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

EAST KHASI HILLS DISTRICT, MEGHALAYA

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

GOVERNMENT OF INDIA

MINISTRY OF JAL SHAKTI

DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

REPORT
ON

"AQUIFER MAPPING AND MANAGEMENT PLAN OF EAST KHASI HILLS DISTRICT, MEGHALAYA"

(AAP 2018-19)

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ABBREVIATION

AAP	Annual Action Plan
AMP	Aquifer Management Plan
AQM	Aquifer Mapping
BIS	Bureau of Indian Standards
BDL	Below detectable level
BCM	Billion Cubic Metres
BW	Bore well
CGWB	Central Ground Water Board
DGM	Directorate of Geology and Mining
DTW	Depth to water table
DW	Dug Well
EC	Electrical Conductivity
EW	Exploratory Well
Fe	Iron
GL	Ground Level
GSI	Geological Survey of India
GEC	Ground water Estimation Committee
GW	Ground Water
GWMS	Ground Water Monitoring Stations
Ha	Hectare
Ham/ham	Hectare meter
ham/yr	Hectare meter per year
IMD	Indian Meteorological Department
Km	Kilometer
LPM/lpm	Litres per minute
LPS/lps	Litres per second
m	metre
m bgl	meters below ground level
MCM	Million Cubic Meter
mm	Milli meter
mg/l	milligram/litre
MP	Measuring Point
m amsl	Metre above mean sea level
NER	North Eastern Region
NAQUIM	National Aquifer Mapping and Management Plan
NESAC	Norh Eastern Space Applications Centre
OW	Observation Well
pH	Potential of Hydrogen
Ppm	Parts per million equivalents to mg/l
Pz	Piezometer
Sq.Km/sq.km.	Square Kilometre
SWL	Static water level
TDS	Total dissolved solid
TH	Total Hardness
µS/cm	Microsimens/centimetre
°C	Degree Celsius
FAO	Food and Agriculture Organization (United Nations)
8”	Eight Inches
NA	Not Available

EXECUTIVE SUMMARY

Aquifer Mapping studies and Management Plan has been carried out in East Khasi Hills district, Meghalaya under National Aquifer Mapping and Management Plan (NAQUIM) programme 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 (mapable area of the district) of aquifer mapping and management plan is 1053 sq.km, out of 2748 sq.km of the district. The area is underlain by consolidated rocks of Archaean Gneissic complex, Granite pluton, limestone, Quartzite and Phyllites (Shillong Group), with narrow belt of dolerite and ultrabasic sills and dykes from khasi green stone belt with limited areal extent in North-Central part. Small patches of conglomerate and sandstone from Khasi Group of rocks are also found in south western part of the district.

Occurrence of ground water in the study area is mainly in weathered and fractured Gneissic, Granite pluton Quartzite formation and to a very less extent in dolerite dykes and sills at some places. The different hydrogeological data are generated through intensive field data collection and testing.The aquifer system in this district can be divided as a two aquifer system viz., first aquifer (shallow) and second aquifer (deeper). Shallow or first aquifer consists of weathered residum where ground water occurs under water table condition and is mainly developed through construction of dug wells. The second aquifer is the deeper aquifer which tapped the fractured zone and is mainly developed through boring and construction of tubewells Based on the study of litholog and analysis of depth of construction of dug wells and bore wells, it is found that the first aquifer occur within 2 to 35 m bgl. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures upto the maximum explored depth of 247.6 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, Aquifer performance test, preliminary yield test and dug well pump tests were carried out during the course of study.Soil infiltration test was also conducted in different parts of the study area to know the infiltration rates at different soil conditions, topography, geology 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 springs was also carried out in the study area. Most of these springs are dentified as depression and topographic or fractured springs. It is observed that the discharge of springs in this area ranges from 0.6 to 240 litre/minute during pre-monsoon and 3 to more than 360 litre/minute during post-monsoon season.

In order to study the chemical quality of ground water in the district, water samples both from first aquifer (dug wells and springs) and second aquifer (CGWB Bore well) were collected during the course of field work and were analyzed. Chemical analyses reveal that

there is a slightly high concentration of iron in shallow and deeper aquifers. Concentration of Fe in springs is below permissible limit. Rest all other parameters in both shallow and deeper aquifers are within permissible limits.

Surface Geophysical studies in the study area were carried out to delineate the subsurface geology as well as to supplement the data gap under the assignment of Aquifer Mapping. A total of 138 VES were conducted as part of geophysical data prospecting.

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 assessed as 9569 ham and the stage of ground water development as 2.45 % which indicate the study area falls 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 is prepared with an emphasis on providing irrigation facilities through ground water development as agriculture is the main means of livelihood of the people living in the district. With the help of Agricultural professionals and using "CROPWAT" model software, developed by FAO, a cropping plan is designed for the district through using groundwater irrigation.

1. INTRODUCTION

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in East Khasi Hills District, Meghalaya during AAP 2016-17 and 2017-18 covering an area of 1053 sq.km out of the total geographical area of 2784 sq. 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 our understanding 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 behaviours, hydraulic characteristics and to establish groundwater quantity, quality, and sustainability, and to estimate the dynamic and static resources accurately through a multidisciplinary scientific approach on 1:50,000 scale and finally formulate a complete, sustainable and effective management plan for ground water development.

1.2 Scope of the Study:

The activities of this Aquifer Mapping and management plan can be envisaged as follows:

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

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, geophysical techniques, hydro-geochemical analysis, remote sensing, besides detailed hydrogeological surveys to delineate multi aquifer system; to bring out the efficacy of various geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environments.

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 regime scenario are being utilized to identify a suitable strategy for sustainable development of the aquifer in the area.

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

(i) Geophysical Surveys through Vertical Electrical Sounding (VES)
(ii) Exploratory drilling and construction of tube/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 and dug wells, soil infiltration test, specific yield determination, 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 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: The East Khasi Hills district is situated in the south-central part of Meghalaya having a common border with Bangladesh in the south. The district lies in the central part of the State and occupies a total geographical area of 2,748 km2. It is situated approximately between 25°07″ and 25°41″ N latitude and 91°21″and 92°09″ E longitude. The district comprises of two civil subdivisions, the Shillong Sadar Subdivision with headquarters at Shillong and the Sohra Subdivision with headquarters at Sohra (Cherrapunjee). The district has eight Community and Rural Development Blocks. The whole district was covered under NAQUIM programme. The district has eight C. &R.D. blocks and the details of the block along with their respective headquarters are given in Table 1.1

Table 1.1: Administrative Set up of East Khasi Hills district

Name of District/C.D. Block/Town	Total/ Rural/ Urban	Area in Km^2	Headquarter	Total number of villages/wards	Number of inhabited villages/wards	Number of inhabited villages/ wards
1	2	3	4	5	6	7
East Khasi Hills District	Total	2748.00	Shillong	975	923	52
	Rural	2679.38	-	975	932	52
	Urban	68.62	-	45	45	0
Mawphlang C.D. Block	Total	301.53	Mawphlang	184	184	0
	Rural	301.53	-	184	184	0
Mylliem C.D. Block	Total	215.33	5^{th} Mile	97	95	2
	Rural	154.51		97	95	2
	Urban	60.82	Shillong	44	44	0
Mawryngkneng C.D. Block	Total	285.52	Mawryngkneng	64	64	0
	Rural	285.52	-	64	64	0
Mawkynrew C.D. Block	Total	345.94	Mawkynrew	71	68	0
	Rural	345.94		71	68	0
Khatarshnong Laitkroh C.D. Block	Total	323.94	Khatarshnong Laitkroh	98	94	4
	Rural	323.94	-	98	94	4
Mawsynram C.D. Block	Total	509.64	Mawsynram	166	162	4
	Rural	509.64	-	166	162	4
ShellaBholaganj C.D. Block	Total	351.99	Sohra	139	123	16
	Rural	344.19		139	123	16
	Urban	7.80	Cherrapunjee	1	1	0
Pynursla C.D. Block	Total	414.11	Pynursla	156	133	23
	Rural	414.11	-	156	133	23

(Source: Directorate of Cenus Operations, Meghalaya)

This area falls partly or fully in the quadrants of Survey of India Toposheets bearing nos. 78O/8, 78O/10, 78O/11, 78O/12, 78O/14, 78O/15, 78O/16, 83C/2 and 83C/3 and is bounded by Ri Bhoi and Assam districts in the north, West Jaintia Hills district in the east, West Khasi Hills and South West Khasi Hills districts in the west and by Bangladesh in the south.

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. Toposheet wise (grid wise) the data gap was analysed for the whole district of East Khasi Hills which is shown in table 1.3. Fig 1.1 shows existing data in the district for data gap analyses. The Data Requirement, Data Availability and Data Gap Analysis are presented in table 1.2.

Table 1.2: Data Availability and Data Gap Analysis in Aquifer Mapping Studies

Sl. No.	Items	Data Requirement	Data Availability	Data Gap
1	Ground Water Exploration Data	As per requirement of Advanced Geophysical Studies for Integration of data and Validation of Techniques	25 EW	Entire study area
2	Geophysics	Geophysical data of the Study area	138 VES	Entire study area
3	Ground Water Monitoring Regime	Representative Monitoring Wells well distributed over the Study Area	7 Monitoring Well	Entire study area
4	Ground Water Quality	Representative Monitoring Wells well distributed over the Study Area	Water quality data of 7 monitoring wells	Representative Monitoring key Wells covering the entire study area
5	Specific yield (Shallow and deeper aquifer)	5 in shallow aquifer and 4 in deeper aquifer	Nil	Entire study area
6	Climate	Season-wise Rainfall pattern	Nil	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	2016-17 data is available	Latest data required
9	Geomorphology	Detailed Information on Geomorphology of the area	District level information	
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, East Khasi Hills district has a population of 825,922, out of which 410,749 were male and 415**,**173 were female respectively. East Khasi Hills ranks 1st in terms of population (8, 25,922) and 4th in terms of area (2748 sq.km.) in the state Meghalaya. In terms of "population per sq.km", East Khasi Hills is the most densely populated district in the state with 301 persons per sq.km as against the state figure of 132 person per square km. Mylliem block has the maximum number of people (2,87,791), followed by Mawphlang and Mawryngkneng block which have 71,491 and 67,291 persons respectively. In terms of sex ratio (921 females per 1000 males), the district stands at a favourable position having the second highest sex ratio in the state. Block level population figure as per 2011 census is given in Table 1.4.

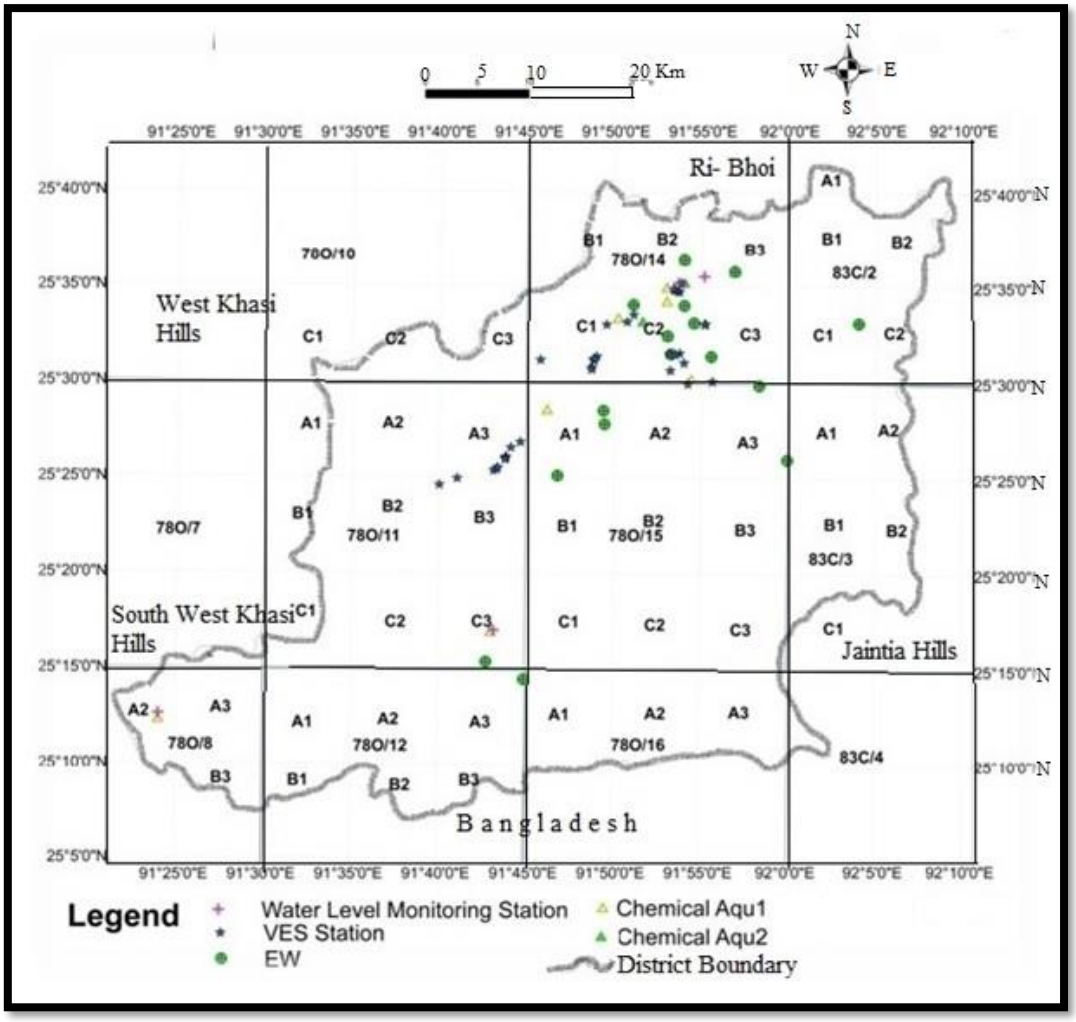


Fig 1.1: Existing data of the district for Data Gap Analyses

1.7 Communication: East Khasi Hills district is well connected to its adjoining districts viz. Assam, Ri bhoi, Jaintia Hills, West khasi hills and South west Khasi Hills districts and the National Highway 40 and 44 E passes through the heart of the district and serves as the lifeline for the State Capital and other districts of the state. The headquarter of the district is at Shillong, which is also the state capital and 100 km from Guwahati. All the eight development block Headquarters that is Mylliem, Mawphlang, Mawsynram, Laitkroh, Shella,.Pynursla, Mawkynrew and Mawryngkneng are connected with Shillong, the district headquarter, by metallic roads.

1.8 Land use: Land utilisation 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 East Khasi Hills district is shown in the Table1.4 and land use map is shown in Fig. 1.2.

Table 1.3: Toposheet wise Data availability, data gap and required data generation in the study area

Toposheet	Grid	Existing data										Data Required/Data Gap									
		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
78O/8	A2	0	0	0	1	1	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0
78O/8	A3	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/8	B3	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/10	C2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/10	C3	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/11	A1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/11	A2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/11	A3	0	0	0	0	0	0	0	2	0	0	1	1	0	1	1	1	1	0	1	1
78O/11	B1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/11	B2	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1
78O/11	B3	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0
78O/11	C1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/11	C2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/11	C3	0	0	0	1	1	1	0	0	0	0	1	1	2	0	0	0	1	2	1	1
78O/12	A1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/12	A2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/12	A3	0	0	0	0	0	1	0	0	0	0	1	1	2	1	1	0	1	2	1	1
78O/12	B1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	1	2	0	0
78O/12	B2	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/12	B3	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/14	B1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/14	B2	0	0	0	1	1	1	0	1	2	0	1	1	1	0	0	0	1	1	0	1
78O/14	B3	0	0	0	0	1	1	0	0	1	0	0	0	2	1	0	0	0	2	0	0
78O/14	C1	0	0	0	1	0	0	0	2	0	0	1	1	2	0	1	1	1	0	1	1
78O/14	C2	0	0	0	2	0	5	0	2	3	0	0	0	0	0	1	0	0	0	0	0
78O/14	C3	0	0	0	0	0	1	0	2	0	0	1	1	2	1	1	0	1	0	1	1
78O/15	A1	0	0	0	0	0	3	0	0	0	0	1	1	2	1	1	0	1	2	1	1
78O/15	A2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/15	A3	0	0	0	0	0	1	0	0	0	0	1	1	2	1	1	0	1	2	1	1
78O/15	B1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/15	B2	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/15	B3	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/15	C1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/15	C2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/15	C3	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/16	A1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
78O/16	A2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
78O/16	A3	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1

83C/2	C1	0	0	0	0	0	1	0	0	0	0	1	1	2	1	1	0	1	2	1	1
83C/2	C2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
83C/2	B1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
83C/2	B2	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
83C/3	A1	0	0	0	0	0	1	0	0	0	0	1	1	2	1	1	0	1	2	1	1
83C/3	A2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	2	0	0
83C/3	B1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0
83C/3	B2	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
83C/3	C1	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	1	1	2	1	1
	Total	0	0	0	6	4	16	0	11	6	0	25	25	87	42	43	18	27	83	24	25

(CHE= Chemical data, WL= Water level data, VES= Vertical Electrical Sounding data, EW=Exploratory well, OW= Observatory well)

Table 1.4: Block level Population of East Khasi Hills District as per 2011 census

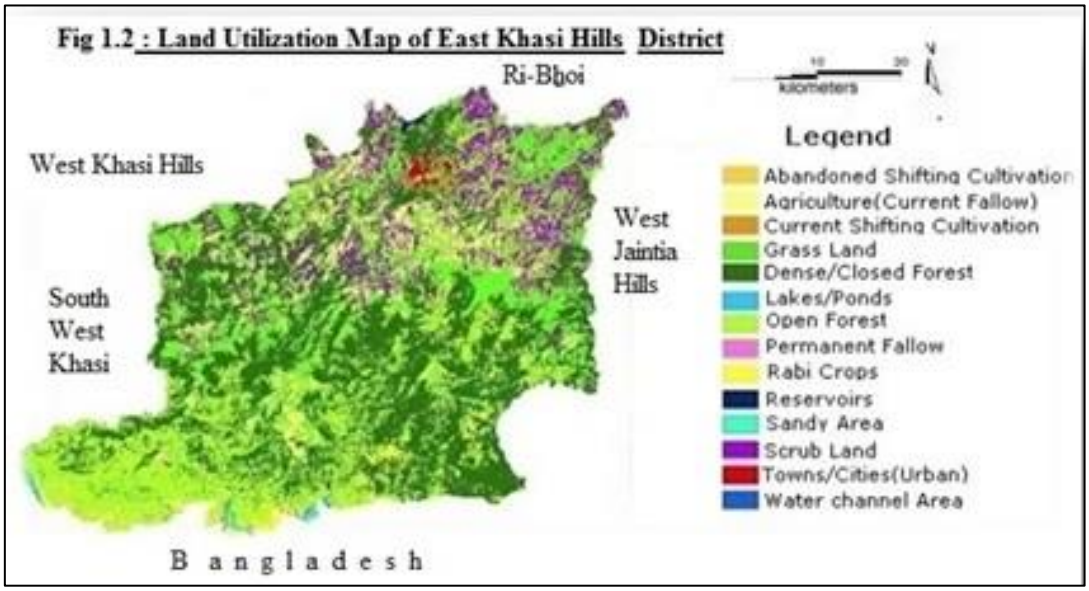
Name of the Block		No of Household	Population 2011		
			Total	Male	Female
	Total	58,551	287,791	143,237	144,554
	Rural	17,240	88,191	43,556	44,635
Mylliem	Urban	41,311	199,600	99,681	99,919
	Total	13,117	71,491	35,331	36,160
	Rural	13,117	71,491	71,491	71,491
Mawphlang	Urban	-	-	-	-
	Total	12,219	67,291	33,396	33,895
	Rural	12,219	67,291	33,396	33,895
Mawryngkneng	Urban	-	-	-	-
	Total	7,995	44,602	22,118	22,484
	Rural	7,995	44,602	22,118	22,484
Mawkynrew	Urban	-	-	-	-
	Total	11,273	57,870	28,506	29,364
	Rural	11,273	57,870	28,506	29,364
Pynursla	Urban	-	-	-	-
	Total	10,661	54,039	27,251	26,788
	Rural	8,409	42,317	21,636	20,681
Shellabholaganj	Urban	2,252	11,722	5,615	6,107
	Total	10,145	54,109	27,143	26,966
	Rural	10,145	54,109	27,143	26,966
Mawsynram	Urban	-	-	-	-
	Total	6,587	33,570	16,723	16,847
Khatarshnong Laitkroh	Rural	6,587	33,570	16,723	16,847
	Urban	-	-	-	-
Total		**164,064**	**825,922**	**410,749**	**415,173**

(Source: Directorate of Cenus operations, Meghalaya)

Table 1.5: Land use pattern in East Khasi Hills District, 2015-16

Land Classifications	Area (in hectares)
A. Geogrphical Area	2,74,800
B. Reporting Area	2,74,787
1. Forests (classed & unclassed)	1,06,956
2. Area not available for cultivation a.(i) Area under non-agricultural uses	
b. Barren and uncultivalble lands	
c. Water logged land	
d. Social Forestry	2,987
e. Land under still water	4,732
f. Other land	11,975
TOTAL = (a+b)	
TOTAL (Column a to f)	19,694
(ii) Barren and unculturable lands	33,960
TOTAL = Col. I & ii	53,654
3. Other uncultivable lands	
a. Permanent pastures and other grazing lands	
b. Land under Misc. tree crops & grooves etc.	16,874
c. Cultivable wastelands	48,667
TOTAL = (a+b+c)	65,541
4. Fallow lands a. Fallow lands other than current fallows b. Current fallows	 5,998 4,786
TOTAL = (a+b)	10,784
5. Net area sown	37,852
6. Area sown more than once	11,126
7. Total Croped area	48,978

(Source: Directorate of Economics & Statistics, Govt. of Meghalaya.)



(Source; NESAC)

1.9 Soil: Geomorphologically, the East Khasi hill is an undulatory one. It comprises of denudational high and low hills with deep gorges. The district represents a remnant of ancient plateau of Indian Peninsular Shield which is deeply dissected suggesting several geotectonic and structural deformities that the plateau has undergone. The northern portion of the district is a dissected Shillong plateau gradually rising southwards to the rolling grasslands with gentle river valleys, and then falls sharply in the Southern portion forming deep gorges and ravines in Mawsynram and Shella Bholaganj, bordering Bangladesh. In the southern border areas, there are fringes of alluvial plains that are localized in nature. Soil type of an area is dependent on factors like geology, relief, climate and vegetation. Red Loamy soil is a product of weathering of rocks like granites, gneisses etc which are relatively rich in clay forming minerals. This soil type are rich in organic matter, nitrogen and acidic in nature. They are found exposed in the central part of the district. Laterite soil is a weathering product of rocks like quartzite, schist, conglomerate etc, which are found exposed in the northern area of East Khasi Hills. The soils are rich in iron and aluminium. Alluvial soils are found exposed in the southern part of the district that are rich in potash but poor in phosphate content. They are acidic in nature.The soil in the study area is mostly deep brown, silty clay to clay loam, permeable and acidic in nature. The acidic character is due to leaching of bases caused by high rainfall. The gneisses, quartzite and basic intrusive gave rise to very deep fine texture soils whereas soil developed over granites are coarse loamy and permeable. The soil developed within the intermontane valleys over colluvial and alluvial deposits are light brown to dark grey in colour, poorly drained, strongly acidic clay loams and are used for agriculture.Soil is one of the most important components of the land through which the interaction of all natural factors takes place. 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. Accordingly, the soils types are broadly classified into three orders as given below.

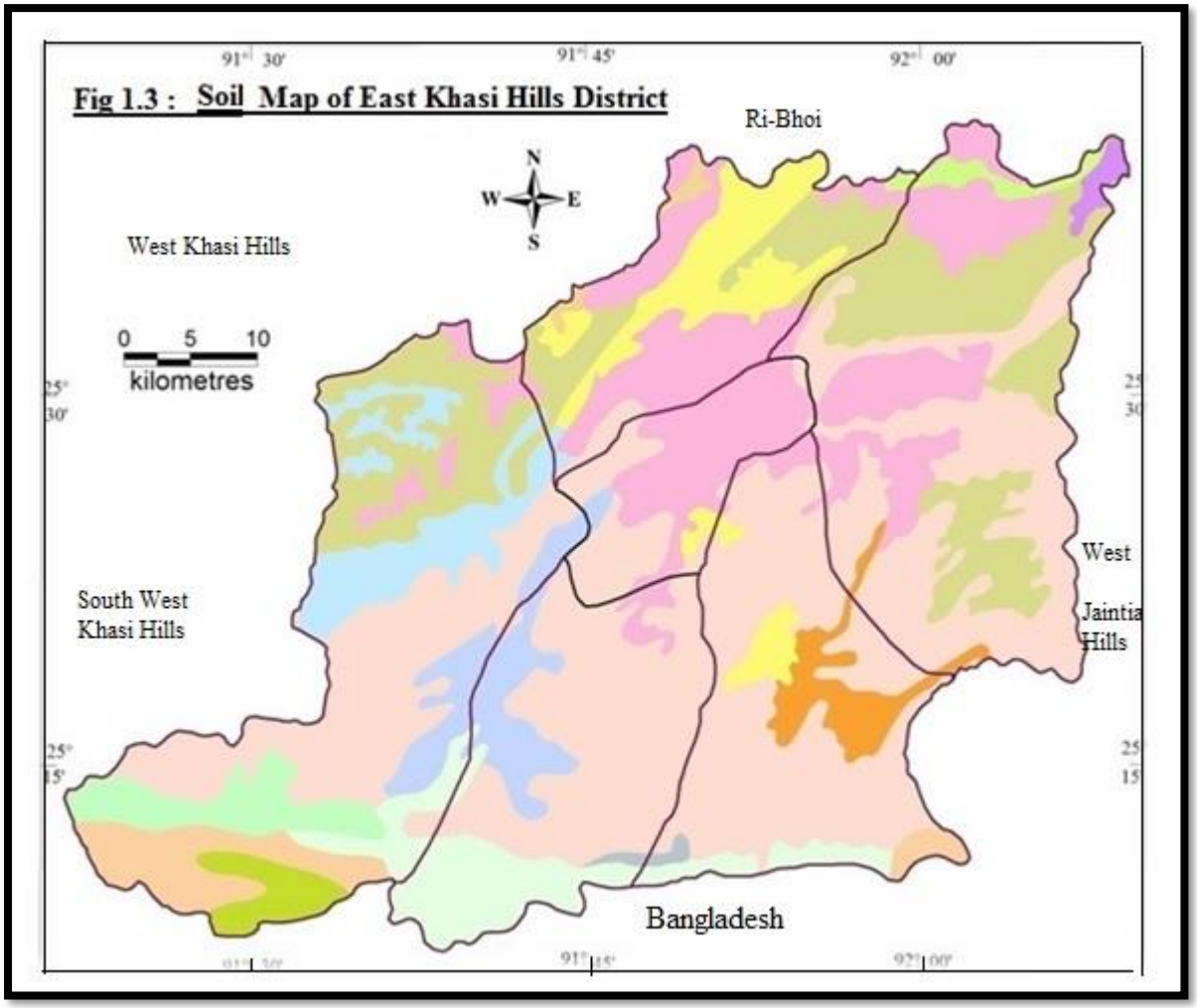
- Red loamy soils
- Laterite soils
- Alluvial soils

Red loamy soil: This soil occupies the central part of the study area. It is generally loamy and red in colour. These are the result of weathering of rocks such as granites, gneisses, diorites and those which are relatively richer in clay forming minerals but poorer in silica. The exposed red loamy soil is rich in organic matter and nitrogen due to humus contains from the litters of tree leaves, grasses etc. These are acidic and suitable for the cultivation of potatoes, rice, fruits in hills slope and terraces.

Laterite soils: This soil is found in the Northern part of the study area. These are resulted due to the weathering of rocks like granites, quartzite, schist, gneisses, conglomerates etc. This area is rich in iron and aluminum and is yellowish red in colour.

Alluvial Soils: The alluvial soils are found the in the southern part of the district, along Bangladesh border. The soil texture varies from sandy to clayey-loam with varying degree of nitrogen and is acidic in nature. The soils are rich in potash but poor in phosphate content.

It is suitable for cultivation of rich and jute. Soil map of the area is given in Fig 1.3.



(*Source: Regional Center of National Bureau of Soil Survey and Land Use Planning*).

1.10 Agriculture: Agriculture is the main means of livelihood of the people in the district and about 80 % 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. Principal crops grown in the district are rice, maize, millets, oilseeds and pulses. Horticulture products include orange, pineapple, pears, peaches, plums, sohiong, sophi, betel nut and many local fruits. Vegetables like potato, sweet potato, ginger, garlic etc. are also grown. Present area under different crops and their productivity is shown in table 1.6.

Table 1.6: Area under different crops and their productivity, East Khasi Hills (2015-16)

Crops	Area (ha)	Avg.Yield (kg/ha)
Autumn rice	284	3282
Winter rice	5439	2308
Spring rice	130	2115
Maize	3113	3361
Millets	261	1241
Pulses	658	3400
Rape and Mustard	93	882
Soyabean	350	1274
Citrus fruits	5786	5022
Arecanut	4924	1206
Papaya	122	7115
Pineapple	936	7869
Strawberry	9	21889
Potato (summer)	34	6147
Sweet potato	8241	11731
Ginger	1027	10674
Turmeric	121	5851
Chillies	145	2476
Black pepper	185	870

(Source: Agriculture Department, Govt. of Meghalaya)

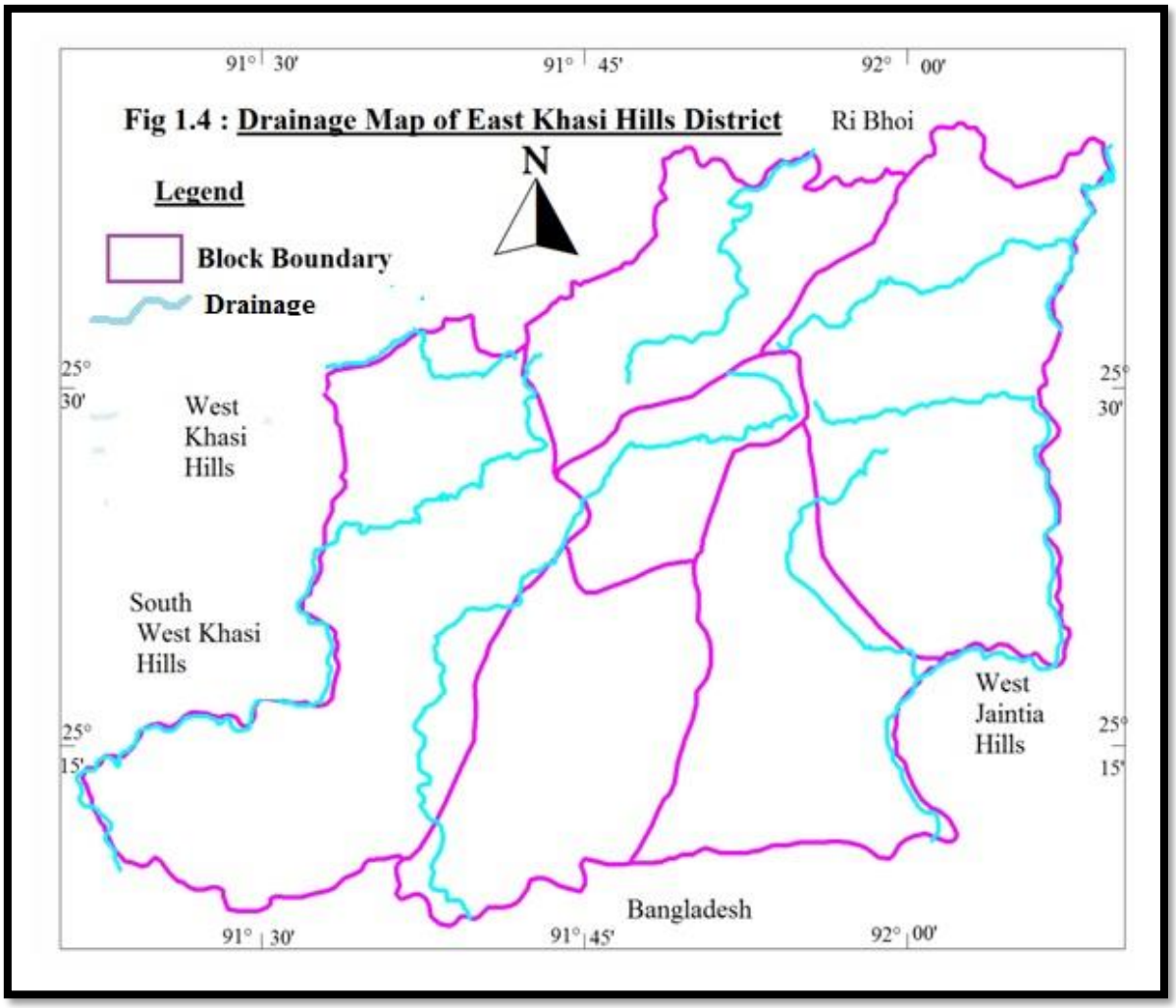
1.11 Irrigation: The district does not have any major or medium irrigation projects. Agriculture is dependent mainly on rainfall.

1.12 Industries: From industrial point of view, the study area is still underdeveloped as of now.

1.13 Forest: As per Forest and Environment Department, Meghalaya, East Khasi Hills district has a total area of 1, 06,956 sq.km (as per 2015-16) under forest (classed & unclassed) and social forestry area of 4,732 of sq.km.

1.14 Drainage: The topography controls the drainage system as it divides the state of Meghalaya into two watersheds namely the Brahmaputra system in the North and Meghna /Surma system in the South. Drainage of the East Khasi Hills district in the north flows toward the Brahmaputra River and in the south, the rivers flow towards the Bangladesh plains into Surma River. The important rivers in the northern part are Umtrew, Umiam and Umkhen. The Umtrew (or Digaru) River originates from the west of the Sohpetbneng range in East Khasi Hills District, near Lum Raitong. It flows towards the west till it meets the

waters from the Umiam River which is being diverted by the Umiam Hydel Project. In the southern part, rivers Umiew (or Shella, also known as Bagra), Umngot, Umngi (Balat), etc. all tributaries of the Surma, originating from southern slopes of Khasi Hills, drain one of the world's heaviest rainfall areas and flow southwards into Bangladesh, have violent flows. The drainage pattern is structurally controlled and parallel to sub-parallel in nature. The drainage map is shown in Fig 1.4.



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.

