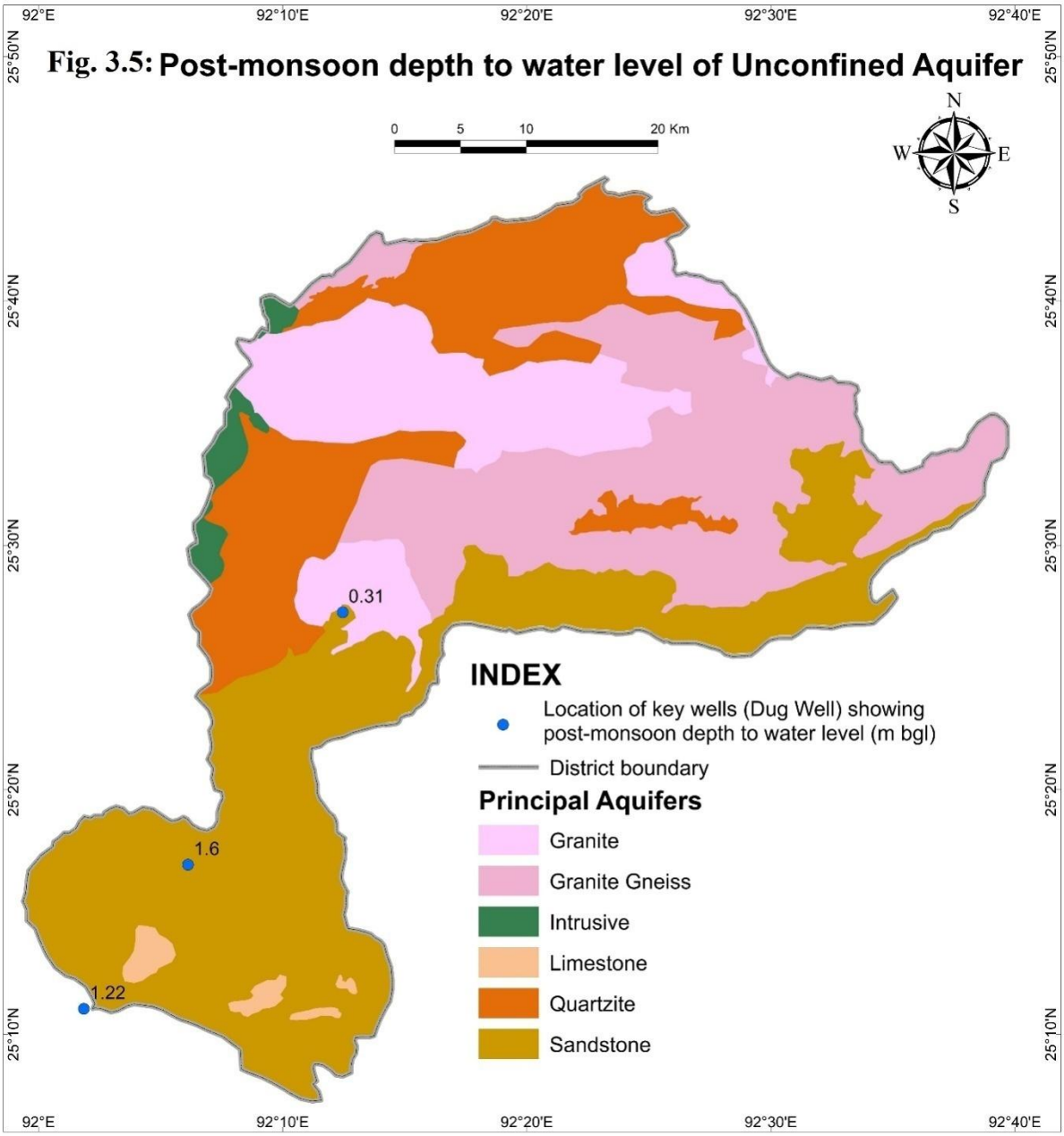


Fig. 3.3: Post-monsoon discharge of Springs

3.2 Depth to Water Level: Study of water level and its behaviorboth in phreatic and confined condition were carried out in the aquifer mapping area. A total of 3 Dug well was established as key well for periodical monitoring to know the water level trend and its behavior in phreatic condition. The depth to water level in these dug well was 0.51 to 1.67 m bgl during pre-monsoon and 0.31to 1.6 m bgl during post-monsoon season and is shown in fig 3.4 and fig. 3.5 and the average water level fluctuation is 1.14 m.





To study the piezometric head, 1 bore wells were monitored periodically. The piezometric head was 13.14m bgl during pre-monsoon and 10.84 m bgl during post-monsoon season and is shown in fig 3.6 and fig. 3.7.

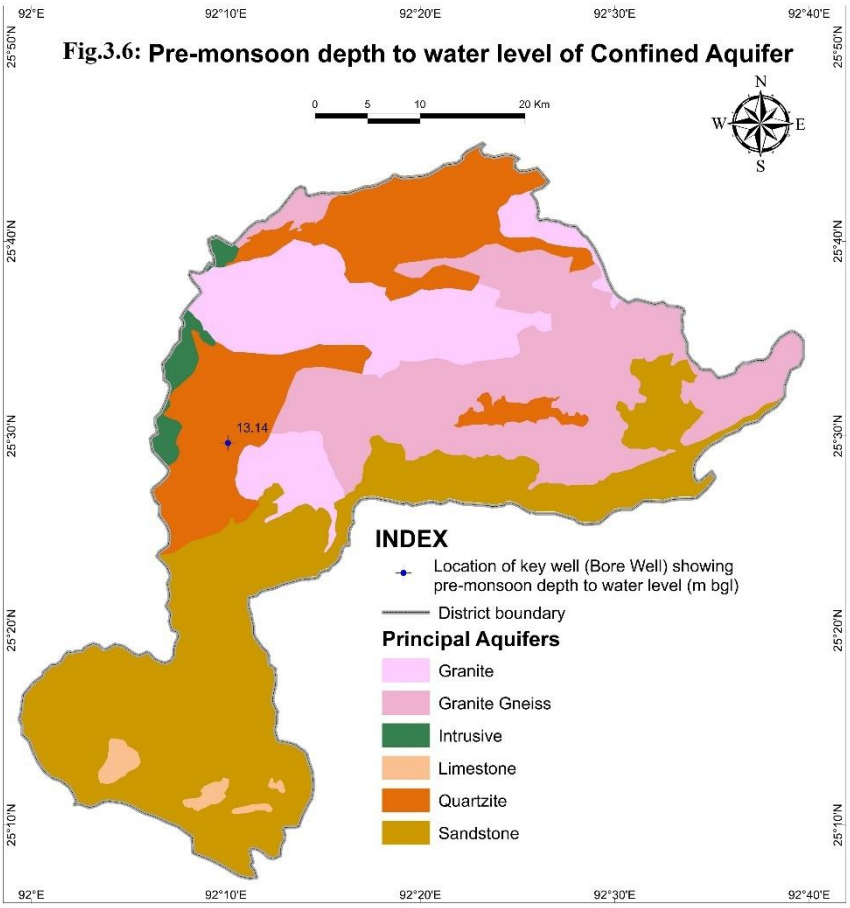


Fig.3.6: Pre-monsoon depth to water level of Confined Aquifer

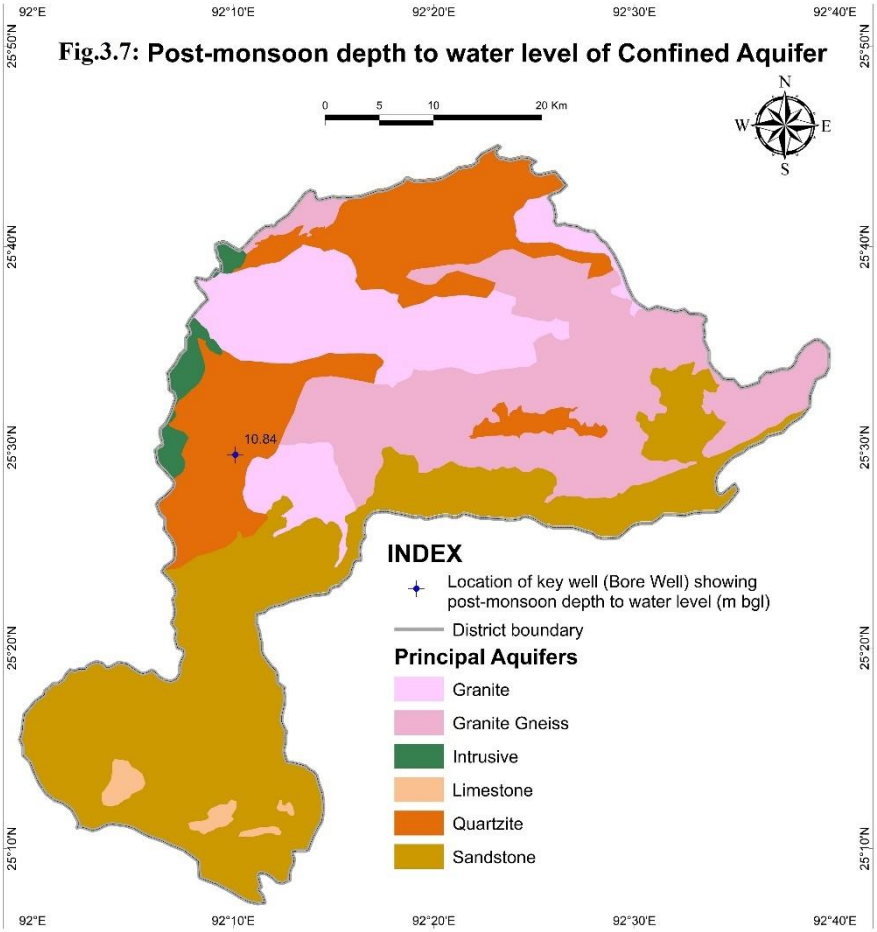


Fig.3.7: Post-monsoon depth to water level of Confined Aquifer

3.3 Aquifer system: The entire study area is underlain by consolidated rocks ofGranite, Granite Gneiss, Intrusive rock, Quartzite, Sandstone and Limestone.The aquifer system exists in all the rock formations. It also exists in both weathered formation as well as fractured system down to the explored depth of 202.5 mbgl. The depth of weathered zone varies from 2 to as high as 40 m below ground level. Thus, hydrogeologically, the study area can be categorized into sixgroups i.e. (i) Granite aquifer, (ii) Granite Gneiss aquifer, (iii) Intrusive rock aquifer, (vi) Quartzite aquifer of Shillong Group, (v) Sandstone aquifer of Jaintia Group and (vi) Limestone aquifer of Jaintia Group. In fig.3.9, disposition of fractures were shown but were not connected because of huge vertical variation and lateral extension of fractures.

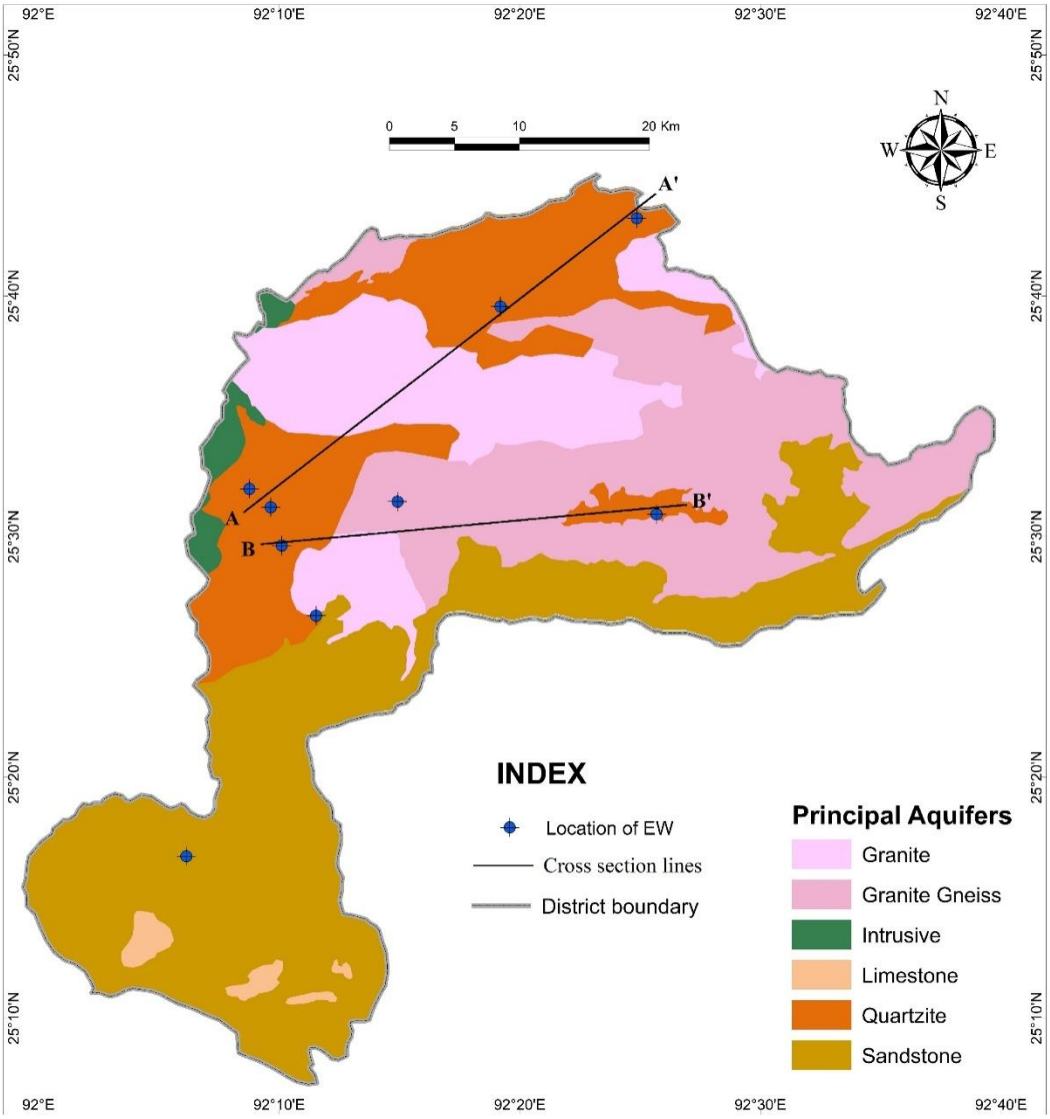
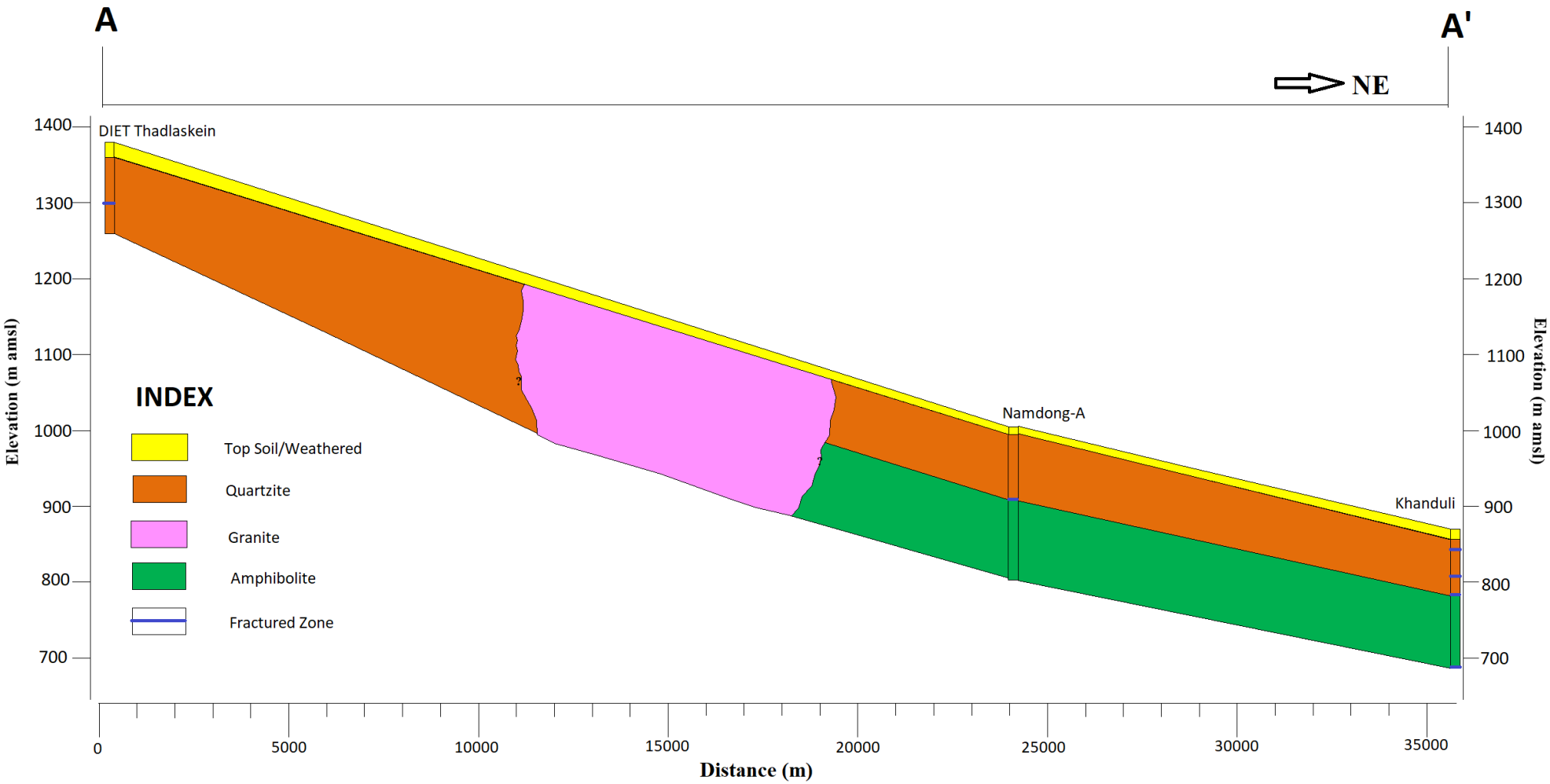