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

2.1.1 Water level monitoring: In the study area, 8 dug wells (7 existing GWMS), 5 bore wells and 54 nos. of springs are established to study the water level, quality, spring discharge and its behavior periodically.

Phreatic aquifer: A total of 8 dug wells (7 existing GWMS) were established as key wells for periodical water evel monitoring to know the water level trend and its behavior. The key observation wells details are presented in Annexure 3A and the pre and post- monsoon Depth to Water Level maps are presented in Fig 2.1 and 3.6 respectively. The location of key observation wells is given in Annexure 3.

Confined/Semi-confined aquifer: For study of piezometric head in the district, a total of 5 bore wells were 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 3.7 and 3.8.

Springs: A total of 54 springs were established and monitored to know the type, discharge and their behaviour. The locations of these springs are given in table 2.1.

2.1.2 Preliminary Yield Test (PYT): A total of 6 preliminary yield tests were carried out during NAQUIM programme in the study area to know the aquifer parameters. The details are shown in Annexure 1.

2.1.3 Dug Well Pump Test: A total of 2 dug well pump test were conducted in the study area to know the specific capacity (Slitchers' Method) of shallow aquifers and its suitability for irrigation purposes. The details are shown in the table 2.2.

2.1.4 Soil Infiltration Studies: Soil infiltration test were conducted using double ring infiltormeter and the constant infiltration rates of different soils were calculated by double ring infiltrometer method. These studies were carried out in different locations to know the infiltration rates at different soil conditions, topography, and geology. This will provide a scientific approach of groundwater recharge, its suitability and to estimate the amount of water recharging in the area, rainfall infiltration factor and will help in calculating ground water resource estimation. The details are shown in table 2. Location of Soil infiltration tests are shown in fig 2.1

Table 2.1 Location of springs in East Khasi Hills district

S. No.	Name of village/site	Latitude in degrees decimal	Longitude in degrees decimal	Elevation (mamsl)	Type	Aquifer	Source
	1	2	3	4	5	6	7
1	Demthring	25°33’30”	91°54’32”	1576	Fracture	I	CGWB
2	Madanryting	25°33’13”	91°54’54”	1590	Depression	I	CGWB
3	Mawshubuit	25°33’34”	92°55’53”	1634	Depression	I	CGWB
4	Lapalang	25°33’51”	91°55’2”	1549	Depression	I	CGWB
5	Umpling	25°34’26”	91°55’08”	1493	?	I	CGWB
6	Nongmysong	25°35’17”	91°54’48”	1455	Fracture	I	CGWB
7	Mawdiangdiang	25°36’44”	91°56’6”	1316	Fracture	I	CGWB
8	Ummawlong	25°36'44"	91°24’52”	1222	Depression	I	CGWB
9	Mawlai	25°36’04"	91°53’26"	1389	Fracture	I	CGWB
10	Lankyrding	25°35’45”	91°54’31”	1441	Fracture	I	CGWB
11	Jiengkieng	25°33’43”	91°54’07”	1553	Fracture	I	CGWB
12	Ladsaheb	25°32’34”	91°54’10”	1802	Fracture	I	CGWB
13	Thangbania	25°32’26”	91°53’58”	1813	Fracture	I	CGWB
14	Smit	25°30’0.6”	91°54’21”	1763	Depression	I	CGWB
15	Laitdeingsai	25°28’13”	91°55’13”	1846	Fracture	I	CGWB
16	Nongthymai	25°27’41”	91°58’42”	1659	Fracture	I	CGWB
17	Umphyrnai	25°31’53”	91°54’47”	1748	Fracture	I	CGWB
18	Mawryngkneng	25°33’11”	92°03’17”	1308	Fracture	I	CGWB
19	Umkhen bridge	25°35'37”	92°03’28”	966	Fracture	I	CGWB
20	At Laimer Shiteng	25°35'49”	91°51’16”	1617	Depression	I	CGWB
21	Madan Sangmein	25°32'15"	91°50’50”	1809	Fracture	I	CGWB
22	Mawkhrie	25°30'02"	91°47’15”	1738	Depression	I	CGWB
23	Mawmaram	25°31'16"	91°42’48”	1772	Depression	I	CGWB
24	Sohoing	25°29'49"	91°42’41”	1732	Depression	I	CGWB
25	Mawphlang	25°27'38"	91°45’35”	1815	Depression	I	CGWB
26	Mawdngung	25°29'06"	91°43’10”	1822	Fracture	I	CGWB
27	Mylliem	25°30'35"	91°48’43”	1669	Depression	I	CGWB
28	7th Mile Mylliem	25°31'45"	91°49’19”	1744	Depression	I	CGWB
29	Umtyngar	25°27'28"	91°49’34”	1714	Fracture	I	CGWB
30	Kyrdemkhla	25°26'17"	91°48’56”	1832	Fracture	I	CGWB
31	Mawkdok	25°25'26"	91°47’30”	1834	Fracture	I	CGWB
32	Dawlieh	25°21'35"	91°44’41”	1696	Fracture	I	CGWB
33	Sohrarim	25°20'41"	91°44’17”	1668	Fracture	I	CGWB
34	Tyrna Mawlong Road	25°14'20"	91°44’32”	652	Fracture	I	CGWB
35	Umwaih	25°13'40"	91°41’58”	471	?	I	CGWB
36	Ringuir	25°12'30"	91°43’34”	578	Fracture	I	CGWB
37	Umkaber Lyngiong	25°25'0.7"	91°41’48”	1665	Depression	I	CGWB
38	Tyrsad	25°24'23"	91°39’34”	1644	Fracture	I	CGWB
39	kyrphie	25°23'28"	91°39’13”	1650	Depression	I	CGWB
40	Weloi	25°21'43"	91°36’53”	1590	Depression	I	CGWB
4 1	Mawsynram	25°18'22"	91°34’56”	1467	Fracture	I	CGWB
42	Mawkasain	25°15'50"	91°31’11”	1128	Fracture	I	CGWB
43	Mawsynram	25°17'46"	91°34’42”	1383	Fracture	I	CGWB
44	Mawpan	25°14'16"	91°26’23”	688	Fracture	I	CGWB
45	Rangweng	25°14'24"	91°24’57”	623	Fracture	I	CGWB
46	Umlamgrim	25°14'16"	91°26’23”	1642	Fracture	I	CGWB
47	Laitlynkgot	25°26'40"	91°50’30”	1833	Depression	I	CGWB
48	Pomlum	25°24'54"	91°52’04”	1672	Depression	I	CGWB
49	Laitmynreng	25°19'44"	91°53’38”	1447	Fracture	I	CGWB
50	Lankyrdem	25°21'08"	91°53’37”	1534	Fracture	I	CGWB
51	Mawriang	25°12'05"	91°59’42”	375	Fracture	I	CGWB
52	Bopumsyiem	25°01'23"	92°01’05”	28	Fracture	I	CGWB
53	Rngain	25°18'30"	92°54’12”	1472	Fracture	I	CGWB

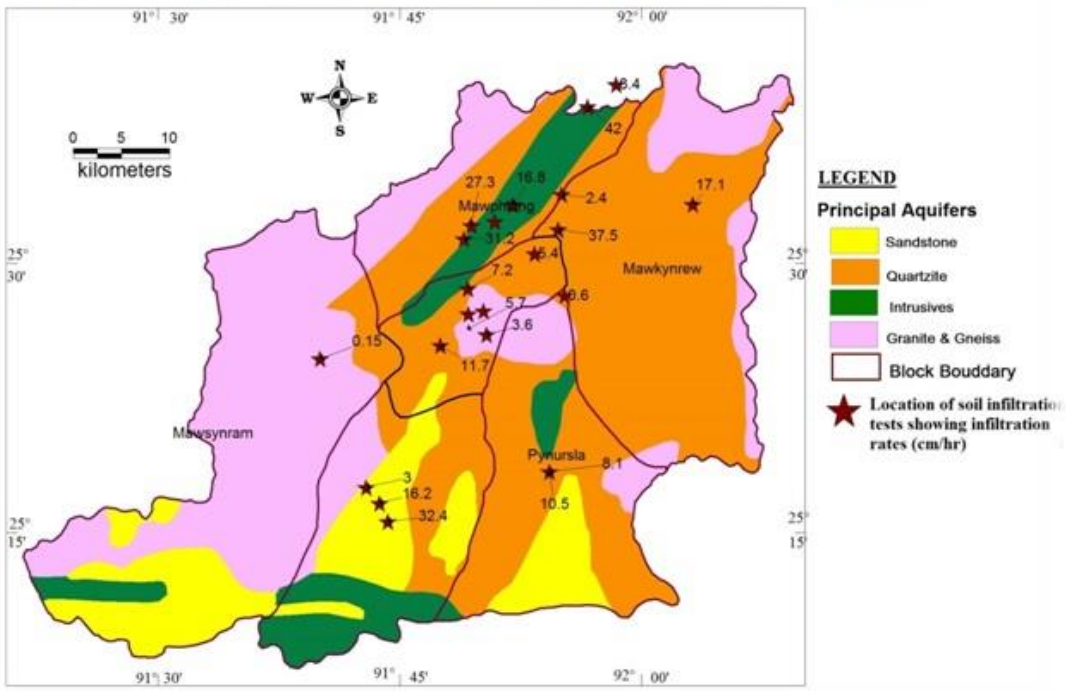
Table 2.2: Details of Dug well Pump test results

Location	Latitude	Longitude	Elevation (ma MSL)	Total depth of DW (mbgl)	Diameter (m)	Measuring Point (m)	Static Water level (m bgl)	Specific capacity (m^3/min/ m of DD)
Dhankheti	25°31’57”	91°53’34”	1515	3.60	0.78	0.65	2.41	0.347
Nonymsong	25°34’46”	91°54’24”	1440	4.70	0.75	0.70	3.36	0.15253

Table 2.3: Details of Soil Infiltration Test studies results

S.No.	Location	Lat.(DMS)	Lon.(DMS)	Elevation(m)	Soil Thikness (m)	Colour	Infiltration rate (cm/hr)	Date of test
	1	2	3	4	5	6	7	8
1	Forest Range Office	25°15'38"	91°44'15"	1255			32.4	
2	Pomsohmen	25°16'39"	91°43'44"	1348			16.2	
3	Sohra Village	25°17'31"	91°42'54"	1468			3	
4	Umtyngar	25°27'11"	91°49'14"	1764			5.7	
5	EAC	25°32°07"	91°49'26"	1762			27.3	
6	Bhanung	25°31'22"	91°48'58"	1722			31.2	
7	Dympep	25°25'26"	91°47'30"	1853			11.7	
8	Kharkemeh	25°28'36"	91°49'12"	1757			7.2	
9	Pomkaniew	25°27'22"	91°50'11"	1817			2.4	
10	Laitlyngkot village	25°26'02"	91°50'22"	1824			3.6	
11	Tyrsad	25˚24'46"	91˚40'37"	1635	1 to 2	Brownish yellow	0.15	01.02.18
12	Laitdiengsai	25˚28'12"	91˚55'12"	1843	1 to 1.2	Brown	0.6	15.12.17
13	Golf Links, Polo	25˚35'12"	91˚53'39"	1431	1 to 2	Yellowish clayey	5.4	12.02.18
14	Madan sangmen	25˚32'20"	91˚50'53"	1788	1 to 2	Brownish yellow	42	08.02.18
15	Pynursla	25˚18'24"	91˚54'16"	1308	1 to 1.5	Yellowish clayey	8.1	02.02.18
16	Lawsohtun	25˚18'24"	91˚54'16"	1596	2.5 to 3	yellow	10.5	13.02.18
17	Laban	25˚33'15"	91˚52'01"	1596	2 to 2.5	yellow	16.8	01.03.18
18	Mawryngneng	25°33'17"	92° 3' 9"	1306	1 to 2	yellowish brown	17.1	28.03.18
19	Umphyrnai	25°31'53"	91°54'47"	1768	1 to 2	Yellowish clayey	37.5	28.03.18
20	Lapalang	25°33'51"	91° 55' 2"	1544	2 to 2.5	Yellowish clayey	2.4	09.02.18
21	Nongkohlew	25˚38'45"	91˚56'38"	1065	2 to 3	Reddish brown	42	14.02.2017
22	Mawsiatkhnam	25˚39'59"	91˚58'23"	1029	1 to 2	Brown	8.4	14.02.18

Fig 2.1: Location of Soil Infiltration Tests Carried out in East Khasi Hills District



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 both 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 many chemical parameters. The analytical data are given in Annexure 2.

2.3 Geophysical studies: Surface Geophysical studies in the study area were carried out before the NAQUIM programme to delineate the subsurface geology as well as to supplement the data gap under the assignment of Aquifer Mapping. A total of 138 VES were conducted (during earlier AAPs). 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.

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 programme was started in the district, 18 EW were constructed and as a part of data gap generation 7 EW were constructed during the course of study. Details of the exploratory wells are presented below in the table 2.4 and table 2.5.

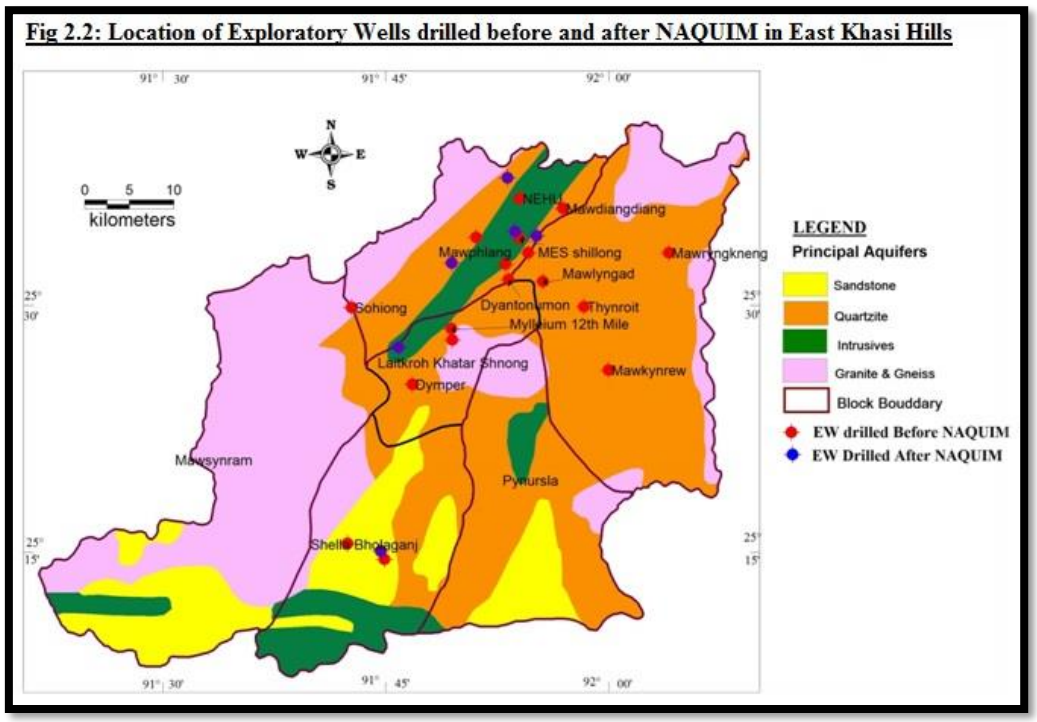
The exploratory wells which were constructed before and during NAQUIM are shown in fig 2.2

Table 2.4: Exploratory wells constructed before NAQUIM, East Khasi Hills District

S.No.	Site Name	Latitude	Longitude	Elevation(m)	AAP Year	Depth drilled (m)
1	Dymper	25°25’08”	91°46'47"	1914	1995-96	80
2	Kyanton-U-Mon	25°031’30”	91°53'15"	1847	1995-96	70
3	Mamluh	25°031’47”	92°9'45"	1331	1995-96	201.13
4	Mawryngkneng	25°033’08”	92°4'02"	1316	1995-97	59.45
5	Sohiong	25°029’45”	92°42'52"	703	1995-97	64
6	Umlyngka	25°034’04”	91°51'05"	1554	1995-97	80
7	Mawsmai -	25°014’30”	91°51'05"	1203	2003-04	247.6
8	Mylliem 12 Mile	25°028’32”	91°51'05"	1805	2003-04	231.95
9	NEHU	25°036’26”	91°51'05"	1395	2003-04	100.9
10	Thynroit	25°029’52”	91°51'05"	1665	2003-04	80
11	MES, Shillong	25°034’02”	91°51'05"	1546	2007-08	108.8
12	ASI, Mawpet	25°033’08”	91°51'05"	1678	2007-08	140.7
13	Umtyngar	25°027’50”	91°51'05"	1747	2011-12	200.05
14	Mawdiangdiang	25°035’50”	91°51'05"	1391	2011-12	200.05
15	Mawkynrew	25°026’00”	91°59'58"	1546	2011-12	153.7
16	Mawlyngad	25°031’23”	91°55'34"	1729	2011-12	200.05
17	LaitkorLumeh	25°032’27”	91°53'03"	1878	2011-12	190.95
18	Mawlyngad	25°31'23"	91°56'55"	1705	-	200.05

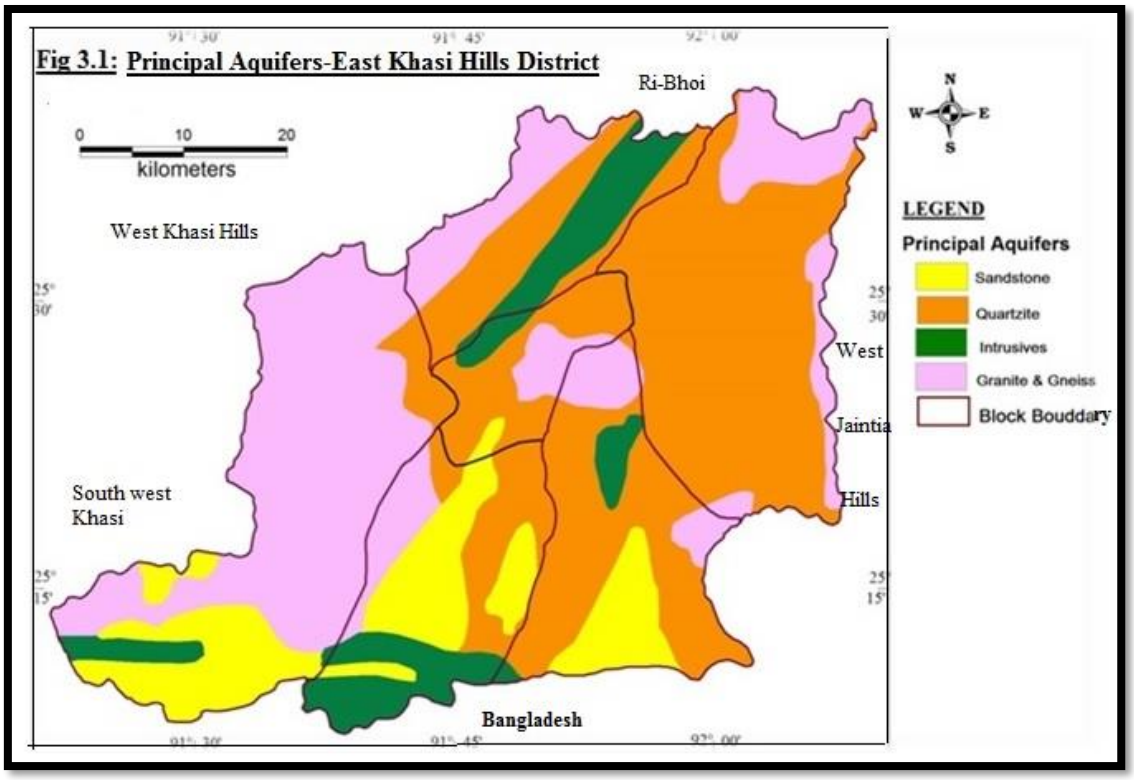
Table 2.5: Exploratory wells constructed during NAQUIM, East Khasi Hills District

S.No.	Site Name	Latitude	Longitude	Elevation(m)	AAP Year	Depth drilled (m)
1	Laitkor	25°32’14”	91°53'33"	1873	2016-17	178.89
2	Cherrapunjee, NIT campus	25°15’01”	91°44'39"	1267	2016-17	111.59
3	Nongpyiur	25°32’31”	91°49'25"	1766	2016-17	215.8
4	JNV , Mawplang	25°27’20.6”	91°58'10"	1670	2016-17	203.56
5	Shillong, WRD	25˚33’56.3”	91°53'46"	1560	2016-17	93.13
6	Mawiong	25˚37’43”	91°53'12"	1279	2016-17	200.33
7	Lapalang	25˚33’56”	91°53'46"	1550	2016-17	111.59



3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 General hydrogeology and occurrence of ground water: The hydrogeological formation of the study area comprised of Gneissic complex of Arcaean to Proterozoic, Quartzite of Palaeo-Meso-Proterozoic, Khasi Basic- Ultra basic intrusive of Proterozoic, Granite plutons (Mylliem granite) of Neo Proterozoic to Early Proterozoic formation. 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

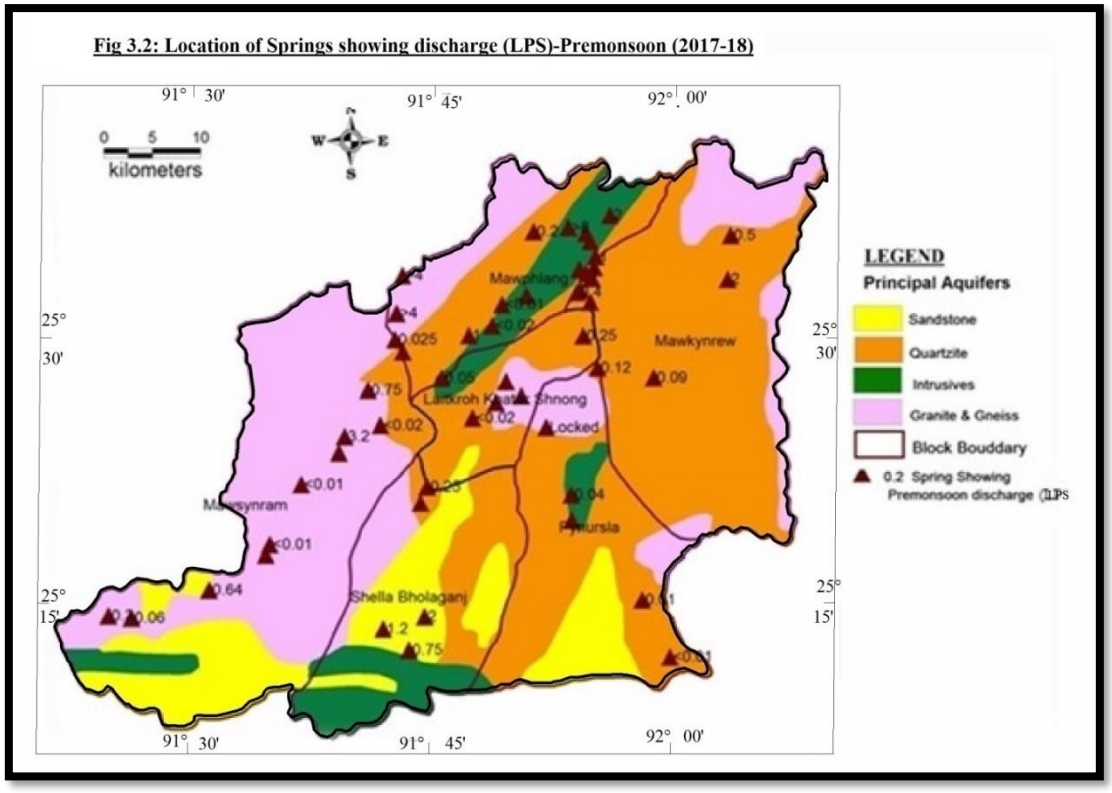


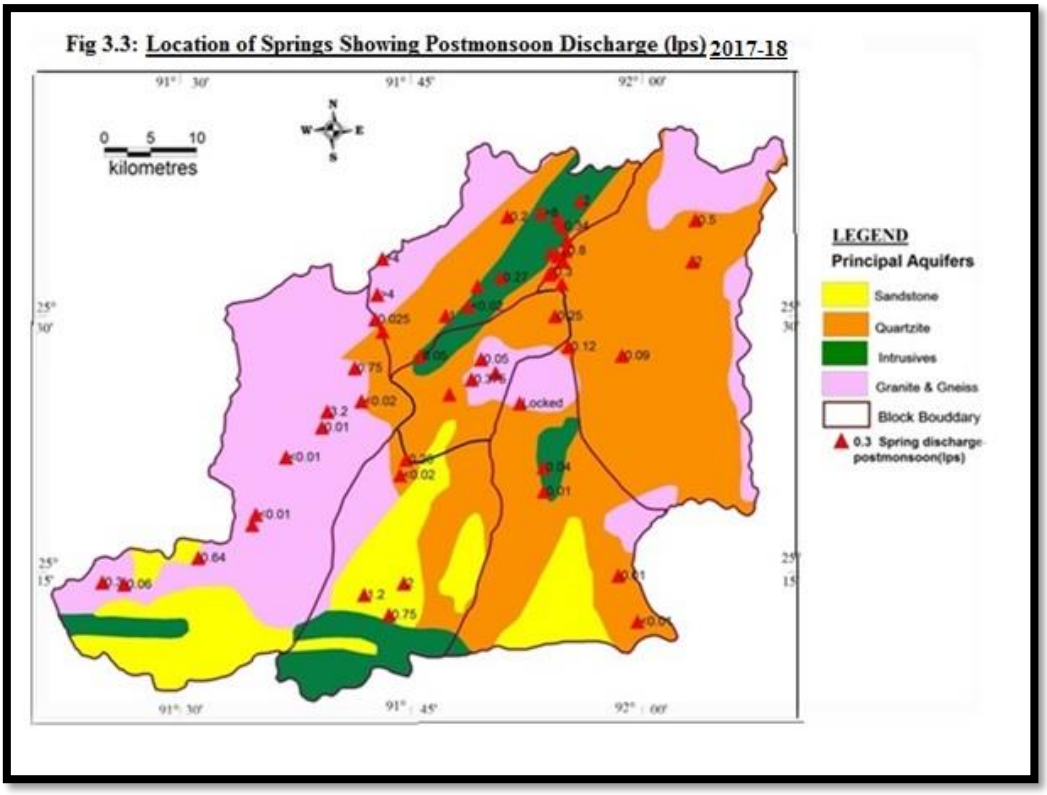
3.1.1 Occurrence of ground water in shallow aquifers: The depth of shallow aquifer in the district ranges from 1.5 to 10.74 meters. This shallow aquifer occurs under unconfined to semi confined condition. Ground water from shallow aquifer is extracted through different types of ground water extraction structures such as dug wells.

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, Gneiss Granite, Kahsi greenstones and limestones. The drilled depth of exploratory wells tapping this aquifer ranges from 64.0 to 247.60 m 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. Two artesian wells were found in the study area, one was at Lawsohtun campus, Shillong (drilled by CGWB earlier) where the discharge is 10.8 m^3/ hr and the other one is at Power Grid campus, Shillong.

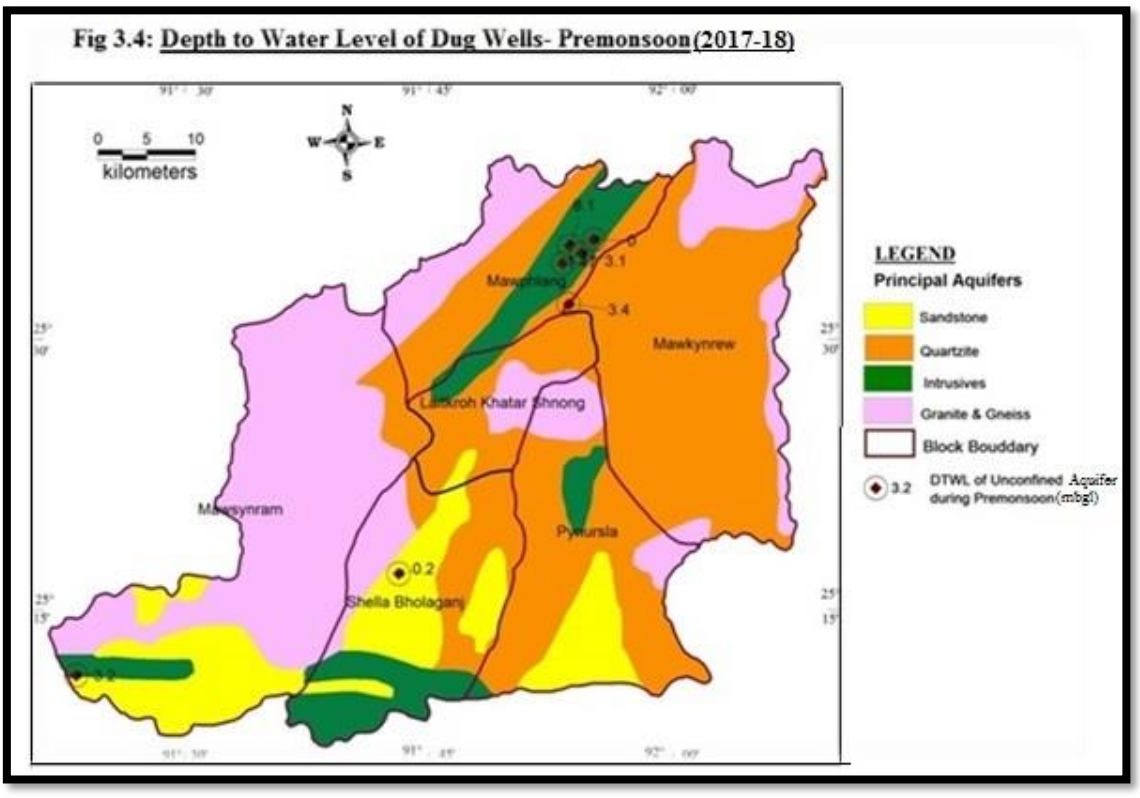
3.1.3 Springs: Spring is defined as a localized natural discharge of ground water appearing at the ground surface as a current of flowing water through well-defined outlets. The discharge may vary from a trickle to a stream. Groundwater flow from springs is governed mainly by

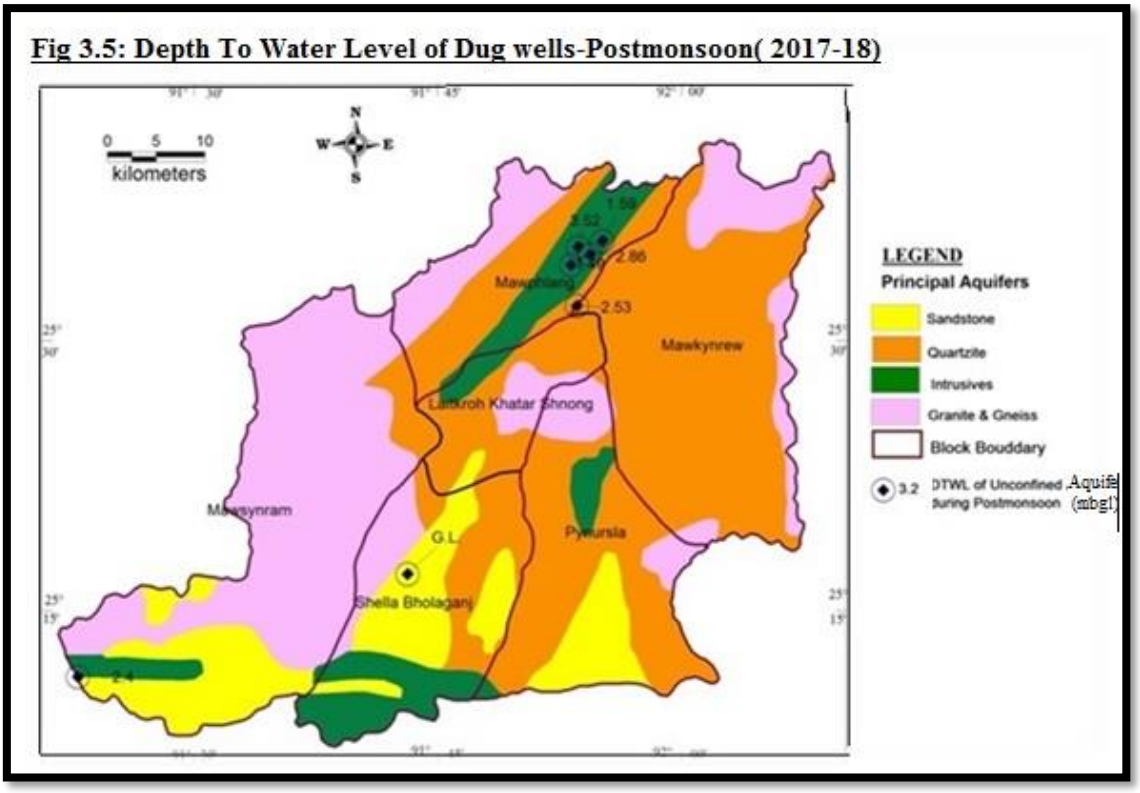
three inter-related factors: geology (type, distribution and permeability characteristics of geologic units), topography (landforms and relief), and climate (timing and amount of precipitation). Topography drives the groundwater flow downhill and largely dictates the occurrence of the spring itself. 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 springs 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 5 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 most of the springs in the district are either depression or topographic or fractured springs. Discharge of springs in general varies from 0.6 to120 litre/minute during pre monsoon and from 3 to180 litre/minute during postmonsoon season. Some springs have high discharge even in premonsoon season viz. springs at Mawlai, Mawsynram and Mawryngkneng (240 litres/minute) while some went dry during premonsoon season viz. spring at Umtyngar. It is observed that the discharge of springs increases during post monsoon. Most of the springs showed drastic increase in discharge during post monsoon season. While a few springs have a gradual impact of rainfall on their discharge.