Fig.3.8 Hydrogeological section lines in WestJaintia Hills


A
A'
NE
DIET Thadlaskein
Namdong-A
Khanduli
INDEX
Top Soil/Weathered
Quartzite
Granite
Amphibolite
Fractured Zone
Elevation (m amsl)
Elevation (m amsl)
1400
1300
1200
1100
1000
900
800
700
0
5000
10000
15000
20000
25000
30000
35000
Distance (m)

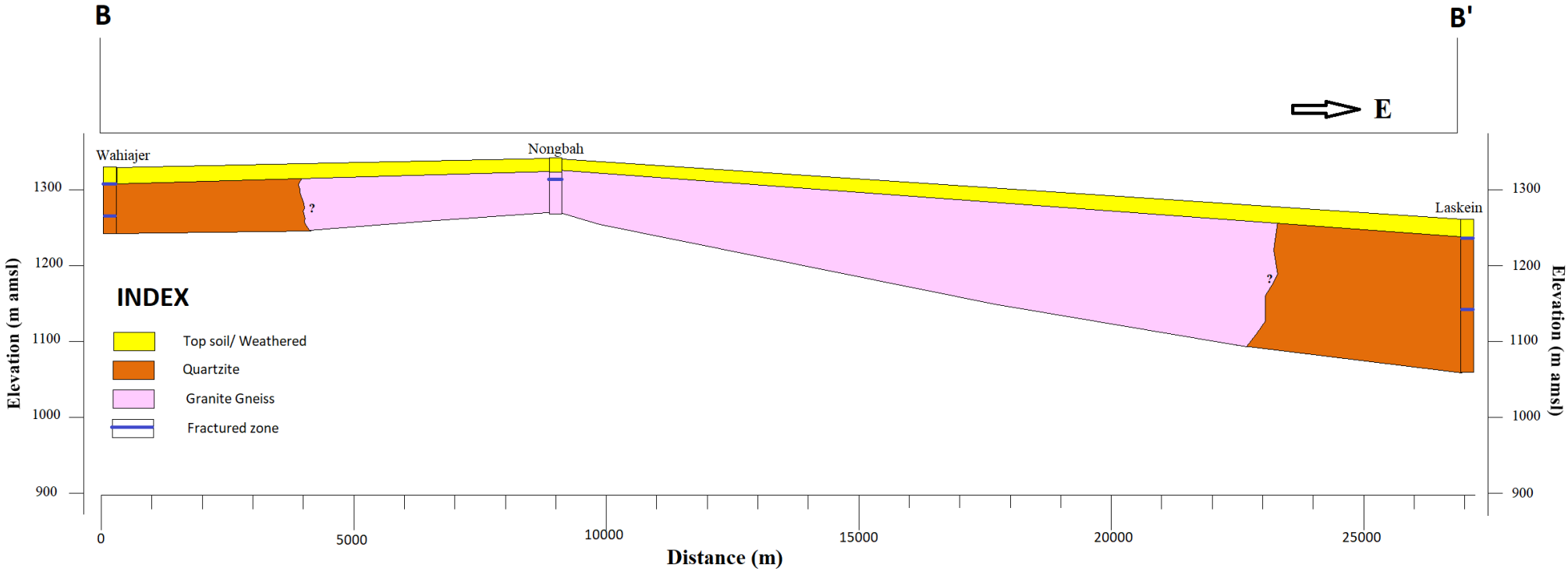


Fig. 3.9 Cross sections along A-A' and B-B'

Formation wise hydrogeological behaviors in the district are discussed below:

3.3.1 Granite: The Granite is exposed in the central parts of the district. The occurrence of ground water in this formation is controlled either by weathering and or by fractures patterns. Groundwater in these formations occurs under phreatic conditions in weathered mantle and under semi-confined to confine conditions in the fractured rocks, which is governed by topography and drainage. CGWB has not constructed any borewell in this formation, therefore the different aquifer properties in this formation are still not known.

3.3.2 Granite Gneiss: The Granite Gneiss is exposed in the central to eastern parts. The occurrence of ground water in this formation isalso controlled either by weathering and or by fractures patterns. Groundwater in these formations occurs under phreatic conditions in weathered mantle and under semi-confined to confine conditions in the fractured rocks, which is governed by topography and drainage. In this formation, depth of first aquifer ranges from 3 to 30 m bgl and the second aquifer ranges beyond 30 m bgl. So far, CGWB has drilled only one bore well in this formation and the discharge of the exploratory well 0.5lpsand Transmissivity was about 0.02 m^2/day. Distribution of fractures at various depth and cumulative discharge is tabulated in table 3.1.

Table 3.1 Location wise details of fracture encountered in Sandstone

Location	Depth drilled in m bgl	Number of fractures encountered					Discharge (in lps)
		0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Nongbah	74.2	1	0				0.5

3.3.3 Intrusive rock: Intrusive rocks exist in some part of the district and are exposed in the western parts. The occurrence of ground water in this formation are largely controlled by fractures patterns only especially in the contact zone. In this formation, the second aquifer ranges from 86.99 to 182.94 m bgl. Discharge of the exploratory wells ranges from 0.15 to 3.8 lps Transmissivity ranges from 0.02 to3.38 m^2/day. Distribution of fractures at various depth and cumulative discharge is tabulated in table 3.2.

Table 3.2 Location wise details of fracture encountered in Intrusive rock

Location	Depth drilled in m bgl	Number of fractures encountered					Discharge (in lps)
		0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Khanduli	184		1	0	1		3.8
Namdong-A	202.5		1	0	0		0.15

The above table reveals that 1 to 2numbers of fractures were encountered within 200 m depth.

3.3.4 Quartzite: Quartziteis exposed in the North -western partsof the district and the occurrence of ground water in this formation are also controlled either by weathering and or by fractures patterns. Groundwater in these formations occurs under phreatic conditions in weathered mantle and under semi-confined to confine conditions in the fractured rocks, which is governed by topography and drainage. In this formation, depth of first aquifer ranges from 2 to 30 m bgl and the second aquifer ranges from 30 to 118.64 m bgl. Discharge of the exploratory wells ranges from 0.08 to 1.74lpsand Transmissivity ranges from 0.209 to 3.65 m^2/day. Distribution of fractures at various depth and cumulative discharge is tabulated in table 3.3.

Table 3.3 Location wise details of fracture encountered in Quartzite

Location	Depth drilled in m bgl	Number of fractures encountered					Discharge (in lps)
		0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Jowai	80.19	1	2				0.28
Tyrsang	82.35	1	1				0.08
Wahiajer	88	1	1				0.14
DIET Thadlaskein	120.4	0	1				1.74
Laskein	201.9	1	0	1			0.14

The above table reveals that 1 to 3 numbers of fractures were encountered within 100 m depth.

3.3.5Sandstone: The Sandstone covers the major part of the district and is exposed in the entire southern parts. Theoccurrence of ground water in this formation is largely controlled either by weathering and or by fractures patterns. Groundwater in these formations occurs under phreatic conditions in weathered mantle and under semi-confined to confine conditions in the fractured rocks. In this sandstone, depth of first aquifer ranges from 2to 40 m bgl and the second aquifer ranges from beyond 40mbgl. The sandstone formation existing in this part is very fragile and loose and therefore could not explore beyond 100 meters. As ground water exploration studies have not been done properly in this formation, the detail aquifer properties in this sandstone is still not known.

3.3.6 Limestone: Limestone is found as small patchin thesouthernmost partof the district. Ground water occurrence and its aquifer properties are still unknown in these formations due to unexplored.

3.4 Aquifer geometry: The aquifer system in this district can be dividedinto two aquifer systemviz., first aquifer (shallow) and second aquifer (deeper).Shallow or first aquifer consists of weathered residuum where ground water occurs under water table condition and is mainly developed by construction of dug wells or shallow bore wells as hand pump. The second aquifer is the deeper aquifer which tapped the fractured zone. Based on the study of litholog and analysis of depth of construction of dug wells and shallow bore wells, it is found that the first aquifer occur within 2 to 40 m bgl. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures upto the maximum depth of 182.92 m bgl. The disposition of these aquifers is shown in fig.3.10.

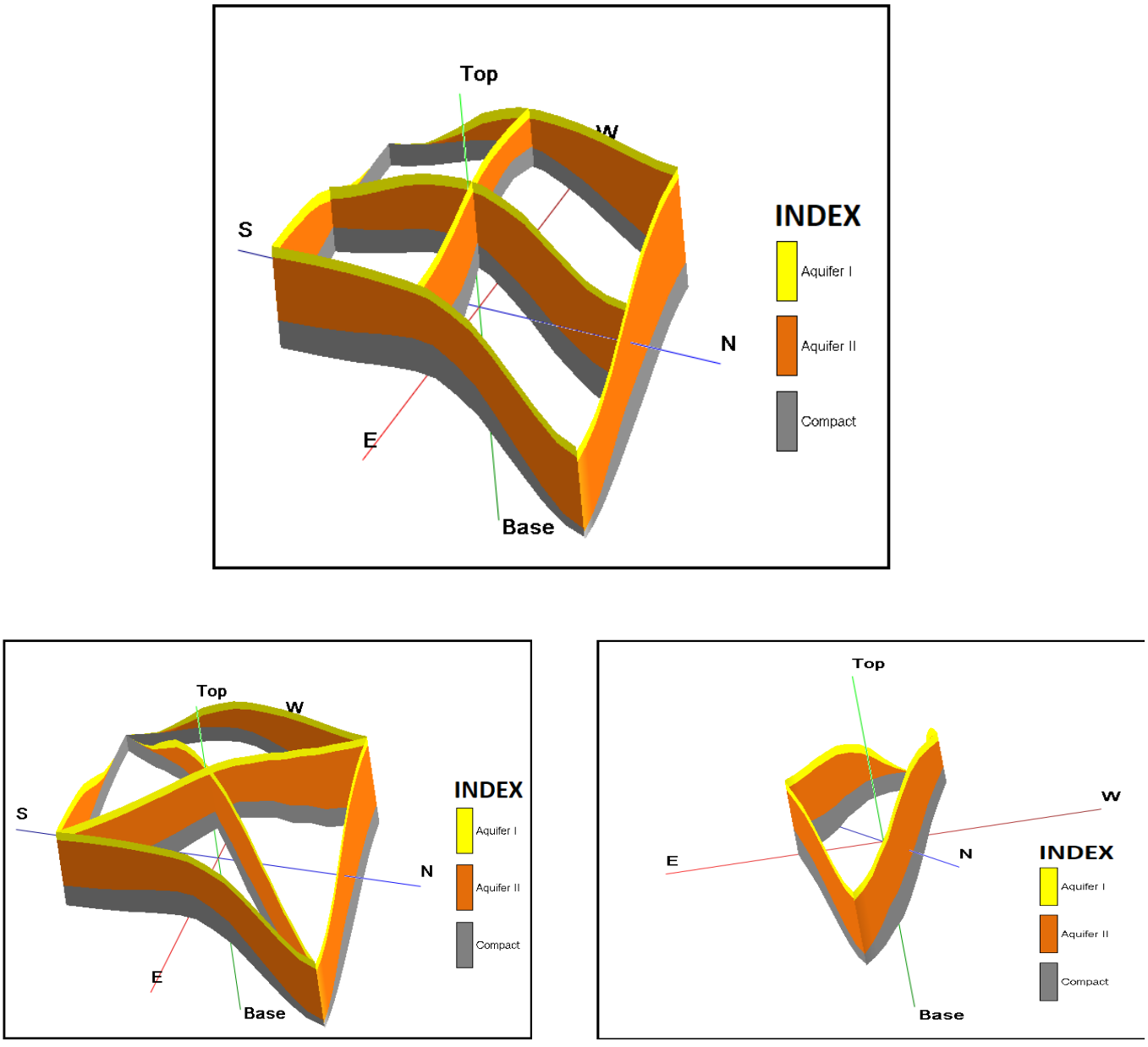


Fig. 3.10 Disposition of aquifers in West Jaintia Hills district, Meghalaya

3.5 Aquifer properties:

Aquifer I: It is the unconfined aquifer where the tapping of aquifer zone ranges within 2 to40 m depth and generally exhibits unconfined nature of the aquifer. The study area is undulating terrain and tapping of Aquifer I is suitable in the valley portion.

Aquifer II: This is the deeper aquifer which occurs as semi confine to confine condition where ground water is found in the fractured zone of consolidated Sandstone and Limestone. The drilled depth of exploratory wells tapping this aquifer ranges from 74.2 to 182.94 m bgl. The number of fractures and zones of encountering fractures varies widely which show the complexity of the hydrogeology of consolidated hard rock formation. Through PYT and Slug test, it was found that transmissivity values vary from 0.02 to 3.65 m^2/day and the discharge in these wells ranges from 0.08 to 3.8lps.

3.6 Hydrochemistry:

The quality of ground water is as important as that of the quantity. In order to study the chemical quality of ground water in the district, water samples fromsprings, exploratory bore wells and dug wells were collected during the course of field work. The parameters analyzed are pH, EC, Turbidity, TDS, CO_3, Cl, SO_4, Na, K, HCO_3, NO_3, F, Ca, Mg, TH and Fe. The details of chemical analysis were given in the Annexure 2.

3.6.1 Ground water quality of unconfined aquifer:

A total of 3 ground water samples from dug wellwere collected during post-monsoon studies and therange of concentrations of different chemical constituents present in the ground water samples are given in table 3.4.

Table 3.4: Chemical quality/ water samples from dug well, WestJaintia district

Sl. No.	Chemical constituents (Concentrations in mg/l except pH & EC)	Range	
		Min	Max.
1	pH	5.59	6.86
2	EC (µs/cm) 25°C	40.42	151.70
3	TDS	23.27	79.10
4	CO3-2	0	0
5	HCO3-1	10	80
6	TA (as CaCO3)	10	80
7	Cl-	7.09	17.18
8	SO4-2	2.27	15.98
9	NO3-1	0	6.7
10	F-	0.06	0.51
11	Ca+2	2	20
12	Mg+2	1.2136	12.0631
13	TH (as CaCO3)	34.0272	55
14	Na	0.91	2.62
15	K	0.12	1.74
16	Fe	0	0.43

It is deciphered from table 3.4 that all of the chemical parameters are within permissible limit for all uses. The EC values are shown in fig 3.11, pH values in fig 3.12 and Fe conc. in fig. 3.13.

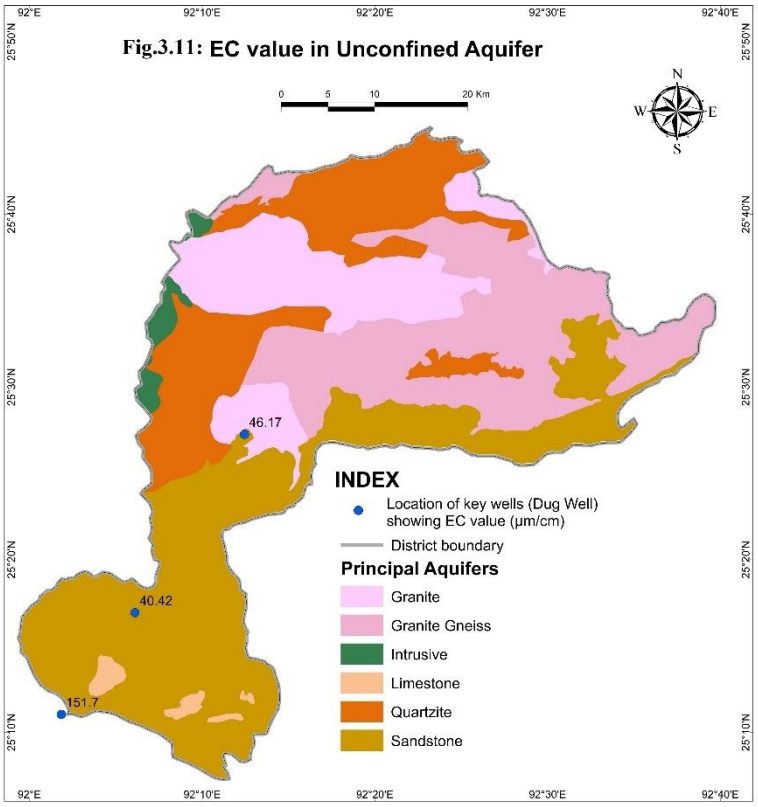


Fig.3.11: EC value in Unconfined Aquifer

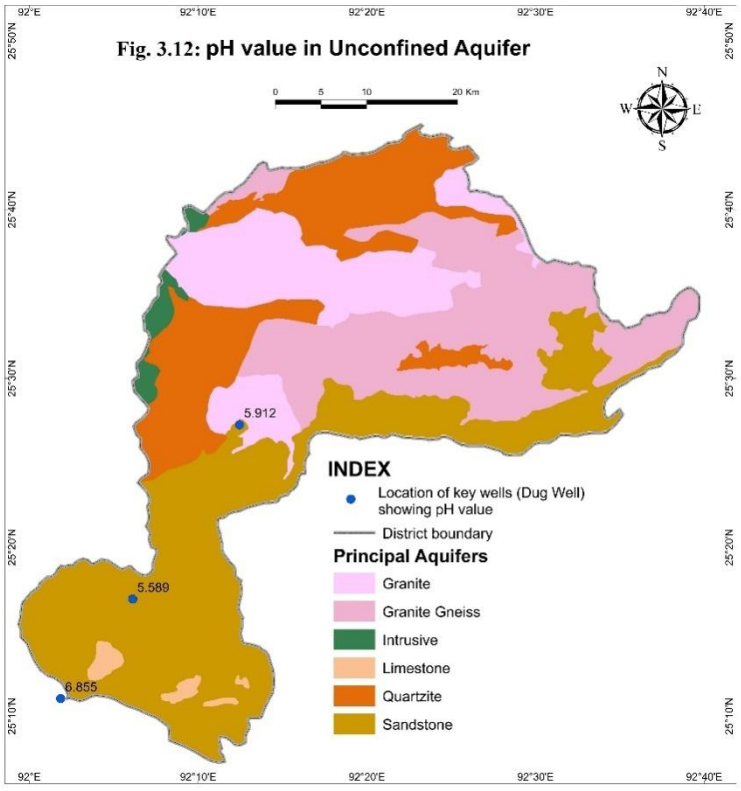


Fig. 3.12: pH value in Unconfined Aquifer

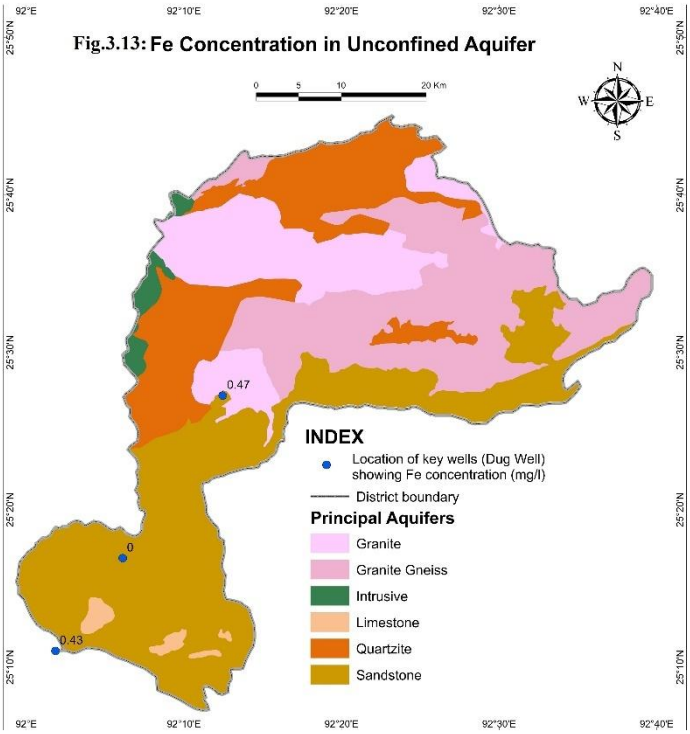


Fig.3.13: Fe Concentration in Unconfined Aquifer

3.6.2 Ground water quality in confined aquifer: Only one water samples was collected during exploratory drilling programme and monitoring during the course of studies. Based on chemical analysis data therange of concentrations of different chemical constituents present in the deeper aquifer samples are given in table 3.5.

Table 3.5: Chemical quality of ground water in deeper aquifer

Sl. No.	Chemical constituents (Concentrations in mg/l except pH & EC)	Range
1	pH	8.1
2	EC (µs/cm) 25C	115
3	TDS	80
4	CO3-2	0
5	HCO3-1	92
6	Cl-	11
7	SO4-2	
8	Ca+2	20
9	Mg+2	12
10	TH (as CaCO3)	100
11	Na	7
12	K	1
13	Fe	0

It can be inferred from table 3.5 thatall the parameters are within the permissible limit. The EC values are shown in fig 3.14, pH values in fig 3.15 and Fe conc. in fig. 3.16.

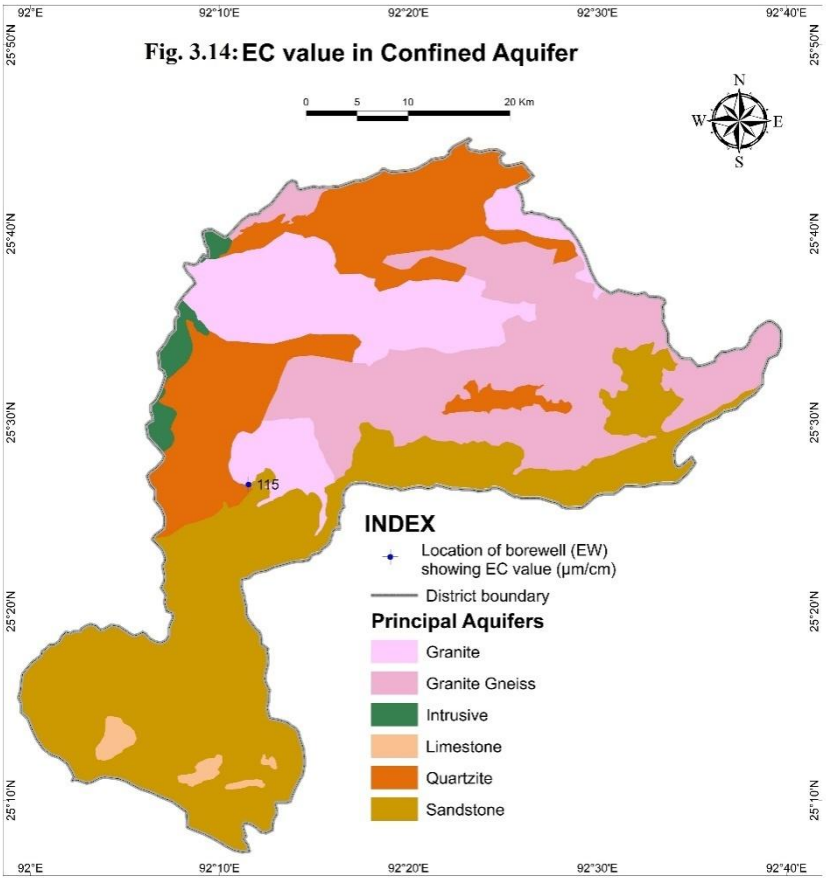


Fig. 3.14: EC value in Confined Aquifer

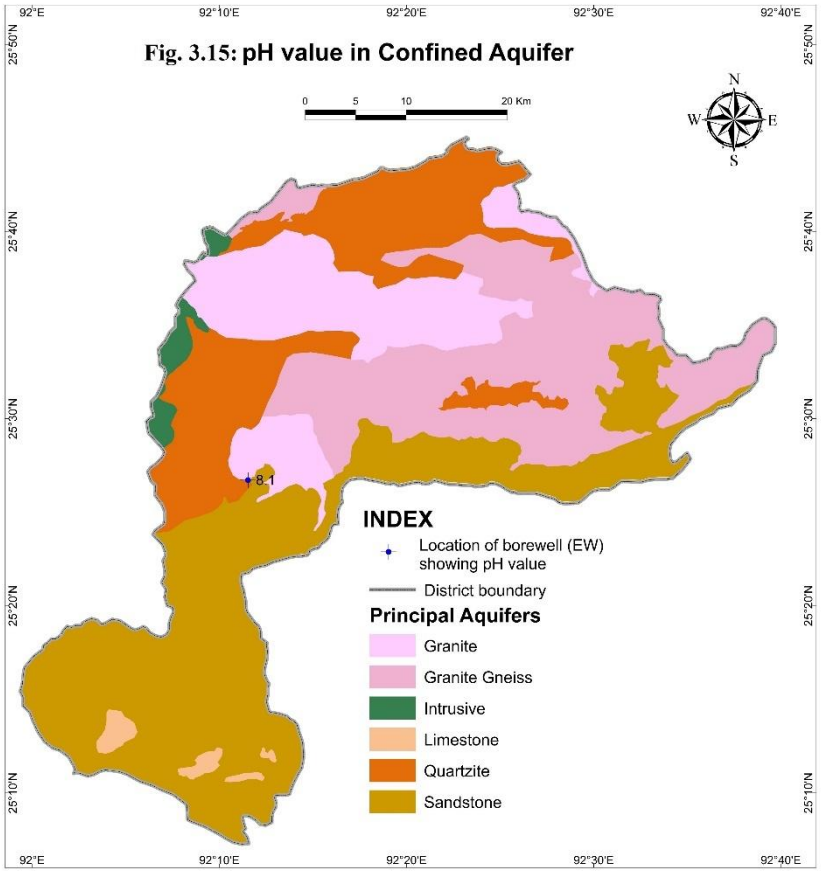


Fig. 3.15: pH value in Confined Aquifer

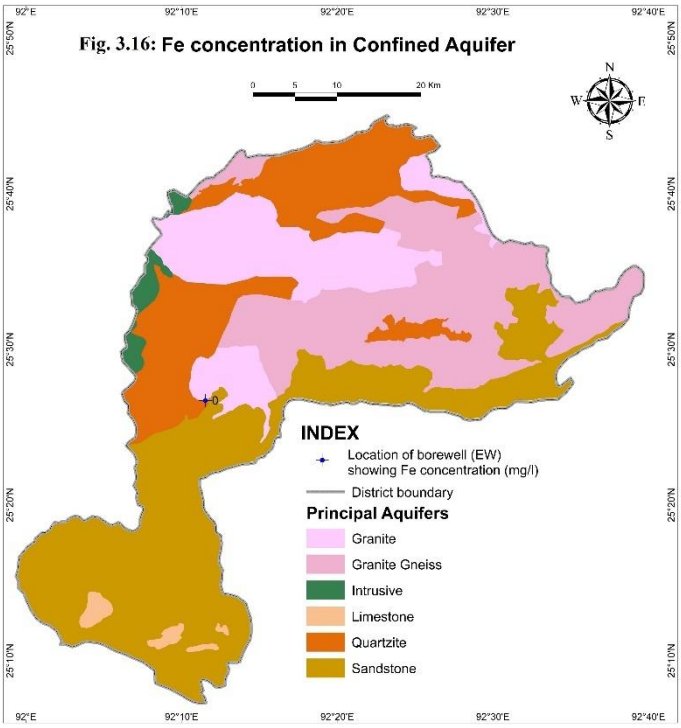


Fig. 3.16: Fe concentration in Confined Aquifer

3.6.3 Water quality of springs: A total of 8 water samples from spring were collected during post-monsoon studies and therange of concentrations of different chemical constituents present in the spring samples is shown in table 3.6

Table 3.6: Chemical quality of spring water, West Jaintia Hills district

Sl. No.	Chemical constituents (Concentrations in mg/l except pH & EC)	Range	
		Min	Max
1	pH	4.60	7.48
2	EC (µs/cm) 25°C	13.03	246.2
3	TDS	9.88	143.2
4	CO3-2	0	0
5	HCO3-1	10	135
6	TA (as CaCO3)	10	135
7	Cl-	14.18	46.085
8	SO4-2		
9	NO3-1	0	5.8473
10	F-	BDL	0.36
11	Ca+2	1.70136	69.75576
12	Mg+2	3.0971	16.5181
13	TH (as CaCO3)	17.0136	242.4438
14	Na	0.13	13.38
15	K	0.04	19.82
16	Fe	0	0.0992

Itcan be inferred from table 3.6 that exceptpH, the other parameters are within the permissible limit. Out of 16 samples analyzed, 11samples have pH value less than 6. The EC values are shown in fig 3.17, pH values in fig 3.18 and Fe conc. in fig. 3.19.