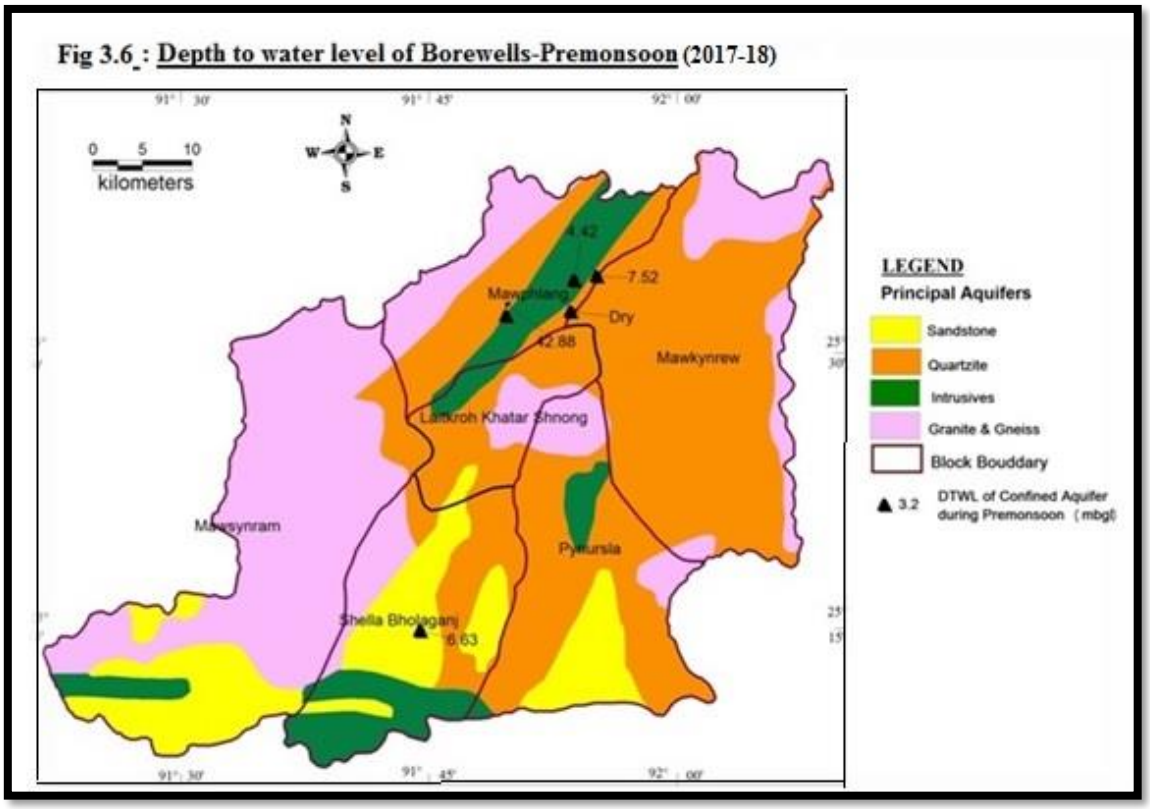


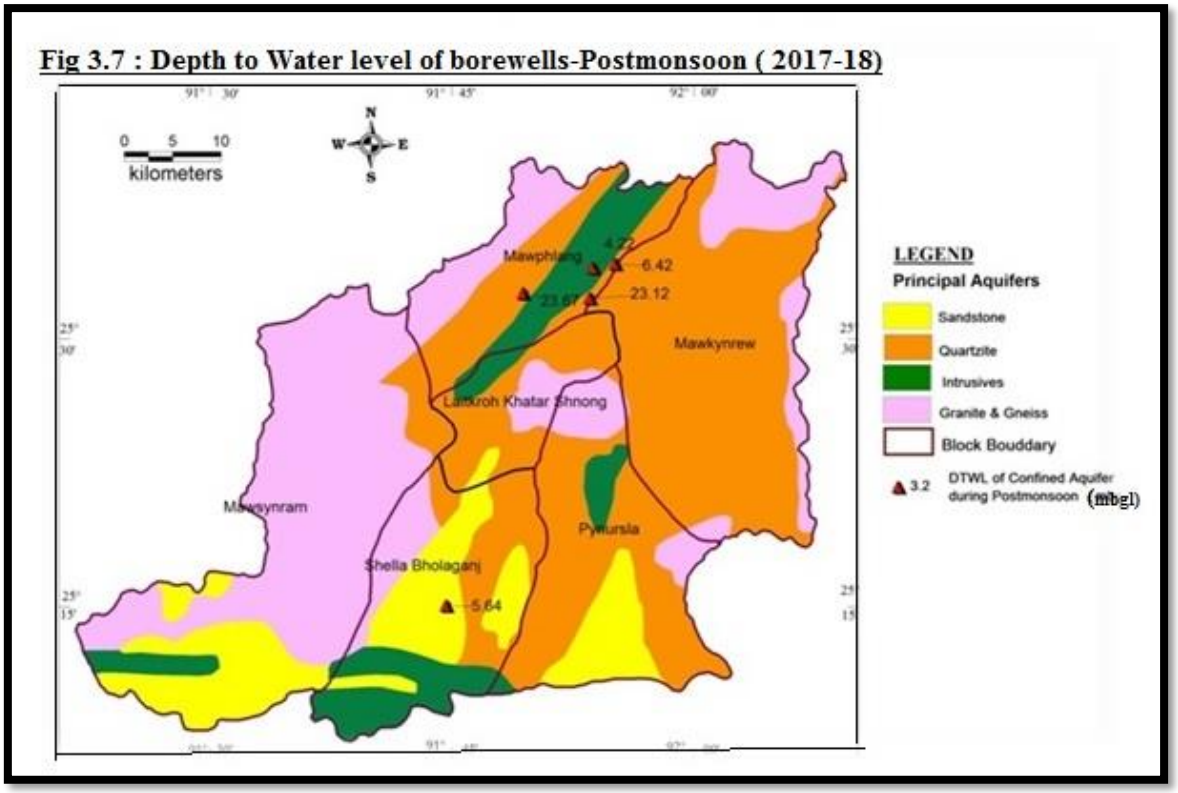
3.2 Depth to Water Level: Study of water level and its behaviour both in phreatic and confined condition were carried out in the aquifer mapping area. A total of 8 Dug wells were established as key wells for periodical monitoring to know the water level trend and its behaviour in phreatic condition. The depth to water level in these dug wells ranges from 0.20 to 8.10 m bgl during pre-monsoon and ground level to 3.52 m bgl during post-monsoon season and is shown in fig 3.4 and fig. 3.5. Average water level fluctuation is 0.827 m.





To study the piezometric head, 5 bore wells were monitored periodically. The piezometric head ranges from 4.42 to 42.88 m bgl during pre-monsoon and 4.22 to 23.67 m bgl during post-monsoon season and is shown in fig 3.6 and fig. 3.7 respectively.





3.3 Aquifer system: The entire study area is underlain by consolidated rocks like Archaean Gneissic complex, Granite pluton Quartzite, Intrusives and with small patches of weathered/fractured sandstone/shale (Jaintia group) in the southern part of the district. North western part of the district has conglomerate and sandstone of upper cretaceous Khasi Group of rocks which is still unexplored. The aquifer system exists mainly in Granitic plutons, quartzites, Archaean Gneissic complex and the intrusives. It also exists in both weathered formation as well as fractured system down to the maximum explored depth of 247.6 m bgl. The depth of weathered zone varies from 1.5 to 10.74 m below ground level. Thus, hydrogeologically, the study area can be categorized into three groups i.e. (i) Granitic gneissic complex aquifer of Archaean (ii) Quartzite aquifer of Shillong Group iii) Khasi Greenstone of Proterozoic age. The aquifer system in these hard rock terrains is a complex one. Number, depth and thickness of fractures were observed not only in different geological formations but also in same geological formation. In figs 3.8 to fig. 3.12, disposition of fractures are shown but were not connected because of huge variation in vertical and lateral extension of fractures.

Fig. 3.8 Section along Mawiong-Mawkynrew

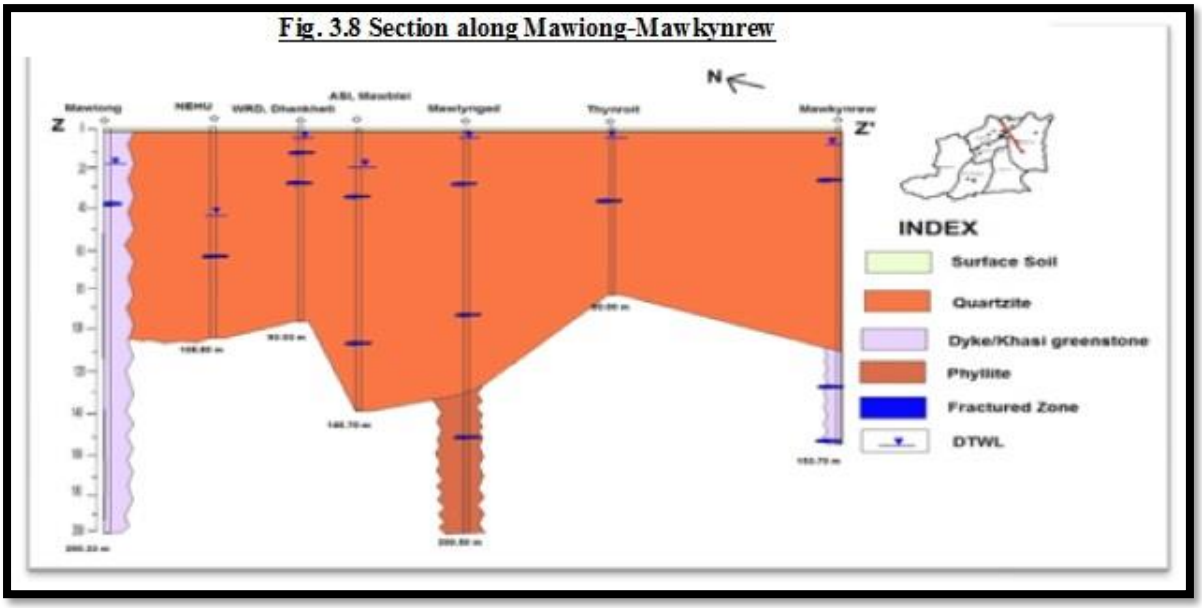
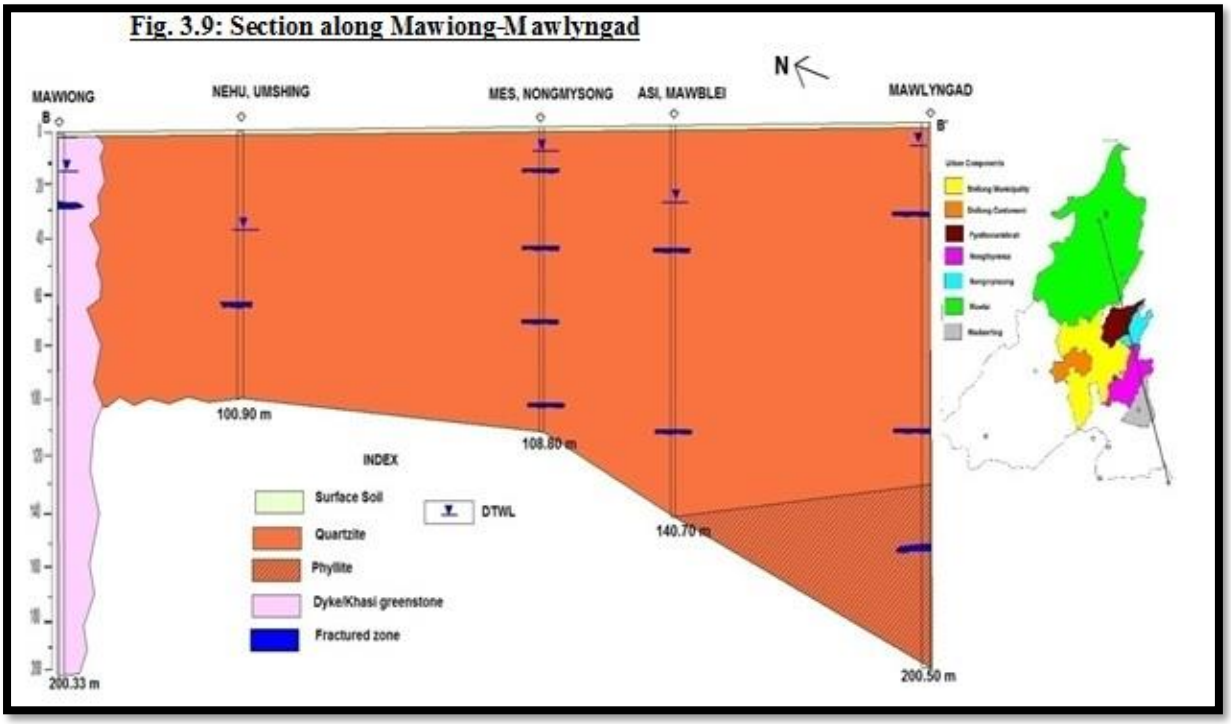


Fig. 3.9: Section along Mawiong-Mawlyngad



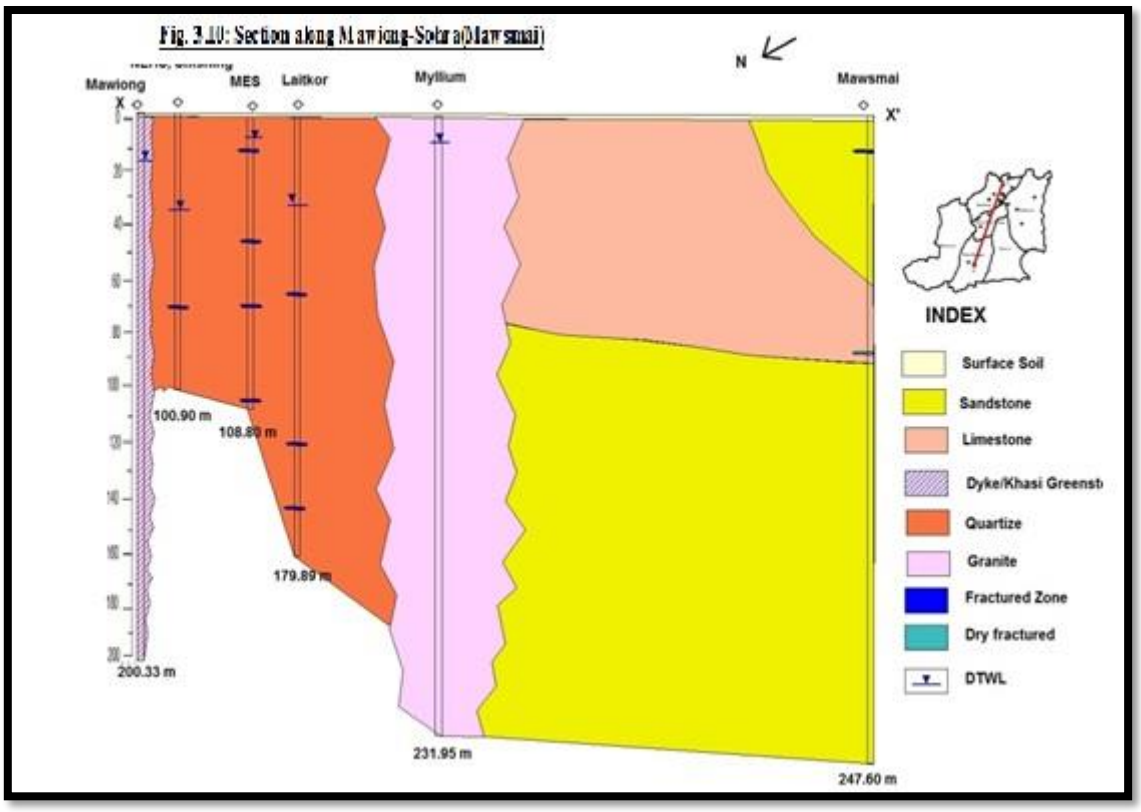


Fig. 3.10: Section along Mawiong-Sohra(Mawsmai)
N
Mawiong
MES
Laitkor
Mylliun
Mawsmai
X
X'
100.90 m
108.80 m
179.89 m
200.33 m
231.95 m
247.60 m
INDEX
Surface Soil
Sandstone
Limestone
Dyke/Khasi Greenst
Quartize
Granite
Fractured Zone
Dry fractured
DTWL

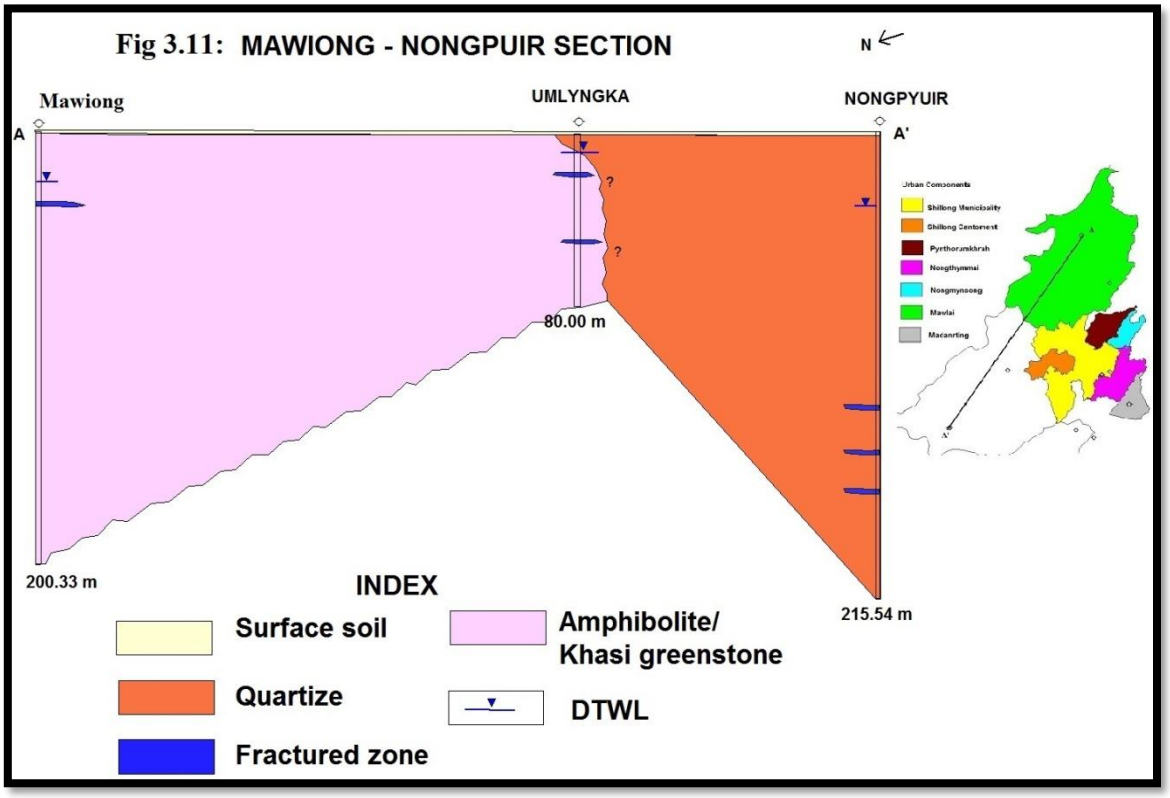


Fig 3.11: MAWIONG - NONGPUIR SECTION
N
Mawiong
UMLYNGKA
NONGPYUIR
A
A'
80.00 m
200.33 m
215.54 m
INDEX
Surface soil
Quartize
Fractured zone
Amphibolite/
Khasi greenstone
DTWL
Urban Components
Shillong Municipality
Shillong Cantonment
Pynthorumkhrah
Nongthymmai
Nongmynsong
Mawlai
Mawlai

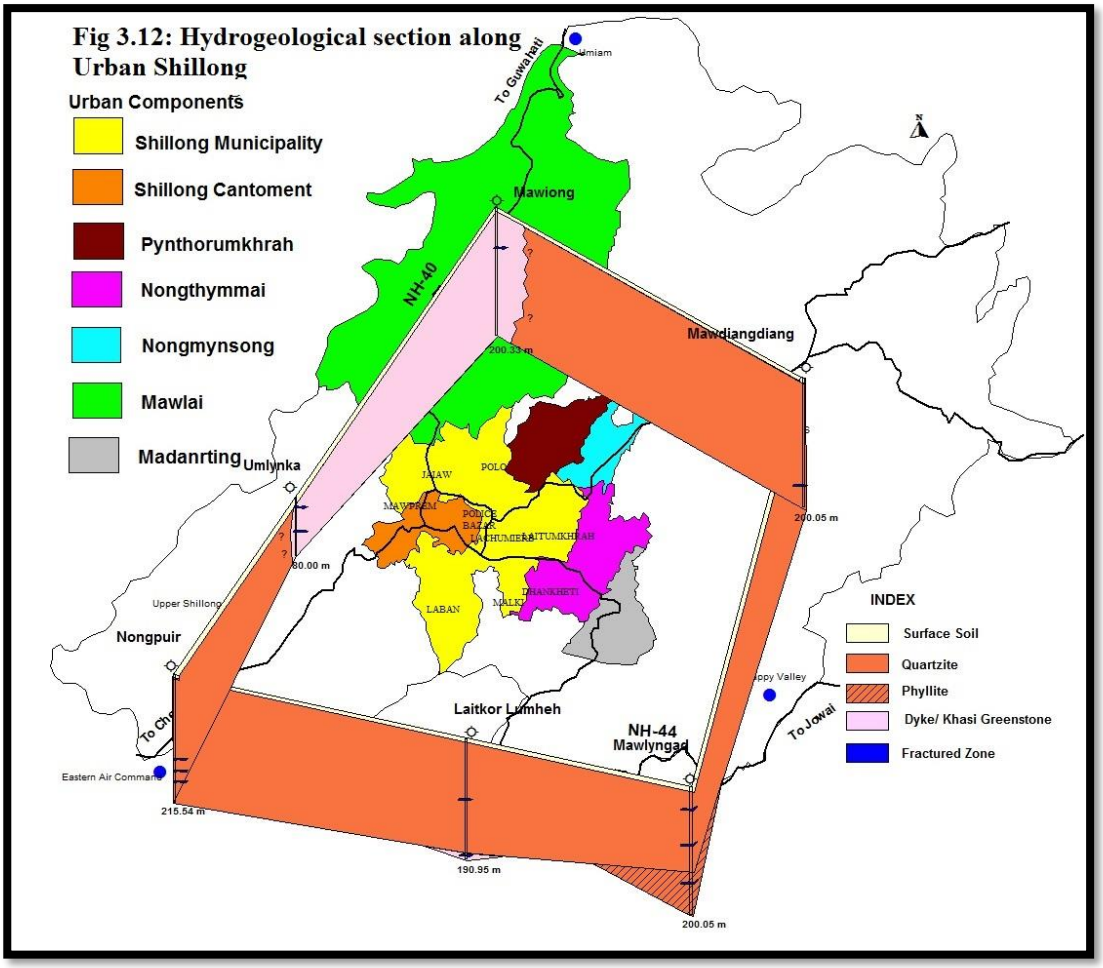


Fig 3.12: Hydrogeological section along
Urban Shillong
Urban Components
Shillong Municipality
Shillong Cantoment
Pynthorumkhrah
Nongthymmai
Nongmynsong
Mawlai
Madanrting
To Guwahati
Umiam
Mawiong
NH-40
Mawdiangdiang
200.33 m
Umlynka
JAIAW
POLO
MAWPREM
POLICE BAZAR
LAITUMKHRAH
LAITHUMKRAH
DHANKHETI
MALKI
LABAN
60.00 m
200.05 m
Upper Shillong
Nongpuir
Laitkor Lumheh
NH-44
Mawlyngad
Eastern Air Command
215.54 m
190.95 m
200.05 m
To Jowai
INDEX
Surface Soil
Quartzite
Phyllite
Dyke/ Khasi Greenstone
Fractured Zone

Formation wise geology of the district is as follows:

3.3.1 Granitic gneissic complex: The granite gneissic rocks are exposed in the southern and northern part and in small patches in the central, northern and eastern part of the district. Granitic plutons of Neoproterozoic to early Paleozoic age (Mylliem granite) comprising of weathered and fractured coarse granite and pegmatite with quartz viens can be categorized under this group of aquifer. This group of aquifer has average ground water potential. The occurrence of ground water in this formation is largely controlled either by weathering or by fractures patterns. In fractured rocks, ground water movement mainly takes place along the fracture and their openings. Groundwater in these formations occurs under phreatic conditions in weathered mantle and under semi-confined to confined conditions in the fractured rocks, which is governed by topography and drainage. In this gneissic complex, depth of first aquifer ranges from 6 to 20 m bgl and the second aquifer ranges from 40 to 179 m bgl. Discharge of the exploratory wells ranges from 1.6 to 1.56 m3/hr. Distribution of fractures at various depths and cumulative discharge is tabulated in table 3.1.

Table 3.1 Location wise details of fracture encountered in Granitic gneissic complex

Location	Depth drilled (in m bgl)	Number of fractures encountered					Discharge (in m^3/hr)
		0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Mylliem - 12th Mile	231.95	NA	NA	NA	-	-	1.6
Umtyngar	200.05	1	2	2	1	-	1.56

The above table reveals that in most of the places, 1 to 2 numbers of fractures were encountered within 50 m, 50-100 m and 100-150 m depth.

3.3.2 Quartzite of Shillong Group: The quartzite and phyllites are exposed in the most part of the study area. They belong to shillong group of rocks. Age of this group of rocks is from Paleo to Meso Proterozoic age and they comprises of weathered/fractured quartzite and phyllite. This aquifer sysyem is the most common in the study area and provides average ground water potential. Ground water occurs in the area under watertable conditions in the top weathered quartzite and in semi-confined to confined condition in the interconnected joints and fractures of the underlying hard quartzite. Exploratory bore wells were constructed in this formation within a depth range of 70.0 to 215.80 m bgl. Discharge in the wells ranges from 0.5 to 14.4 m^3/hr. Transmissivity ranges from 1.28 m^2/day (at Water Resources Department campus, Shillong) to 87 m^2/day (at MES, Shillong) under Mylliem block. One artesian wells which is at Lawsohtun was constructed long back ago by CGWB in this terrain under ground water exploration programme. 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 Quartzite

Location	Year of Drilling	Depth drilled (in m bgl)	Number of fractures encountered					Discharge (in m^3/hr)
			0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Dymper	1995-96	80.0	1	1	1	2	1	NA
Kyanton-U-Mon	1995-96	70.0	3	0	-	-	-	3.79
Umlyngka	1995-96	80.0	1	1	-	-	-	9.0
NEHU	2003-04	100.9	-	-	-	-	-	-
Thynroit	2003-04	80.0	-	-	-	-	-	0.54
MES, Shillong	2007-08	108.8	2	2	1	-	-	-
ASI, Mawpet	2007-08	140.7	1	0	3	-	-	9.3
Mawdiangdiang	2011-12	200.05	1	0	1	1	-	6.3
Mawkynrew	2011-12	153.7	0	1	3	-	-	14.4
Laitkor	2016-17	178.89	0	2	3	-	-	8.08
Nongpyiur	2016-17	215.8	0	0	2	2	-	3.78
Shillong, WRD	2016-17	93.13	2	0	-	-	-	1.48
Lapalang	2016-17	111.59	2	0	-	-	-	1.41
Mawryngkneng	1995-96	59.45	1	-	-	-	-	8.08
Sohiong	1995-96	64	3	-	-	-	-	5.32
JNV, Mawphlang	2016-17	203.56	0	0	0	1	--	0.0325

3.3.3 Intrusives/Khasi Greenstone: This aquifer system in the district comprises of dolerites and ultrabasic dykes and sills of Proterozoic age. Ground water occurs in fractures in this aquifers and ground water potential is poor. This aquifer is confined to a very limited arial extent and is mainly found as narrow belt in central-northern part of the district. Exploratory bore wells were constructed in this formation within a depth range of 190.95 to 200.33 m bgl. Discharge in the wells ranges from 3.7 to 13 m^3/hr. Transmissivity ranges from 1.46 m^2/day (at Mawiong) to 18 m^2/day (at Laitkor Lumeh) under Mylliem block. 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 Intrusives

Location	Year of Drilling	Depth drilled (in m bgl)	Number of fractures encountered					Discharge (in m^3/hr)
			0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Laitkor Lumeh		190.95	0	1	1	1	-	6.3
Mawlyngad		200.05	1	1	1	1	-	13
Mawiong		200.33	1	0	0	0	-	3.77

3.3.4 Limestone/ Sandstone: This aquifer system comprises of limestone in which ground water occurs owing to secondary porosity viz. fracture, solution cavity etc. This aquifer is not very common and is confined (as per CGWB exploration till now) to Cherrapunjee Location of Sohra

block. Exploratory bore wells were constructed in this formation within a depth range of 11.59 to 247.6 m bgl. Discharge in the wells ranges from 0.55 to 2.1 m^3/hr. The Distribution of fractures at various depth and cumulative discharge is tabulated in table 3.4.

Table 3.4: Location wise details of fracture encountered in Limestone

Location	Year of Drilling	Depth drilled (in m bgl)	Number of fractures encountered					Discharge (in m^3/hr)
			0 to 50 m	50 to 100 m	100 to 150 m	150 to 200 m	200 to 250 m	
Mamluh	1995-96	190.95	0	1	1	1	-	NA
Mawsmai - Cherrapunjee	2003-04	200.05	1	1	1	1	-	2.1
Cherrapunjee, NIT campus	2016-17	111.59	1	1	-	-	-	0.55

3.4 Aquifer geometry: The aquifer system in this district can be divided as a two aquifer system viz., 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. The second aquifer is the deeper aquifer which tapped the fractured zones. 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 20 m bgl. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures upto the maximum depth of 247 m bgl.

3.5 Aquifer properties:

Aquifer I: It is the unconfined aquifer where the tapped aquifer zone ranges within 2 to 35 m depth and generally exhibits unconfined nature of the aquifer. Pumping tests in dug wells show specific capacity varies from 0.15253 to 0.347 m^3/min/m of drawdown (Slitcher's method).

Aquifer II: This is the deeper aquifer delineated in Quartzite, Gneiss and Granite, Intrusives and limestone which occurs as semi-confined to confined condition. Drilled depth of the exploratory wells ranges from 64.0 to 247.60 m bgl. The number of fractures and depth of encountering fractures varies widely which show the complexity of the hydrogeology of consolidated hard rock formation. The piezometric head ranges from 0.5 to 78.75 m bgl. At JNV, Mawphlang, the static water level measured at the time of completion of drilling is more the 100 m. Through PYT test it is found that transmissivity values vary from 1.28 to 87 m^2/day and the storativity ranges from $1.7x10^{-4}$ to $3.85x10^{-2}$. The discharge in these wells ranges from 0.032 to 14.4 m^3/hr (72 m^3/hr discharge at Mawlyngad).

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 from springs, 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 7 ground water samples from dug well were collected during pre-monsoon and post-monsoon studies and the range of concentrations of different chemical constituents present in the ground water samples are given in table 3.5

Table 3.5: Chemical Quality of water samples from Dug wells, East Khasi Hills district (2017-18)

Sl.No.	Chemical constituents	Range (Concentrations in mg/l except pH) Premonsoon		Range (Concentrations in mg/l except pH) Postmonsoon	
		Min	Max	Min	Max
1	pH	5.53	7.1	5.2	6.5
2	E.C. in *micro seimens/cm at 25°C*	82	528	53	489
3	Turbidity(NTU)	0.1	1.2	NA	NA
4	TDS	43	282	28.55	275.1
5	TH	NA	NA	NA	NA
6	Ca	2	70	1.7	47.6
7	Mg	0	7.2	2.0	24.7
8	Na	5.5	24.9	5.2	17
9	K	1.1	17	2.2	45.1
10	CO_3	0	0	0	0
11	HCO_3	20	220	15	60
12	SO_4	1.9	6.6	BDL	2.15
13	NO_3	0	6.5	0.9	29.3
14	Fe	BDL	1.3	0	2.3

It is deciphered from table 3.5 that water is slightly acidic and except iron, rest of the chemical parameters is within permissible limit for all uses. Out of 7 samples, 2 samples are having Fe concentration of more than 1 mg/l; other 3 samples have Fe conc. of 0.03 to 0.20 mg/l. The EC values, pH values and Fe conc. of water samples collected from dug wells during premonsoon season are shown in fig 3.13 in fig 3.14 in fig. 3.15 respectively.