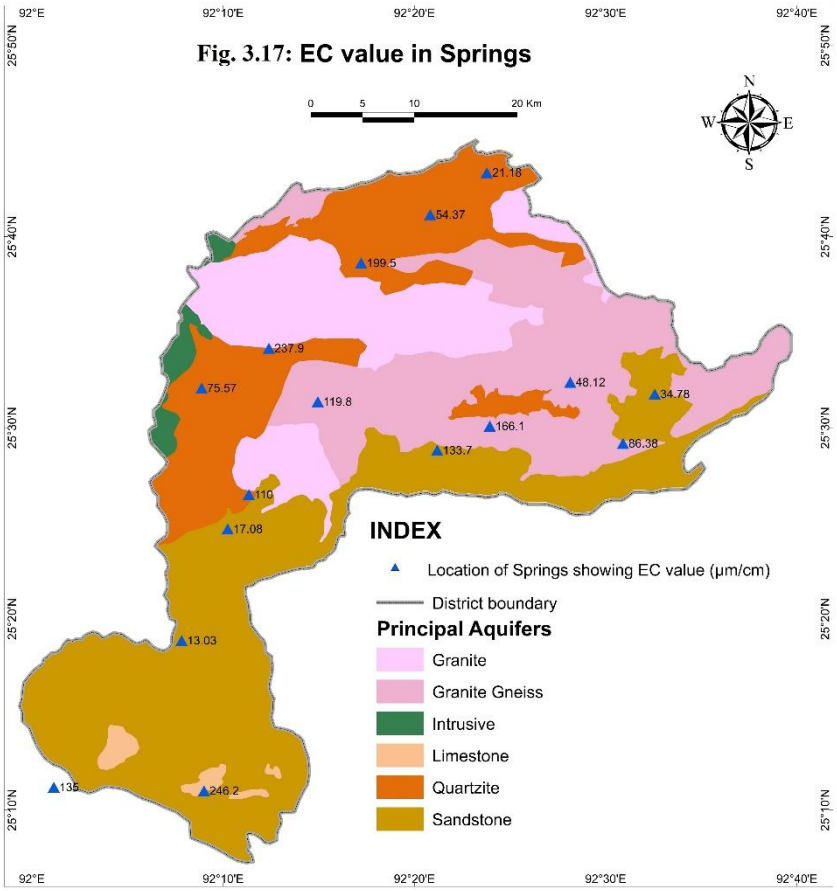


Fig. 3.17: EC value in Springs

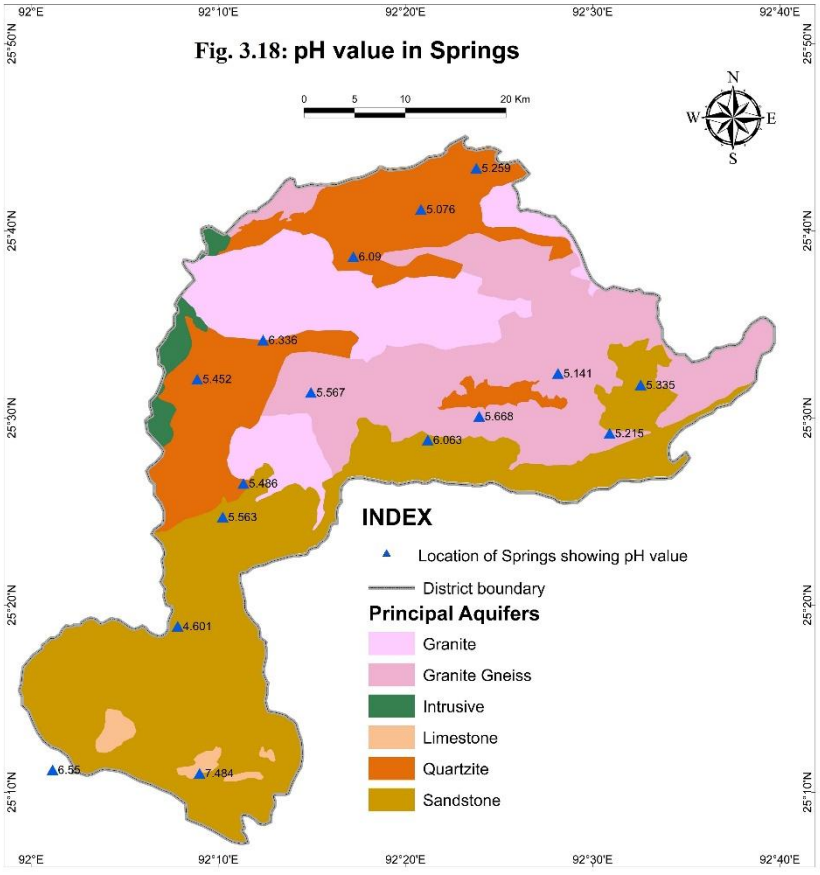


Fig. 3.18: pH value in Springs

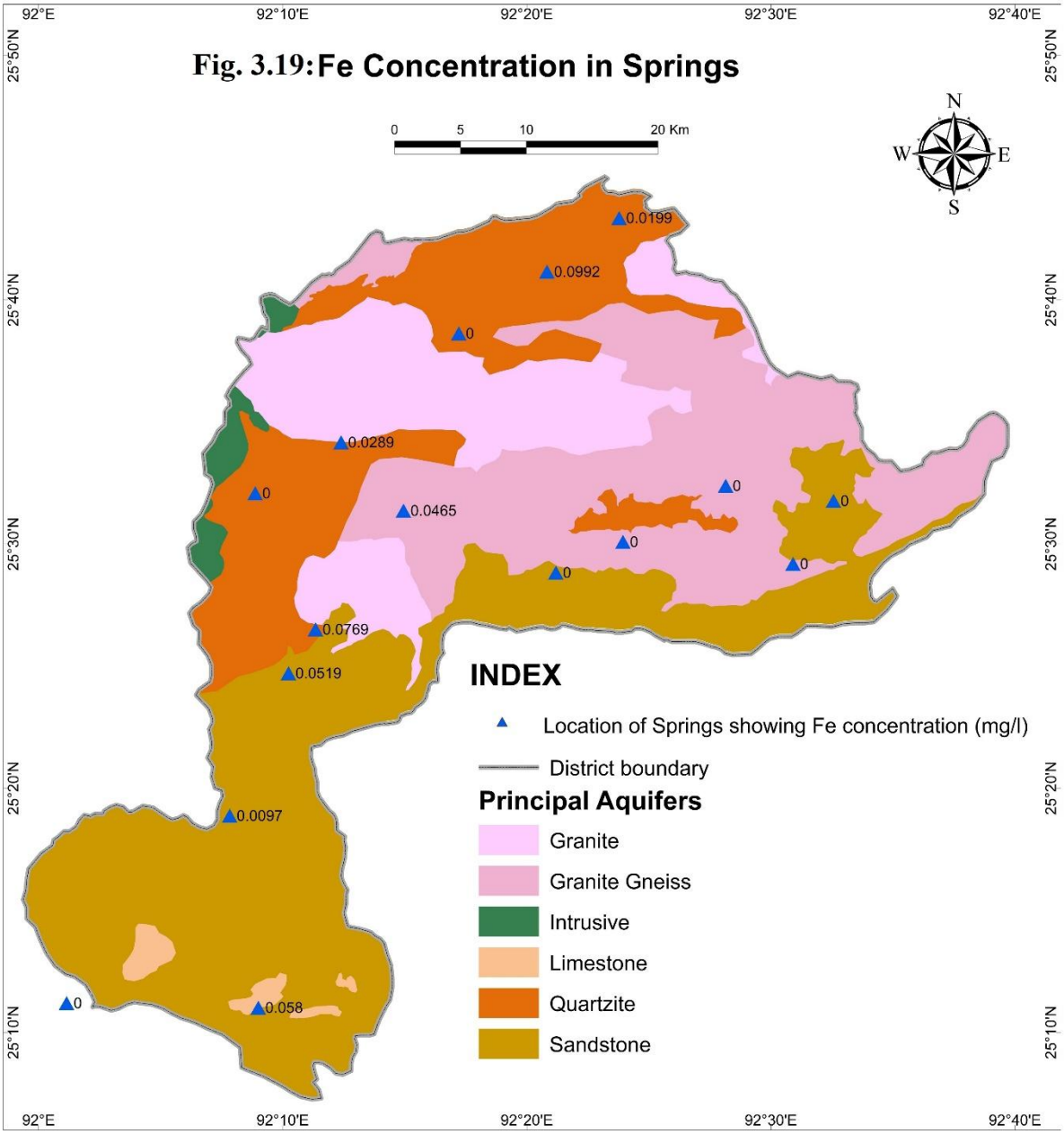


Fig. 3.19: Fe Concentration in Springs

4. GROUNDWATER RESOURCES

Dynamic Groundwater Resources of West Jaintia Hills district has been estimated based on the methodology recommended by Groundwater Estimation Committee (GEC'97). The resources computed for the groundwater year 2017-18. In the present resource estimation, the smallest administrative unit considered for resource estimation is district since block-wise data is not available. The following sub-units are recommended for the computation of various figures in the methodology and these are considered in details below:

Hilly Area: Area with more than 20% slope has been excluded for the recharge computation. As per NESAC, total recharge worthy area in the district is 997 sq.km.

Poor Groundwater Quality Area: In the district, there is no mappable area, which can be demarcated as poor groundwater quality and hence not considered.

Command and Non-Command Area: The methodology envisages computation of various figures separately for command & non-command area. In the district, there is no major or medium canal irrigation scheme and thus the entire rechargeable area has been considered as a non-command area.

Lithological sub-units: The entire district is underlain by consolidated rocks of Quartzite, Granite, Granite Gneiss, Sandstone, Limestone and Intrusive rock. Different units considered for computation of recharge are Quartzite, Granite, Granite Gneiss, Sandstone, Limestone and Intrusive rock.

4.1 Groundwater Resources – Recharge for Various Seasons: The rainfall infiltration factor recommended by GEC'97 for Quartzite, Granite, Granite Gneissand Intrusive rock are 0.02, Sandstone is 0.12 and Limestone is 0.06. During fieldworks 7 nos. of Infiltration studies were carried out, mostly in area underlain by Tertiary sediments and Quartzites. Rainfall recharge factor (RRF) calculated from these studies show that average RRF is 4%.

For calculating recharge from return flow from irrigation, an average water requirement of 1.2 m & 0.1 m for paddy & non-paddy has been considered (as per discussion with Agriculture department, Govt. of Meghalaya). Computation factor for return flow from surface water irrigation is taken as 0.30 – 0.50 as per GEC'97 methodology. Return flow from surface water irrigation has not been considered for monsoon season because aquifers remains fully saturated during the periods of intensive rainfall, additional recharge from ponds & tanks during this period is negligible. Recharge from ponds and tanks during non-monsoon period are considered for 100 days.

Recharge from Rainfall has been computed separately for monsoon and non-monsoon periods for the entire district. The recharge from rainfall during monsoon season has not been computed using water level fluctuation method (WLFM) as Ground Water Monitoring Wells (GWMW) in the district is very few. The rainfall recharge estimated for non-command area of the entire district and the details are shown in annexure 8.

Recharge from All Sources: Total recharge to groundwater has several components, rainfall being the major one. The other components include seepage from canals, return flow from surface water irrigation, return flow from groundwater irrigation, seepage from tanks/ ponds etc. Recharge from various sources has been calculated for monsoon as well as non-monsoon periods and details have been shown in table 4.1.

Table 4.1: Recharge from various sources (ham).

District	Recharge from Rainfall	Return Flow from Surface water Irrigation	Return Flow from Groundwater Irrigation	Recharge from ponds & tanks	Total recharge from other sources	Total Annual Recharge
West Jaintia Hills	17252	970	0	24	994	18246

Recharge from rainfall in the district is 17252 ham .Comparison of monsoon & non-monsoon rainfall recharge shows that monsoon recharge accounts for 73%. In comparison to recharge from rainfall, recharge from sources other than rainfall shows that the later accounts for about than 5% of the total recharge.

4.2 Groundwater Draft for Various Purposes: Groundwater draft for domestic use has been estimated based on number of households using groundwater (Census 2011 data) and number of tube wells used by PHED to supply water and on number of structures used in different industrial units. Unit draft of bore wells used by industries is 1 ham/yr. Groundwater draft for irrigation is nil. It was found that groundwater draft for all uses in the district is 59 ham.

4.3 Stage of Groundwater Development &Categorization of the Blocks: The district falls under "**SAFE"** category. The stage of development is 0.36%. Summary of groundwater resources, stages of development and categorization are given in annexure 8.

4.4 Comparison with groundwater resource over the years: In table 4.2, a comparison amongst the total annual groundwater recharge, total groundwater resources available, net annual draft and balance groundwater resources available for future development estimated during 2012-13 and modified resource estimation during 2017-18 (taking into consideration infiltration rate) has been presented.

Table 4.2: Comparison between Groundwater Resources Estimatedduring 2012-13and 2017-18 is as below. (Ground water resources in ham)

	2017-18	**2012-13**
Rainfall recharge during monsoon	12557	31668
Rainfall recharge during non-monsoon	4695	1897
Recharge from other sources	994	994
Annual GW recharge	18246	34558
Net GW availability	16421	31102
GW draft for irrigation	0	0
Gross GW draft	59	59
Annual Allocation of ground water for domestic & industrial water supply upto 2025	590	2020
Balance GW for future irrigation development	15831	29077
Stage of development	0.36%	0.19%

The reasons behind the differences between the groundwater resources estimated during are as follows;

(1) Difference in Rainfall recharge – (a) Normal monsoon rainfall used in 2012-13 but in the present estimation maximum threshold of 3000 mm was used. (b) Use GEC norm of Rainfall infiltration factor (RIF) in 2012-13 but in the present estimation RIF taken from field studies.

(2) Annual Allocation of ground water for domestic & industrial water supply upto 2025 was calculated as per GEC'97 methodology during 2012-13 but it is too high in comparison to present ground water draft. So, in the present estimation it is considered as 10 times of present annual draft.

(3) Difference in Balance groundwater available for future irrigation and stage of development – due to above reasons these figures show changes.

5. GROUND WATER RELATED ISSUES

There are two major ground water related issues found in the study area.

5.1 Low stage of ground water development: As per ground water resource estimation 2013, the stage of ground water development is just 0.19 % and there is no utilization of ground water for irrigation in this area. All the irrigation schemes in the district are dependent upon the surface water resources. Therefore, there is enough scope for future development of ground water in the study area to bring more area under irrigation practice. At present the irrigation practice by utilizing ground water (constructing bore well) is not accepted by villagers due to small land holding, high cost for construction and running of a well compared to production outcome. Another major obstacle in accelerating ground water irrigation is the absence of power lines in most of the cultivated/cultivable area.

5.2 Ground water quality: As per water quality analysis data, it was found that there is a very low pH value in most of the springs which the people are mainly dependent for drinking purpose. Apart from these, the other parameters are within the permissible limit.

6. MANAGEMENT STRATEGIES

As per dynamic ground water resource estimation of West Jaintia Hills District for 2013, net ground water availability is 31102 ham and stage of development is only 0.19%. The district is having balance net ground water availability for future irrigation use in the tune of 29077 ham. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then 17446 ham of groundwater resources is available in the district for the future irrigation uses. From this available resource (planned for future development) 19300 nos. of shallow tube wells (considering a unit draft of 0.9 ham/year) can be constructed in the aquifer mapping area. Therefore, there is enough scope for future development of ground water in the study area to bring more area under irrigation practice.

Present land under irrigation during kharif season is 2597 ha, during rabi season it is 555 ha. All the schemes which are used for irrigation is using surface water sources. Present irrigation from ground water source is almost nil. Hence, there is ample scope for ground water development for irrigation purpose which will bring prosperity to the society and help the district in achieving self-reliance on food grain. To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. Necessary input to design a cropping plan was taken as advised by the eminent scientists of Assam Agricultural University, Jorhat and ICAR, Umiam. Cropping pattern data for the district is presented in table 6.1.

During 2015-16, net sown area in the district is 25169 ha, area sown more than once is 381 ha and cropping intensity is 101%. The net sown area included field crops as well as horticulture and plantation crops on slopes and hills. Cropping intensity is calculated generally from field crops, which are of short duration whereas horticulture (like citrus, banana, pineapple) and plantation crops like spices are long duration crops. Again crops grown on the hills like pineapple, turmeric and ginger are having negligible or nil irrigation requirements. During kharif season, paddy is cultivated in 7938 ha and land under Maize cultivation is 2855 ha. After Kharif crops were grown major portion of this area remains fallow during Rabi season. The intention of this plan is to bring this fallow land of about 10793 ha under assured irrigation during Rabi season which will help to increase gross cropped area to 21586 ha and thereby increase cropping intensity up to 200%. In rice fallow, potato, mustard and rabi vegetables can be grown with the support of irrigation and in maize fallow, soyabean, pulses and vegetables can be grown with the support of irrigation. Present

cropping pattern, proposed cropping pattern, intended 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 taken 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

(File: C:\ProgramData\CROPWAT\data\sessions\jowai.PAT)

Cropping pattern name: Jowai

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...ata\CROPWAT\data\	MAIZE (Grain)	15/04	17/08	13
2	...Data\CROPWAT\data	Rice	04/06	01/10	7
3	...Data\CROPWAT\data	Rice	11/06	08/10	10
4	...Data\CROPWAT\data	Rice	18/06	15/10	15
5	...Data\CROPWAT\data	Rice	25/06	22/10	5
6	...\CROPWAT\data\cro	Soybean	26/08	18/11	9
7	...a\CROPWAT\data\cr	Pulses	26/08	13/12	4
8	rape___mustard.CRO	Mustard	15/10	27/05	11
9	...\CROPWAT\data\cro	Potato	15/11	24/03	7
10	...CROPWAT\data\crop	Small Vegetables	05/02	10/05	6
11	...\CROPWAT\data\cro	Tomato	01/12	24/04	6
12	...\CROPWAT\data\cro	Potato	15/01	24/05	7

Table 6.2a. Cropping pattern, proposed cropping pattern, intended cropping intensity, West Jaintia Hills District.

Cropping pattern (s)				
Rice based cropping pattern				
1. Rice-Potato 2. Rice-Mustard 3. Rice-Vegetables	Present Cultivated area (**ha**)	Area to be cultivated (**%**)	Area to be cultivated (**ha**)	Irrigation requirement (**ha m**)
	1	2 (= % of 1)	3	4
Rice (main crop)	7938		7938	1173
Potato	130	37	2938	620
Mustard	80	31	2500	680
Vegetables	?	32	2500	529
Net cultivated area	7938		**7938**	
Gross cultivated area (1+potato/+mustard/+Veg)	8148		**15876**	
Total irrigation requirement				3002
Cropping intensity	**103% (Present)**		**200% (Intended)**	
Maize based cropping pattern				
1. Maize-soybean 2. Maize-pulses				
Maize (main crop)	2855		2855	0
Soybean	593	70	2000	55
Pulses	138	30	855	62
Net cultivated area	2855		**2855**	
Gross cultivated area (Maize+soybean/+pulses/+Veg)	3586		**5710**	
Total irrigation requirement				118
Cropping intensity	**126 % (Present)**		**200% (Intended)**	
Total (West Jaintia Hills district)				3120

Table 6.2b. Proposed cropping pattern with water deficit months and IWR, West Jaintia Hills district

Rice based cropping pattern			
Crop	**Growing period (Months)**	**Periods/months of water deficit**	**Irrigation requirement (ha m)**
Rice	4	1 – 2	1173
Potato	6	6	620
Mustard	6	5 - 6	680
Vegetables	3	3	529
Maize based cropping pattern			
Maize	4	0	0
Soybean	3	1	0
Pulses	4	2	6

Table 6.3: Crop-wise and month-wise precipitation deficit (IWR) from CROPWAT 8, West Jaintia Hills District.

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit (in mm)												
1. MAIZE (Grain)	0	0	0	0	0	0	0	0	0	0	0	0
2. Rice	0	0	0	0	147	59.4	0	0	0	2.4	0	0
3. Rice	0	0	0	0	49.3	98	0	0	0	0	0	0
4. Rice	0	0	0	0	49.4	66.8	0	0	0	0	0	0
5. Rice	0	0	0	0	0	146.9	0	0	0	4.4	0	0
6. Soybean	0	0	0	0	0	0	0	0	0	0	28.1	0
7. Pulses	0	0	0	0	0	0	0	0	0	0	60.2	12.2
8. Mustard	45	52.8	73	30	0	0	0	0	0	0	42.4	43.3
9. Potato	53.8	63.4	51.6	0	0	0	0	0	0	0	14.7	32.2
10. Small Vegetables	0	37.1	74.2	41.1	0	0	0	0	0	0	0	0
11. Tomato	41.2	63.6	91.6	30.3	0	0	0	0	0	0	0	29.8
12. Potato	14.6	39.4	89.8	50.7	0	0	0	0	0	0	0	0

Table 6.4: Irrigation Water Requirement (in ham), West Jaintia Hills District

Crops	% of total area of 21586 ha	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation deficit (ham)														
1. MAIZE (Grain)	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
2. Rice	7	0.0	0.0	0.0	0.0	222.1	89.8	0.0	0.0	0.0	3.6	0.0	0.0	316
3. Rice	10	0.0	0.0	0.0	0.0	106.4	211.5	0.0	0.0	0.0	0.0	0.0	0.0	318
4. Rice	15	0.0	0.0	0.0	0.0	160.0	216.3	0.0	0.0	0.0	0.0	0.0	0.0	376
5. Rice	5	0.0	0.0	0.0	0.0	0.0	158.5	0.0	0.0	0.0	4.7	0.0	0.0	163
6. Soybean	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.6	0.0	55
7. Pulses	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.0	10.5	63
8. Mustard	11	106.9	125.4	173.3	71.2	0.0	0.0	0.0	0.0	0.0	0.0	100.7	102.8	680
9. Potato	7	81.3	95.8	78.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.2	48.7	326
10. Small Vegetables	6	0.0	48.1	96.1	53.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	197
11. Tomato	6	53.4	82.4	118.6	39.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.6	332
12. Potato	7	22.1	59.5	135.7	76.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	294
Total	100	263.6	411.1	601.7	240.3	488.5	676.1	0.0	0.0	0.0	8.4	229.5	200.6	3120

Under ground water exploration programme, CGWB has constructed 9 bore wells in this area and has established that the aquifer in most part of the district is having low potentiality, having an average discharge of about 5 m^3/hr from quartzites in Thadlaskein block but in other areas discharge is too low.

The ground water potentiality of the area is low to moderate, especially in the low-lying valley areas which are feasible for sustainable ground water development. Therefore, those areas can be brought under irrigation by developing ground water through bore wells or large diameter dug wells of size 2 to 3 m (dia) X 10 to 15 m (depth) can be constructed.

A bore well in the area is expected to yield 7.5 m^3/hr. If such a bore well runs for 10 hrs/day for 120 days, then it will create a draft of 0.9 ham. Bore wells can be designed within a depth of 100m, expected to encounter 2 – 3 fractures. Bore wells can be constructed by using $8^{//}$ dia. casing pipe down to 30 m.

In considered net sown area of 10793 ha, 2700 nos. of shallow bore wells can be constructed (considering 200m distance between any two shallow bore well). 2700 nos. of bore wells can extract 2430 ham of water annually.

Annual irrigation water requirement is 3120 ham while irrigation water requirement during dry season spanning from October to March it is 1715 ham. Again proportionate dynamic groundwater resources available for future irrigation use in the considered area are 9910 ham. Hence, this area can be brought under assured irrigation from groundwater sources. The demand of 1715 ham can be harnessed by constructing 1900 bore wells. At possible places water harvesting methods should be employed.

Groundwater in the area have low pH in almost all the springs, dug well and bore well and needs to be treated before consumption. This acidic water can be treated byacid neutralizing filters or chemical feed pump.

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Annexure 1: Hydrogeological details of bore wells constructed by CGWB in Aquifer mapping area.

Sl. No.	Village/ Location	Taluka/ Block	District	Toposheet No.	Longitude	Latitude	Type of well (DW/BW/TW)	Depth	Dia	Date of pumping Test	Draw down (m)	Transmissivity (m^2/day)	Source/ Agency	Remarks
1	Jowai	Thadlaskein	West Jaintia Hills	83 C/3	92°11'32"	25°26'43"	BW	80.19	5 1/2""	06.01.1991	21.9	0.209	CGWB	
2	Nongbah	Thadlaskein	West Jaintia Hills	83 C/2	92°14'55"	25°31'27"	BW	74.2	5 1/2""		27.8	0.02	CGWB	
3	Tyrsang	Thadlaskein	West Jaintia Hills	84 C/2	92°08'15"	25°32'01"	BW	82.35	5 1/2""		39.55	2.28	CGWB	
4	Wahiajer	Thadlaskein	West Jaintia Hills	85 C/2	92°09'45"	25°31'47"	BW	88	5 1/2""		30.3	0.92	CGWB	
5	DIST Thadlaskein	Thadlaskein	West Jaintia Hills	83 C/3	92°10'06"	25°29'37"	BW	120.4	6 1/2"/7"		1.12	3.65	CGWB	
6	Amlarem	Amlarem	West Jaintia Hills	83 C/3	92˚06’08”	25˚16’43”	BW	92.7	6 1/2"/7"				CGWB	
7	Laskein	Laskein	West Jaintia Hills	83 C/6	92˚25’40”	25˚30’55”	BW	201.9	6 1/2"/7"			0.34	CGWB	
8	Khanduli	Thadlaskein	West Jaintia Hills	84 C/6	92˚24’51”	25˚43’13”	BW	184	6 1/2"/7"	28.05.2018	28.18	3.38	CGWB	
9	Namdong-A	Thadlaskein	West Jaintia Hills	85 C/6	92˚19’11”	25˚39’33”	BW	202.5	6 1/2"/7"	12.07.2018		0.02	CGWB	

Annexure 2: Dynamic water level data of borewells and dug well

Sl. No.	Location/Village	Block	District	Latitude	Longitude	RL (m)	Drilled depth (m)	Measuring point (m)	Type (DW/BW /Spring)	DTW (m bgl) May-17	DTW (m bgl) Aug-17	DTW (m bgl) Nov-17	DTW (m bgl) Jan-18	DTW (m bgl) April-18
1	Dawki	Amlarem	West Jaintia Hills	25°11’02"	92°01’51"	19	5.8	0.7	DW	0.85	0.73	1.22	1.15	1
2	Jowai New	Thadlaskein	West Jaintia Hills	25°27’15"	92°12’27"	1366	2.2	0.83	DW	0.66	0.22	0.31	0.47	0.51
3	Amlarem	Amlarem	West Jaintia Hills	25°16’55"	92°06’07"	1010	2.47	0	DW	1.31	0.96	1.6	2.1	1.67
4	DIET Thadlaskein	Thadlaskein	West Jaintia Hills	25°29'37"	92°10'06"	1380	120.4	0.62	BW	11.94	10.54	10.84	12.18	13.14