Fig 3.13: EC of water samples collected from Shallow Aquifer (Unconfined)

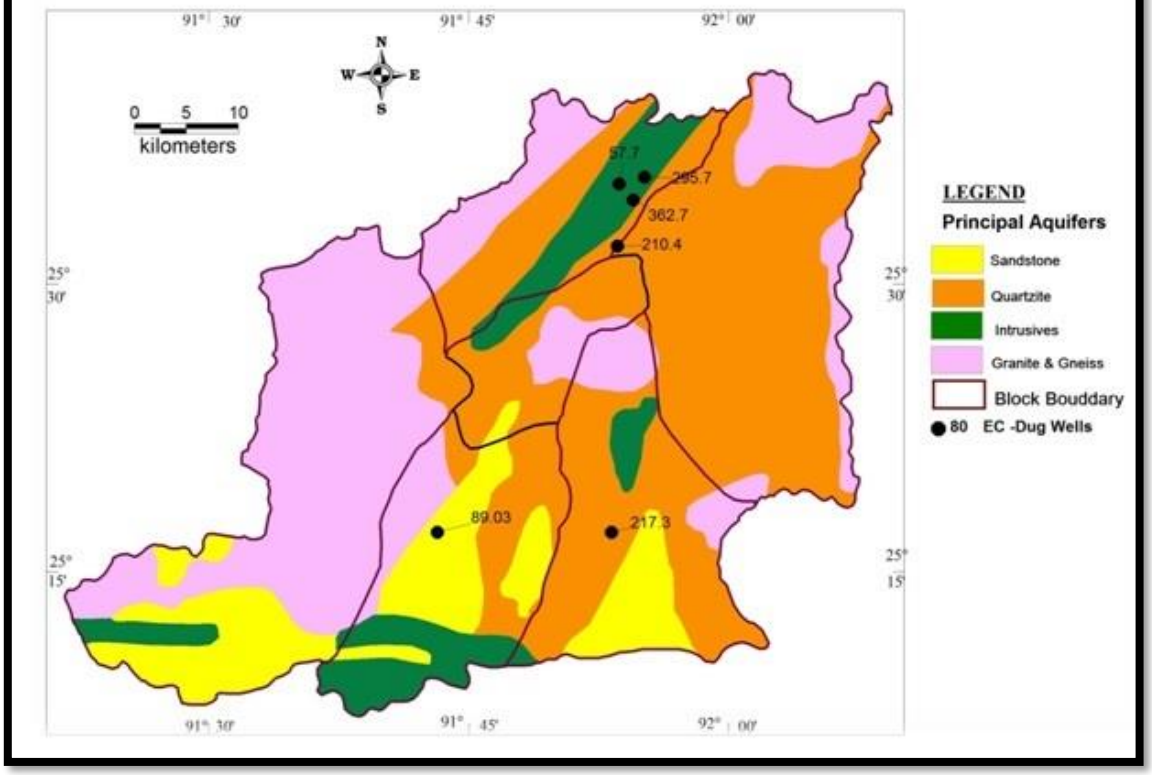
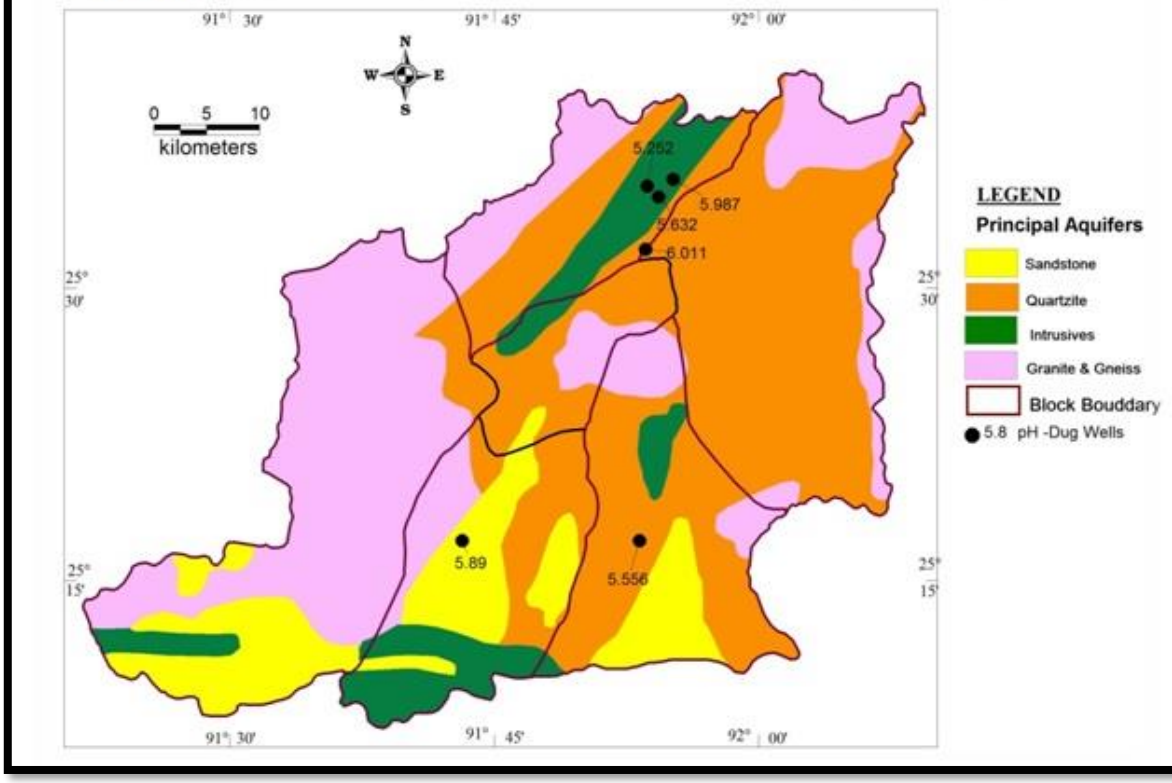
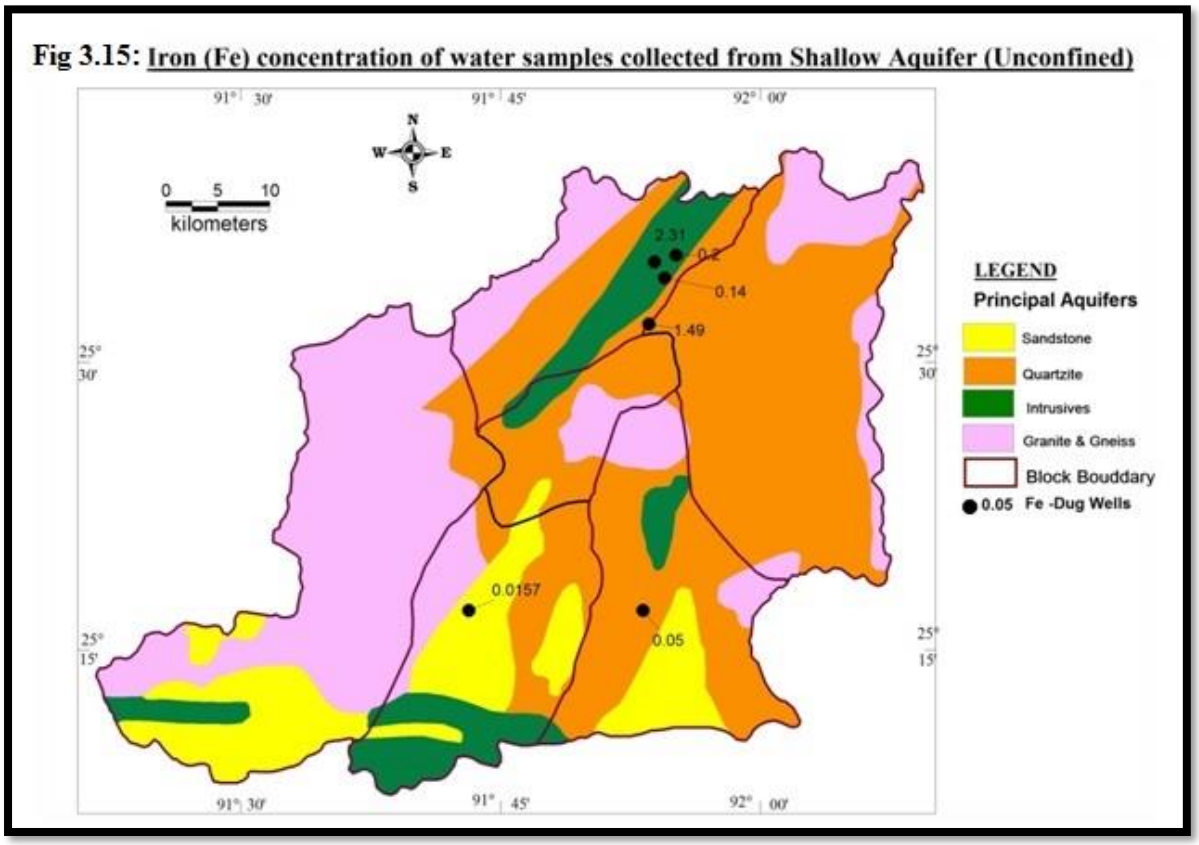


Fig 3.14: pH of water samples collected from Shallow Aquifer (Unconfined)





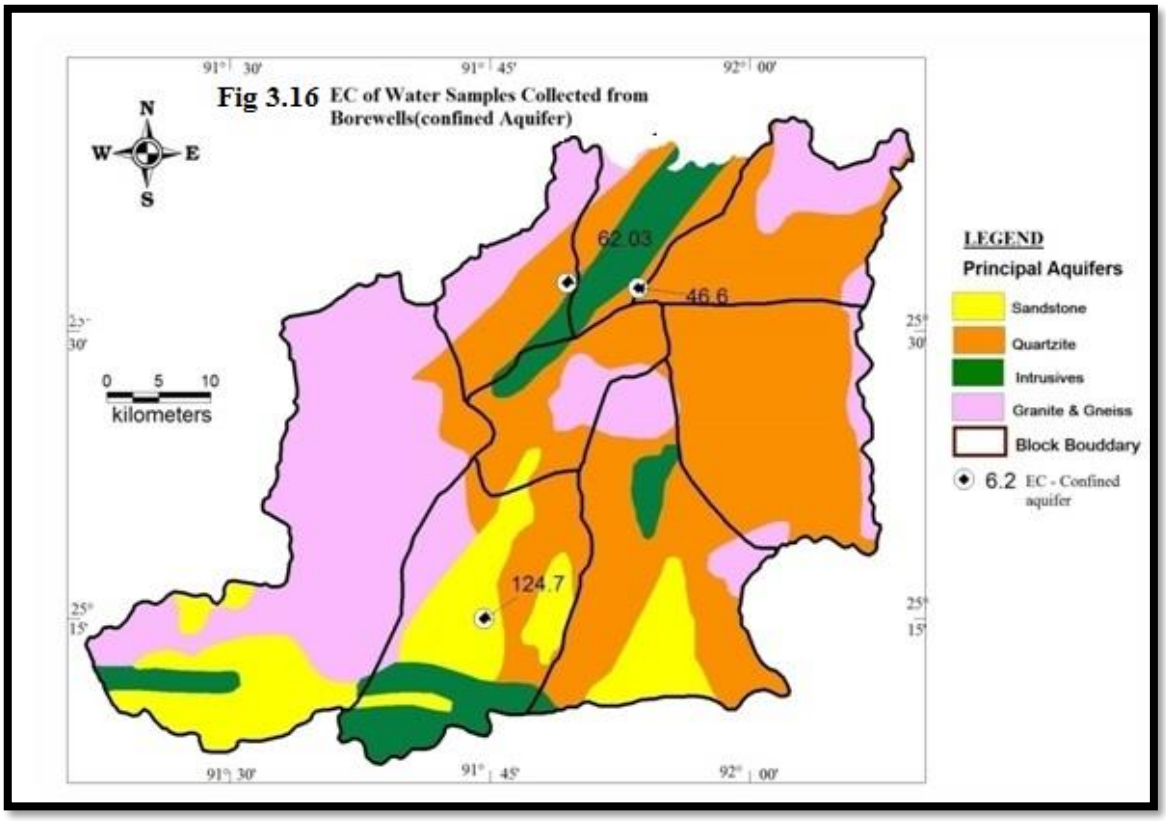
3.6.2. Ground water quality in deeper aquifer: A total of 3 water samples were collected during exploratory drilling programme. Based on chemical analysis data the range of concentrations of different chemical constituents present in the deeper aquifer samples is given in table 3.5.

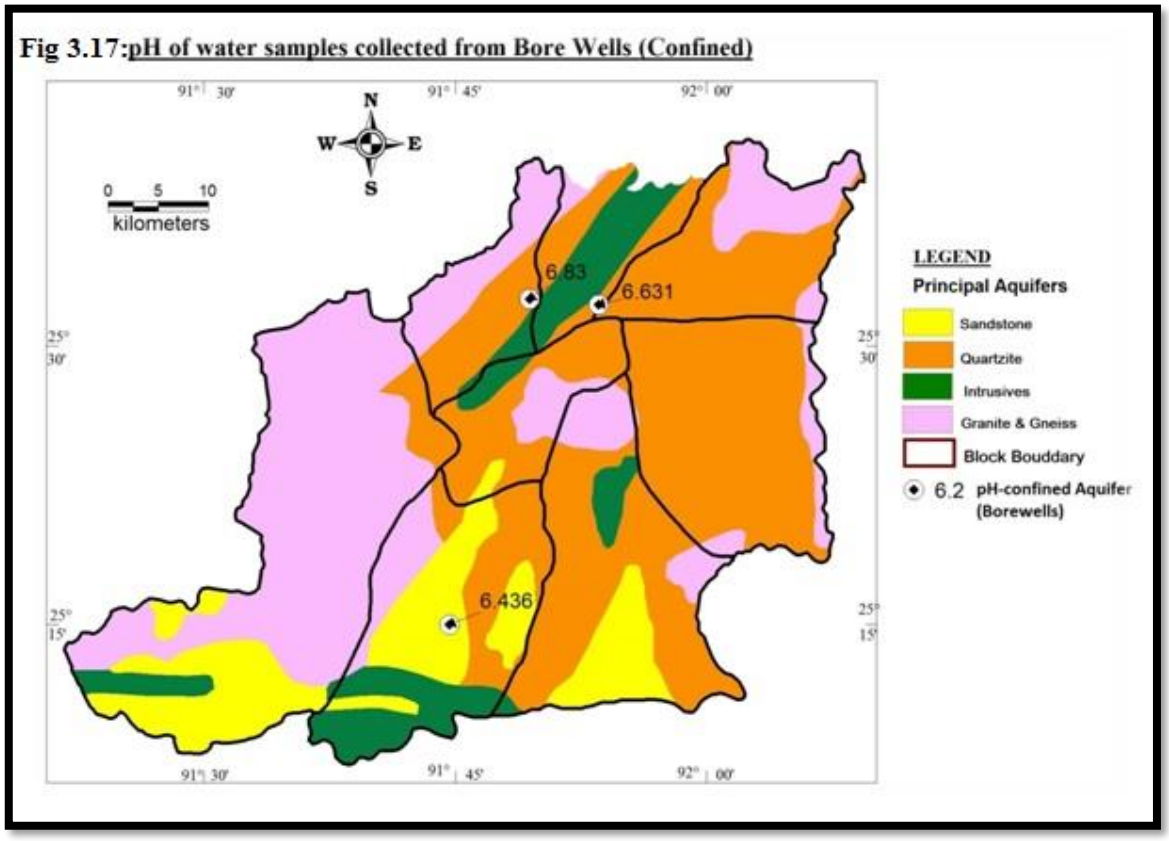
Table 3.6: Chemical Quality of Water Samples in Deeper Aquifer, East Khasi Hills District (2017-18)

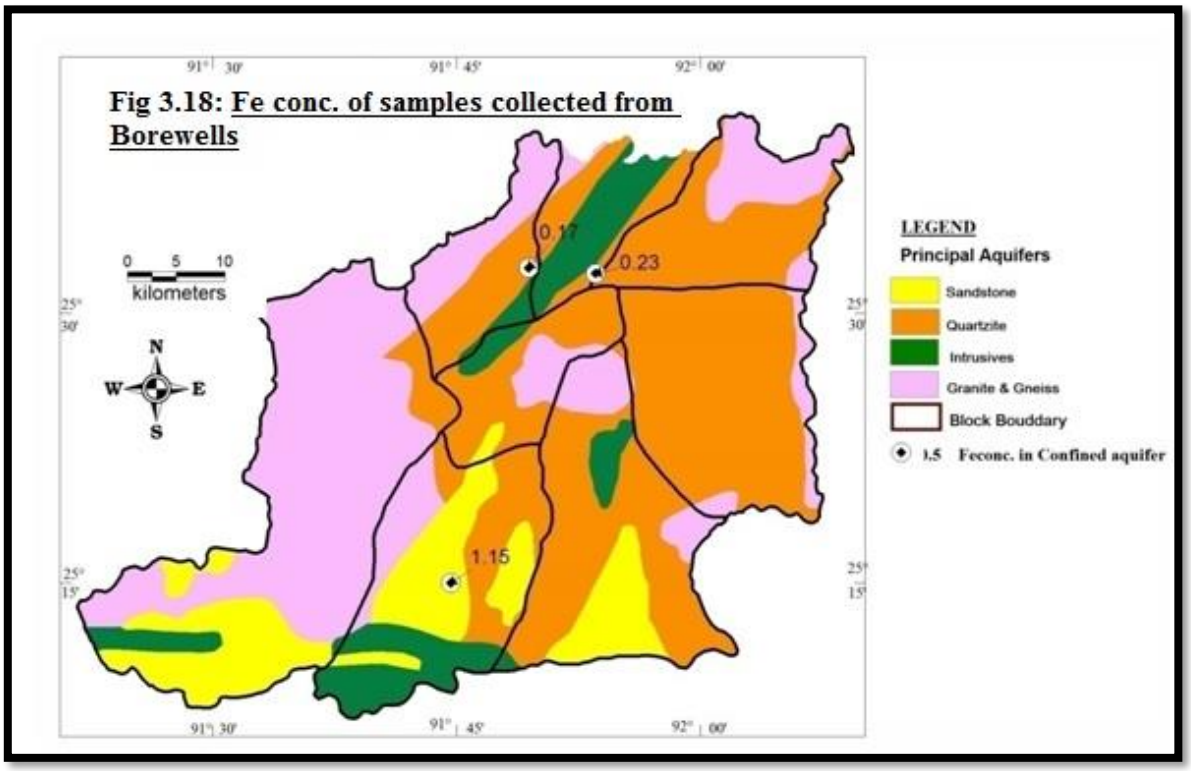
Sl.No.	Chemical constituents (Concentrations in mg/l except pH)	Range	
		Min	Max
1	pH	6.44	6.83
2	E.C. in micromhos/cm at 25º C	46.6	124.7
3	Turbidity(NTU)	NA	NA
4	TDS	23.82	67.42
5	TH	10	20
6	Ca	4	8
7	Mg	1.21	3.64
8	Na	0.88	8.99
9	K	0.7	7.6
10	CO_3	0	0
11	HCO_3	10	20
12	SO_4	1.69	4.37
13	NO_3	0.4	1.4
14	Fe	BDL	1.15

It can be inferred from table 3.6 that except iron, the other parameters are within the permissible limit. Out of three samples, one sample shows Fe conc. of more than 1 mg/l, 2 samples have Fe

conc. less than 0.3 mg/l. The EC values are shown in fig 3.16, pH values in fig 3.17 and Fe conc. in fig. 3.18.





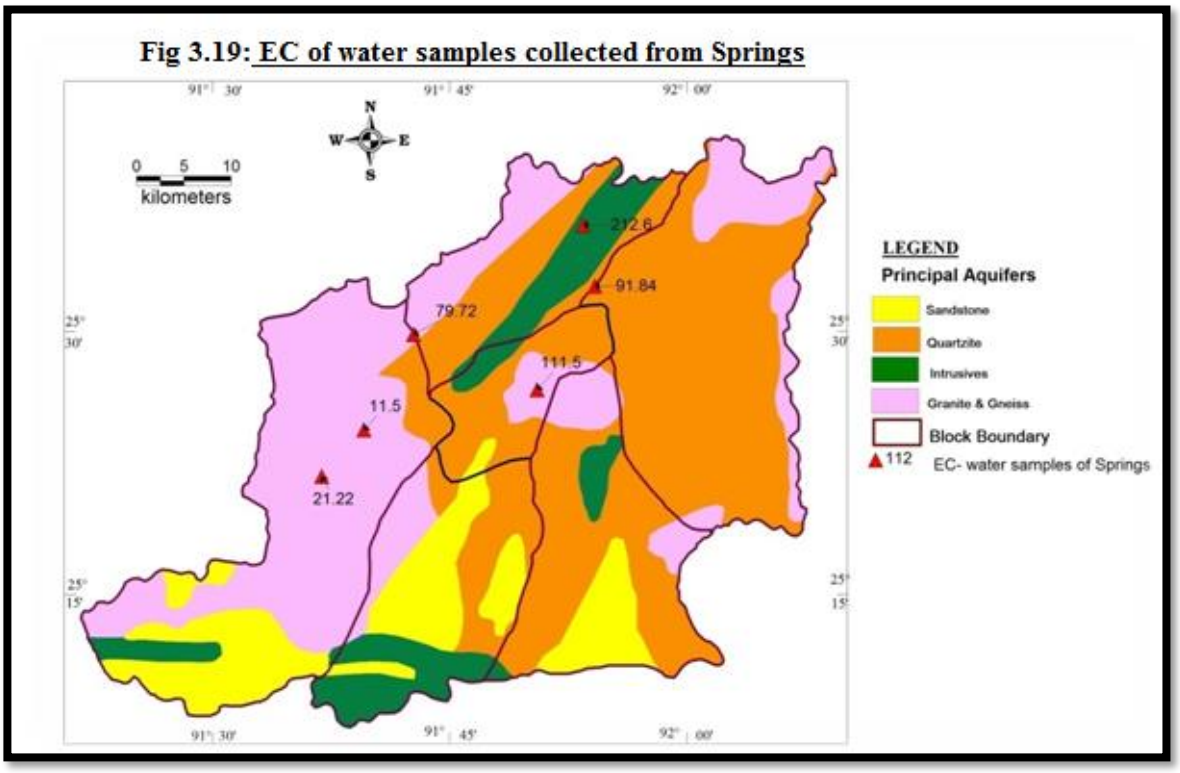


3.6.3 Water quality of springs: A total of 6 water samples from springs were collected during post-monsoon studies and the range of concentration of different chemical constituents present in the spring samples is shown in table 3.7

Table 3.7: Chemical Quality of spring water, East Khasi Hills district 2017-18

Sl.No.	Chemical constituents (Concentrations in mg/l except pH)	Range	
		Min	Max
1	pH	4.7	7.4
2	E.C. in micromhos/cm at 25º C	21.22	212.6
3	Turbidity(NTU)	NA	NA
4	TDS	11.94	120.1
5	TH	15	45
6	Ca	1.7	20.4
7	Mg	4.12	13.42
8	Na	4.16	27.88
9	K	4.16	27.88
10	CO_3	0	0
11	HCO_3	15	45
12	SO_4	NA	NA
13	NO_3	0.7	2.5
14	Fe	BDL	BDL

It can be inferred from table 3.6 that all parameters are within the permissible limit.. The EC values are shown in fig 3.19, pH values in fig 3.20 and Fe conc. in fig. 3.21.



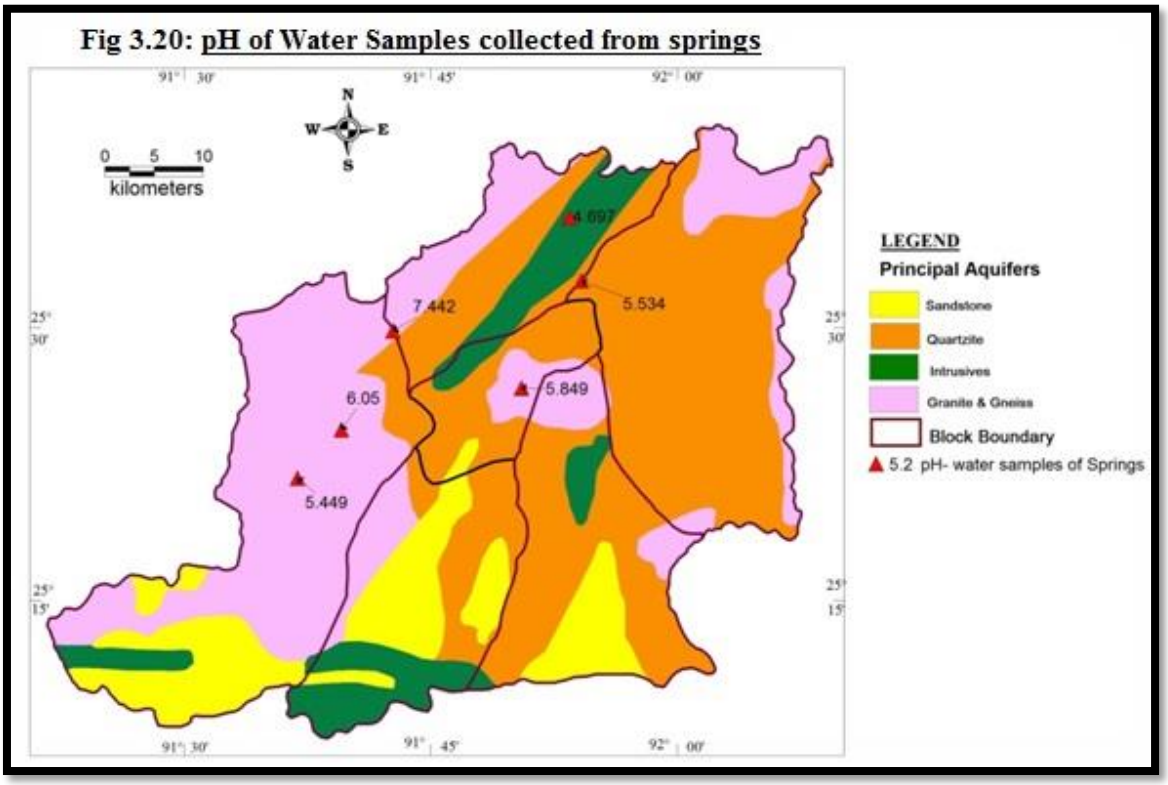
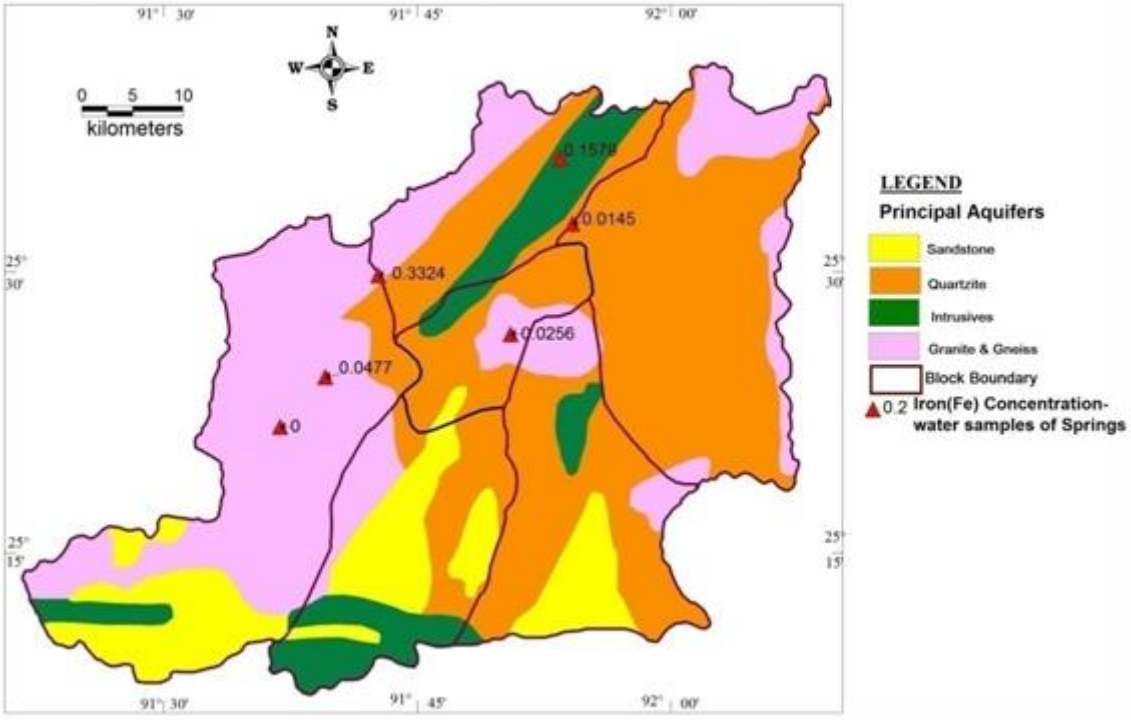


Fig 3.21: Iron Conc. of water samples collected from springs



4. Urban Hydrogeology: Greater Shillong, Meghalaya

4.1 Introduction

Shillong is the capital of Meghalaya, one of the smaller states in north-east India. It is also the district headquarters of East Khasi Hills District. Shillong is situated at an altitude of 1,496 m (4,908 ft) above sea level in the centre of the Shillong plateau. Shillong urban agglomerate comprising of Shillong Municipality and 12 suburbs (Census Towns), viz., Shillong Cantonment, Madanryting, Mawlai, Nongthymmai, Pynthorumkhrah, Nongmynsong, Mawpat, Umlyngka, Umpling, Nongkseh and Lawsohtun. The Greater Shillong area falls under Mylliem block, East Khasi Hills district, Meghalaya and covers an area of approximately 61 sq. km. The area lies between north latitudes 25°33'15" to 25°36'02" and east longitude 91°50'50" to 91°56'17" and falls in the survey of India toposheet No. 78 O/14. Location Map of Greater Shillong is shown in Fig. 4.1. A few reserve forests can be found around and near Shillong viz., Riatkhwan, Short Round, Shyrwat, Upper Shillong, Riatlaban & Laitkor. As per 2011 Census, the total population of the urban area is 354,759 as against 267,662 in 1991 indicating a decadal growth of about 24%. The city features a subtropical highland climate with temperature varying from 2° to 25.0° C. Winter usually starts from October and continues up to March. During the months of December and January ground frost in early morning is very common. Summer is rather of short duration followed by monsoons which generally starts from May and continues till September and so. 90% of the total annual rainfall takes place in this season. Rainfall is high in the area with an annual rainfall of about 2400 mm.

4.2 Physiography and Drainage

The area under Greater Shillong forms a part of the Shillong plateau. It is located on a gently undulatory area with steep slopes running in different directions. The master slope runs mainly in south-west to north-east direction. The average height of the area is about 1400-1500 m above msl. The highest point of Shillong is Shillong peak, which is situated at a height of 1960 m above mean sea level. The plateau is dissected by a number of streams into hills and intermontane valleys. One major intermontane valley lies to the north of the city along Wah Umkhrah river in the Polo Ground area.

The main drainage of Shillong is carried by two rivers, namely Wah Umshirpi and Wah Umkhrah, which confluence near Beadon and Bishop Falls to form the Wah Ro Ro river, a tributary to Wah Umium river. These two rivers surround the Shillong town and roughly determine the Municipal limits. The numerous streams in the western and southern parts of the city are tributaries of Wah Umshirpi, whereas streams in northern and eastern parts of the city are tributaries of Wah Umkhrah which starts as Umpling river near Umpling. The drainage pattern of the area is angular to sub-angular, typical of hard rock hilly terrain. The streams are not perennial in nature. The discharge in the streams varies from season to season.

4.3 Soil Type

The soils present in and around Shillong Urban area are Ultisols, colloquially known as "red clay soil". The soils are shallow to moderately deep, loamy, skeletal, fine and excessively drained, with

severe to very severe erosion hazards. Ultisols vary in color from purplish-red, to a blindingly bright reddish-orange, to pale yellowish-orange and even some subdued yellowish-brown tones. They are typically quite acidic, often having a pH of less than 5. The red and yellow colors result from the accumulation of iron oxide (rust) which is highly insoluble in water. Major nutrients, such as calcium and potassium, are typically deficient in Ultisols, which means they generally cannot be used for sedentary agriculture without the aid of lime and other fertilizers such as superphosphate.

4.4 Hydrogeological conditions in Shillong Urban Area

4.4.1 Geology

The area is underlain by Shillong group of rocks consisting of quartzite & phyllites. The base of Shillong Group is marked by conglomerate bed containing cobbles and boulders of earlier rocks, i.e., Archaean crystalline rocks, which formed the basement rocks over which the Shillong Group of rocks were laid down as sedimentary deposits during Pre-Cambrian times and metamorphosed over time. The rocks were intruded by epidiorite rocks known as Khasi greenstone. These metabasic rocks occur mostly as sills being concordant with the formations they intruded.

The surface area is covered by red soil to mixed soil type having thickness ranging from few centimeters to 2 m. The rocks are highly weathered at shallow depth leading to the formation of thick soil cover in the low lying areas & thin veneer of soil layer at higher elevation. This weathered zone is underlain by jointed and fractured quartzite. The distribution and disposition of these joints and fractures are of complex nature due to the various tectonic and structural disturbances to which country rocks are subjected to. The depth of this zone varies from 10-60 m below ground level. This is followed by hard massive quartzites, which are generally devoid of prominent structural features. However fracture/jointed rocks are found to occur at greater depths in certain exploratory wells drilled in similar formations in the area. Broadly, there are three sets of lineaments in the area, mainly along ENE–WSW, NW–SE and E–W directions. Lineaments along NE–SW, NNW–SSE and N–S directions are also developed.

4.4.2 Ground Water Scenario

Ground water occurs in the area under water table conditions in the top weathered and fractured zone of quartzite. Further below, semi-confined to confined condition exist in the interconnected joints, fractures etc of the underlying hard quartzite. The weathered quartzites have poor to moderate yields.. The underlying second zone is fissured and jointed which is the zone of saturation. The distribution and disposition of these joints and fractures are of complex nature due to the various tectonic and structural disturbances to which country rocks are subjected to. Groundwater occurs under semi-confined condition in this zone.

Quartzite and recent valley fills (in Polo area) constitute the major aquifer system in the area. Ground water occurs under unconfined condition in the weathered rock and residuum. Ground water development in the urban agglomeration is both by dug wells generally confining to the weathered zone & bore wells, which mainly tap, fractured zone in

the hard rocks. These fractures sometime extend very deep occurring even beyond 60mbgl, but otherwise generally close before 60m depth. The hydrogeological map of Greater Shillong is shown in **Fig.4.4.**

As the topography is uneven and the thickness of the weathered horizon varies considerably, open wells are restricted to the Umkhrah valley in polo ground and Pynthorumkhrah area.

Central Ground Water Board has drilled 11 nos. of borewells wells till 2017-18, under Ground water Exploration Programme to identify aquifers present in the area. The litholog studies of the wells drilled by CGWB reveal that the ground water is confined to the fractures of quartzites of shillong group and Mylliem granite under semi-confined to confined condition in urban shillong. These aquifers give poor to average ground water yield potential.

Central Ground Water Board ismonitoring monthly water level from 5 dug wells and 4 borewells. The piezometric head in pre-monsoon season varies from 2.63 m bgl (Lapalang) to 17.2 m bgland during post-monsoon season it varies from 1.97 m bgl to 14.32 m bgl at the same locations respectively. In unconfined aquifer (dug wells), depth to water level varies from 0.95 mbgl (Lower Lachumiere) to 6.97 mbgl (Golf Links) during pre-monsoon 2016-17 and during post-monsoon 2016-17, from 0.84 mbgl to 3.05 mbgl at the same locations respectively. The average seasonal water level fluctuation is about 1 m with minimum fluctuation of 0.09 m at Dhankheti and maximum 3.92m at Golf Links.

Details of borewells drilled by PHE, Shillong and private wells are given in annexure 9(A) and 9(B) repectively

4.4.3 Occurrence of Ground Water as springs

Spring plays a major role for the water requirement of the people in Shillong. They serve as a major source of water supply to drinking water and other uses. Spring discharge is controlled by rainfall, land use, vegetation, and geomorphology of the recharge zone. Geologically, the springs monitored in the study area are of gravity type. During 2017-18 springs study was done as a part of National Aquifer Mapping programme. It has been observed that all the springs monitored shows relatively higher discharge in May-June compared to January-March, which is due to the incidence of high rainfall during April-June. Hence the discharge measured in the month of Jan-Mar has been taken as the discharge in dry period (summer) and in Nov-Dec as wet period (post monsoon). The discharge of the springs, according to urban hydrogeological survey during 2017-18, in dry period varies from 15552 lpd (at Jiengkien) to 51,8400 lpd (at Mawlai) and in wet period from 43200 lpd (at Jiengkien) to 691200 lpd (at Mawlai). Looking at the hydrogeological behavior of these springs it can be inferred that each spring has its own character, which is influenced by a combination of factors, operated in the recharge zone. Map Showing Urban components of Shillong and hydrogeological data of Urban Shillong are shown in Fig.4.1. Fig 4.2 shows the location of springs and dugwells monitored by CGWB in Urban shilling. Fig 4.3 shows the location of tubewells drilled by CGWB, PHE and private tubewells in Urban shillong.

Fig 4.1 Urban Components of Shillong

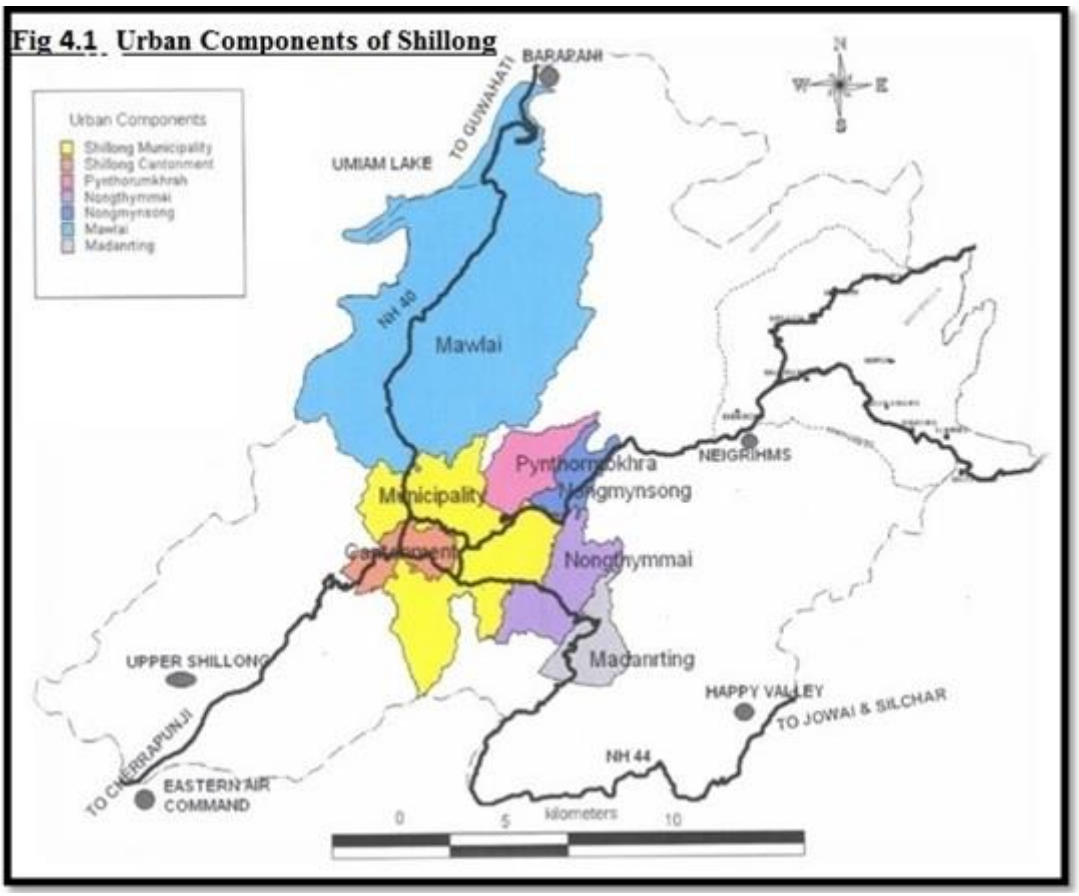


Fig 4.2: Location of springs and Dugwells- Urban Shillong

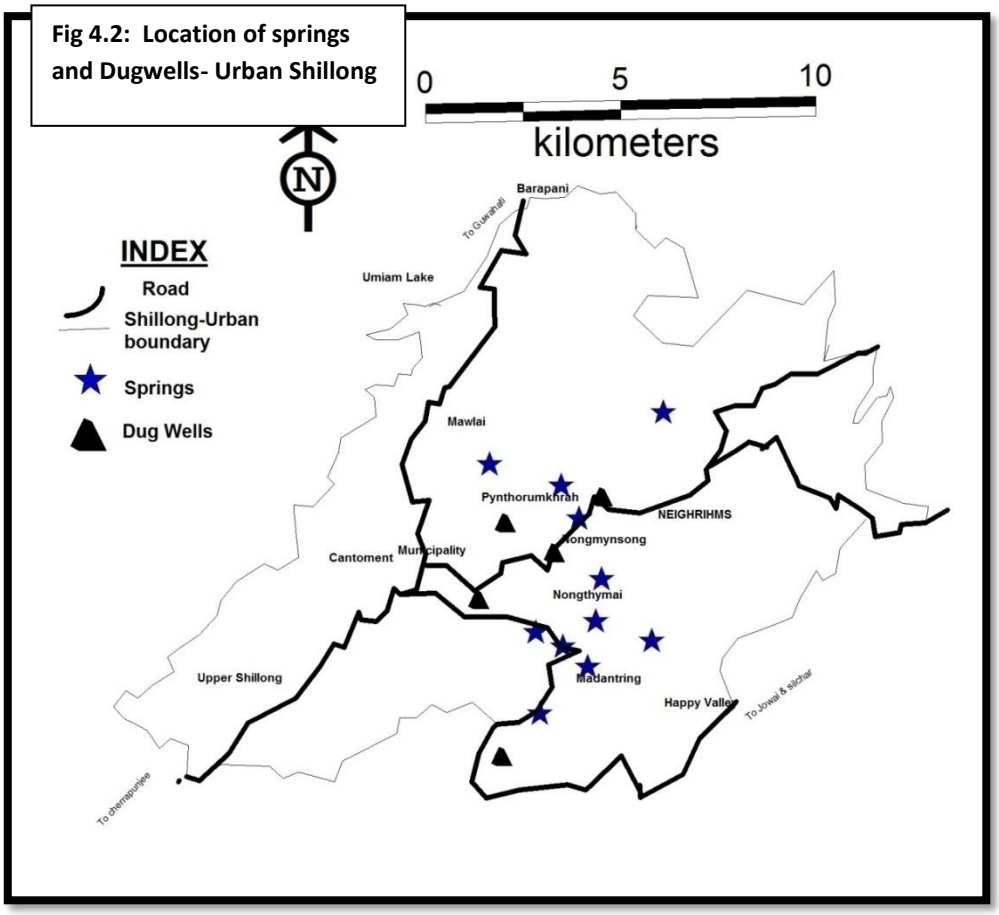
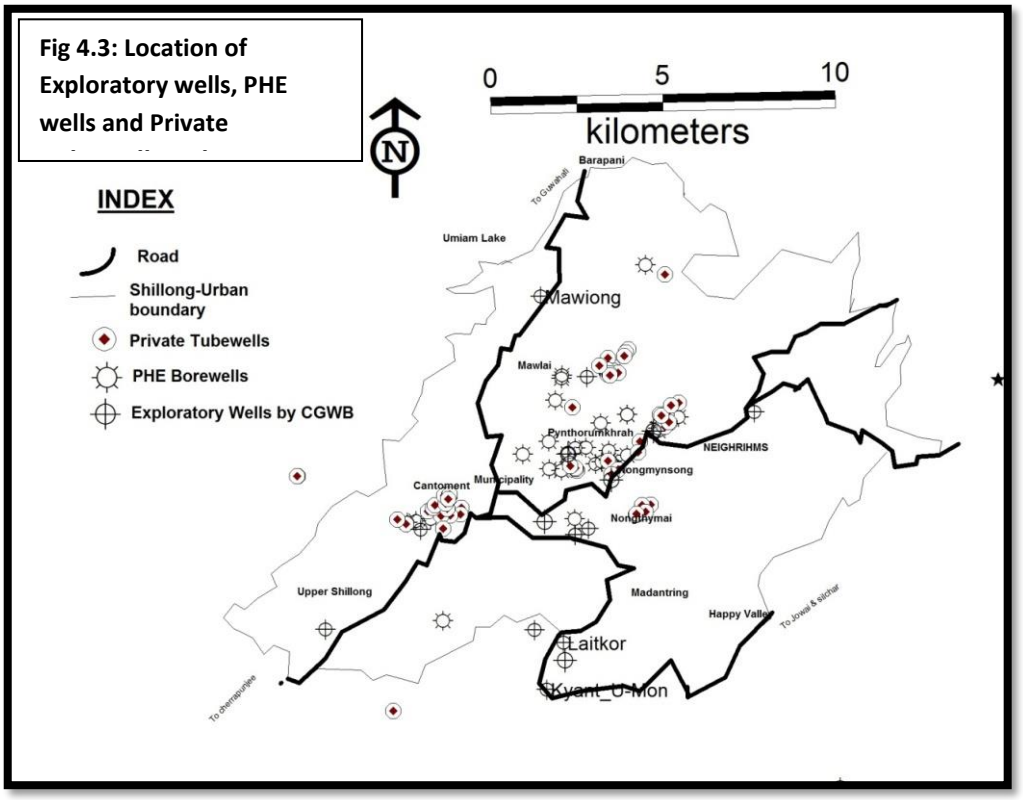


Fig 4.3: Location of Exploratory wells, PHE wells and Private



4.5 GROUNDWATER RESOURCES – GREATER SHILLONG

Dynamic Groundwater Resources of Greater Shillong area has been estimated based on the methodology recommended by Groundwater Estimation Committee (GEC'97). The resources computed for the groundwater year 2017-18. Shillong urban agglomerate area is 61 sq.km. but for groundwater resource estimation an area of 180 sq.km.was considered. Out of this area, recharge worthy area is 158 sq.km. The area is underlain mostly by Quartzite and Khasi Greenstone intrusive.

4.5.1 Groundwater Recharge: The rainfall infiltration factor (RRF) recommended by GEC'97 for Granitic- Gneissic complex and Quartzite are 5%. During fieldworks 5 nos. of Infiltration studies were carried out. Rainfall recharge factor (RRF) calculated from these studies show that average RRF is 3%.

Recharge from Rainfall has been computed separately for monsoon and non-monsoon periods by using water level fluctuation method (WLFM) as well as Rainfall Infiltration Factor method.

Total recharge to groundwater has several components but for greater Shillong only rainfall recharge has been estimated due to paucity of data. Recharge from rainfall during monsoon season is 761 ham while during non-monsoon it is 355 ham. Comparison of monsoon & non-monsoon rainfall recharge shows that monsoon recharge accounts for 68% of the total recharge.

4.5.2 Groundwater Extraction: 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 private parties is 0.18 ham/yr and Unit draft of bore wells used by PHED is 2.54 ham/yr. Groundwater draft for irrigation is nil. It was found that groundwater draft for all uses is 122.72 ham.

4.5.2 Stage of Groundwater Development & Categorization of the Blocks: The area falls under "**SAFE"** category. The stage of development is 16.63%. Summary of groundwater resources, stages of development and categorization are given in annexure 11.

4.6 Hydrochemistry

The water quality analysis results of some of the samples collected in Greater Shillong area are given in Table 4.1.

Table 4.1: Details of chemical analysis results of ground water samples (2016-17)

S. No.	Location In Shillong	Source	pH	EC	CO3	HCO3	Cl	Ca	Mg	TH	Fe
1	Laitkor	Spring	5.53	91.84	0	15	21.2	5.10	8.25	46.7	0.01
2	Mawlai	Spring	4.70	212.6	0	15	42.5	13.6	13.4	89.3	0.15
3	Lr.Lachaumier	Dugwell	5.56	217.3	0	35	10.6	18	6.06	70	0.05
4	Mawpat	Dugwell	5.99	295.7	0	115	53.1	34	3.64	100	0.2
5	Nongmynsong	Dugwell	5.63	362.7	0	35	24.8	34	4.85	105	0.14
6	Dhankheti	Dugwell	6.01	210.4	0	70	21.2	24	4.85	80	1.49
7	Golf Links	Dugwell	5.25	57.7	0	25	14.1	2	3.64	20	2.31
8	Nongpyiur	Borewell	6.83	62.03	0	10	14.1	6	1.21	20	0.17
9	Laitkor	Borewell	6.63	46.6	0	20	24.8	4	3.64	25	0.23

Source: CGWB (All Units are in mg/l except E.C., which is expressed in at microsiemens/cm at 25°C)

A perusal of the above chemical data indicates that groundwater around the area of investigation is slightly acidic to alkaline with pH values ranging from 4.7 to 6.83. The electrical conductivity values vary from 46 to 362 microsiemens/cm at 25^{o}C indicating that the water is potable. The carbonate content is nil. Total hardness (Ca+Mg) expressed as $CaCO_3$ in ppm is small indicating that the water is soft in quality. The other chemical constituents of ground water namely HCO_3, Cl, Ca, Mg, etc. all are within permissible limit according to Bureau of Indian Standard (IS: 10500-91). The iron concentration in ground water varies from 0.01 to 2.31 ppm. The highest iron content of 2.31 ppm is observed in dug wells while lowest occur in spring water. The iron content is moderately high. Thus it can be concluded that the ground water in the area is generally good except for iron and potable which can be used for domestic and industrial use. The water is expected to contain chemical constituents within the permissible limits. Details of chemical analyses of water from private borewells and wells drilled by PHE are given in Annexure 2(B) and Annexure 2(C) respectively. Chemical analyses results by PHE also depict the problem of high concentration of iron and slightly acidic water in few areas.

4.7 Major Ground Water Related Problems

The physiography of the rugged hilly terrain restricts development of groundwater. Many areas are unapproachable for truck-mounted rigs and there is need for In-well Drilling Rigs. Fig 4.3 depicts concentration of tubewell constructed in some pockets. These well fields may create problem in near future. Hence, state water policy on construction of bore well /tube well is a need of the time.

Ground water in the area is generally good and suitable for drinking, domestic and industrial use. However, concentrations of greater than 1 mg/litre iron in ground water in some pockets have been reported to occur in Greater Shillong. The presence of iron in drinking water supplies is objectionable for a number of reasons unrelated to health. Under the pH conditions existing in drinking-water supplies, ferrous salts are unstable and precipitate as insoluble ferric hydroxide, which settles out as a rust coloured silt. Such water often tastes unpalatable and stains laundry and plumbing fixtures.

4.8 Ground Water Development Strategy

Apart from constructing bore well for water supply, there is ample scope for the construction of large diameter open wells in a few selected intermontane valleys of Greater Shillong area, which can considerably help in augmenting the water supply system. The favourable areas are as follows-

1. In the linear valley on the eastern side of the meter factory of MESB, marked in **Fig. 4.4** as A.
2. In the linear valley on the eastern side of the Sacred Church Convent in Mawlai area marked in **Fig. 4.4** as C.
3. In the small valley adjacent to and NNW of Bara Bazar, south of District Council Office, at the junction of G.S. Road and Cantonment road, marked in **Fig. 4.4** as F.
4. A broad valley on the southern side of NH-40 near Fire brigade ground, marked in **Fig. 4.4** as H.
5. The main Polo river valley, marked in **Fig. 4.4** as M.

6. Broad flat valley of Wah Yblam river between CPRS and Government Agriculture Farm. The valley extends for about a km and has an average width of about 100 m, marked in **Fig. 4.4** as L.

Though ground water has the possibility to further augment the drinking water supply of the city, conjunctive use of surface and ground water sources is highly recommended. For better utilization of the surface sources like springs, streams, it is recommended that effort should be make to tap the springs right at the source of emergence and water be conducted through large diameter pipes to avoid pollution and other losses. Groundwater development may be regulated by permitting development only in needy areas and new colonies. Further, rainwater harvesting techniques should be universally educated and brought to practice with immediate effect.

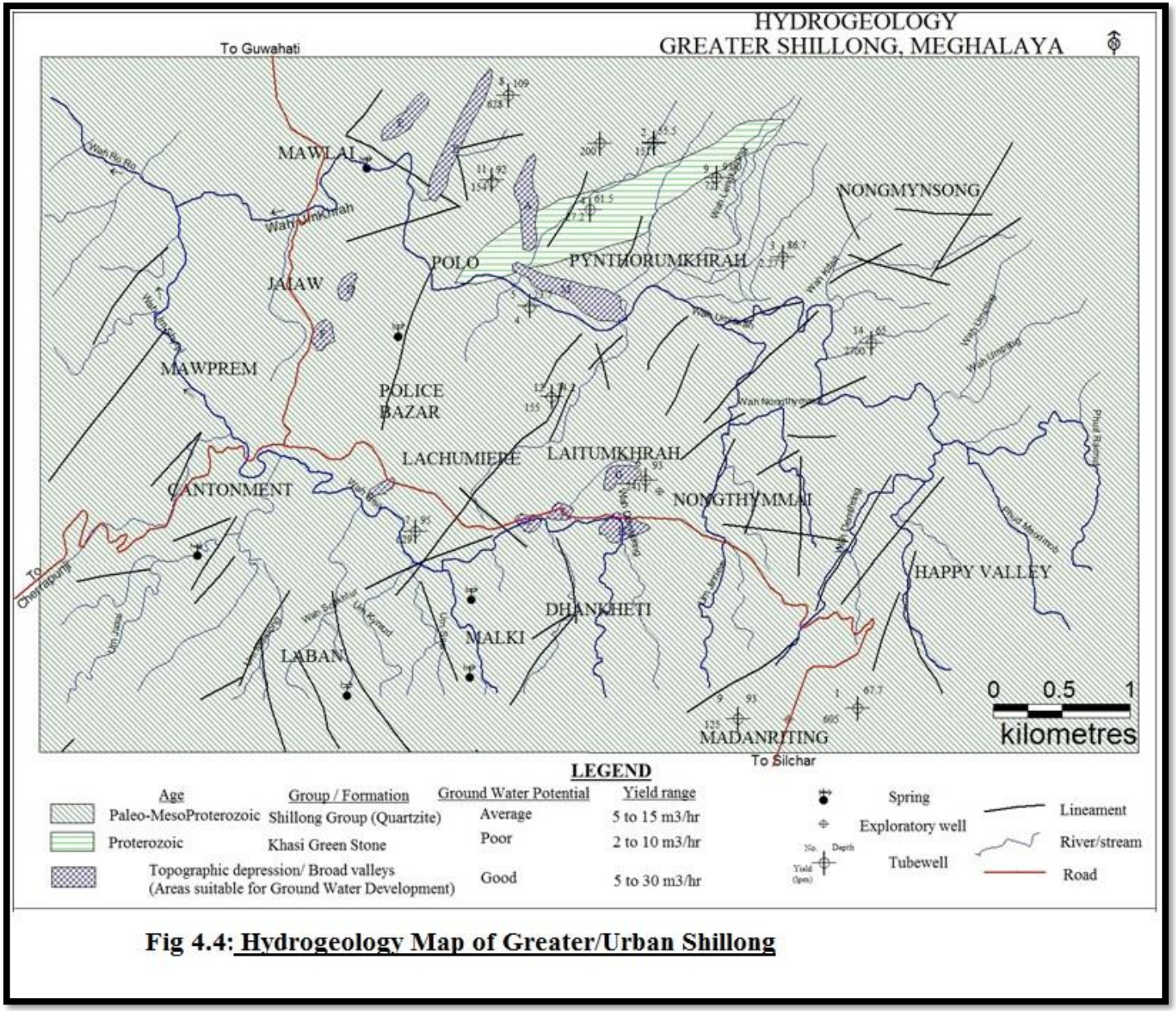


Fig 4.4: Hydrogeology Map of Greater/Urban Shillong

5. GROUNDWATER RESOURCES –EAST KHASI HILLS DISTRICT

Dynamic Groundwater Resources of East Khasi 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 894 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 like Archaean Gneissic complex, Granite pluton, Qartzite, Khasi Greenstone intrusive and limestone/sandstone. Different units considered for computation of recharge are Granitic-Gneissic complex, Quartzites, valley fills and alluvium.

5.1 Groundwater Resources – Recharge for Various Seasons: The rainfall infiltration factor recommended by GEC'97 for Granitic- Gneissic complex and Quartzites are 0.05, for alluvium it is 0.20. During fieldworks 22 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 3%.

For calculating recharge from return flow from irrigation, an average water requirement of 1.5 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.

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 5.1: 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
East Khasi Hills	10425	206	0	1	207	10632

Recharge from rainfall in the district is 10425.30 ham. Comparison of monsoon & non-monsoon rainfall recharge shows that monsoon recharge accounts for 67%. In comparison to recharge from rainfall, recharge from sources other than rainfall shows that the later accounts for about than 2 % of the total recharge.

5.2 Groundwater Extraction for Various Purposes: Groundwater extraction 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 private parties is 0.11 ham/yr and Unit draft of bore wells used by PHED is 2.46 ham/yr. Groundwater extraction for irrigation is nil. It was found that groundwater extraction for all uses in the district is 235 ham.

5.3 Stage of Groundwater Development & Categorization of the Blocks: The district falls under "**SAFE"** category. The stage of development is 2.45%. Summary of groundwater resources, stages of development and categorization are given in annexure 10.

6. GROUND WATER RELATED ISSUES

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

6.1 Low stage of ground water development: As per ground water resource estimation 2017-18, the stage of ground water development is just 2.45 % 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 utilising 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.

6.2 Ground water quality: As per water quality analysis data, it is found that there is a moderately high concentration of iron in both shallow aquifer and deeper aquifer. The comparison of iron content in shallow and deeper aquifer shows that there is more concentration of iron in deeper aquifer which needs to be filtered before using it. Apart from iron, the other parameters are within the permissible limit.

7. MANAGEMENT STRATEGIES

As per dynamic ground water resource estimation of East Khasi Hills for 2017-18, net ground water availability is 9569 ham and stage of development is only 2.45 %. The district is having balance net ground water availability for future irrigation use in the tune of 8450 ham. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then 5070 ham of groundwater resources is available in the district for the future irrigation uses. From this available resource (planned for future development) about 5,280 nos. of shallow tube wells (considering a unit draft of 0.96 ham/year) can be constructed. 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 4679 ha, during Rabi season it is 3435 ha. Present minor irrigation schemes are using surface water sources only. Present irrigation from ground water sources 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. A suitable cropping plan for the district was prepared in consultation with Water Management Division of ICAR, Umiam. Cropping pattern data for the district is presented in Table 7.1.

During 2015-16, net sown area in the district is 37,866 ha and cropping intensity is 130%. The net sown area included field crops as well as horticulture and plantation crops cultivated on hills and their slopes. Cropping intensity is calculated generally from field crops, which are of short duration whereas horticulture (like citrus, banana and pineapple) and plantation crops like spices are long duration crops. Again crops grown on the hills like orange, turmeric and ginger are having negligible or nil irrigation requirements. During kharif season, paddy is cultivated in 5435 ha and land under potato cultivation is 3524 ha. After Kharif crops, potato are cultivated in 8224 ha but major portion of paddy cultivated area remains fallow during Rabi season. The intention of this plan is to utilize this paddy fallow land (kharif/ winter paddy area is 5435 ha and rabi paddy area is 261 ha) of about 5175 ha under assured irrigation during Rabi season which will help to increase gross cropped area to 10350 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. Present cropping pattern, proposed cropping pattern, targeted increase in cropping intensity were shown in Table 7.2a and 7.2b.

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been estimated from CROPWAT after giving necessary meteorological, soil, crop plan inputs and the same has been shown in Table 7.1. Cropping pattern, proposed cropping pattern, intended cropping intensity, East Khasi Hills district, proposed cropping pattern with water deficit months and IWR, East Khasi Hills district Crop-wise and month-wise precipitation deficit (mm) using CROPWAT 8 for East Khasi Hills District has been presented in Table 7.2(a), 7.2(b) and 7.3 respectively.

Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in Table 7.4 .

Table 7.1

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

Cropping pattern name: EKH

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...Data\CROPWAT\data	Rice	04/06	01/10	12
2	...Data\CROPWAT\data	Rice	11/06	08/10	13
3	...Data\CROPWAT\data	Rice	25/06	22/10	12
4	...Data\CROPWAT\data	Rice	02/07	29/10	13
5	...\CROPWAT\data\cro	Potato	25/11	03/04	13
6	rape___mustard.CRO	Mustard	15/10	26/02	12
7	...CROPWAT\data\crop	Small Vegetables	05/02	10/05	13
8	...CROPWAT\data\crop	Small Vegetables	15/02	20/05	12

Source: CROPWAT

Table 7.2 a. Cropping pattern, proposed cropping pattern, intended cropping intensity, East Khasi Hills district.

Cropping pattern				
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 (ham)
	1	2	3(= % of 1)	4
Rice (main crop)	5175	5175		434
Potato (main crop)	0	1294	25	104
Mustard	0	1294	25	65
Vegetables	0	2587	50	115
Net cultivated area	5175	5175		
Gross cultivated area (1+potato/+mustard/+Veg)	5175	10350		
Total irrigation requirement				718
Cropping intensity	100% (Present)	200% (Intended)		

Table 7.2 b. Proposed cropping pattern with water deficit months and IWR, East Khasi Hills district

Rice Based Cropping Pattern			
Crop	Growing period (Months)	Periods/months of water deficit	Irrigation requirement (ha m)
Rice	4	1 – 2	434
Potato	5	5	104
Mustard	5	4	65
Vegetables	3	3	115
Total			718

The total area of rice cultivation is comprised of (5175 ha) 50 % of the targeted cultivated area of (10350 ha). During kharif season, rice is cultivated from June to mid-July. Since this huge area cannot be cultivated in a single day (one planting date), so it is considered/ planned to cultivate rice in four stages during this period.

It is planned to utilize rice fallow of 5175 ha for the cultivation of potato, mustard and vegetables. It is considered to cultivate potato and mustard in 1294 ha each and vegetable in 2587 ha, including present cultivation area for these crops. Area under vegetable cultivation is also considered/ planned to cultivate in two stages during this period.

The peak water requirement for irrigation for rice is in the month of June, for potato it is in the month of February, for mustard it is in the month of December and for vegetables it is during March.

Table 7.3: Crop-wise and month-wise precipitation deficit (mm) using CROPWAT 8 for East Khasi Hills District.

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit (mm)												
1. Rice	0	0	0	0	147	60.8	0	0	0	2.4	0	0
2. Rice	0	0	0	0	49.3	98	0	0	0	0	0	0
3. Rice	0	0	0	0	0	146.9	0	0	0	4.4	0	0
4. Rice	0	0	0	0	0	164	0	0	0	0	0	0
5. Potato	38.2	49.4	44.9	0	0	0	0	0	0	0	3.3	18.1
6. Mustard	31.2	19.8	0	0	0	0	0	0	0	0	20.4	33.4
7. Small Vegetables	0	24.3	44.1	30.1	0	0	0	0	0	0	0	0
8. Small Vegetables	0	13.6	35.5	30.1	0	0	0	0	0	0	0	0

Table 7.4: Irrigation water requirement (ham) of East Khasi Hills District.

Crops	% of total area of 5175 ha	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation deficit (ham)														
1. Rice	12	0.00	0.00	0.00	0.00	91.29	37.76	0	0	0	1.49	0.00	0.00	130.53
2. Rice	13	0.00	0.00	0.00	0.00	33.17	65.93	0	0	0	0.00	0.00	0.00	99.10
3. Rice	12	0.00	0.00	0.00	0.00	0.00	91.22	0	0	0	2.73	0.00	0.00	93.96
4. Rice	13	0.00	0.00	0.00	0.00	0.00	110.33	0	0	0	0.00	0.00	0.00	110.33
5. Potato	13	25.70	33.23	30.21	0.00	0.00	0.00	0	0	0	0.00	2.22	12.18	103.54
6. Mustard	12	19.38	12.30	0.00	0.00	0.00	0.00	0	0	0	0.00	12.67	20.74	65.08
7. Vegetables	13	0.00	16.35	29.67	20.25	0.00	0.00	0	0	0	0.00	0.00	0.00	66.27
8. Vegetables	12	0.00	8.45	22.05	18.69	0.00	0.00	0	0	0	0.00	0.00	0.00	49.18
Total	100	45.07	70.32	81.92	38.94	124.5	305.4	0	0	0	4.22	14.89	32.92	717.98

Under ground water exploration programme, CGWB has constructed 25 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 8 m^3/hr but can be sustainably developed and use for irrigation purpose.

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. Pumping tests of a few dug wells in quartzite areas show that specific capacity values vary from 0.15 to 0.35 m^3/min/ m of drawdown. This type of dug wells can be used to irrigate about 0.1 ha of land especially under Rabi vegetables. However, majority of the farmers in the district are marginal to small and their average land holding is 0.5ha. To irrigate 0.5 ha land especially for Rabi vegetables (maximum demand of 49 mm/month for March after CROPWAT) 245m^3/month water is required (for October to March). Considering 70% of irrigation efficiency the demand will rise to 350 m^3/month. This amount of water can be extracted by constructing large diameter dug wells of size 2 to 3 m (dia) x 10 to 15 m (depth). If these dug wells are pumped for 16 – 17 days in a month then unit draft created by such a dug well will be 0.13 ham/yr.

A bore well in the area is expected to yield 8 m^3/hr. If such a bore well runs for 10 hrs/day for 120 days, then it will create a draft of 0.96 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 5175 ha, 1290 nos. of shallow bore wells can be constructed (considering 200 m distance between any two shallow bore well). 1290 nos. of bore wells can extract 1238 ham of water annually.

Annual irrigation water requirement is 718 ham while irrigation water requirement during dry season spanning from October to March it is 249 ham. However, proportionate dynamic groundwater resources available for future irrigation use in 5175 ha in the district are 268 ham. During Rabi season, there is no shortage between irrigation demand and availability but there is a shortage of 450 ham for entire year.

During Rabi season, If 100 nos. of large diameter dug wells are constructed, then 50 to 75 ha land can be brought under assured irrigation. Rest of area i.e., 5100 ha land can be brought under irrigation by constructing bore wells by using 245 ham of groundwater resources, that can be harnessed by constructing 230 bore wells.

Groundwater in the area is infested with iron, therefore before consumption aeration/ filtering/ installation of Iron Removal Plant is necessary.Groundwater from unconfined aquifer is slightly acidic in nature which can be consumed after aeration, treatment with potash alum and even treatment with normal filters at home.

REFERENCES

i. **Central Ground Water Board, Ministry of Water Resources, New Delhi** Dynamic Groundwater Resources of India (as on march 2011).

ii. **Central Ground Water Board, Ministry of Water Resources, NER, Guwahati** Dynamic Groundwater resources of Meghalaya State (as on march 2013)

iii. **Central Ground Water Board, Ministry of Water Resources, NER, Guwahati** Meghalaya State report (as on march 2013)

iv. **Central Groundwater Board, Ministry of Water Resources, New Delhi** Ground Water Information Booklet of East Khasi Hills District, Meghalaya (2017-18)

v. **Central Groundwater Board, Ministry of Water Resources, New Delhi** Manual on Aquifer Mapping

vi. **Directorate of Economics and Statistics, Government of Meghalaya.**Statistical Hand Book of Meghalaya, 2016.

vii. **Geological Survey of India,** Geology and Mineral Resources of the States of India, MISC. PUB. 30 PT.4 VOL. 2

viii. **Year Book, NER, 2015-16 and 2016-17.**

ix. **Todd, D. K. (1959)** Groundwater hydrology; 4th Ed.; John Willy and Sons Inc.; N.Y.; 535

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

S.No.	Site Name	Latitude	Longitude	Block	District	Toposheet	AAP Year	Depth drilled	Casing depth(mbgl)	Static Water level(m)	Discharge(m3/hr)	Drawdown(m)	Transmissivity (m2/hr)	Specipic Capacity (lpm/m)	Storativity(S)	Formation/Geology	Agency
1	Dymper	25°25'08"	91°46'47''	Mylliem	East Khasi Hills	78O/15	1995-96	80	2.4							Precambrian/Quartzite	CGWB
2	Kyanton-U-Mon	25°031'30"	91°53'15''	Mylliem	East Khasi Hills	78O/14	1995-96	70	8.38	2.35	3.79	2.5				Quartzite	CGWB
3	Mamluh	25°031'47"	92°9'45''	Sohra	East Khasi Hills	78O/11	1995-96	201.13								Limestone	CGWB
4	Mawryngkneng	25°033'08"	92°4'02''	Mawryngkneng	East Khasi Hills	83C/2	1995-97	59.45	4.8	5.91	8.08	13.08	7			Quartzite	CGWB
5	Sohiong	25°029'45"	92°42'52''		East Khasi Hills	78O/11	1995-97	64	15	1.7	5.32						CGWB
6	Umlyngka	25°034'04"	91°51'05''	Mylliem	East Khasi Hills	78O/14	1995-97	80	6.4	3.5	9	40				Quartzite	CGWB
7	Mawsmai - Cherrapunjee	25°014'30"	91°51'05''	Sohra	East Khasi Hills	78O/12	2003-4	247.6		49	2.1					Limestone	CGWB
8	Mylliem - 12th Mile	25°028'32"	91°51'05''	Mylliem	East Khasi Hills	78O/15	2003-4	231.95			1.6					Mylliem Granite	CGWB
9	NEHU	25°036'26"	91°51'05''	Mylliem	East Khasi Hills	78O/14	2003-4	100.9								Quartzite	CGWB
10	Thynroit	25°029'52"	91°51'05''	Mylliem	East Khasi Hills	78O/15	2003-4	80	20	1.95	0.54	24.1				Quartzite	CGWB
11	MES, Shillong	25°034'02"	91°51'05''	Mylliem	East Khasi Hills	78O/14	2007-08	108.8	13.3	8.2		2.4	87			Quartzite with Pegmatite, Khasi grrenstone	CGWB
12	ASI, Mawpet	25°033'08"	91°51'05''		East Khasi Hills	78O/14	2007-08	140.7	13.3	23.8	9.3	15.1	3			Quartzite	CGWB
13	Umtyngar	25°027'50"	91°51'05''	Mylliem	East Khasi Hills		2011-12	200.05	22.4	14.15	1.56					Mylliem Granite	CGWB
14	Mawdiangdiang	25°035'50"	91°51'05''	Mylliem	East Khasi Hills		2011-12	200.05	14.4	78.75	6.3					Fr. Quartzite	CGWB
15	Mawkynrew	25°026'00"	91°59'58''	Mawkynrew	East Khasi Hills		2011-12	153.7	20.5	8	14.4					Fr. Quartzite, Fr. Dolerite	CGWB