Annexure 3: Spring discharge data collected during 2017-18

Location	Block	District	Latitude	Longitude	RL (m)	Type	Lithology	Discharge (lps) May-17	Discharge (lps) Nov-17	Discharge (lps) April-18
Raliang	Laskein	West Jaintia Hills	25°30'05"	92°23'56"	1276	Depression	Granite Gneiss	0.04	0.03	0.025
Madanrwan	Laskein	West Jaintia Hills	25°32'23"	92°28'08"	1041	Depression	Granite Gneiss	0.08	0.2	0.11
Niawkmai	Laskein	West Jaintia Hills	25°32'58"	92°29'59"	981	Depression	Granite Gneiss	0.1	0.1	0.08
Banmuhur	Laskein	West Jaintia Hills	25°31'46"	92°32'33"	906	Depression	Sandstone	0.01	0.01	0.003
Nongringkoh	Laskein	West Jaintia Hills	25°29'11"	92°30'54"	1082	Depression	Granite Gneiss	0.06	0.05	0.042
Shangpung	Laskein	West Jaintia Hills	25°28'49"	92°21'11"	1260	Depression	Sandstone	0.012	0.015	0.007
Thadlaskien	Thadlaskein	West Jaintia Hills	25°29'42"	92°10'13"	1368	Depression	Quartzite	0.009	0.017	0.0086
Tyrsang	Thadlaskein	West Jaintia Hills	25°32'04"	92°08'52"	1328	Fracture	Quartzite	0.006	0.01	Dry
Lad Mukhla	Thadlaskein	West Jaintia Hills	25°30'37"	92°09'52"	1344	Depression	Quartzite	0.002	0.008	0.001
Mukhla	Thadlaskein	West Jaintia Hills	25°30'20"	92°10'17"	1362	Depression	Quartzite	0.003	0.01	0.002
Nartiang	Thadlaskein	West Jaintia Hills	25°34'09"	92°12'23"	1204	Depression	Quartzite	0.008	0.01	0.0072
Moobakhon	Thadlaskein	West Jaintia Hills	25°38'37"	92°17'12"	1045	Depression	Quartzite	0.006	0.01	0.0057
Namdong	Thadlaskein	West Jaintia Hills	25°39'33"	92°19'36"	990	Depression	Quartzite	0.07	0.08	0.061
Khonsaro	Thadlaskein	West Jaintia Hills	25°41'09"	92°20'49"	963	Depression	Quartzite	0.015	0.02	0.005
Saitsama	Thadlaskein	West Jaintia Hills	25°43'15"	92°23'01"	891	Depression	Quartzite	0.3	0.45	0.25
Khanduli	Thadlaskein	West Jaintia Hills	25°43'11"	92°24'55"	859	Depression	Quartzite	0.28	0.37	0.21
UmsyneirSaitsama	Thadlaskein	West Jaintia Hills	25°43'21"	92°23'46"	878	Depression	Quartzite	0.1	0.15	0.08
Mukoh	Thadlaskein	West Jaintia Hills	25°40'25"	92°21'01"	960	Depression	Quartzite	0.02	0.06	0.009
Nongbah	Thadlaskein	West Jaintia Hills	25°31'22"	92°14'56"	1313	Fracture	Granite Gneiss	0.013	0.021	0.18
Jowai	Thadlaskein	West Jaintia Hills	25°26'30"	92°11'20"	1263	Depression	Quartzite	0.04	0.05	0.047
Mostam	Amlarem	West Jaintia Hills	25°24'42"	92°10'14"	1318	Depression	Sandstone	0.01	0.02	0.02
Shkendyrsit	Amlarem	West Jaintia Hills	25°21'49"	92°08'51"	1304	Fracture	Sandstone	0.001	0.001	Dry
Umjarang	Amlarem	West Jaintia Hills	25°18'52"	92°07'49"	1142	Fracture	Sandstone	0.32	0.21	0.083
Dawki	Amlarem	West Jaintia Hills	25°11'11"	92°01'08"	28	Fracture	Sandstone	0.82	0.67	0.61
Amlari	Amlarem	West Jaintia Hills	25°11'01"	92°08'59"	418	Fracture	Limestone	0.22	0.21	0.0054

Annexure 4: Aquifer wise water quality data of Aquifer mapping area

Sl. No.	Village/ Location	Taluka/ Block	District	Toposheet No.	Lat	Long	RL (m)	Aquifer Type	Depth	pH	EC (µs/cm) 25C	TDS	CO3-2	HCO3-1	TA (as CaCO3)	Cl-	SO4-2	NO3-1	F-	Ca+2	Mg+2	TH (as CaCO3)	Na	K	Fe
Spring																									
1	Raliang	Laskein	West Jaintia Hills	83 C/6	25°30′05″	92°23′56″	1276	Granite Gneiss	Spring	5.67	166.1	96.17	0	20	20	31.905		4.6558	0.04	17.0136	10.3238	85.068	10.2	4.17	0
2	Madanrwan	Laskein	West Jaintia Hills	83 C/6	25°32′23″	92°28′08″	1041	Granite Gneiss	Spring	5.14	48.12	27.27	0	30	30	17.725		0	0.13	5.10408	4.1295	29.7738	2.34	2.12	0
3	Banmuhur	Laskein	West Jaintia Hills	83 C/10	25°31′46″	92°32′33″	906	Sandstone	Spring	5.34	34.78	19.93	0	10	10	21.27		0	0.1	1.70136	4.1295	21.267	0.98	0.03	0
4	Nongringkoh	Laskein	West Jaintia Hills	83 C/11	25°29′11″	92°30′54″	1082	Granite Gneiss	Spring	5.22	86.38	49.17	0	20	20	21.27		1.3791	0.36	1.70136	7.2267	34.0272	5.7	3.4	0
5	Shangpung	Laskein	West Jaintia Hills	83 C/6	25°28′49″	92°21′11″	1260	Sandstone	Spring	6.06	133.7	77.15	0	25	25	28.36		1.2165	0.15	17.0136	5.1619	63.801	9.07	3.64	0
6	Tyrsang	Thadlaskein	West Jaintia Hills	83 C/2	25°32′04″	92°08′52″	1328	Quartzite	Spring	5.45	75.57	43.78	0	10	10	28.36		0.1974	0.07	6.80544	5.1619	38.2806	6.86	1.57	0
7	Nartiang	Thadlaskein	West Jaintia Hills	83 C/2	25°34′09″	92°12′23″	1204	Quartzite	Spring	6.34	237.9	139.5	0	65	65	35.45		2.8051	0.25	27.22176	10.3238	110.5884	11.07	19.82	0.0289
8	Moobakhon	Thadlaskein	West Jaintia Hills	83 C/6	25°38'37″	92°17′12″	1045	Quartzite	Spring	6.09	199.5	116.2	0	25	25	46.085		5.8473	0.18	18.71496	8.2590	80.8146	13.38	7.27	0
9	Khonsaro	Thadlaskein	West Jaintia Hills	83 C/6	25°41'09"	92°20′49″	963	Quartzite	Spring	5.08	54.37	31.62	0	15	15	21.27		0	0.08	6.80544	4.1295	34.0272	3.68	0.3	0.0992
10	UmsyneirSaitsama	Thadlaskein	West Jaintia Hills	83 C/6	25°43'21"	92°23′46″	878	Quartzite	Spring	5.26	21.18	12.27	0	20	20	14.18		0	0.07	1.70136	7.2267	34.0272	0.32	1.07	0.0199
11	Nongbah	Thadlaskein	West Jaintia Hills	83 C/2	25°31'22"	92°14′56″	1313	Granite Gneiss	Spring	5.57	119.8	69.19	0	20	20	21.27		2.7308	0.09	6.80544	11.3562	63.801	5.17	8.42	0.0465
12	Jowai	Thadlaskein	West Jaintia Hills	83 C/3	25°26'30"	92°11′20″	1263	Quartzite	Spring	5.49	110	63.45	0	30	30	28.36		2.7078	0.09	6.80544	7.2267	46.7874	8.52	2.09	0.0769
13	Mostam	Amlarem	West Jaintia Hills	83 C/3	25°24'42"	92°10′14″	1318	Sandstone	Spring	5.56	17.08	9.88	0	20	20	17.725		0	0.06	1.70136	5.1619	25.5204	0.83	0.51	0.0519
14	Umjarang	Amlarem	West Jaintia Hills	83 C/3	25°18'52"	92°07′49″	1142	Sandstone	Spring	4.60	13.03	7.814	0	20	20	21.27		0	BDL	1.70136	3.0971	17.0136	0.13	0.04	0.0097
15	Dawki	Amlarem	West Jaintia Hills	83 C/4	25°11'11"	92°01′08″	28	Sandstone	Spring	6.55	135	77.53	0	55	55	24.815		0	0.14	32.32584	8.2590	114.8418	2.9	1.26	0
16	Amlari	Amlarem	West Jaintia Hills	83 C/4	25°11'01"	92°08′59″	418	Limestone	Spring	7.48	246.2	143.2	0	135	135	17.725		0	0.27	69.75576	16.5181	242.4438	0.96	0.4	0.058
Shallow Aquifer																									
1	Dawki	Amlarem	West Jaintia Hills	83 C/4	25°11′02"	92°01′51"	19	Sandstone	5.8	6.86	151.70	79.10	0	80	80	7.09	2.27	0.70	0.38	20	1.2136	55	1.74	10.75	0.43
2	Jowai New	Thadlaskein	West Jaintia Hills	83 C/3	25°27′15"	92°12′27"	1366	Quartzite	2.2	5.91	46.17	25.19	0	10	10	17.18	15.98	6.70	0.51	2	12.0631	65	2.62	0.12	0.47
3	Amlarem	Amlarem	West Jaintia Hills	83 C/4	25°16′55"	92°06′07"	1010	Sandstone	2.47	5.59	40.42	23.27	0	15	15	17.725		0	0.06	5.10408	5.1619	34.0272	0.91	0.49	0
Deeper Aquifer																									
1	Jowai	Thadlaskein	West Jaintia Hills	83 C/3	25°26'43"	92°11'32"		Quartzite	80.19	8.1	115	80	0	92		11				20	12	100	7	1	0

Annexure 5: Litholog of exploratory wells

Unique ID	
Village	Jowai
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/3
Latitude	25°26'43"
Longitude	92°11'32"
RL (m amsl)	1344
Drilled Depth	80.19
Casing	20.35
SWL (mbgl)	14.88
Discharge (lps)	0.28
Date/year	06.01.1991

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	4	4	Top soil, reddish brown in colour
4	23.19	19.19	Granite, weathered
23.19	24.19	1	Granite, fractured
24.19	55.79	31.6	Quartzite, micaceous, compact
55.79	56.79	1	Quartzite, fractured
56.79	75	18.21	Quartzite, compact
75	76	1	Quartzite, fractured
76	80.19	4.19	Quartzite, compact

Unique ID	
Village	Nongbah
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/2
Latitude	25°31'27"
Longitude	92°14'55"
RL (m amsl)	1342
Drilled Depth	74.2
Casing	17.2
SWL (mbgl)	13.5
Discharge (lps)	0.5
Date/year	23.03.1991

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	4	4	Top soil, reddish brown
4	18.2	14.2	Granite Gneiss, weathered
18.2	27.4	9.2	Granite Gneiss, compact
27.4	28.4	1	Granite Gneiss, fractured
28.4	74.2	45.8	Granite Gneiss, compact

Unique ID	
Village	Tyrsang
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/2
Latitude	25°32'01"
Longitude	92°08'15"
RL (m amsl)	1320
Drilled Depth	82.35
Casing	8.3
SWL (mbgl)	6.14
Discharge (lps)	0.08
Date/year	1990-91

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	4	4	Top soil, reddish brown
4	22.35	18.35	Quartzite, weathered
22.35	23.35	1	Quartzite, fractured
23.35	59.95	36.6	Quartzite, compact
59.95	60.95	1	Quartzite, fractured
60.95	82.35	21.4	Quartzite, compact

Unique ID	
Village	Wahiajer
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/2
Latitude	25°31'47"
Longitude	92°09'45"
RL (m amsl)	1330
Drilled Depth	88
Casing (mbgl)	19.2
SWL (mbgl)	5.51
Discharge (lps)	0.14
Date/year	1990-91

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	7	7	Top soil, reddish brown
7	21.45	14.45	Quartzite, weathered
21.45	22.45	1	Quartzite, fractured
22.45	64.65	42.2	Quartzite, compact
64.65	65.65	1	Quartzite, fractured
65.65	88	22.35	Quartzite, compact

Unique ID	
Village	DIET Thadlaskein
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/3
Latitude	25°29'37.8"
Longitude	92°10'6.3"
RL (m amsl)	1380
Drilled Depth	120.4
Casing	10
SWL (mbgl)	10.24
Discharge (lps)	1.74
Date/year	2006-07

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	6	6	Top soil, reddish brown
6	20	14	Quartzite, weathered
20	80.7	60.7	Quartzite, compact
80.7	81.7	1	Quartzite, fractured
81.7	120.4	38.7	Quartzite, compact

Unique ID	
Village	Amlarem
Taluka/Block	Amlarem
District	West Jaintia Hills
Toposheet No	83 C/3
Latitude	25˚16’43.30”
Longitude	92˚06’08.45”
RL (m amsl)	1021
Drilled Depth	92.7
Casing	36
SWL (mbgl)	
Discharge (lps)	
Date/year	20.11.2017

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	35.95	35.95	Sandstone, highly weathered, sample cuttings are fine grained size, redddish brown in colour.
35.95	62.47	26.52	Limestone, compact, sample cuttings are medium to coarse grained size, grey in colour.
62.47	92.7	30.23	Sandstone, compact, sample cuttings are fine to medium grained size, grayish brown in colour.

Unique ID	
Village	Laskein
Taluka/Block	Laskein
District	West Jaintia Hills
Toposheet No	83 C/6
Latitude	25˚30’55.39”
Longitude	92˚25’40.90”
RL (m amsl)	1261
Drilled Depth	201.9
Casing	20.8
SWL (mbgl)	14.83
Discharge (lps)	0.41
Date/year	31.03.2018

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	10.3	10.3	Top Soil, reddish brown in colour.
10.3	22.56	12.26	Quartzite, weathered, sample cuttings are medium grained, brown in colour.
22.56	23.56	1	Quartzite, fractured, sample cuttings are medium to coarse grained, grey in colour.
23.56	117.64	94.08	Quartzite, compact, sample cuttings are medium to coarse grained, mixture of grey and brown in colour.
117.64	118.64	1	Quartzite, fractured, sample cuttings are medium to coarse grained, pinkish brown in colour.
118.64	201.9	83.26	Quartzite, compact, sample cuttings are medium to coarse grained mixed, pinkish brown in colour.

Unique ID	
Village	Khanduli
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/6
Latitude	25˚43’13.36”
Longitude	92˚24’51.47”
RL (m amsl)	870
Drilled Depth	184
Casing	14.2
SWL (mbgl)	9.34
Discharge (lps)	3.78
Date/year	23.05.2018

Depth range (mbgl)		Thickness (m)	Litholog
From	To		
0	4	4	Top soil/weathered Quartzite, reddish brown in colour
4	25.69	21.69	Quartzite, compact, sample cuttings are fine grained, brown in colour
25.69	26.69	1	Quartzite, minor fractured, sample cuttings are medium to coarse grained, brown in colour
26.69	62.47	35.78	Quartzite, compact, sample cuttings are medium to coarse grained, greyish brown in colour
62.47	63.47	1	Quartzite, fractured, sample cuttings are medium to coarse grained, brown in colour
63.47	86.99	23.52	Quartzite, compact, sample cuttings are fine to medium grained, brown in colour
86.99	87.99	1	Amphibolite, fractured, sample cuttings are medium to coarse grained, black in colour
87.99	181.94	93.95	Amphibolite, compact, sample cuttings are fine to medium grained, black in colour
181.94	182.94	1	Amphibolite, fractured, sample cuttings are medium to coarse grained, black in colour
182.94	184	1.06	Amphibolite, compact, sample cuttings are fine to medium grained, black in colour

Unique ID	
Village	Namdong-A
Taluka/Block	Thadlaskein
District	West Jaintia Hills
Toposheet No	83 C/6
Latitude	25˚39’33.54”
Longitude	92˚19’11.50”
RL (m amsl)	1005
Drilled Depth	202.5
Casing	12
SWL (mbgl)	11.59
Discharge (lps)	0.15
Date/year	07.07.2018

Depth range (mbgl)		**Thickness (m)**	**Litholog**
From	To		
0	4	4	Top soil, reddish in colour
4	10.3	6.3	Quartzite, weathered, sample cuttings are fine grained, reddish brown in colour
10.3	96.12	85.82	Quartzite, compact, sample cuttings are fine to coarse grained, brown in colour
96.12	97.12	1	Amphibolite, fractured, sample cuttings are medium to coarse grained, black in colour
97.12	202.5	105.38	Amphibolite, compact, sample cuttings are medium to coarse grained, black in colour

Annexure 6: Geophysical data

Sl. No.	VES No.	District	Village	Location	Coordinates	General Geology	Layer Resistivity in Ohm-m					Layer Thickness in meters						Total Depth in m.	Remarks
							ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	P_6	h_1	h_2	h_3	h_4	h_5		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	88	West Jaintia Hills	Nongbah	90 m N35°E of School	N25°30'54" E92°14'53"	Archaean gneissic complex.	6000	4500	1500	800			0.8	9.3	28			38	
2	89	West Jaintia Hills	Nongbah	Due east of red building on the main road(Smt.Jietthabru)	N25°30'38" E92°14'43"	Archaean gneissic complex.	2400	1300	1100	600	400	1500	0.9	3.1	6	20	12	42	
3	90	West Jaintia Hills	Nongbah	200 m South of VES-89(opposite to green building Sri.Wanpadit)	N25°30'31" E92°14'41"	Archaean gneissic complex.	900	700	400	1350			0.8	2.4	37			40	
4	91	West Jaintia Hills	Nongbah	150 m South of VES-90	N25°30'26" E92°14'41"	Archaean gneissic complex.	1600	800	350	1800	370		0.8	2.2	9	30		42	
5	92	West Jaintia Hills	Nongbah	Pynkai Colony play ground	N25°30'41" E92°15'07"	Archaean gneissic complex.	1150	350	200	600			8.5	22	10			40	Zones up to 40m.
6	93	West Jaintia Hills	Nongbah(Mangkariang)	Centre of South western corner of the Bull fight ground	N25°30'16" E92°14'59"	Archaean gneissic complex.	700	1900	700	1700			0.8	4.7	20			25	
7	94	West Jaintia Hills	Nongbah(Mangkariang)	100m N 65° E of VES-93.	N25°30'16" E92°14'59"	Archaean gneissic complex.	730	1500	750	4500			0.7	5.3	36			42	
8	95	West Jaintia Hills	Nongbah(Mangkariang)	200m N 65° E of VES-93.	N25°30'16" E92°14'59"	Archaean gneissic complex.	4000	1200	900	400	8000		0.8	3.2	7	19		30	
9	96	West Jaintia Hills	Nongbah(Mangkariang)	70m N 25° W of VES-94.		Archaean gneissic complex.	2200	800	200	6000			0.9	19	14			34	Zones from 20m and up to 40m and fractures between 50 and 70m.
10	97	West Jaintia Hills	Nongbah(Mangkariang)	30m S 25° E of VES-94.		Archaean gneissic complex.	2500	1000	3000	500			0.8	4.7	42			47	
11	98	West Jaintia Hills	Nongbah	60m North of culvert.	N25°30'29" E92°14'34"	Archaean gneissic complex.	800	1350	650				1	7.5				8.5	
12	99	West Jaintia Hills	Nongbah	300m North 0f VES- 98 and centre of the foot ball ground.	N25°30'41" E92°14'36"	Archaean gneissic complex.	1600	1200	800	45	600		1	1.5	9	8.5		20	
13	100	West Jaintia Hills	Tharraumlong	200 m south of junction of the road leading to the village Tharra and Umlong	N25°30'04" E92°14'20"	Archaean gneissic complex.	420	5000	800	325	1500		1	3	8	78		90	Zones from 15m to 90m.
14	101	West Jaintia Hills	Tharraumlong	180m South of VES-100 in the valley.	N25°31'00" E92°14'16"	Archaean gneissic complex.	800	250	600				1	3				4	
15	102	West Jaintia Hills	Tharraumlong	200m South of VES-101 in the valley.	N25°30'54" E92°14'07"	Archaean gneissic complex.	380	2500	800	450	3000		1	4	4	15		23.5	
16	103	West Jaintia Hills	Lower Umlong	In the farm house and the farm house is located at 150m South of VES-102.	N25°30'49" E92°14'16"	Archaean gneissic complex.	1000	1800	500	2200			1	4	28			32	
17	104	West Jaintia Hills	Lower Umlong	125m South of VES-103.	N25°30'45" E92°14'13"	Archaean gneissic complex.	2800	1100	350	VH			1	5	21			27	
28	115	West Jaintia Hills	Lumstong(Marwa)	70m South of the bridge.	N25°36'53" E92°16'54"	Shillong Group	943	1760	13,200				1.6	1.3				2.9	Not amenable for interpretation
29	116	West Jaintia Hills	Lumstong(Marwa)	115m South of VES-115.	N25°36'48" E92°16'53"	Shillong Group	1400	1500	250	2200			1.5	5	31			37	Zones from 7 to 37m and fractures between 50 and 60m.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
30	117	West Jaintia Hills	Lumstong(Marwa)	120m South of VES-116.		Shillong Group	800	20000	200				0.5	8.5				9	
31	118	West Jaintia Hills	Mynriang (Upper)	40m N20°E of the shed without roof.	N 25°37'04" E 92°16'35"	Shillong Group	3500	350	300	190	359		0.4	0.9	5.5	28		35	Zones from 8m to 35m. Fractures between 50 and 60m.
32	119	West Jaintia Hills	Mynriang (Upper)			Shillong Group	700	1500	120	240			0.9	2.1	10			13	
33.	120	West Jaintia Hills	Kshehrynshung	In Nongseingfoot ball ground.	N 25°37'04" E 92°16'51"	Shillong Group	1500	225	110	400			0.8	5.2	17			23	Zones from 6m to 25m and fractures between 60and 70m.
34	121	West Jaintia Hills	Kshehrynshung	80m SE of VES-120 and 80 m north of the bridge.		Shillong Group	1400	1500	150	300			0.8	2.7	26			29	Zones from 5 to 30m and fractures are expected between 50 and 60m.
35	122	West Jaintia Hills	Kshehrynshung	80 m West of VES-121.		Shillong Group	1800	600	6500				2.4	5.8				8.2	
36	123	West Jaintia Hills	Kshehrynshung	80 m West of VES-122.		Shillong Group	1000	350	7500	2000			1	4	19			24	
37	124	West Jaintia Hills	Kshehrynshung	25m West of the bridge on the main road in the valley.	N 25°36'57" E 92°16'44"	Shillong Group	2000	1100	8000	150			1	5	19			25	
38	125	West Jaintia Hills	Kshehrynshung	90m West of VES-124.		Shillong Group	2000	2060	45000	755			1	3	3.5			7.5	
39	126	West Jaintia Hills	Ksherynshung	185m NW of the31 Km stone on Jowai road.	N 25°37'25" E 92°16'00"	Shillong Group	1050	10000	2000				7	8				15	
40	127	West Jaintia Hills	Wahiajar. Maya club ground	Maya club ground. Adjecent to the road.	N 25°32'23" E 92°09'45"	Archaean Gneissic complex	2500	4000	1000	5000	2500		0.8	1.5	3.7	74		80	
41	128	West Jaintia Hills	Wahiajar. Maya club ground	80m East of VES-127 and 50 m west of cell tower.		Archaean Gneissic complex	650	375	9999				1	13				14	
42	129	West Jaintia Hills	Wahjar bull fight ground	100m S30°E of the fencing which is adjacent to the road.	N 25°32'41" E 92°10'04"	Archaean Gneissic complex	1050	1300	4000	50	15000		1	3.8	10	3		25	
43	130	West Jaintia Hills	Wahjar bull fight ground	50m N 30°W of VES-129.		Archaean Gneissic complex	1100	3000	200	900	80	3000	1	1.7	3.3	15	16	37	Zones from 18 to 40m. Fractures between 70 and 80m.
44	131	West Jaintia Hills	Wahjar bull fight ground	50m East of VES-129.		Archaean Gneissic complex	1800	1300					0.8	20				21	
45	132	West Jaintia Hills	Wahijar (Bhadakha)	40m S30°W of VES-133	N 25°31'22" E 92°10'04"	Archaean Gneissic complex	1950	1600	300	7500			1	3	14			17.5	
46	133	West Jaintia Hills	Wahijar (Bhadakha)	70m S30°W of VES-134	N 25°31'21" E 92°10'03"	Archaean Gneissic complex	1300	2000	650	8000			1	4	30			35	
47	134	West Jaintia Hills	Wahijar (Bhadakha)	Near the South Eastern side goal post in the foot ball ground.	N 25°31'23" E 92°10'00"	Archaean Gneissic complex	2000	1250	200	7500			1	2.5	14			17	
48	135	West Jaintia Hills	Umlong	80m South of VES-136	N 25°31'00" E 92°09'00"	Archaean Gneissic complex	2000	140	2424	600			2.4	2.9	50			55	
49	136	West Jaintia Hills	Umlong	100m East of 1 km stone Tyrshang – Umlong road.	N 25°31'34" E 92°08'59"	Archaean Gneissic complex	1800	10000	450	3500			1.6	8.9	28			38	
50	137	West Jaintia Hills	Mukhla	80m west of VES-138	N 25°29'45" E 92°10'50"	Archaean Gneissic complex	1800	250	2300	12500	150		0.8	2.2	18	9		30	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
51	138	West Jaintia Hills	Mukhla	25m SW of the Southern goal post of the foot ball ground.	N 25°29'45" E 92°10'48"	Archaean Gneissic complex	1700	2200	350	3200	800		0.9	2.3	1.5	25		30	
52	139	West Jaintia Hills	Mukhla	On the road leading to Thadlaskein lake	N 25°29'46" E 92°10'32"	Archaean Gneissic complex	2000	1600	5000				1	2.5				3.5	
53	140	West Jaintia Hills	Mukhla	-do-	N 25°29'50" E 92°10'33"	Archaean Gneissic complex	1050	1650	1000				1	15				16	
54	141	West Jaintia Hills	Umlong	In the school play ground and 80m NE corner of Little Flower Sec. school.	N 25°31'08" E 92°08'26"	Archaean Gneissic complex	1000	1500	100	60			1	4	19			24	
55	142	West Jaintia Hills	Umlong	Opposite to the Little Flower Sec. School and on the other side of the road.	N 25°31'07" E92°08'31"	Archaean Gneissic complex	2800	1800	300	80	v.H		1	4.5	6.5	33		45	
56	143	West Jaintia Hills	Phramear	80m South of St. Lawrence Primary School.	N 25°28'03" E 92°17'30"	Archaean Gneissic complex	1200	1750	2000				2.5	3.5				6	
57	144	West Jaintia Hills	Phramear	In the centre of the foot ball ground.	N 25°28'03" E 92°17'29"	Archaean Gneissic complex	2800	5000	1350				0.8	1.8				2.6	
58	145	West Jaintia Hills	Phramear	100m S30°E of the school.	N 25°28'03" E 92°17'34"	Archaean Gneissic complex	2800	1400	3500	1900			0.5	2.5	17			20	
59	146	West Jaintia Hills	Ialong	Opp. To the cell tower and sign board on the Jowai-Silchar road.	N 25°27'58" E 92°14'48"	Archaean Gneissic complex	650	375	3100	4000			2.5	5	23			30	
60	147	West Jaintia Hills	Amlarem	43m S60°E of VES-148.	N 25°16'57" E 92°06'13"	Shillong Group/Sand stone	5000	2500	1800	900			1.1	2.9	28			32	
61	148	West Jaintia Hills	Amlarem	South of the village and 150m North of the check post on Dawki-Amlarem road.	N 25°16'57" E 92°06'11"	Shillong Group/Sand stone	850	500	2200	850			1	1.5	14			16	
62	149	West Jaintia Hills	Amlarem	80m east of SD office. N20°W of DI office.		Shillong Group/Sand stone	2200	4000	2000	2500			5	20	25			50	
63	150	West Jaintia Hills	Amlarem	50m N25°E of VEs-149		Shillong Group/Sand stone	4000	1650	4500	600			1	4.5	38			42	
64	151	West Jaintia Hills	Amlarem	Near Amlarem square, Dawki 27 Km.	N 25°17'11" E 92°06'10"	Shillong Group/Sand stone	2700	4200	1600	500			1.2	7.8	66			76	
65	152	West Jaintia Hills	Amlarem	70m east of VES VES-151.		Shillong Group/Sand stone	4250	5250	1200	3500	800		1	4	11	37		53	
66	153	West Jaintia Hills	Amlarem	In the premises of Amlarem Sec. School. Due north of School board.		Shillong Group/Sand stone	3000	750	600	9999			1.5	5.5	44			51	Test drilling up to 60m.

Annexure 7: Soil Infiltration Test data

a. Location – Muphlang

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		24		0	0	f0 = 2.1 from the curve	ft	
1	1	24	23.7	0.3	0.3	18	15.9	
2	1	23.7	23.4	0.3	0.6	18	15.9	
3	1	23.4	23.3	0.1	0.7	6	3.9	
4	1	23.3	23.2	0.1	0.8	6	3.9	
5	1	23.2	23.1	0.1	0.9	6	3.9	
6	1	23.1	23	0.1	1	6	3.9	
7	1	23	22.9	0.1	1.1	6	3.9	
8	1	22.9	22.8	0.1	1.2	6	3.9	
9	1	22.8	22.7	0.1	1.3	6	3.9	
10	1	22.7	22.6	0.1	1.4	6	3.9	
15	5	22.6	22.1	0.5	1.9	6	3.9	
20	5	22.1	21.6	0.5	2.4	6	3.9	
25	5	21.6	21.3	0.3	2.7	3.6	1.5	
30	5	21.3	20.9	0.4	3.1	4.8	2.7	
35	5	20.9	20.5	0.4	3.5	4.8	2.7	
40	5	20.5	20.2	0.3	3.8	3.6	1.5	
45	5	20.2	19.9	0.3	4.1	3.6	1.5	
50	5	19.9	19.6	0.3	4.4	3.6	1.5	
55	5	19.6	19.3	0.3	4.7	3.6	1.5	
60	5	19.3	19	0.3	5	3.6	1.5	
65	5	19	18.7	0.3	5.3	3.6	1.5	
70	5	18.7	18.2	0.5	5.8	6	3.9	
80	10	18.2	17.8	0.4	6.2	2.4	0.3	
90	10	17.8	17.4	0.4	6.6	2.4	0.3	
100	10	17.4	17	0.4	7	2.4	0.3	
120	20	17	16.2	0.8	7.8	2.4	0.3	
140	20	16.2	15.5	0.7	8.5	2.1	0	
160	20	15.5	14.8	0.7	9.2	2.1	0	
180	20	14.8	14.1	0.7	9.9	2.1	0	
200	20	14.1	13.4	0.7	10.6	2.1	0	