16	**Mawlyngad**	25°031’23”	91°55'34''		East Khasi Hills		2011-12	200.05	13	0.5	72	20.01	3			Fr. Quartzite, Phyllite	CGWB
17	**LaitkorLumeh**	25°032’27”	91°53'03''	Mylliem	East Khasi Hills		2011-12	190.95	7.95	28.1	6.3	5.56	18			Quartzite, Khasi Grenstone	CGWB
18	**Mawlyngad**	25°31'23.19"	91°56'55.34''		East Khasi Hills			200.05		0.52	13		3			Quartzite, Khasi Grenstone	CGWB
19	**Laitkor**	25˚32’14.3”	91°53'33''	Mylliem	East Khasi Hills	78O/14	2016-17	178.89	7.5	35.75	8.08	3.55	25.49		3.85x10^{-2}	Quartzite	CGWB
20	**Nongpyiur**	25°32’31.2”	91°49'25''	Mylliem	East Khasi Hills	78O/14	2016-17	215.8	12.15	42.67	3.78	13.66	4.68		3.3 x 10-3	Quartzite	CGWB
21	**JNV , Mawplang**	25°27’20.6”	91°58'10''	Mawphlang	East Khasi Hills		2016-17	203.56	12.15	More than 100m	0.0325	---	---			Quartzite	CGWB
22	**Shillong, WRD**	25˚33’56.3”	91°53'46.3''	Mylliem	East Khasi Hills	78O/14	2016-17	93.13	10.07	1.55	1.48	25.31	1.28		1.7 x 10-4	Quartzite	CGWB
23	**Mawiong**	25˚37’43.1”	91°53'12.4''	Mylliem	East Khasi Hills	78O/14	2016-17	200.33	25.46	16.83	3.77	25.05	1.46			Khasi Greenstone	CGWB
24	**Lapalang**	25˚ 33’56.3”	91°53'46.3''	Mylliem	East Khasi Hills	78O/14	2016-17	111.59	25.5	5.2	1.41	----	----			Quartzite	CGWB
25	**Cherrapunjee, NIT campus**	25˚15’01”	91˚44’39”	Sohra	East Khasi Hills	78O/12		111.59	6.5	16	0.55					Limestone and sandstone	CGWB

Annexure 2(A): Aquifer wise water quality data of Aquifer mapping area

Village/ Location	Taluka/ Block	District	Lat	Long	Aquifer Type	pH	EC (µs/cm) 25C	TDS (mg/l)	CO_3 (mg/L)	HCO_3 (mg/L)	TA (as CaCO3)	Cl- (mg/L)	NO3-1 (mg/L)	F- (mg/L)	Ca+2 (mg/L)	Mg+2 (mg/L)	TH (as CaCO3)	Na (mg/L)	K (mg/L)	Fe (mg/L)
SPRINGS																				
Laitkor	Mylliem	East Khasi Hills	25°32'34.6"	91°54'10.3"	I	5.53	91.84	51.79	0	15	15	21.27	2.5	0.07	5.10	8.25	46.78	8.83	5.04	0.0145
Mawlai	Mylliem	East Khasi Hills	25°36'04.4"	91°53'26.4"	I	4.70	212.6	120.1	0	15	15	42.54	0	0.02	13.61	13.42	89.32	27.88	5.54	0.1579
Laitlynkgot	Pynursla	East Khasi Hills	25°26'40.4"	91°50'30.3"	I	5.85	111.5	62.99	0	35	35	21.27	1.2	0.05	20.41	6.19	76.56	7.18	7.87	0.0256
Tyrsad	Mawsynram	East Khasi Hills	25°24'39.0"	91°39'49.1"	I	6.05	11.5	6.484	0	15	15	21.27	0	0.07	1.70	4.12	21.267	5.57	6.9	0.0477
Weloi	Mawsynram	East Khasi Hills	25°21'43.7"	91°36'53.6"	I	5.45	21.22	11.94	0	25	25	21.27	2.1	0.04	1.70	5.16	25.52	5.36	4.35	0
Sohiong	Mawphlang	East Khasi Hills	25°29'49"	91°42'41.8"	I	7.44	79.72	45.09	0	45	45	17.72	0.71	0.17	6	6.06	40	4.16	5.93	0.3324

Village/ Location	Taluka/ Block	District	Lat	Long	Aquifer Type	pH	EC (µs/cm) 25C	TDS (mg/l)	CO_3 (mg/L)	HCO_3 (mg/L)	TA (as CaCO3)	Cl- (mg/L)	SO4-2(mg/L)	NO3-1 (mg/L)	F- (mg/L)	Ca+2 (mg/L)	Mg+2 (mg/L)	TH (as CaCO3)	Na (mg/L)	K (mg/L)	Fe (mg/L)
SHALLOW AQUIFER (DUG WELL)																					
Lr.Lachaumiere	Mylliem	East Khasi Hills	25°34'13.6"	91°53'13.7"	I	5.56	217.3	116.8	0	35	35	10.63	29.12	9.9	0.06	18	6.06	70	15.52	1.91	0.05
Mawpat	Mylliem	East Khasi Hills	25°35'33.9"	91°55'08.9"	I	5.99	295.7	157.4	0	115	115	53.1	5.94	2	0.12	34	3.64	100	21.74	11.08	0.2
Nongmynsong	Mylliem	East Khasi Hills	25°34'47.9"	91°54'24.5"	I	5.63	362.7	193.8	0	35	35	24.81	35.88	11	0.08	34	4.85	105	5.37	3.47	0.14
Shillong Dhankheti	Mylliem	East Khasi Hills	25°31'57.9"	91°53'34.4"	I	6.01	210.4	113.7	0	70	70	21.27	13.98	1.4	0.08	24	4.85	80	9.59	2.88	1.49
Shillong Golf Links	Mylliem	East Khasi Hills	25°35'12.6"	91°53'40.0"	I	5.25	57.7	30.86	0	25	25	14.18	5.021	0.4	0.04	2	3.64	20	8.09	3.54	2.31
Sohra dug well	Sohra	East Khasi Hills	25°17'02.7"	91°43'10.3"	I	5.89	89.03	50.26	0	25	25	17.72		3.2	0.07	23.81	2.06	68.05	5.2	3.27	0.015

Village/ Location	Taluka / Block	District	Lat	Long	Aquifer Type	Depth	pH	EC (mS/cm)	Turbidity(NTU)	TDS (mg/L)	TH (mg/L)	Ca (mg/ L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	NO_3 (mg/ L)	Fe (mg/L)
Deeper Aquifer																				
Nongpyiur	Mylliem	East Khasi Hills	25º 32’31.2”	91º49’25”	Fractured quartzite	215.8	6.83	62.03	0.2	32.84	20	6	1.2136	5.16	1.03	0	10	1.99	1.40	0.17
NIT, Cherrapunjee	Sohra	East Khasi Hills	$25^0$15’01”	91º44’39”	Fractured Limestone and sandstone	111.59	6.44	124.70	0.2	67.42	25	8	1.2680	0.88	0.77	0	10	4.37	0.40	1.15
Laitkor	Mylliem	East Khasi Hills	25^0 32’14.3”	$91^0$53’33”	Fractured Quartzite	178.89	6.63	46.6	1	23.82	25	4	3.6408	8.99	7.66	0	20	1.69	0.9	0.23

Annexure 2(B): **Details of chemical analysis results of ground water samples of private tubewells in Urban Shillong and Adjoining area**

S.No.	Location	pH	Total Hardness	Iron	Chloride
1	Mawlai Mawroh	7	4	0.1	14.2
2	Mawlai Mawroh	7	4	0.1	14.2
3	Manianglah A	7	16	0.1	17.05
4	Manianglah B	7	16	0.1	17.05
5	Mawpun	6.9	13	0.2	4.6
6	Nonglum	7.1	41	0.1	9.2
7	Mawria	6.8	53.2	0.08	8.3
8	St. Edmunds	7	50	0.12	7.21
9	Nongmynsong	7	21.4	0.08	10
10	Nongmynsong	7.5	26	0.06	12.2
11	Nongmynsong	6.9	32	0.2	4.6
12	Nongmynsong	7.1	33	0.1	8.2
13	Nongmynsong	7.3	33.3	0.04	13.4
14	Nongmynsong	7.2	42.7	0.08	16.1
15	Nongmynsong	6.5	26	0.08	8.3
16	Nongmynsong	6.9	37	0.04	10.2
17	Nongmynsong	6.6	32.5	0.08	7.2
18	Nongmynsong	6.7	33.5	0.06	8.5
19	Mawpat	6.9	22.1	0.16	11.2
20	Mawpat	6.9	18.7	0.2	8.3
21	Mawpat	6.86	19.2	0.2	9.3
22	Mawpat	6.95	19.3	0.09	6.6
23	Mawpat	7.1	20.8	0.04	10
24	Mylliem	6.9	30	0.2	8.5
25	Pynthorbah	7	13.4	0.08	11.3
26	Pynthorbah	6.8	11.6	0.05	7.1
27	Pynthorbah	7.2	12.7	0.1	8.9
28	Pynthorbah	7.1	20	0.08	10.6
29	Pynthorbah	6.9	21.4	0.2	15.1
30	Pynthorbah		31	0.2	4.6
31	Pynthorbah	6.6	35	0.08	8.3
32	Pynthorbah	7	26	0.04	12.2
33	Pynthorbah	6.8	11.2	0.06	7.3
34	Pynthorbah	6.9	42.5	0.07	6.7
35	Pynthorbah	6.75	50	0.1	17.5
36	Pynthorbah	6.8	42.3	0.08	12.3
37	Pynthormukhrah	7	37.1	0.2	14
38	Pynthormukhrah	7.1	41	0.12	18.1
39	Pynthormukhrah	6.9	29.8	0.06	13.2
40	Jingthangbriew	7.2	25.2	0.14	31
41	Jaiaw Laitdom	6.89	20	0.05	21.5
42	Lawjynriew	5.6	3.6	1.76	11.8
43	Lawjynriew	5.7	3.6	2.88	11.8
44	Lawjynriew	5.6	3.6	1.76	11.8
45	Pdeng Shong	5.8	68.4	2.3	50.8
46	Lawsohtun	6.9	10	0.1	9
47	Lawsohtun	6.6	12	0.1	9
48	Lawsohtun	6.8	22	0.8	13
49	Mylliem	6.2	10	0.64	9
50	Umpling	6.75	11.7	0.07	10.5
51	Umpling	6.8	12.8	0.05	17.2
52	Umpling	6.9	20	0.2	18.1
53	Umpling	6.6	26	0.08	9.2
54	Umpling	7	35	0.2	10.5
55	Umpling	6.8	29.8	0.12	7.2
56	Umpling	6.9	40	0.06	10.6

57	Umpling	6.75	42.1	0.07	9.2
58	Umshning	6.8	32.2	0.2	4.6
59	Umshning	6.7	32.5	0.15	8.5

(Source: PHE, Shillong)

Annexure 2(C): Details of chemical analysis results of ground water samples of tube wells drilled by PHE in Urban Shillong and Adjoining area

S.No.	Location	pH	Total Hardness	Iron	Chloride
1	Mawlai Mawroh	7	4	0.1	14.2
2	Mawlai Ma wroh	7	4	0.1	14.2
3	Manianglah A	7	16	0.1	17.05
4	Manianglah B	7	16	0.1	17.05
5	Mawpun	6.9	13	0.2	4.6
6	Nonglum	7.1	41	0.1	9.2
7	Mawria	6.8	53.2	0.08	8.3
8	St. Edmunds	7	50	0.12	7.21
9	Nongmynsong	7	21.4	0.08	10
10	Nongmynsong	7.5	26	0.06	12.2
11	Nongmynsong	6.9	32	0.2	4.6
12	Nongmynsong	7.1	33	0.1	8.2
13	Nongmynsong	7.3	33.3	0.04	13.4
14	Nongmynsong	7.2	42.7	0.08	16.1
15	Nongmynsong	6.5	26	0.08	8.3
16	Nongmynsong	6.9	37	0.04	10.2
17	Nongmynsong	6.6	32.5	0.08	7.2
18	Nongmynsong	6.7	33.5	0.06	8.5
19	Mawpat	6.9	22.1	0.16	11.2
20	Mawpat	6.9	18.7	0.2	8.3
21	Mawpat	6.86	19.2	0.2	9.3
22	Mawpat	6.95	19.3	0.09	6.6
23	Mawpat	7.1	20.8	0.04	10
24	Mylliem	6.9	30	0.2	8.5
25	Pynthorbah	7	13.4	0.08	11.3
26	Pynthorbah	6.8	11.6	0.05	7.1
27	Pynthorbah	7.2	12.7	0.1	8.9
28	Pynthorbah	7.1	20	0.08	10.6
29	Pynthorbah	6.9	21.4	0.2	15.1
30	Pynthorbah		31	0.2	4.6
31	Pynthorbah	6.6	35	0.08	8.3
32	Pynthorbah	7	26	0.04	12.2
33	Pynthorbah	6.8	11.2	0.06	7.3
34	Pynthorbah	6.9	42.5	0.07	6.7
35	Pynthorbah	6.75	50	0.1	17.5
36	Pynthorbah	6.8	42.3	0.08	12.3
37	Pynthormukhrah	7	37.1	0.2	14
38	Pynthormukhrah	7.1	41	0.12	18.1
39	Pynthormukhrah	6.9	29.8	0.06	13.2
40	Jingthangbriew	7.2	25.2	0.14	31
41	Jaiaw Laitdom	6.89	20	0.05	21.5
42	Lawjynriew	5.6	3.6	1.76	11.8
43	Lawjynriew	5.7	3.6	2.88	11.8
44	Lawjynriew	5.6	3.6	1.76	11.8
45	Pdeng Shong	5.8	68.4	2.3	50.8
46	Lawsohtun	6.9	10	0.1	9
47	Lawsohtun	6.6	12	0.1	9
48	Lawsohtun	6.8	22	0.8	13
49	Mylliem	6.2	10	0.64	9
50	Umpling	6.75	11.7	0.07	10.5
51	Umpling	6.8	12.8	0.05	17.2
52	Umpling	6.9	20	0.2	18.1

53	Umpling	6.6	26	0.08	9.2
54	Umpling	7	35	0.2	10.5
55	Umpling	6.8	29.8	0.12	7.2
56	Umpling	6.9	40	0.06	10.6
57	Umpling	6.75	42.1	0.07	9.2
58	Umshning	6.8	32.2	0.2	4.6
59	Umshning	6.7	32.5	0.15	8.5

Annexure 3: Water level monitoring data compilation

Name of Village/site	Latitude	Longitude	RL(mamsl)	Total Depth of Pz/Dw	Type(Pz/Dw/Spring)	Aquifer Group	Measuring point(magl)	Agency
Shallow aquifer								
Cherrapunji	25°17’02.7"	91°43’10.2”	1430	1.55	Dug	I	G.L	CGWB
Lr.Lachaumiere	25°34’13.6”	91°53’13.7”	1586	2.65	Dug	I	0.9	CGWB
Mawpat	25°35’33.9”	91°55’08.9”	1462	10	Dug	I	0.54	CGWB
Nongmynsong	25°34’47.9”	91°54’24.5”	1437	4.45	Dug	I	0.52	CGWB
Shillong Dhankheti	25°31’57.9”	91°53’34.4”	1515	3.6	Dug	I	0.66	CGWB
Shillong Golf Links	25°35’12.6”	91°53’40.0”	1440	10.74	Dug	I	0.75	CGWB
Dangar	25°11’20.8"	91°22’53.1”	19	2.9	Dug	I	0.8	CGWB
Shella	25°09'54.0"	91°41’12.6”	51		Dug	I	0.9	CGWB

Name of Village/site	Latitude	Longitude	RL(mamsl)	Total Depth of Pz/Dw	Type(Pz/Dw/Spring)	Aquifer Group	Measuring point(magl)	Agency
Deeper Aquifer								
Water Resources Department	25°33’56.3"	91°53’46.3”	1514	90	BW	II	0.5	CGWB
NIT Cherrapunji	25°15’01"	91°44’39”	594	25.5	BW	II	0.5	CGWB
Nongpyiur	25°32’31.2"	91°49’25”	1772	215.8	BW	II	0.8	CGWB
Laitkor	25°33’44.7”	91°38’21.8”	1514	90	BW	II	0.7	CGWB
Lapalang	25°34’09.6”	91°55’08.3”	1500	111.6	BW	II	0.42	CGWB

Annexure 4 A (1) Details of wells:

S. No.	State	District	Village	Well_No	Well_Type	Lat DMS	Long DMS	MP(m)	Present Status
1	Meghalaya	East Khasi Hills	Balat	78O4B1	Dug Well	25°12'20"	91°24'00"	0.78	Abondened
2	Meghalaya	East Khasi Hills	Mawngap	78O3D1	Dug Well	25°28'35"	91°46'10"	GL	Abandoned
3	Meghalaya	East Khasi Hills	Shillong Polo	78O2D1	Dug Well	25°35'00"	91°53'00"	0.85	Abandoned
4	Meghalaya	East Khasi Hills	Rynjah R& R Colony		Dug Well	25°34’39"	91°54’00”	GL	Abandoned
5	Meghalaya	East Khasi Hills	Cherrapunji	78O3C1	Dug Well	25°17'00"	91°43'00"	0.20	Monitoring
6	Meghalaya	East Khasi Hills	Shillong Dhankheti	MLEK08	Dug Well	25°31’57.9”	91°53’34.4”	0.66	Monitoring
7	Meghalaya	East Khasi Hills	Shillong Golf Links	MLEK07	Dug Well	25°35’12.6”	91°53’40.0”	0.75	Monitoring
8	Meghalaya	East Khasi Hills	Lachumeire	MLEK09	Dug Well	25°34’13.6”	91°53’13.7”	0.8	Monitoring
9	Meghalaya	East Khasi Hills	Mawpat	MLEK11	Dug Well	25°35’33.9”	91°55’08.9”	0.54	Monitoring
10	Meghalaya	East Khasi Hills	Nonmyngsong	MLEK12	Dug Well	25°34’47.9”	91°54’24.5”	0.52	Monitoring
11	Meghalaya	East Khasi Hills	Dangar	MLEK13	Dug Well	25°11’20.8"	91°22’53.1”	0.8	Monitoring

Annexure 4 A (2): Dynamic water level data

Location	DTWL (mbgl) March 13	DTWL (mbgl) Aug 13	DTWL (mbgl) Nov 13	DTWL (mbgl) Jan 14	DTWL (mbgl) Mar 14	DTWL (mbgl) Aug 14	DTWL (mbgl) Nov 14	DTWL (mbgl) Jan 15	DTWL (mbgl) Mar 15	DTWL (mbgl) Aug 15	DTWL (mbgl) Nov 15	DTWL (mbgl) Jan 16	DTWL (mbgl) Mar16	DTWL (mbgl) Aug 16	DTWL (mbgl) Nov 16	DTWL (mbgl) Jan 17	DTWL (mbgl) Mar 17	DTWL (mbgl) Aug 17	DTWL (mbgl) Nov 17	DTWL (mbgl) Jan 18	DTWL (mbgl) Apr 18
Shallow Aquifer																					
Balat		2.15	3.49	2.42	7.51	2.62	6.53	8.57		2.82				3.7	4.05	**Abondened**					
Mawngap	**Abondoned on March, 2013**																				
Shillong Polo	1.35	0.54	0.64	3.85		1.47		1.25		**Sealed**											
Rynjah	**Established in 2014**					3.9		5.32		3.2	Dry	Dry	NA	NA	4.57	**Abondoned**					
Cherrapunji		0.00	0.28	1.59	1.38		0.41	0.54	1.09	-0.20				o.o6	0.11	1.45	0.15	GL	GL	0.65	0.2
Shillong Dhankheti	1.8	1.77	1.81	1.35	1.86			1.63		1.19	1.76	1.78	1.74	1.79	1.69	1.77	1.78	1.49	2.53	1.74	3.4
Shillong Golf Links				4.6	7.57			3.73		0.9	2.73	4.03	6.6	2.38	3.05	4.95	6.97	1.65	3.52	4.91	8.1
Lachumeire		0.54	0.78	0.75	1.11	0.45		1.01		0.25	0.75	0.73	0.8	0.7	0.84	0.8	0.95	0.42	1.49	1.05	1.47
Mawpat						6.26		2.4		0.14	0.9	1.4	2.2	0.67	1.43	2.27	3.4	0.16	1.59	3.02	NA
Nonmyngson	**Established in May, 2014**					1.44		2.72		0.91	2.79	2.97	2.88	2.53	2.92	3.12	2.84	1.3	2.86	2.75	3.1
Dangar	**Established in january, 2017**															2	2.37	1.1	2.4	1.1	3.2

Name of village/site	DTWL (mbgl) Nov 16	DTWL (mbgl) Jan 17	DTWL (mbgl) Mar 17	DTWL (mbgl) Aug 17	DTWL (mbgl) Nov 17	DTWL (mbgl) Jan 18	DTWL (mbgl) Apr 18	Remarks
Deeper Aquifer								
Water Resources Department	1.56	1.97	2.42	0.49	4.22	4.1	8.1	**Established in Nov. 2016**
NIT Cherrapunji			4.48	5.37	5.64	5.75	6.63	**Established in Mar.2017**
Nongpyiur			42.49	15.3	23.12	32.75	42.88	**Established in Mar.2017**
Laitkor		34	43.54	15.5	23.67	32.33	Dry	**Established in Jan.2017**
Lapalang					6.42	6.81	7.52	**Established in Nov. 2017**

Annexure 4 B: Spring discharge monitored in East Khasi Hills district during 2017-18

Sl. No.	State	District	Block	Location	Latitude	Longitude	RL (m)	Type of Spring	Discharge (LPS) June-2017*	Discharge (LPS) Nov-2017*	Discharge (LPS) April-2018*
1	Meghalaya	East Khasi Hills	Mylliem	At Demthring	25°33’30”	91°54’32”	1576	Fracture	0.37	1	
2	Meghalaya	East Khasi Hills	Mylliem	Madanryting	25°33’13”	91°54’54”	1590	Depression	0.5	0.8	
3	Meghalaya	East Khasi Hills	Mylliem	Mawshubuit	25°33’34”	92°55’53”	1634	Depression	1.34	1.56	
4	Meghalaya	East Khasi Hills	Mylliem	At Lapalang	25°33’51”	91°55’2”	1549	Depression	0.5	0.8	<0.5
5	Meghalaya	East Khasi Hills	Mylliem	At Umpling	25°34’26”	91°55’08”	1493	?	0.5	1	
6	Meghalaya	East Khasi Hills	Mylliem	Nongmysong	25°35’17”	91°54’48”	1455	Fracture	0.956	0.34	0.5
7	Meghalaya	East Khasi Hills	Mylliem	Mawdiangdiang	25°36’45”	91°56’1”	1316	Fracture	2	2	
8	Meghalaya	East Khasi Hills	Mylliem	Ummawlong	25°36'44"	91°24’52”	1222	Depression	1.1	0.75	
9	Meghalaya	East Khasi Hills	Mylliem	Mawlai	25°36’04"	91°53’26"	1389	Fracture	6	>8	6
10	Meghalaya	East Khasi Hills	Mylliem	Lankyrding	25°35’45”	91°54’32”	1441	Fracture	0.5	1	
11	Meghalaya	East Khasi Hills	Mylliem	At Jiengkieng (Spring Side)	25°33’43”	91°54’07”	1553	Fracture	0.18	0.5	
12	Meghalaya	East Khasi Hills	Laitkor	Laitkor(Ladsaheb)	25°32’34”	91°54’10”	1802	Fracture	0.35	0.5	0.35

13	Meghalaya	East Khasi Hills	Laitkor	Thangbania stream	25°32’26”	91°53’59”	1813	Fracture	0.35	0.4	0.45
14	Meghalaya	East Khasi Hills	Mawkynrew	Smit	25°30’1”	91°54’21”	1763	Depression	0.2	0.25	
15	Meghalaya	East Khasi Hills	Mawkynrew	Laitdeingsai	25°28’13”	91°55’13”	1846	?	1.8	2.2	
16	Meghalaya	East Khasi Hills	Mawkynrew	Nongthymai	25°27’41”	91°58’42”	1659	Fracture	0.157	0.3	
17	Meghalaya	East Khasi Hills	Mawryngkneng	Umphyrnai	25°31’54”	91°54’48”	1748	Fracture	2.2	3	
18	Meghalaya	East Khasi Hills	Mawryngkneng	Mawryngkneng	25°33’11”	92°03’17”	1308	Fracture	3.34	2	
19	Meghalaya	East Khasi Hills	Mawryngkneng	Umkhen bridge	25°35'37”	92°03’29”	966	Fracture	0.5	0.5	
20	Meghalaya	East Khasi Hills	Mylliem	At Laimer Shiteng	25°35'49”	91°51’16”	1617	Depression	1	1.8	
21	Meghalaya	East Khasi Hills	Mylliem	Madan Sangmein	25°32'15"	91°50’50”	1809	Fracture	0.28	0.45	1
22	Meghalaya	East Khasi Hills	Mawphlang	Mawkhrie	25°30'02"	91°47’15”	1738	Depression	1	2	2
23	Meghalaya	East Khasi Hills	Mawphlang	Mawmaram	25°31'16"	91°42’49”	1772	Depression	0.434	>4	
24	Meghalaya	East Khasi Hills	Mawphlang	Sohoing	25°29'49"	91°42’42”	1732	Depression	0.121	0.025	
25	Meghalaya	East Khasi Hills	Mawphlang	Mawphlang	25°27'40"	91°45’35”	1815	Depression	0.157	0.5	
26	Meghalaya	East Khasi Hills	Mawphlang	Mawdngung	25°29'06"	91°43’10”	1822	Fracture	0.05	0.12	
27	Meghalaya	East Khasi Hills	Mylliem	Mylliem	25°30'35"	91°48’43”	1669	Depression	<0.02	<0.02	

28	Meghalaya	East Khasi Hills	Sohra	7th Mile Mylliem	25°31'45"	91°49’20”	1744	Depression	<0.01	<0.01	
29	Meghalaya	East Khasi Hills	Sohra	Umtyngar	25°27'28"	91°49’34”	1714	Fracture	0.05	0.58	dry
30	Meghalaya	East Khasi Hills	Sohra	Kyrdemkhla	25°26'17"	91°48’57”	1832	Fracture	1.2	1.8	1
31	Meghalaya	East Khasi Hills	Sohra	Mawkdok	25°25'26"	91°47’30”	1834	Fracture	<0.02	0.21	0.05
32	Meghalaya	East Khasi Hills	Sohra	Dawlieh	25°21'35"	91°44’41”	1696	Fracture	0.25	0.9	
33	Meghalaya	East Khasi Hills	Sohra	Sohrarim	25°20'41"	91°44’17”	1668	Fracture	<0.02	0.05	
34	Meghalaya	East Khasi Hills	Sohra	Tyrna Mawlong Road	25°14'20"	91°44’32”	652	Fracture	2	2.4	2.4
35	Meghalaya	East Khasi Hills	Sohra	Umwaih	25°13'40"	91°41’58”	471	?	1.2	1.67	
36	Meghalaya	East Khasi Hills	Sohra	Ringuir	25°12'30"	91°43’34”	578	Fracture	0.75	>4	
37	Meghalaya	East Khasi Hills	Mawsynram	Umkaber Lyngiong	25°25'1"	91°41’48”	1665	Depression	<0.02	<0.02	
38	Meghalaya	East Khasi Hills	Mawsynram	Tyrsad	25°24'24"	91°39’34”	1644	Fracture	3.2	>4	
39	Meghalaya	East Khasi Hills	Mawsynram	kyrphie	25°23'28"	91°39’13”	1650	Depression	0.01	0.01	
40	Meghalaya	East Khasi Hills	Mawsynram	Weloi	25°21'43"	91°36’53”	1590	Depression	<0.01	<0.01	
41	Meghalaya	East Khasi Hills	Mawsynram	Mawsynram	25°18'22"	91°34’56”	1467	Fracture	<0.01	0.5	
42	Meghalaya	East Khasi Hills	Mawsynram	Mawkasain	25°15'50"	91°31’11”	1128	Fracture	0.64	0.807	
43	Meghalaya	East Khasi Hills	Mawsynram	Mawsynram	25°17'46"	91°34’42”	1383	Fracture	>4	>6	
44	Meghalaya	East Khasi Hills	Mawsynram	Mawpan	25°14'17"	91°26’23”	688	Fracture	0.06	0.67	0.58

45	Meghalaya	East Khasi Hills	Mawsynram	Rangweng	25°14'24"	91°24’57”	623	Fracture	0.3	0.37	
46	Meghalaya	East Khasi Hills	Mawsynram	Umlamgrim	25°14'17"	91°26’23”	1642	Fracture	0.5	1.2	0.05
47	Meghalaya	East Khasi Hills	Pynursla	Laitlynkgot	25°26'40"	91°50’30”	1833	Depression	<0.01	0.01	<0.01
48	Meghalaya	East Khasi Hills	Pynursla	Pomlum	25°24'54"	91°52’04”	1672	Depression	0.5	Locked	0.05
49	Meghalaya	East Khasi Hills	Pynursla	Laitmynreng	25°19'44"	91°53’38”	1447	Fracture	0.01	0.17	
50	Meghalaya	East Khasi Hills	Pynursla	Lankyrdem	25°21'08"	91°53’37”	1534	Fracture	0.04	0.1	
51	Meghalaya	East Khasi Hills	Pynursla	Mawriang	25°12'05"	91°59’42”	375	Fracture	<0.01	<0.01	
52	Meghalaya	East Khasi Hills	Pynursla	Bopumsyiem	25°01'23"	92°01’05”	28	Fracture	0.5	0.67	
53	Meghalaya	East Khasi Hills	Pynursla	Rngain	25°18'31"	92°54’12”	1472	Fracture	0.1	0.75	

Annexure 5: Litholog of exploratory wells

Location	MES Campus, shillong
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78 O/14
Latitude	25°034'02"
Longitude	91°51'05"
RL (m amsl)	1546
Drilled Depth	108.8
Casing	13.3
SWL (mbgl)	8.2
Discharge (lps)	NA
Date/year	2007-08

Depth Range (m)	Thickness (m)	Lithological Description
00-4.00	4	Surface soil, loose yellowish brown in color
4.00-11.00	7	Weathered Quartzite
11.00-36.00	25	Quartzite, light pink in color, intruded by quartz veins at 16.70-17.40 m depth
36.00-52.90	16.9	Granite Gneiss, dark grey, containing dark minerals
52.90-74.20	21.3	Granite Gneiss, hard, containing mica, feldspar and biotite as traces
74.20-108.80	34.6	Granite Gneiss, rich in pyroxene, amphibolite, biotite, pyrite etc.,

Location	Laitkor Lumeh
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78 O/14
Latitude	25°032'27"
Longitude	91°53'03''
RL (m amsl)	1878
Drilled Depth	190.95
Casing	7.95
SWL (mbgl)	28.1
Discharge (m3/hr)	6.3
Date/year	2011-12

Depth range (m bgl)	Thickness (m)	Lithology
00 - 1.85	1.85	Top Soil, Reddish silty
1.85 - 59.75	57.9	Quartzite, pulverized sample, light yellowish
59.75 - 87.25	27.5	Quartzite, chips of quartzite, grey
87.25 - 93.35	6.1	Quartzite, pulverized, very fine grained sample , grey
93.35 - 117.75	24.4	Quartzite, coarse grained sample with chips of quartzite (3 to 10 mm), fractured, grey
117.75 - 123.85	6.1	Quartzite, medium to fine grained sample, massive, grey
123.85 - 129.95	6.1	Basic rock (?), intrusive body, dark grey in colour
129.95 - 142.15	12.2	Quartzite, coarse grained sample, pink colour
142.15 - 172.65	30.5	Quartzite, very coarse grained sample, light grey
172.65 - 175.65	3	Dyke, Khasi Greenstone, massive
175.65 - 178.75	3.1	Dyke, fractured
178.75 - 190.95	12.2	Dyke, Khasi Greenstone, massive

Location	Mawlyngad
Toposheet No	78 O/14
Latitude	25°031’23”
Longitude	91°55'34"
RL (m amsl)	1729
Drilled Depth	200.05
Casing	13
SWL (mbgl)	0.5
Discharge (m3/hr)	72
Date/year	2011-12

Depth range (m bgl)	Thickness (m)	Lithological description
00 - 3.0	3	Top Soil
3.0 - 23.15	20.15	Quartzite, highly weathered, light yellowish.
23.15 - 35.35	12.2	Quartzite, massive, light yellowish
35.35 - 38.45	6.1	Quartzite, partially fractured, light yellowish
38.45 - 75.05	36.6	Quartzite, massive, light yellowish
75.05 - 96.35	21.3	Quartzite, highly massive, light yellowish
96.35 - 114.65	18.3	Quartzite, partially fractured, light yellowish
114.65 - 136.05	21.4	Quartzite, highly massive, light yellowish
136.05 - 148.25	12.2	Phyllite, massive, dark grey.
148.25 - 154.35	6.1	Phyllite, highly massive, dark grey.
154.35 - 178.75	30.5	Phyllite, partially fractured, dark grey.
178.75 - 200.05	21.03	Phyllite, massive, dark grey.

Location	Mawkynrew
Taluka/Block	Mawkynrew
District	East Khasi Hills
Toposheet No	
Latitude	25°026’00”
Longitude	91°59'58"
RL (m amsl)	1546
Drilled Depth	153.7
Casing (m)	20.5
SWL (mbgl)	8
Discharge (m3/hr)	14.4
Date/year	2011-12

Depth range (m bgl)	Thickness (m)	Lithological description
00 - 03	3	Top Soil
03 - 17.00	14	Quartzite, Highly weathered, Clayey
17.0 - 26.00	9	Green Colored Rock (Quartzite ?), Highly fractured, big pieces
26.0 - 32.00	6	Quartz Vein, Smoky colored, Highly fractured
32.0 39.00	7	Dark Grey Quartzite (?), Fractured
39.0 - 82.00	43	Dark Grey Quartzite (?), massive Fractured at 60.0 – 63.0 m.
82.0 - 88.00	6	Dark Grey Quartzite (?)+ Pink quartzite, fractured
88.0 - 94.00	39	Quartzite, Pink, Fractured +Smoky Quartz vein
94.0 - 106.00	12	Quartzite, Pink, massive
106.0 - 109.00	3	Quartz vein, Smoky to white, Fractured
109.0 - 112.00	3	Dyke
112.0 - 115.00	3	Quartzite, Pink, massive
115.0 - 121.00	6	Quartzite, Pink, mixed with green chips (?)
121.0 - 124.00	3	Dyke, Dark grey, massive
124.0 - 127.00	3	Dyke, Dark grey, Highly fractured
127.0 - 130.00	3	Dyke, Dark grey, partially fractured (?)
130.0 - 148.60	18.6	Dyke, Dark grey, massive
148.60 - 153.70	6.1	Dyke, Dark grey, Highly fractured

Location	Mawdiangdiang
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78 O/14
Latitude	25°035’50”
Longitude	91°51'05"
RL (m amsl)	1391
Drilled Depth	200.05
Casing(m)	14.4
SWL (mbgl)	78.75
Discharge (lps)	6.3
Date/year	2011-12

Depth range (m bgl)	**Thickness (m)**	**Lithological description**
00 – 3.0	3	Top Soil, Weathered quartzite, brick-red colored.
3.0 - 12.00	9	Highly weathered quartzite, Buff colored.
12.0 - 15.00	3	Quartzite, highly fractured, grey colored.
15.0 - 36.00	21	Quartzite, partially weathered, grey colored.
36.0 - 48.00	12	Quartzite, massive, buff colored.
48.0 - 60.00	12	Quartzite, massive, smoky colored.
60.0 - 69.00	9	Quartzite, fractured, grey colored.
69.0 - 108.00	39	Quartzite, massive, grey colored.
108.0 - 132.00	24	Quartzite, massive, dark grey colored.
132.0 - 138.00	6	Weathered & little fractured Quartzite, grey colored.
138.0 - 159.00	21	Quartzite, massive, grey colored.
159.0 - 168.00	9	Quartzite, highly fractured, grey colored
168.0 - 180.00	12	Quartzite, less fractured, grey colored.
180.0 - 183.00	3	Massive Quartzite, grey colored.
183.0 - 200.05	17.05	Massive Quartzite, grey colored.