b. Location – Pamdabuh

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		18.5		0	0	f0 = 5.1 from the curve	ft	
1	1	18.5	17.6	0.9	0.9	54	48.9	
2	1	17.6	16.9	0.7	1.6	42	36.9	
3	1	16.9	16.5	0.4	2	24	18.9	
4	1	16.5	16.2	0.3	2.3	18	12.9	
5	1	16.2	15.9	0.3	2.6	18	12.9	
6	1	15.9	15.6	0.3	2.9	18	12.9	
7	1	15.6	15.4	0.2	3.1	12	6.9	
8	1	15.4	15.2	0.2	3.3	12	6.9	
9	1	15.2	15	0.2	3.5	12	6.9	
10	1	15	14.8	0.2	3.7	12	6.9	
15	5	14.8	13.6	1.2	4.9	14.4	9.3	
20	5	18.5	17.6	0.9	5.8	10.8	5.7	Refilled
25	5	17.6	16.8	0.8	6.6	9.6	4.5	
30	5	16.8	14.9	1.9	8.5	22.8	17.7	
35	5	18.5	17.6	0.9	9.4	10.8	5.7	Refilled
40	5	17.6	16.7	0.9	10.3	10.8	5.7	
45	5	16.7	16	0.7	11	8.4	3.3	
50	5	16	15.4	0.6	11.6	7.2	2.1	
55	5	18.5	17.9	0.6	12.2	7.2	2.1	Refilled
60	5	17.9	17.3	0.6	12.8	7.2	2.1	
70	10	18.5	17.4	1.1	13.9	6.6	1.5	Refilled
80	10	17.4	16.4	1	14.9	6	0.9	
90	10	18.5	17.5	1	15.9	6	0.9	Refilled
100	10	17.5	16.5	1	16.9	6	0.9	
120	20	18.5	16.7	1.8	18.7	5.4	0.3	Refilled
140	20	16.7	15	1.7	20.4	5.1	0	
160	20	18.5	16.8	1.7	22.1	5.1	0	Refilled
180	20	16.8	15.1	1.7	23.8	5.1	0	

c. Location – Mynsngat

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		22		0	0	f0 = 1.5 from the curve	ft	
1	1	22	21.5	0.5	0.5	30	28.5	
2	1	21.5	21.2	0.3	0.8	18	16.5	
3	1	21.2	21	0.2	1	12	10.5	
4	1	21	20.8	0.2	1.2	12	10.5	
5	1	20.8	20.7	0.1	1.3	6	4.5	
6	1	20.7	20.7	0	1.3	0	-1.5	
7	1	20.7	20.6	0.1	1.4	6	4.5	
8	1	20.6	20.6	0	1.4	0	-1.5	
9	1	20.6	20.5	0.1	1.5	6	4.5	
10	1	20.5	20.5	0	1.5	0	-1.5	
15	5	22	21.8	0.2	1.7	2.4	0.9	Refilled
20	5	21.8	21.6	0.2	1.9	2.4	0.9	
25	5	21.6	21.4	0.2	2.1	2.4	0.9	
30	5	21.4	21.3	0.1	2.2	1.2	-0.3	
35	5	21.3	21.2	0.1	2.3	1.2	-0.3	
40	5	21.2	21.1	0.1	2.4	1.2	-0.3	
50	10	22	21.5	0.5	2.9	3	1.5	Refilled
60	10	21.5	21	0.5	3.4	3	1.5	
70	10	21	20.6	0.4	3.8	2.4	0.9	
80	10	22	21.7	0.3	4.1	1.8	0.3	Refilled
90	10	21.7	21.4	0.3	4.4	1.8	0.3	
100	10	21.4	21.1	0.3	4.7	1.8	0.3	
120	20	22	21.4	0.6	5.3	1.8	0.3	Refilled
140	20	22	21.5	0.5	5.8	1.5	0	Refilled
160	20	22	21.5	0.5	6.3	1.5	0	Refilled
180	20	22	21.5	0.5	6.8	1.5	0	Refilled

d. Location – Saitsama

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		23.8		0	0	f0 = 14.1 from the curve	ft	
1	1	23.8	22.7	1.1	1.1	66	51.9	
2	1	22.7	22.1	0.6	1.7	36	21.9	
3	1	22.1	21.8	0.3	2	18	3.9	
4	1	21.8	21.4	0.4	2.4	24	9.9	
5	1	21.4	21	0.4	2.8	24	9.9	
6	1	21	20.6	0.4	3.2	24	9.9	
7	1	20.6	20.2	0.4	3.6	24	9.9	
8	1	20.2	19.9	0.3	3.9	18	3.9	
9	1	19.9	19.6	0.3	4.2	18	3.9	
10	1	19.6	19.3	0.3	4.5	18	3.9	
15	5	23.8	22.3	1.5	6	18	3.9	Refilled
20	5	22.3	20.8	1.5	7.5	18	3.9	
25	5	20.8	19.3	1.5	9	18	3.9	
30	5	23.8	22.5	1.3	10.3	15.6	1.5	Refilled
35	5	22.5	21.2	1.3	11.6	15.6	1.5	
40	5	21.2	19.9	1.3	12.9	15.6	1.5	
50	10	23.8	21.2	2.6	15.5	15.6	1.5	Refilled
60	10	23.8	21.2	2.6	18.1	15.6	1.5	Refilled
70	10	23.8	21.3	2.5	20.6	15	0.9	Refilled
80	10	23.8	21.4	2.4	23	14.4	0.3	Refilled
90	10	23.8	21.4	2.4	25.4	14.4	0.3	Refilled
100	10	23.8	21.4	2.4	27.8	14.4	0.3	Refilled
120	20	23.8	19.1	4.7	32.5	14.1	0	Refilled
140	20	23.8	19.1	4.7	37.2	14.1	0	Refilled
160	20	23.8	19.1	4.7	41.9	14.1	0	Refilled

e. Location- Ummulong

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		21		0	0	f0 = 1.5 from the curve	ft	
1	1	21	20.4	0.6	0.6	36	34.5	
2	1	20.4	20.2	0.2	0.8	12	10.5	
3	1	20.2	20	0.2	1	12	10.5	
4	1	20	19.8	0.2	1.2	12	10.5	
5	1	19.8	19.6	0.2	1.4	12	10.5	
6	1	19.6	19.5	0.1	1.5	6	4.5	
7	1	19.5	19.4	0.1	1.6	6	4.5	
8	1	19.4	19.3	0.1	1.7	6	4.5	
9	1	19.3	19.2	0.1	1.8	6	4.5	
10	1	19.2	19.1	0.1	1.9	6	4.5	
15	5	21.8	21.4	0.4	2.3	4.8	3.3	Refilled
20	5	21.4	21	0.4	2.7	4.8	3.3	
25	5	21	20.7	0.3	3	3.6	2.1	
30	5	20.7	20.4	0.3	3.3	3.6	2.1	
35	5	20.4	20.2	0.2	3.5	2.4	0.9	
40	5	20.2	20	0.2	3.7	2.4	0.9	
45	5	20	19.8	0.2	3.9	2.4	0.9	
50	5	19.8	19.6	0.2	4.1	2.4	0.9	
60	10	21.8	21.4	0.4	4.5	2.4	0.9	Refilled
70	10	21.4	21.1	0.3	4.8	1.8	0.3	
80	10	21.1	19.8	1.3	6.1	7.8	6.3	
90	10	19.8	19.5	0.3	6.4	1.8	0.3	
100	10	19.5	19.2	0.3	6.7	1.8	0.3	
120	20	21.8	21.3	0.5	7.2	1.5	0	Refilled
140	20	21.3	20.8	0.5	7.7	1.5	0	
160	20	20.8	20.3	0.5	8.2	1.5	0	

f. Location – Raliang

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		25.2		0	0	f0 = 13.8 from the curve	ft	
1	1	25.2	24.4	0.8	0.8	48	34.2	
2	1	24.4	23.9	0.5	1.3	30	16.2	
3	1	23.9	23.4	0.5	1.8	30	16.2	
4	1	23.4	22.9	0.5	2.3	30	16.2	
5	1	22.9	22.4	0.5	2.8	30	16.2	
6	1	22.4	21.9	0.5	3.3	30	16.2	
7	1	21.9	21.4	0.5	3.8	30	16.2	
8	1	21.4	21	0.4	4.2	24	10.2	
9	1	21	20.6	0.4	4.6	24	10.2	
10	1	20.6	20.2	0.4	5	24	10.2	
15	5	25.2	23.4	1.8	6.8	21.6	7.8	Refilled
20	5	23.4	21.8	1.6	8.4	19.2	5.4	
25	5	21.8	20.4	1.4	9.8	16.8	3	
30	5	20.4	19.2	1.2	11	14.4	0.6	
35	5	25.2	24	1.2	12.2	14.4	0.6	Refilled
40	5	24	22.8	1.2	13.4	14.4	0.6	
45	5	22.8	21.6	1.2	14.6	14.4	0.6	
50	5	21.6	20.4	1.2	15.8	14.4	0.6	
60	10	25.2	22.8	2.4	18.2	14.4	0.6	Refilled
70	10	25.2	22.7	2.5	20.7	15	1.2	Refilled
80	10	25.2	22.7	2.5	23.2	15	1.2	Refilled
100	20	25.2	20.6	4.6	27.8	13.8	0	Refilled
120	20	25.2	20.6	4.6	32.4	13.8	0	Refilled
140	20	25.2	20.6	4.6	37	13.8	0	Refilled

g. Location - Mowkaiwa

Time (t)	Time difference	After filling	Before filling	Depth of Infiltration	Cummulative Infiltration	Infiltration rate	f-fc	Remarks
min	min	cm	cm	cm	cm	cm/hr	f0	
0		28		0	0	f0 = 4.2 from the curve	ft	
1	1	28	27.4	0.6	0.6	36	31.8	
2	1	27.4	27	0.4	1	24	19.8	
3	1	27	26.6	0.4	1.4	24	19.8	
4	1	26.6	26.2	0.4	1.8	24	19.8	
5	1	26.2	26	0.2	2	12	7.8	
6	1	26	25.8	0.2	2.2	12	7.8	
7	1	25.8	25.6	0.2	2.4	12	7.8	
8	1	25.6	25.4	0.2	2.6	12	7.8	
9	1	25.4	25.2	0.2	2.8	12	7.8	
10	1	25.2	25.1	0.1	2.9	6	1.8	
15	5	28	27	1	3.9	12	7.8	Refilled
20	5	27	26.2	0.8	4.7	9.6	5.4	
25	5	26.2	25.6	0.6	5.3	7.2	3	
30	5	25.6	25.1	0.5	5.8	6	1.8	
35	5	25.1	24.7	0.4	6.2	4.8	0.6	
40	5	24.7	24.3	0.4	6.6	4.8	0.6	
45	5	24.3	23.9	0.4	7	4.8	0.6	
50	10	23.9	23.5	0.4	7.4	2.4	-1.8	
60	10	28	27.2	0.8	8.2	4.8	0.6	Refilled
70	10	27.2	26.5	0.7	8.9	4.2	0	
80	10	26.5	25.8	0.7	9.6	4.2	0	
100	20	28	26.6	1.4	11	4.2	0	Refilled
120	20	26.6	25.2	1.4	12.4	4.2	0	

Annexure 8: Ground water resource

a) General Description of Ground Water Assessment in West Jaintia Hills district for 2017-18 (area in ha)

Name of Ground Water Assessment Unit	West Jaintia Hills
Type of Ground Water Assessment Unit	District
Type of rock formation	Quartzite, Granite, Granite Gneiss, Sandstone, Limestone and Intrusive rock
Total area of Groundwater Assessment Unit	169300
Hilly area	69600
Command area	0
Non-command area	99700
Poor ground water quality area	0
Area considered for groundwater recharge	99700

b) Ground Water Resource Potential in WestJaintia Hills district during 2017-18

Assessment Unit / District	WestJaintia Hills
Command/ Non-Command/ Total	Total
Recharge from rainfall during monsoon season	12557 ham
Recharge from other sources during monsoon season	0 ham
Recharge from rainfall during non-monsoon season	4695 ham
Recharge from other sources during non- monsoon season	994 ham
Total Ground Water Recharge	18246 ham
Net Annual Ground Water Availability	16421 ham

c) Ground Water Draft for All Uses in WestJaintia Hills district

District	WestJaintia Hills
Total draft for domestic and industrial purpose (as per households)	59 ham
Total draft for irrigation	0 ham
Total groundwater draft	59 ham

d) Balance Ground Water Resources Available and Stage of Groundwater Development in the Study Area as On 31st March 2013

Assessment Unit / District	WestJaintia Hills
Command/ Non-Command/ Total	Total
Net Annual Ground Water Availability	31102 ham
Existing Gross Ground Water Draft for Irrigation	0 ham
Existing Gross Ground Water Draft for domestic and industrial water supply	59 ham
Existing Gross Ground Water Draft for All Uses	59 ham
Allocation for domestic and industrial requirement supply upto next 25 years	2020 ham
Net Annual Ground Water Availability for future irrigation development	29077 ham
Stage of ground water development	0.19%

e) Categorization for Ground Water Development of WestJaintia Hills district during 2017-18

Assessment Unit/ District	WestJaintia Hills
Stage Of Ground Water Development (%)	0.36%
Is there a significant decline of pre-monsoon water table levels (Yes / No)	No
Is there a significant decline of post-monsoon water table levels (Yes / No)	No
Categorization For Future Ground Water Development (Safe / Semi-Critical/ Critical/ Over-Exploited)	Safe

Annexure 9: Data gap and data requirement in WestJaintia hills district

Toposheet No.	Grid	Data Existing										Data required									
		Aquifer I					Aquifer II					Aquifer I					Aquifer II				
		EW	OW	VES	CHE	WL	EW	OW	VES	CHE	WL	EW	OW	VES	CHE	WL	EW	OW	VES	CHE	WL
83 C/2	B2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/2	B3	0	0	0	0	0	2	0	2	0	0	0	0	0	1	1	0	0	0	0	0
83 C/2	C1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/2	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/2	C3	0	0	0	0	0	1	0	2	0	0	1	1	0	1	1	0	0	0	0	0
83 C/3	A3	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/3	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/3	B2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/3	B3	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	0
83 C/3	C1	0	0	0	1	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
83 C/3	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/3	C3	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/4	A1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	1	2	1	1
83 C/4	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/4	B2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/4	C1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/4	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/6	A1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/6	A2	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	0
83 C/6	A3	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	1	1
83 C/6	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/6	B2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/6	B3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/6	C1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/6	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/6	C3	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/7	A1	0	0	0	0	0	0	0	2	0	0	1	1	0	1	1	1	1	0	1	1
83 C/7	A2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/7	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/7	C1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/10	A2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
83 C/10	A3	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/10	B3	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
83 C/11	A1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	2	1	1
	TOTAL	**0**	**0**	**0**	**2**	**2**	**5**	**1**	**12**	**0**	**0**	**19**	**19**	**0**	**32**	**32**	**18**	**18**	**54**	**18**	**18**

FIELD PHOTOGRAPHS

Ground Water Exploration at Amlarem

Post monsoon spring discharge at Amlari

Pre monsoon spring discharge at Amlari

Soil Infiltration Test Studies in West Jaintia Hills