Location	JNV Mawphlang
Taluka/Block	Mawphlang
District	East Khasi Hills
Toposheet No	
Latitude	25°27’20.6”
Longitude	91°58'10"
RL (m amsl)	1670
Drilled Depth	203.56
Casing	12.15
SWL (mbgl)	More than 100m
Discharge (lps)	0.0325
Date/year	2016-17

Depth range (in m bgl)	Thickness (m)	Lithology
G.L. to 28.69 m bgl	28.69	Quartzite, compact, sample cuttings are very fine to fine grained size, grayish white in colour.
28.69 to 53.21 m bgl	24.52	Quartzite, compact (Iron content), sample cuttings are very fine to fine grained size, brownish grey in colour.
53.21 to160.55 m bgl	107.34	Quartzite, compact, sample cuttings are very fine to fine grained size, grayish white in colour.
160.55 to 192 m bgl	31.45	Quartzite, compact, sample cuttings are fine to medium grained size, grayish white in colour.
192 to 192.50 m bgl	0.5	Quartzite, fractured (minor), sample cuttings are medium grained size, grayish white in colour.
192.50 to 203.56 m bgl	11.06	Quartzite, compact, sample cuttings are medium grained size, grayish white in colour.

Location	Laitkor
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25˚32’14.3”

Depth range (in m bgl)	Thickness (m)	Lithology
G.L. to 13.43 m bgl	13.43	Top Soil, reddish brown in colour.
13.43 to 50.21 m bgl	36.78	Quartzite, compact.
50.21 to 62.47 m bgl	12.26	Quartzite, fracture.

Longitude	91°53'33"
RL (m amsl)	1873
Drilled Depth	178.89
Casing	7.5
SWL (mbgl)	35.75
Discharge (lps)	8.08
Date/year	2016-17

62.47 to 65.47 m bgl	3	Quartzite, compact.
65.47 to 89.99 m bgl	24.52	Quartzite, fracture .
89.99 to 120.64 m bgl	18.66	Quartzite, compact.
120.64 to 139.30 m bgl	18.66	Quartzite, fracture .
139.30 to 142.16 m bgl	2.86	Quartzite, compact.
142.16 to 145.16 m bgl	3	Quartzite, fracture .
145.16 to 178.89 m bgl	33.73	Quartzite, compact.

Location	NIT , Cherapunjee
Taluka/Block	Sohra
District	East Khasi Hills
Toposheet No	78O/12
Latitude	25˚15’01”
Longitude	91˚44’39”
RL (m amsl)	1873
Drilled Depth	111.59
Casing	6.5
SWL (mbgl)	16
Discharge (lps)	0.55
Date/year	2016-17

Depth range (in m bgl)	Thickness (m)	Lithology
G.L. to 2 m bgl	2	Top Soil, reddish brown in colour.
2 to 4 m bgl	2	Sandstone, weathered, sample cuttings are fine grained size, greyish brown in colour.
4 to 22 m bgl	18	Sandstone, compact, sample cuttings are fine grained size, grayish brown in colour.
22 to 22.5 m bgl	0.5	Sandstone, fractrued, sample cuttings are fine grained size, grey in colour.
22.5 to 68.68 m bgl	46.18	Sandstone, compact, sample cuttings are fine to medium grained size, grey in colour.
68.68 to 69.68 m bgl	1	Limestone, fractured (Dry), sample cuttings are fine grained size, grey in colour.
69.68 to 111.59 m bgl	41.91	Limestone, compact, sample cuttings are fine to medium grained size, grey in colour.

Location	Nongpyiur
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25°32’31.2”
Longitude	91°49'25"
RL (m amsl)	1766

Depth range (in m bgl)	Thickness (m)	Lithology
G.L. to 4 m bgl	4	Top Soil.
4 to 31.82 m bgl	27.82	Quartzite, weathered, sample cuttings are very fine grained size, brown in colour.
31.82 to 139.03 m bgl	107.21	Quartzite, compact, sample cuttings are very fine grained size, reddish brown in colour.
139.03 to 140.03 m bgl	1	Quartzite, fractured, sample cuttings are fine to medium grained size, reddish brown in colour.
140.03 to 156.42 m bgl	16.39	Quartzite, compact, sample cuttings are medium grained size, greyish brown in colour.

Drilled Depth	215.8
Casing	12.15
SWL (mbgl)	42.67
Discharge (lps)	3.78
Date/year	2016-17

156.42 to 157.42 m bgl	1	Quartzite, fractured, sample cuttings are medium grained size, reddish brown in colour.
157.42 to 172.81 m bgl	15.39	Quartzite, compact, sample cuttings are medium grained size, reddish brown in colour.
172.81 to 173.81 m bgl	1	Quartzite, fractured, sample cuttings are medium grained size, reddish brown in colour.
173.81 to 215.54 m bgl	41.73	Quartzite, compact, sample cuttings are medium grained size, reddish brown in colour.

Location	Mawiong
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25˚37’43.1”
Longitude	91°53'12.4"
RL (m amsl)	1279
Drilled Depth	200.33
Casing	25.46
SWL (mbgl)	16.83
Discharge (lps)	3.77
Date/year	2016-17

Depth range (in m bgl)	Thickness (m)	Lithology
G.L. to 13.43 m bgl	13.43	Top Soil, reddish brown in colour.
13.43 to 31.82 m bgl	18.39	Khasi Greenstone, weathered.
31.82 to 37.95 m bgl	6.13	Khasi Greenstone, compact.
37.95 to 40.95 m bgl	3	Khasi Greenstone, fractured.
40.95 to 200.33 m bgl	159.38	Khasi Greenstone, compact.

Location	lapalang
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25˚ 33’56.3”
Longitude	91°53'46.3"
RL (m amsl)	1514
Drilled Depth	111.59
Casing	25.5
SWL (mbgl)	5.2
Discharge (m3/hr)	1.41
Date/year	2016-17

Depth range (in m bgl)	Thickness (m)	Lithology
0 to 4	4	Top Soil, reddish brown in colour.
4 to 24.5	20.5	Quartzite, weathered, sample cuttings are very fine grained, brownish grey in colour, loose formation.
24.5 to 27	2.5	Quartzite, compact, sample cuttings are very fine to medium grained, brownish in colour.
27 to 29	2	Quartzite, partially fractured, sample cuttings are medium grained, grey in colour.
29 to 111.59	86.59	Quartzite, friable, sample cuttings are medium to coarse grained, grey in colour. loose formation (leading to collapse of Well)

Location	Water Resources Dept. Campus
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25˚33’56.3”
Longitude	91°53'46.3"
RL (m amsl)	1560
Drilled Depth	93.13
Casing	10.07
SWL (mbgl)	1.55
Discharge (m3/hr)	1.48
Date/year	2016-17

Depth range (in m bgl)	Thickness (m)	Lithology
G.L. to 6 m bgl	6	Top Soil, blackish brown in colour.
6 to 10 m bgl	4	Quartzite, weathered, sample cuttings are fine grained size, dark brown in colour.
10 to 11 m bgl	1	Quartzite, fracture, sample cuttings are medium to coarse grained size, light grey in colour.
11 to 35 m bgl	24	Quartzite, compact, sample cuttings are fine grained size, grey in colour.
35 to 36 m bgl	1	Quartzite, fractured, sample cuttings are medium to coarse grained size, grey in colour.
36 to 77 m bgl	41	Quartzite, compact, sample cuttings are medium grained size, grey in colour.
77 to 93.13 m bgl	16.13	Quartzite, loose formation, encountered collapsing of well after 77 m bgl sample cuttings are fine grained size, light grey in colour.

Location	12th Mile Mylliem
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25°028’32”
Longitude	91°49'24"
RL (m amsl)	1805
Drilled Depth	231.95
Casing(m)	14
SWL (mbgl)	NA
Discharge (m3/hr)	1.6
Date/year	2004-05

DEPTH RANGE (M Bgl)	THICKNESS (M)	LITHOLOGY
0.00 to 6.25	6.25	Granite, Reddish brown, surface soil, medium to coarse grained
6.25 to 18.45	12.2	Granite, Reddish brown, fine to medium with fragment of mica, orthoclase feldspar, quartz
18.45 to 27.55	9.1	Granite, light grey, medium grained with few broken chip of quartz, feldspar & mica
27.55 to 61.15	33.6	Granite, grey, fine grained, fragment of mica, orthoclase feldspar, quartz
61.15 to 85.55	24.4	Granite, dark grey, medium grained with few broken chip of quartz, feldspar & mica
85.55 to 108.85	23.3	Granite, dark grey, medium to coarse grained with few broken chip of quartz, feldspar & mica
108.85 to 123.25	14.4	Granite, pink, coarse grained with max. broken chip of quartz, feldspar & mica
123.25 to145.55	22.3	Granite, pinkish grey, fine to coarse grained with few broken chip of quartz, feldspar & mica
145.55 to 158.55	13	Granite, dark grey, medium grained with few broken chip of quartz, feldspar & mica
158.55 to 186.15	27.6	Granite, grey, fine to medium grained with few broken chip of quartz, feldspar & mica
186.15 to 201.45	15.3	Granite, pink, coarse grained with max. broken chip of quartz, feldspar & mica
201.45 to 231.95	30.5	Granite, dark grey, fine to medium grained with few broken chip of quartz, feldspar & mica.

Location	ASI,	**Depth(m)**	**Thickness(m)**	**Lithology**

	Mawblei			
Taluka/Block	Mylliem	0.00-3.50	3.50	surface soil, Quartzite
District	East Khasi Hills	3.50-15.70	12.20	Quartzite, weathered
Toposheet No	78O/14	15.70-21.80	6.10	Quartzite, weathered,
Latitude	25°033’08”			highly fractured
Longitude	91°51'05"	21.80-27.90	6.10	Quartzite
RL (m amsl)	1678	27.80-37.00	9.20	Quartzite, friable
Drilled Depth	140.7	37.00-43.10	6.10	Quartzite, fraible
Casing(m)	13.3	43.10-48.00	4.90	Quartzite, highly fractured
SWL (mbgl)	23.8	48.00-55.30	7.30	Quartzite
Discharge (m3/hr)	9.3	55.30-64.50	9.20	Quartzite, friable
Date/year	2004-05	64.30-79.70	15.40	Quartzite, friable
		79.70-85.80	6.10	Quartzite, friable
		85.80-98.00	12.20	Quartzite, friable
		98.00-110.20	12.20	Quartzite, fraible
		110.20-116.30	6.10	Quartzite, highly fractured
		116.30-122.40	6.10	Quartzite, fraible
		122.40-125.50	3.10	Quartzite, moderately
				fractured
		125.50-140.70	15.20	Quartzite, friable

Location	Thyrnoit
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	
Latitude	25°029’52”
Longitude	91°51'05"
RL (m amsl)	1665
Drilled Depth	80
Casing(m)	20
SWL (mbgl)	1.95
Discharge (m3/hr)	0.54
Date/year	

Depth range (m bgl)	Thickness (m)	Lithological description
00 - 2.90	2.901	Top soil, clay.
2.90-18.20	15.3	Clay brown non sticky
18.20-23.95	5.15	Weathered zone of quartzite brown coating, water struck at 20m
23.35-25.45	2.1	Quartzite, white, soft.
25.45-28.45	3	Quartzite, pink, hard.
28.45-33.55	5.1	Quartzite friable, whit.
33.55-34.55	1	Quartzite, pink.
34.55-40.65	6.1	Quartzite, friable, white.
40.65-43.75	3.1	Quartzite, white, fractured, water less, probably.
45.75-50.85	5.1	Quartzite pink
50.85-53.85	3	Quartzite, white.
53.85-58.95	5.1	Quartzite, pink
58.95-63.05	4.1	Quartzite, white hard
63.05-74.75	11.7	Quartzite, white.

Location	Umlyngka

Depth	Thickness	Lithological description

Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25°034’04”
Longitude	91°51'05''
RL (m amsl)	1554
Drilled Depth	80
Casing(m)	6.4
SWL (mbgl)	3.5
Discharge (m3/hr)	9
Date/year	

Range (m bgl)	(m)	
00-4.00	4	Top Soil, Reddish brown, weathered fine grained surface material,
4.00-6.00	2	Quartzite, Light brown, weathered quartzite gravel
6.00-13.00	7	Amphibolite (Khasi Green Stone), Dark Green, weathered, fractured amphibolite, composed mainly of hornblende, non –productivefracture
13..0 - 20.00	7	Amphibolite, Dark green fractured Amphibolite, angular fragments. The zone is productive.
20.00-35.00	15	Amphibolite, dark green, massive, sample fresh and fine grained.
35.00-39.00	4	Amphibolite, Dark green, fractured amphibolite, angular fragments, unproductive zone.
39.00-56.00	17	Amphibolite, Dark green, massive amphibolite, fine grained fresh sample.
56.00-60.00	4	Amphibolite, Dark green fractured amphibolite, angular fragments. The zone is productive (discharge-5300 litre/hour)
60.00-80.00	20	Amphibolite, Dark green massive amphibolite.

Location	Kyanton-U-Mon
Taluka/Block	Mylliem
District	East Khasi Hills
Toposheet No	78O/14
Latitude	25°031’30”
Longitude	91°53'15''
RL (m amsl)	1847
Drilled Depth	70
Casing(m)	8.38
SWL (mbgl)	2.35
Discharge (m3/hr)	3.79
Date/year	1995-96

Depth range (m bgl)	Thickness (m)	Lithological description
00-5.70	5.7	Top soil, weathered zone.
5.7-10.0	4.3	Boulders of meta-basic rock.
10.0-12.0	2	Quartzite, weathered, mixed with meta-basic rock fragments.
12.0-15.0	3	Meta-basic rock, hard greenish.
15.0-19.0	4	Quartzite, weathered, brownish.
19.0-20.0	1	Meta-basic rock, hard, greenish.
20.0-23.0	3	Quartzite, weathered, brownish.
23.0-28.4	5.4	Quartzite, fresh, partially fractured.
28.4-30.4	2	Quartzite, hard, massive.
30.4-35.5	5.1	Quartzite partially fractured.
35.5-57.0	21.5	Quartzite, hard, massive.
57.0-59.0	2	Quartzite partially fractured, non- productive.

Annexure 6: Geophysical data, East Khasi Hills District

Sl. No.	VES No.	Village	Location	Coordinates	General Geology	Layer Resistivity in Ohm-m					Layer Thickness in meters						Total Depth (m)	Remarks with expected zones/fractures (for recommended sites)
						ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	P_6	h_1	h_2	h_3	h_4	h_5		
1	1	Ladnongkrem	Laitkor Football Ground	N25°31'32", E91°53'8.7"	Shillong Group	2100	2400	500	-		-	2	6				8	
2	2	Ladnongkrem	Near PHE Bore well in the same ground	N25°31'32", E91°53'8.7"	Shillong Group	1900	300	1000	45	4500	-	1..5	4	4.5	9		19	Near existing successful PHE tube well
3	3	Ladnongkrem	100m. South of Assam Rifles Construction coy. By the side of the road	N25°30'40.2" ,E91°53'13.2"	Shillong Group	1150	150	1100	1800	400		1	4.2	10.3	15.1		30.6	
4	4	Ladnongkrem	80m. South of VES 3 and 40m, East of hut.	N25°30'40.2", E91°53'13.2"	Shillong Group	1100	2100	300	1500			2	11	5			18	
5	5	SMIT	In SMIT Bazar, Opp. The house of Sri Nongrum, 20m. towards play grounds	N25°29'58.6", E91°54'13.5"	Shillong Group	800	1200	300				1	6				7	
6	6	SMIT	In SMIT Bazar, Opp. The house of Sri Nongrum, 20m. from play grounds	N25°29'58.6", E91°54'13.5"	Shillong Group	1000	1500	300				2	4				6	
7	7	Ularulang	1.5 km from VES 5 in the elevated	N25°31'32", E91°53'8.7"	Shillong Group	2200	3000	400	50	700		1	3	12	14		30	

			football ground															
8	8	Umphirnai	40m SW of the gate	N25°31'45", E91°54'00"	Shillong Group	933	1578	2630	7627	Vh		1.6	8.4	15.3	9.4		34.7	
9	9	Umphirnai	10m North of the road, after the Hotel	N25°31'34.7", E91°53'44.8"	Shillong Group	1300	100	8153	20250	3156	1090	1.3	0.7	22.7	21.3	15	60	
10	10	Laitkor	Behind the house of Sri Theila Lingdoh Nonglait, 20m from the compound wall	N25°31'29.7", E91°53'31.4"	Shillong Group	2000	5460	8645	21000	10900		1.7	10.2	15.5	14		41.4	
11	11	ARC, Happy Valley, Shillong	Firing Range-15m NE corner of the field engineering training area building.	N25°33'06.5", E91°55'13.7"	Shillong Group	220	3000	150	600			0.5	3	26.5			30	Zones up to 30mbgl and Fractures expected between 50m and 70mbgl.
12	12	ARC, Happy Valley, Shillong	Firing range - 35m NW of VES 11;	N25°33'06.5", E91°55'13.7"	Shillong Group	400	1000	1400	350	200		1	1	3	13		18	
13	13	ARC, Happy Valley, Shillong	Firing Range – on the eastern bank of the nala and opp. Western corner of the park	N25°33'04.6", E91°55'.9.8"	Shillong Group	250	800	700	1000	600		1	1	8	24		34	
14	14	ARC, Happy Valley, Shillong	Firing range- 45m from the bridge on shivdhara nala and near the 6th pole of the fencing demarcating the civil and defence area.	N25°30'05.7", 91°55'38.2"	Shillong Group	1000	1500	120	300			1	4	3			8	Zones from 8m to 60mbgl.
15	15	ARC, Happy Valley, Shillong	75m North of VES 14	N25°30'05.7", E91°55'38.2"	Shillong Group	500	1000	70	1000			1	4	7			12	

16	16	ARC, Happy Valley, Shillong	120m North of VES 15, near the end of river retaining wall		Shillong Group	300	400	20000				5.5	1.5				7	
17	17	Upper Shillong, 4th mile	In the play ground, Opp. Sunny side, Don-bosco.		Shillong Group	220	700	1800	6000			3.1	0.9	6			10	
18	18	Upper Shillong,	Opp. Vet. Dispensary (C&RD) & Petrol bunk, 45m N 15°W of the bunk indicator post.	N25°33'12.1", E91°50'43.4"	Shillong Group	1200	3000	6000	800			3.1	0.9	16			20	
19	19	Mawklot	Opp. Electric pole of Godown of Sri Sinungklow/Nongthymmai	N25°33'03.3", E91°49'32.9"	Shillong Group	250	950	350	Vh			0.5	2	25.5			28	Zones up to 25m
20	20	Myllieum/Baniu m	In the ground, 29m S20° east of electrical transformer.	N25°31'23.2",E91°48'59.8"	Shillong Group/Granite	1000	150	60				1	33				34	
21	21	Umtyngar	State trg. Centre, Scouts & Guides, 24m S30°E of main building chimney		Granite	1500	3000	900	2500			1	5	44			50	
22	22	Mawblah-Myllieum	69m N20°Eof NE corner of Hamid Nongbri's Brick works.	N25°31'11.9", E91°48'48.5"	Granite	600	100	9999				23	7				30	
23	23	Mawblah-Myllieum	50m N30°W of VES-22	N25°31'13.2", E91°48'47.6"	Granite	893	250	1200	250	vh		1.4	3.6	3	22		30	Zones from 10-30m
24	24	Mawblah-Myllieum	65 m SW of VES-23	N25°31'12", E91°45'45.9"	Granite	750	350	Vh				1.4	25.6				27	
25	25	Mawblah-Myllieum	Due east of sign Board of	N25°31'16.1", E91°48'52.2"	Granite	790	300	700				1	26				27	

			Command area Agriculture Department. At a distance of 58m															
26	26	Marbaniang	50m S70° east of public shed on the main road.	N25°30'50.1", E91°48'42.9"	Shillong Group/ Granite	160	100	700				4	16				20	
27	27	Sengsamla	60m S50° west of Sengsamla bus stop.	N25°30'42.5", E91°48'41.3"	Shillong Group/ Granite	1500	170	Vh				0.8	64.2				65	Zones up to 65m
28	28	Polo Ground, Shillong.	Behind national stadium, 70m N28°E of Gate No. 1 of indoor sports trg. Hall.	N25°34'46.9", E91°53'43.3"	Shillong Group/Quartzite	160	120	250	150			1.3	0.7	13			15	
29	29	Polo Ground, Shillong.	50 m due east of VES 28.		Shillong Group/Quartzite	60	350	90	Vh			0.7	3.3	40			44	Zones up to 45m
30	30	Polo Ground, Shillong.	Inside the National Stadium right below commentator's box.	N25°34'48.9", E91°53'36.4"	Shillong Group/Quartzite	80	40	2				1	24				25	
31	31	Polo Ground, Shillong.	55m from VES 30, in the middle of the ground.		Shillong Group/Quartzite	200	40	200	3.5			2	3	35			40	
32	32	Polo Ground, Shillong.	100m from VES 30 on the western edge of the ground.		Shillong Group/Quartzite	60	10					8					8	
33	33	Polo Ground, Shillong.	In the cricket ground- 20m south of the road leading to the stadium - in the centre of the northern side of the Stadium.	N25°34'48.9", E91°53'36.4"	Shillong Group/Quartzite	80	200	80	5000			1.5	3.5	22			27	
34	34	Polo Ground,	In the cricket	N25°34'48.9",	Shillong	70	Vh					29					29	

		Shillong.	ground - in centre of the eastern side of the stadium.	E91°53'36.4”	Group/Quartzite													
35	35	Polo Ground, Shillong.	In the cricket ground - in centre of the Southern side of the stadium.	N25°34'48.9”, E91°53'36.4”	Shillong Group/Quartzite	120	18/0	600				1	23				24	
36	36	Polo Ground, Shillong.	In the cricket ground - in centre of the Western side of the stadium.	N25°34'48.9”, E91°53'36.4”	Shillong Group/Quartzite	180	70	500	175			1	2	27			30	Zones from 30-60m
37	37	Polo Ground, Shillong.	In the centre of the cricket ground, near the pitch.	N25°34'48.9”, E91°53'36.4”	Shillong Group/Quartzite	100	130	50	1000			1	2	9			12	
38	38	Polo Ground, Shillong.	50 m. North of the VES 35.	N25°34'48.9”, E91°53'36.4”	Shillong Group/Quartzite	130	190	60	350			1	5	9			15	
39	39	Shilling - sports association ground	5 m centre of the podium/eastern side of the stadium	N25°34'55.2”, E91°53'22.1”	Shillong Group/Quartzite													
40	40	Shilling - sports association ground	30 m west of VES-39	N25°34'55.2”, E91°53'22.1”	Shillong Group/Quartzite	30	700	60				0.8	19.2				20	
41	41	Shilling - sports association ground	10m west of the road approaching to the JLN Sports complex and 90m from the back side gate of the foot ball ground (1st Division)/centre of the eastern border of the	N25°34'52.6”, E91°53'27.5”	Shillong Group/Quartzite	200	300	756	Vh			1	1	10			12	

			ground.															
42	42	Shilling - sports association ground	80m from the road leading to the JLN sports complex and 25m from the Western wall of the cricket ground.	N25°34'52.6", E91°53'27.5"	Shillong Group/Quartzite	300	500	80	700	400		0.8	1.2	3	15		20	
43	43	Shilling - sports association ground	110m N30° W of the gate of the cricket ground (backside on the western side)	N25°34'52.6", E91°53'27.5"	Shillong Group/Quartzite	700	900	150	60	400		0.8	2.2	6	12		21	
44	44	Shilling - sports association ground	6m S60°E of the Booking counter of the foot ball ground) 1st Division.	N25°34'52.6", E91°53'27.5"	Shillong Group/Quartzite	160	1800	150	90	400		1.1	0.7	3.2	43		48	Zones up to 48m and may expect fractures up to 60m
45	45	Shilling - sports association ground	In the centre of the 2nd foot ball ground and it is 90m S50°E of VES 2.	N25°34'52.6", E91°53'27.5"	Shillong Group/Quartzite	100	500	150	50	5000		1.1	0.7	8.2	7		17	
46	46	Shillong - sports association ground	Centre of the western border of the sports association ground	N25°34'55.2", E91°53'22.1"	Shillong Group/Quartzite	80	180	40	5000			2	10	15			27	
47	47	Shillong – 16th hole Golf course	105 m N55° East of Yellow stone on the road bearing no.B 50 NF.	N25°35'13.3", E91°53'48.9"	Shillong Group/Quartzite	2500	2300	1800	180	700		1	2	10	25		38	Zones up to 40m
48	48	Shillong – 16th hole Golf course	100 m NE of VES-47 (16th hole golf course).		Shillong Group/Quartzite	1200	2000	230	4250			1	8	43			52	
49	49	Shillong – 16th	100 m NE of VES-		Shillong	160	180	358	120	VH		0.	6.	3	29		39	

		hole Golf course	48 (16th hole golf course).		Group/Quartzite	0	0					8	2					
50	50	Shillong – Golf course	120 m NW of VES-49 (16th hole golf course).		Shillong Group/Quartzite	1200	1400	5000	180			0.8	5.7	25.5			32	
51	51	Shillong – Golf course	100 m NW of VES-50 and 37m south 75 E of electric pole (PHE PH 02B 33) near abandoned building.		Shillong Group/Quartzite	2500	2900	9000	300			2.5	1	12.5			15	
52	52	Shillong – 17th hole Golf course	125m south 55° west of VES-47 and 20m south 55 west of Yellow stone.	N25°35'13.3", E91°53'48.9"	Shillong Group/Quartzite	1300	700	150				10	6				16	
53	53	Shillong – 17th hole Golf course	Opposite to point 2(stone)		Shillong Group/Quartzite	2000	500	100	800			9	16	20			45	Zones up to 45m.
54	54	Shillong – 17th hole Golf course	100 m West of VES-53 , near 150-(X)		Shillong Group/Quartzite	1500	500	130	3000			9	14	17			40	
55	55	Shillong – 17th hole Golf course	50 m West of VES – 54		Shillong Group/Quartzite	1450	1800	350	200	3000		6	4	13	15		38	
56	56	Shillong – 17th hole Golf course	60 m West of VES -55, opp. Lockto lodge		Shillong Group/Quartzite	1200	1800	550	70	4300		1	1.5	12.5	7		22	
57	57	Shillong – 17th hole Golf course	60 m east of point 2-stone and 15m north of 18-Mowpuling		Shillong Group/Quartzite	1200	500	220	550			13	6	26			45	Zones up to 45m.
58	58	ICAR FARM HOUSE-Barnyhat	In the Experimental farm division of agriculture. 50 m east of existing		Shillong Group/Quartzite	1000	92	30	9999			1	3.6	10.4			15	Near existing borewell

			CGWB -EW (road to Umrai Airport)															
59	59	ICAR FARM HOUSE-Barnyhat	60 m South of bore-well		Shillong Group/Quartzite	200	377	610	5000			1	11	21			33	
60	60	Shillong – 16th hole Golf course	Near 10 hall canteen.	N25°35'13.3", E91°53'48.9"	Shillong Group/Quartzite	2000	6000	1600	850	VH		0.6	2.4	2	25		29	
61	61	Garrison Grounds, Shillong	60m. SE of the Green which is nearer to the Entrance gate.		Shillong Group/Quartzite	250	588	250	110	5000		1.2	6.7	11.1	7		25	
62	62	Garrison Grounds, Shillong	55m. SW of the Green which is in the SE corner of the ground.		Shillong Group/Quartzite	800	400	500	50			1.2	1.8	12			15	
63	63	Garrison Grounds, Shillong	45m. NW of the Green which in the South Western corner of the ground.		Shillong Group/Quartzite	350	700	200	770			1.2	2.8	10			14	Zones up to 14m and fractures are at 60m
64	64	Garrison Grounds, Shillong	In between the VES 61 and VES 63. 100m from VES 62.		Shillong Group/Quartzite	600	800	2700	20			1.2	2.8	31			35	
65	65	Tyrsad - E.Khasi Hills	78m North of Mowlam-Tyrsad, play ground sitting gallery.	N25°24'39.1", E91°40'00.6"	Granite/Quartzite	600	15000	200	800			0.5	1.5	10			12	
66	66	Sohjhursaw	35m South 30° west of sign board on the foot bridge and about 210 m from VES-65.		Granite/Quartzite	4000	20000	2999	800			0.6	2.4	5			8	
67	67	Lyngiongthainro	140m South 60°	N25°24'59.9",	Granite/Quartzit	200	800	46.	150			0.	2.	18			21	Zones

		h	west of Beshu-Maribaniang's house.	E91°41'01.8"	e	0	0	5				6	4					between 21 and 65m
68	68	Nonglwai Madanseir	90m North 35°west of community hall	N25°25'29.0", E91°43'16.4"	Shillong group/Quartzite	2000	1000	500	2200			0.6	4.4	15			20	
69	69	Lyngiongyweipyllum	N40°East of the bridge and 300m South 70° west of VES 68.	N25°25'25.1", E91°43'06.9"	Shillong group/Quartzite	2400	926	85	Vh			3	1	20			24	
70	70	Lyngiongmawponghong	Near the Lower primary School. 65m South 70° west of football ground western goal post.	N25°25'34.4", E91°43'20.8"	Shillong group/Quartzite	1700	4000	2000				3	5				8	
71	71	Umlyngkien	90m South of Check dam. West of the village in the valley.		Shillong group/Quartzite	1500	6000	800	2000	300		1	3	17	38		65	Zones from 3to 22m and fractures beyond 65m.
72	72	Umlyngkien	12 m North of Check dam.		Shillong group/Quartzite	4000	7000	2400	400	2000		1	1	3	14		19	
73	73	Umlyngkien	50m west of VES-72.		Shillong group/Quartzite	900	6000	3500	850	3000		1.5	0.5	2	31		35	
74	74	Umlyngkien	50m South of VES-73		Shillong group/Quartzite	3000	5000	1029	1770			0.5	5.5	39			45	
75	75	Lyngkien-Kyien	110m S40W of ICDS school	N25°26'07.6", E91°43'49.9"	Shillong group/Quartzite	500	750	250	1000	2000		1.5	10.3	11.2	39		62	Zones from 12 to 25m.
76	76	Wahlyngkein	125 m N75°E of VES-75	N25°26'05.1", E91°43'46.5"	Shillong group/Quartzite	800	1500	400	900	2000		1	2	15	12		30	
77	77	Wahlyngkein	270 m N30°E of VES -75	N25°26'00.0", E91°43'45.7"	Shillong group/Quartzite	700	1000	644	250	900	4300	1	2	3	23	29	55	
78	78	Wahlyngkein-Ramklang	300m S55°W of Bridge(Behind the Bus shelter on	N25°26'37.1", E91°44'05.8"	Shillong group/Quartzite	4200	17000	2870	577	577	863	1	1	4	31		37	

			road side of the village)															
79	79	Wahlyngkein-Ramklang	100m S25°W of VES-78.		Shillong group/Quartzite	1000	3000	250	1290	2500		1	3	14	28		46	
80	80	Madanlyngkien-suien	Centre of foot ball ground	N25°26'37.1", E91°44'05.8"	Shillong group/Quartzite	2000	5000	224	123			1	2.5	1.5	41		46	
81	81	Umlykein	300m South of VES-74 & 60m North of check dam near broken bridge. Eastern side of the river.		Shillong group/Quartzite	5000	8000	800	200			1	2	1	16		20	
82	82	Umlykein	50m SE of VES-81 also	N25°26'54.1", E91°44'38.7"	Shillong group/Quartzite	2000	7000	800	250			1.5	1	16			20	
83	83	Umlykein	100 m west of VES-82		Shillong group/Quartzite	5000	13000	800	250			1.5	1.5	5	16		24	
84	84	Umlykein	120m of west of VES-83		Shillong group/Quartzite	2000	5000	1623	327	234	700	1.5	1.5	4	17	15	39	Zones from 10 to 40m and may expect deeper fractures.
85	85	Umlykein	60 m west of VES-84		Shillong group/Quartzite	1000	3000	1273	173			1.5	1.5	3	29		35	
86	86	Madan Iewrynghelp play ground (fire-brigade-Shillong)	Centre of the play ground		Shillong group/Quartzite	90	300	128	400			1.5	2	0.5	15		19	
87	87	Umpling-shillong	In the play ground between failed bore-wells.		Shillong group/Quartzite	100	2200	1200				0.5	22.5				23	
88	154	Jongksha	120m North of the junction road with sign board showing Mawlyngot-0km	N 25°27'56.0" E 91°58'03.07"	Qurtzites of Shillong group.	1750	850	8400				1	2				3	Fracture are expected between and 60 –

			on Jongksha-Mawkynrew road.															100m.
89	155	Jongksha	140m S20°W of the junction road with sign board showing Mawlyngot-0km on Jongksha-Mawkynrew rd.	N 25°27'45.2" E 91°58'28.1"	Qurtzites of Shillong group.	8000	4500	20000	14000			0.9	2.1	11			14	
90	156	Rapling	15m from the Eastern goal post of the foot ball ground.	N 25°28'29.1" E 91°56'11.3"	Qurtzites of Shillong group.	4000	2000	25000				0.8	1.1				1.9	
91	157	Rapling	About 100m south of the culvert on SMM road and nearly opp. to the church on the other side of the road.	N 25°28'20.8" E 91°55'53.2"	Qurtzites of Shillong group.	5500	6600	22000				1	2.5				3.5	
92	158	Mawlyndun	At the centre of the play ground.	N 25°26'20.8" E 91°55'50.8"	Qurtzites of Shillong group.	3850	2310					1.9						Data not amenable for interpretation
93	159	Mawpran	20m NW of Western side goal post of foot ball ground.	N 25°17'57.7" E 91°57'10.3"	Granite/Shillong group	2700	3200	15000	900			1.2	3.1	15.7			20	
94	160	Mawpran	Centre of the foot ball ground.	N 25°17'52.2" E 91°57'09.7"	Granite/Shillong group	1400	1600	9999	650			1.2	5.8	9			16	
95	161	Mawpran	70m North of the Western side goal post and 70m North of VES-160.	N 25°17'54.5" E 91°57'09.4"	Granite/Shillong group	5000	2500	14000	750			0.9	3.1	14			18	
96	16	Pynursla	19m N10°W of	N 25°18'25.7" E	Shillong	650	320	120				1.	18				20	

	2		Eastern goal post of the foot ball ground.	91°54’29.0”	Group/Sand stone of Jaintia Group		0	0				2	.8					
97	163	Pynursla	15m South of the sports club building.	N 25°18’08.0” E 91°54’28.4”	Shillong Group/Sand stone of Jaintia Group	500	4500	650				1.1	26.9				28	
98	164	Pongtong	40m due north of PHC main gate.	N 25°15’03.6” E 91°56’59.5”	Shillong Group/Sand stone of Jaintia Group	5500	700	1300	425			1	10	23			34	Zones from 35m to 90m
99	165	Pongtong	60m west of the approach road to PHC and 75m north of PHC.	N 25°15’01.7” E 91°56’57.7”	Shillong Group/Sand stone of Jaintia Group	260	950					1.3					1.3	
100	166	Dingsapoh	In the centre of the foot ball ground.	N 25°35’30.3” E 92°02’25.1”	Shillong Group/Sand stone of Jaintia Group	1300	450	5000				0.9	1.6				2.5	
101	167	Dingsapoh	SW corner of the foot ball ground.	N 25°35’31.0” E 92°02’24.7”	Shillong Group/Sand stone of Jaintia Group	167	800	180	7500			0.9	2.8				3.7	
102	168	Jaroit	In the centre of the foot ball ground.	N 25°36’53.4” E 92°04’12.1”	Shillong Group/Sand stone of Jaintia Group	2000	2800	20000	2585			1.1	3.4	22.5			27	
103	169	Nonghalli	On the approach road from Jaroit about 500 m before the Nonghalli village.	N 25°36’55.5” E 92°06’16.7”	Shillong Group/Sand stone of Jaintia Group	800	85	600				5	30				35	Zones upto 35m
104	170	Golf course, Shillong.	14m north of Dangrphong Point 4.	N 25°35’23.3” E 91°53’51.3”	Shillong Group/Sand stone of Jaintia Group	3000	550	60	9999			1.1	3.3	11.6			16	
105	171	Golf course, Shillong.	100m West of VES-170.		Shillong Group/Sand	800	75	120	2000			1.2	7.8	16			25	

					stone of Jaintia Group													
106	172	Golf course, Shillong.	100m SW of the VES-171.		Shillong Group/Sand stone of Jaintia Group	1800	300	2500	550			1	5	6			12	
107	173	Golf course, Shillong.	50 West of VES-171.		Shillong Group/Sand stone of Jaintia Group	5500	500	850	150	5000		0.9	19.1	3	17		40	Zones from 23-40m
108	174	Golf course, Shillong.	60m SW of VES-173.		Shillong Group/Sand stone of Jaintia Group	2200	1600	130	800			1	2.3	18.7			22	
109	175	Golf course, Shillong.	120m SW of VES-174.		Shillong Group/Sand stone of Jaintia Group	2200	130	6000				2	35				37	Zones up to 37m
110	176	Shella	On the RHS of the cart track leading to Hamuki and Kalateki villages from Shella and 28m SW of the South Eastern side goal post of the foot ball ground (Abandoned?)		Khasi Group(Sand Stone/Shales/Lime Stone)	16000	20000	1000	90			1.1	2.4	17.5			21	
111	177	Dhorom-Ichamati	N10°E of Dhorom LP School (Ichamati)	N 25°09’36.7” E 91°41’14.2”	Khasi Group(Sand Stone/Shales/Lime Stone)	110	85	32	110			1	1.5	27.5			30	Zones beyond 30m and up to 100m.
112	178	Dhorom-Ichamati	80m S35°E of VES-177.	N 25°09’34.2” E 91°41’17.7”	Khasi Group(Sand Stone/Shales/Lime Stone)	130	85	30	75			1	2.7	19.3			23	

113	179	Dhorom-Ichamati	47.5 due east of VES-178.		Khasi Group(Sand Stone/Shales/Lime Stone)	100	80	20	90			1	2.5	21.5			25	
114	180	Shella Bazar	On the bank of the river and 30m due west of steps leading to the PWD Guest House.	N 25°10'41.9" E 91°38'11.1"	Khasi Group(Sand Stone/Shales/Lime Stone)	6500	11000	1800	100			1	2.5	14.5			18	Zones up to 40m.
115	181	Ichamati (Umtaru)	By the side of the road leading to Bhoolagang. North 50°W of Chunna Bhatti. 100m south of the foot bridge.	N 25°10'09.9" E 91°41'47.0"	Khasi Group(Sand Stone/Shales/Lime Stone)	130	1250	65	20			0.4	1.8	13.8			16	
116	182	Ichamati (Umtaru)	60m east of Sri Prem Nongkynriah's house. 120m N30°E of VES-181.		Khasi Group(Sand Stone/Shales/Lime Stone)	2000	330	80	6500			1.4	6.6	17			23	
117	183	Jatab	At the centre of the foot ball ground.	N 25°09'35.1" E 91°39'06.4"	Khasi Group(Sand Stone/Shales/Lime Stone)	4800	8000	2000	250			1	2	20			23	
118	184	Jatab	110m NE of Shell telephone exchange and in front of telephone pole No. 632.		Khasi Group(Sand Stone/Shales/Lime Stone)	350	3000	80				1.1	9.9				11	
119	185	Dhorom	60m S50°W of Dhorom BRTF bridge.	N 25°09'18.8" E 91°41'25.7"	Khasi Group(Sand Stone/Shales/Lime Stone)	200	35	140				1.3	26.7				28	Beyond 30m and up to 100m.
12	18	Dhorom	100m North of	N 25°09'22.9" E	Khasi	95	22	60				3.	26				30	

0	6		BRTF bridge.	91°41’27.9”	Group(Sand Stone/Shales/Lime Stone)							4	.6					
121	187	Dongai	15m from the International boarder fencing gate with Bangladesh.	N 25°09’28.9” E 91°42’01.6”	Khasi Group(Sand Stone/Shales/Lime Stone)	34	8	90				14	11				25	
122	188	Ichamati	100 m South of bridge under construction on Ichamati – Shella road.	N 25°10’0.7” E 91°41’18.2”	Khasi Group(Sand Stone/Shales/Lime Stone)	210	75	20	200			1	7	32			40	
123	189	Mawsmai	At the centre of the foot ball ground.	N 25°14’31.7” E 91°43’47.3”	Lime stone	2100	160	100				4	22				26	
124	209	Rangshken	44m due NE from the south western basket post of the basket ball ground.	N 25°28’39.3” E 91°43’50.7”	Shillong Group(Quarzite/ Phillites)	3000	300	145	600			0.8	3.2	21			25	Zones up to 30m and fractures from 80m to 100m.
125	210	Rangshken	90mN60°W of VES-209.	N 25°28.4’1.2” E 91°43’48.3”	Shillong Group(Quarzite/ Phillites)	2500	200	500	175			2.5	11.5	41			55	
126	211	Rangshken	70m N40°E of VES-210.	N 25°28’42.8” E 91°43’49.7”	Shillong Group(Quarzite/ Phillites)	2200	3700	900	250	150		1	2.5	7.5	24		35	
127	212	Rangshken	70m N40°E of VES-209.	N 25°28’41” E 91°43’52.2”	Shillong Group(Quarzite/ Phillites)	2000	500	75	450	15		1	2.4	11.6	25		40	
128	213	Rangshken	85m S60°E of VES-212.	N 25°28’39.9” E 91°43’55.1”	Shillong Group(Quarzite/ Phillites)	3500	1200	150	230			1	2.5	26.5			30	fractures beyond 30m.
129	214	Rangshken	85m S60°E of VES-209.	N 25°28’37.2” E 91°43’54.1”	Shillong Group(Quarzite/ Phillites)	140	450	9999				20	22				42	
13	21	Rangshken	50m S40°E of	N 25°28’39.8” E	Shillong	450	180	120	350			0.	1.	10			12	

0	5		VES-210.	91°43’47.1”	Group(Quarzite/ Phillites)		0					8	2					
131	216	Rangshken	10m south of the western end of the saw mill and 70 mN75E of the house Sri Nebellin.	N 25°28’47.4” E 91°43’40.5”	Shillong Group(Quarzite/ Phillites)	2500	450	600				2.7	9.3				12	
132	217	Rangshken	S50°E of VES-216.		Shillong Group(Quarzite/ Phillites)	2000	1500	250				1.5	4.5				6	
133	218	Rangshken	100m east of VES-217.	N 25°28’45.8” E 91°43’45.7”	Shillong Group(Quarzite/ Phillites)	2000	1100	130				1	6				7	
134	219	Rangshken	95m SE of VES-217 and 60m S35W of VES-218.	N 25°28’44.1” E 91°43’44.1”	Shillong Group(Quarzite/ Phillites)	3000	2000	500	60			0.8	2.7	18.5			22	
135	220	Rangshken	80m S65°E of VES-219 and 120m N60W of VES-210	N 25°28’43.1” E 91°43’45.7”	Shillong Group(Quarzite/ Phillites)	1800	1400	250	80	400		0.5	3.5	15	17		36	
136	221	Rangshken (Mawjam)	30m due N40°E from NW corner of the Mawjam school.	N 25°28’47.1” E 91°43’58.2”	Shillong Group(Quarzite/ Phillites)	1500	2200	70	3			0.65	2.35	5			8	
137	222	Rangshken (Mawjam)	78m N35°E of VES-221.	N 25°28’48.9” E 91°43’59.3”	Shillong Group(Quarzite/ Phillites)	2500	70	10				1.2	6.8				8	
138	223	Rangshken (Mawjam)	82m S25°E of VES-222.	N 25°28’46.8” E 91°43’01.1”	Shillong Group(Quarzite/ Phillites)	1050	900	120	250			1	2.7	16.3			20	Zones 3m to 20m and fractures between 20m and 70m.

Annexure 7: Dug Well Pump Test Data

Test	Dug Well
Location	Dhankheti
Owner	Govt. of Assam
SWL	2.41 m bmp
Depth	3.60 m bmp
Dia	0.80 m
MP	0.65 m
Motor	
Q =m3/hr	3.2
Duration	12 min
DD	0.78 m
Latitude	25°31'57.9"
Longitude	91°53'34.4"
RL (m)	1515
Date of Test	14.12.2017

	Drawdown data	
Time (min)	DTW (m bmp)	DD (m)
1	2.5	0.09
2	2.59	0.18
3	2.655	0.245
4	2.73	0.32
5	2.79	0.38
6	2.85	0.44
7	2.91	0.5
8	2.97	0.56
9	3.03	0.62
10	3.08	0.67
11	3.14	0.73
12	3.19	0.78

Recovery measurement data

Sl. No.	Time (Min)	DTW (m bmp)	RDD (m)	S1/S2	Time (min)	Recovery %
1	0	3.19	0.78	1.000	0	0.00
2	1	3.17	0.76	1.026	1	2.56
3	2	3.16	0.75	1.040	2	3.85
4	3	3.12	0.71	1.099	3	8.97
5	4	3.1	0.69	1.130	4	11.54
6	5	3.08	0.67	1.164	5	14.10
7	6	3.06	0.65	1.200	6	16.67
8	7	3.04	0.63	1.238	7	19.23
9	8	3.02	0.61	1.279	8	21.79
10	9	3	0.59	1.322	9	24.36
11	10	2.99	0.58	1.345	10	25.64
12	15	2.9	0.49	1.592	15	37.18
13	20	2.84	0.43	1.814	20	44.87
14	25	2.77	0.36	2.167	25	53.85
15	30	2.72	0.31	2.516	30	60.26
16	40	2.68	0.27	2.889	40	65.38
17	50	2.6	0.19	4.105	50	75.64
18	60	2.54	0.13	6.000	60	83.33
19	80	2.47	0.06	13.000	80	92.31
20	100	2.44	0.03	26.000	100	96.15
21	120	2.425	0.015	52.000	120	98.08

Test	Dug Well
Location	Nonymsong
Owner	Private
SWL	3.36m bmp
Depth	4.70 m bmp
Dia	0.75 m
MP	0.70 m
Motor	
Q =m3/hr	3
Duration	20
DD	0.45 m
Latitude	25°34'46.76"
Longitude	91°54'24.71"
RL (m)	
Date of Test	15.02.2018

Drawdown data

Time (min)	DTW (m bmp)	DD (m)
1	3.4	0.04
2	3.43	0.07
3	3.46	0.1
4	3.49	0.13
5	3.51	0.15
6	3.53	0.17
7	3.55	0.19
8	3.57	0.21
9	3.6	0.24
10	3.62	0.26
11	3.64	0.28
12	3.66	0.3
13	3.68	0.32
14	3.69	0.33
15	3.71	0.35
16	3.73	0.37
17	3.75	0.39
18	3.77	0.41
19	3.79	0.43
20	3.81	0.45

Recovery measurement

Sl. No.	Time (Min)	DTW (m bmp)	RDD (m)	S1/S2	Time (min)	Recovery %
1	0	3.81	0.45	1.000	0	0.00
2	1	3.77	0.41	1.098	1	8.89
3	2	3.74	0.38	1.184	2	15.56
4	3	3.72	0.36	1.250	3	20.00
5	4	3.7	0.34	1.324	4	24.44
6	5	3.7	0.34	1.324	5	24.44
7	6	3.69	0.33	1.364	6	26.67
8	7	3.67	0.31	1.452	7	31.11
9	8	3.66	0.3	1.500	8	33.33
10	9	3.65	0.29	1.552	9	35.56
11	10	3.64	0.28	1.607	10	37.78
12	12	3.62	0.26	1.731	12	42.22
13	14	3.61	0.25	1.800	14	44.44
14	16	3.59	0.23	1.957	16	48.89
15	18	3.58	0.22	2.045	18	51.11
16	20	3.57	0.21	2.143	20	53.33
17	25	3.54	0.18	2.500	25	60.00
18	30	3.53	0.17	2.647	30	62.22
19	35	3.51	0.15	3.000	35	66.67
20	40	3.49	0.13	3.462	40	71.11
21	45	3.47	0.11	4.091	45	75.56
22	50	3.46	0.1	4.500	50	77.78
23	60	3.45	0.09	5.000	60	80.00
24	70	3.44	0.08	5.625	70	82.22
25	90	3.41	0.05	9.000	90	88.89
26	110	3.38	0.02	22.500	110	95.56

Annexure 8: Soil Infiltration Test data

1. Location – Nongkohlew

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		23.2		0	0	f0 = 42 from the curve	ft	
1	1		21.1	2.1	2.1	126	84	
2	1		19.7	1.4	3.5	84	42	
3	1		18.5	1.2	4.7	72	30	
4	1		17.5	1	5.7	60	18	
5	1		16.6	0.9	6.6	54	12	
6	1		15.7	0.9	7.5	54	12	
7	1		14.8	0.9	8.4	54	12	
8	1		14	0.8	9.2	48	6	
9	1		13.2	0.8	10	48	6	
10	1		12.6	0.6	10.6	36	-6	
12	2	23.2	21.5	1.7	12.3	51	9	Refilled
14	2	23.2	21.5	1.7	14	51	9	Refilled
16	2	23.2	21.6	1.6	15.6	48	6	Refilled
18	2	23.2	21.7	1.5	17.1	45	3	Refilled
20	2	23.2	21.9	1.3	18.4	39	-3	Refilled
25	5	23.2	19.3	3.9	22.3	46.8	4.8	Refilled
30	5	23.2	19.3	3.9	26.2	46.8	4.8	Refilled
35	5	23.2	19.4	3.8	30	45.6	3.6	Refilled
40	5	23.2	19.5	3.7	33.7	44.4	2.4	Refilled
45	5	23.2	19.5	3.7	37.4	44.4	2.4	Refilled
50	5	23.2	19.6	3.6	41	43.2	1.2	Refilled
55	5	23.2	19.6	3.6	44.6	43.2	1.2	Refilled
60	5	23.2	19.6	3.6	48.2	43.2	1.2	Refilled
70	10	23.2	16	7.2	55.4	43.2	1.2	Refilled
80	10	23.2	16.1	7.1	62.5	42.6	0.6	Refilled
90	10	23.2	16.1	7.1	69.6	42.6	0.6	Refilled
100	10	23.2	16.2	7	76.6	42	0	Refilled
120	20	23.2	9.2	14	90.6	42	0	Refilled
140	20	23.2	9.2	14	104.6	42	0	Refilled
160	20	23.2	9.2	14	118.6	42	0	Refilled
180	20	23.2	9.2	14	132.6	42	0	Refilled

2. Location – Mawsiatkhnam

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		24.5		0	0	f0 = 8.4 from the curve	ft	
1	1		22.9	1.6	1.6	96	87.6	
2	1		22.2	0.7	2.3	42	33.6	
3	1		21.6	0.6	2.9	36	27.6	
4	1		21.2	0.4	3.3	24	15.6	
5	1		20.8	0.4	3.7	24	15.6	
6	1		20.5	0.3	4	18	9.6	
7	1		20.1	0.4	4.4	24	15.6	
8	1		19.9	0.2	4.6	12	3.6	
9	1		19.6	0.3	4.9	18	9.6	
10	1		19.4	0.2	5.1	12	3.6	
10		24.5						Refilled
12	2		24	0.5	5.6	15	6.6	
14	2		23.4	0.6	6.2	18	9.6	
16	2		23	0.4	6.6	12	3.6	
18	2		22.5	0.5	7.1	15	6.6	
20	2		22	0.5	7.6	15	6.6	
20		24.5						Refilled
25	5		23.4	1.1	8.7	13.2	4.8	
30	5		22.5	0.9	9.6	10.8	2.4	
35	5		21.6	0.9	10.5	10.8	2.4	
40	5		20.8	0.8	11.3	9.6	1.2	
45	5		20	0.8	12.1	9.6	1.2	
50	5		19.3	0.7	12.8	8.4	0	
55	5		18.6	0.7	13.5	8.4	0	
60	5		17.9	0.7	14.2	8.4	0	
100		24.5						Refilled
70	10		23.1	1.4	15.6	8.4	0	
80	10		21.7	1.4	17	8.4	0	
90	10		20.3	1.4	18.4	8.4	0	
100	10		18.9	1.4	19.8	8.4	0	
100		24.5						Refilled
120	20		21.7	2.8	22.6	8.4	0	
140	20		18.9	2.8	25.4	8.4	0	

3. Location-Forest Range Office, Cherrapunjee

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		20		0	0	f0 = 32.4 from the curve	ft
1	1	21.7	24	2.3	2.3	138	105.6
2	1	20	21.7	1.7	4	102	69.6
3	1	22.5	24	1.5	5.5	90	57.6
4	1	23.1	24	0.9	6.4	54	21.6
5	1	22.8	24	1.2	7.6	72	39.6
6	1	22.8	24	1.2	8.8	72	39.6
7	1	22.8	24	1.2	10	72	39.6
8	1	23.1	24	0.9	10.9	54	21.6
9	1	23	24	1	11.9	60	27.6
10	1	23.1	24	0.9	12.8	54	21.6
15	5	19.2	24	4.8	17.6	57.6	25.2
20	5	19.5	24	4.5	22.1	54	21.6
25	5	19.8	24	4.2	26.3	50.4	18
30	5	20.3	24	3.7	30	44.4	12
35	5	20.4	24	3.6	33.6	43.2	10.8
40	5	20.4	24	3.6	37.2	43.2	10.8
50	10	17.3	24	6.7	43.9	40.2	7.8
60	10	17.8	24	6.2	50.1	37.2	4.8
70	10	18.1	24	5.9	56	35.4	3
80	10	18.1	24	5.9	61.9	35.4	3
90	10	18.6	24	5.4	67.3	32.4	0
100	10	18.6	24	5.4	72.7	32.4	0
110	10	18.6	24	5.4	78.1	32.4	0
130	20	13.2	24	10.8	88.9	32.4	0
150	20	13.2	24	10.8	99.7	32.4	0
170	20	13.2	24	10.8	110.5	32.4	0

4. Location-Sohra-Pomsohmen

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		24.2		0	0	f0 = 16.2 from the curve	ft
1	1	24.2	23.4	0.8	0.8	48	31.8
2	1	24.2	23.8	0.4	1.2	24	7.8
3	1	24.2	23.9	0.3	1.5	18	1.8
4	1	24.2	24	0.2	1.7	12	-4.2
5	1	24.2	24	0.2	1.9	12	-4.2
6	1	24.2	24	0.2	2.1	12	-4.2
7	1	24.2	24	0.2	2.3	12	-4.2
8	1	24.2	24	0.2	2.5	12	-4.2
9	1	24.2	24	0.2	2.7	12	-4.2
10	1	24.2	24	0.2	2.9	12	-4.2
15	5	24.2	22.3	1.9	4.8	22.8	6.6
20	5	24.2	22.3	1.9	6.7	22.8	6.6
25	5	24.2	22.4	1.8	8.5	21.6	5.4
30	5	24.2	22.5	1.7	10.2	20.4	4.2
35	5	24.2	22.4	1.8	12	21.6	5.4
40	5	24.2	22.5	1.7	13.7	20.4	4.2
50	10	24.2	21.3	2.9	16.6	17.4	1.2
60	10	24.2	21.4	2.8	19.4	16.8	0.6
70	10	24.2	21.5	2.7	22.1	16.2	0
80	10	24.2	21.5	2.7	24.8	16.2	0
100	20	24.2	18.8	5.4	30.2	16.2	0
120	20	24.2	18.8	5.4	35.6	16.2	0
140	20	24.2	18.8	5.4	41	16.2	0

5. Location-Sohra

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		26		0	0	f0 = 3 from the curve	ft
1	1	26	25.8	0.2	0.2	12	9
2	1	25.8	25.7	0.1	0.3	6	3
3	1	25.7	25.5	0.2	0.5	12	9
4	1	25.5	25.4	0.1	0.6	6	3
6	2	25.4	25.3	0.1	0.7	3	0
8	2	26	25.9	0.1	0.8	3	0
10	2	26	25.9	0.1	0.9	3	0
15	5	26	25.9	0.1	1	1.2	-1.8
20	5	25.9	25.6	0.3	1.3	3.6	0.6
25	5	25.6	25.3	0.3	1.6	3.6	0.6
30	5	25.3	25	0.3	1.9	3.6	0.6
40	10	25	24.5	0.5	2.4	3	0
50	10	24.5	24	0.5	2.9	3	0
60	10	24	23.5	0.5	3.4	3	0
70	10	23.5	23	0.5	3.9	3	0
90	20	23	22	1	4.9	3	0
110	20	22	21	1	5.9	3	0
130	20	21	20	1	6.9	3	0

6. Location-Umtyngar

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		26.2		0	0	f0 = 5.7 from the curve	ft
1	1	26.2	25.5	0.7	0.7	42	36.3
2	1	25.5	25	0.5	1.2	30	24.3
3	1	25	24.6	0.4	1.6	24	18.3
4	1	24.6	24.1	0.5	2.1	30	24.3
5	1	24.1	23.7	0.4	2.5	24	18.3
6	1	23.7	23.4	0.3	2.8	18	12.3
7	1	23.4	23	0.4	3.2	24	18.3
8	1	23	22.7	0.3	3.5	18	12.3
9	1	22.7	22.4	0.3	3.8	18	12.3
10	1	22.4	22.1	0.3	4.1	18	12.3
15	5	26.3	24.6	1.7	5.8	20.4	14.7
20	5	24.6	23	1.6	7.4	19.2	13.5
25	5	23	21.4	1.6	9	19.2	13.5
30	5	21.4	19.9	1.5	10.5	18	12.3
35	5	19.9	18.4	1.5	12	18	12.3
40	5	18.4	17	1.4	13.4	16.8	11.1
50	10	26.3	24.1	2.2	15.6	13.2	7.5
60	10	24.1	22	2.1	17.7	12.6	6.9
70	10	22	19.9	2.1	19.8	12.6	6.9
80	20	19.9	17.8	2.1	21.9	6.3	0.6
100	20	26.3	24.3	2	23.9	6	0.3
120	20	26.3	24.4	1.9	25.8	5.7	0
140	20	26.3	24.4	1.9	27.7	5.7	0

7. Location – EAC

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		25.3		0	0	f0 = 27.3 from the curve	ft
1	1	25.3	24.3	1	1	60	32.7
2	1	24.3	23.4	0.9	1.9	54	26.7
3	1	23.4	22.5	0.9	2.8	54	26.7
4	1	22.5	21.7	0.8	3.6	48	20.7
5	1	21.7	21.1	0.6	4.2	36	8.7
6	1	21.1	20.4	0.7	4.9	42	14.7
7	1	26.1	25.4	0.7	5.6	42	14.7
8	1	25.4	24.6	0.8	6.4	48	20.7
9	1	24.6	23.8	0.8	7.2	48	20.7
10	1	23.8	23	0.8	8	48	20.7
15	5	23	20.6	2.4	10.4	28.8	1.5
20	5	26	23.1	2.9	13.3	34.8	7.5
25	5	26	23.3	2.7	16	32.4	5.1
30	5	26	23.7	2.3	18.3	27.6	0.3
35	5	26	23.3	2.7	21	32.4	5.1
40	5	26	23.3	2.7	23.7	32.4	5.1
50	10	26	20.3	5.7	29.4	34.2	6.9
60	10	26	21.8	4.2	33.6	25.2	-2.1
70	10	26	21.3	4.7	38.3	28.2	0.9
80	10	26	21.5	4.5	42.8	27	-0.3
90	10	26	21.3	4.7	47.5	28.2	0.9
100	10	26	21.3	4.7	52.2	28.2	0.9
110	10	26	21.3	4.7	56.9	28.2	0.9
130	20	26	16.9	9.1	66	27.3	0
150	20	26	16.8	9.2	75.2	27.6	0.3
170	20	26	16.9	9.1	84.3	27.3	0
190	20	26	16.9	9.1	93.4	27.3	0

8. Location – Bhanung

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		23.8		0	0	f0 = 31.2 from the curve	ft
1	1	23.8	22.2	1.6	1.6	96	64.8
2	1	22.2	21.4	0.8	2.4	48	16.8
3	1	21.4	20.6	0.8	3.2	48	16.8
4	1	20.6	19.8	0.8	4	48	16.8
5	1	19.8	19.2	0.6	4.6	36	4.8
6	1	23.8	23.2	0.6	5.2	36	4.8
7	1	23.2	22.5	0.7	5.9	42	10.8
8	1	22.5	21.7	0.8	6.7	48	16.8
9	1	21.7	20.9	0.8	7.5	48	16.8
10	1	20.9	20.3	0.6	8.1	36	4.8
15	5	23.8	20.4	3.4	11.5	40.8	9.6
20	5	23.8	20.6	3.2	14.7	38.4	7.2
25	5	23.8	20.6	3.2	17.9	38.4	7.2
30	5	23.8	20.6	3.2	21.1	38.4	7.2
35	5	23.8	20.6	3.2	24.3	38.4	7.2
40	5	23.8	20.6	3.2	27.5	38.4	7.2
50	10	23.8	17.5	6.3	33.8	37.8	6.6
60	10	23.8	17.6	6.2	40	37.2	6
70	10	23.8	17.7	6.1	46.1	36.6	5.4
80	10	23.8	17.9	5.9	52	35.4	4.2
90	10	23.8	17.8	6	58	36	4.8
100	10	23.8	17.9	5.9	63.9	35.4	4.2
120	20	23.8	12.8	11	74.9	33	1.8
140	20	23.8	13.3	10.5	85.4	31.5	0.3
160	20	23.8	13.4	10.4	95.8	31.2	0
180	20	23.8	13.4	10.4	106.2	31.2	0

9. .Location – Dympep, Sohra

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		23.1		0	0	f0 = 11.7	ft
1	1	23.1	22.5	0.6	0.6	36	24.3
2	1	22.5	22	0.5	1.1	30	18.3
3	1	22	21.6	0.4	1.5	24	12.3
4	1	21.6	21.2	0.4	1.9	24	12.3
5	1	21.2	20.8	0.4	2.3	24	12.3
6	1	20.8	20.5	0.3	2.6	18	6.3
7	1	20.5	20.1	0.4	3	24	12.3
8	1	20.1	19.7	0.4	3.4	24	12.3
9	1	19.7	19.4	0.3	3.7	18	6.3
10	1	19.4	19.1	0.3	4	18	6.3
15	5	23.3	21.9	1.4	5.4	16.8	5.1
20	5	23.3	22	1.3	6.7	15.6	3.9
25	5	23.3	22	1.3	8	15.6	3.9
30	5	23.3	22	1.3	9.3	15.6	3.9
40	10	23.3	20.8	2.5	11.8	15	3.3
50	10	23.3	21	2.3	14.1	13.8	2.1
60	10	23.3	21.2	2.1	16.2	12.6	0.9
70	10	23.3	21.2	2.1	18.3	12.6	0.9
80	10	23.3	21.2	2.1	20.4	12.6	0.9
100	20	23.3	19.3	4	24.4	12	0.3
120	20	23.3	19.4	3.9	28.3	11.7	0
140	20	23.3	19.4	3.9	32.2	11.7	0
160	20	23.3	19.4	3.9	36.1	11.7	0

10.Location – Mylliem-12 kharkemeh

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		23.5		0	0	f0 = 7.2 from the curve	ft
1	1	23.5	23	0.5	0.5	30	22.8
2	1	23	22.8	0.2	0.7	12	4.8
3	1	22.8	22.7	0.1	0.8	6	-1.2
4	1	22.7	22.5	0.2	1	12	4.8
5	1	22.5	22.3	0.2	1.2	12	4.8
6	1	22.3	22.1	0.2	1.4	12	4.8
7	1	22.1	21.9	0.2	1.6	12	4.8
8	1	21.9	21.7	0.2	1.8	12	4.8
9	1	21.7	21.5	0.2	2	12	4.8
10	1	21.5	21.4	0.1	2.1	6	-1.2
15	5	23.5	22.8	0.7	2.8	8.4	1.2
20	5	23.5	22.9	0.6	3.4	7.2	0
25	5	23.5	22.9	0.6	4	7.2	0
30	5	23.5	22.9	0.6	4.6	7.2	0
40	10	23.5	22.3	1.2	5.8	7.2	0
50	10	23.5	22.3	1.2	7	7.2	0
60	10	23.5	22.3	1.2	8.2	7.2	0
80	20	23.5	21.1	2.4	10.6	7.2	0
100	20	23.5	21.1	2.4	13	7.2	0
120	20	23.5	21.1	2.4	15.4	7.2	0

10. Location - Pomkaniew

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		26.1		0	0	f0 = 2.4 from the curve	ft
1	1	26.1	25.8	0.3	0.3	18	15.6
2	1	25.8	25.6	0.2	0.5	12	9.6
3	1	25.6	25.5	0.1	0.6	6	3.6
4	1	25.5	25.3	0.2	0.8	12	9.6
5	1	25.3	25.1	0.2	1	12	9.6
6	1	25.1	25	0.1	1.1	6	3.6
7	1	25	24.9	0.1	1.2	6	3.6
8	1	24.9	24.8	0.1	1.3	6	3.6
9	1	24.8	24.7	0.1	1.4	6	3.6
10	1	24.7	24.6	0.1	1.5	6	3.6
15	5	26.1	25.8	0.3	1.8	3.6	1.2
20	5	25.8	25.4	0.4	2.2	4.8	2.4
25	5	25.4	25	0.4	2.6	4.8	2.4
30	5	25	24.8	0.2	2.8	2.4	0
35	5	24.8	24.5	0.3	3.1	3.6	1.2
40	5	24.5	24.2	0.3	3.4	3.6	1.2
50	10	26.1	25.7	0.4	3.8	2.4	0
60	10	25.7	25.3	0.4	4.2	2.4	0
70	10	25.3	24.9	0.4	4.6	2.4	0
90	20	24.9	24.1	0.8	5.4	2.4	0
110	20	24.1	23.3	0.8	6.2	2.4	0
130	20	23.3	22.5	0.8	7	2.4	0

11. Location –Laitlynkgot, Pynursla

Time t	Time diff	Before filling	Aftr filling	Depth of Infiltration	Cummulative Infiltration	Infilt rate	f-fc
min	min	cm	cm	cm	cm	cm/hr	f0
0		24.6		0	0	f0 = 3.6 from the curve	ft
1	1	24.6	24.5	0.1	0.1	6	2.4
2	1	24.5	24.4	0.1	0.2	6	2.4
3	1	24.4	24.3	0.1	0.3	6	2.4
4	1	24.3	24.2	0.1	0.4	6	2.4
5	1	24.2	24	0.2	0.6	12	8.4
6	1	24	23.9	0.1	0.7	6	2.4
7	1	23.9	23.8	0.1	0.8	6	2.4
8	1	23.8	23.7	0.1	0.9	6	2.4
9	1	23.7	23.6	0.1	1	6	2.4
10	1	23.6	23.5	0.1	1.1	6	2.4
15	5	23.5	23	0.5	1.6	6	2.4
20	5	23	22.6	0.4	2	4.8	1.2
25	5	22.6	22.2	0.4	2.4	4.8	1.2
30	5	22.2	21.8	0.4	2.8	4.8	1.2
40	10	21.8	21.2	0.6	3.4	3.6	0
50	10	21.2	20.6	0.6	4	3.6	0
60	10	20.6	20	0.6	4.6	3.6	0
80	20	24.6	23.4	1.2	5.8	3.6	0
100	20	24.6	23.4	1.2	7	3.6	0
120	20	24.6	23.4	1.2	8.2	3.6	0

13. Location - Tyrsad

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 = 0.15	ft	
1	1		23.6	0.2	0.2	12	11.85	
2	1		23.5	0.1	0.3	6	5.85	
3	1		23.5	0	0.3	0	-0.15	
4	1		23.5	0	0.3	0	-0.15	
5	1		23.5	0	0.3	0	-0.15	
6	1		23.4	0.1	0.4	6	5.85	
7	1		23.4	0	0.4	0	-0.15	
8	1		23.4	0	0.4	0	-0.15	
9	1		23.4	0	0.4	0	-0.15	
10	1		23.3	0.1	0.5	6	5.85	
15	5		23.2	0.1	0.6	1.2	1.05	
20	5		23.1	0.1	0.7	1.2	1.05	
25	5		23	0.1	0.8	1.2	1.05	
30	5		22.9	0.1	0.9	1.2	1.05	
40	10		22.9	0	0.9	0	-0.15	
50	10		22.7	0.2	1.1	1.2	1.05	
70	20		22.5	0.2	1.3	0.6	0.45	
90	20		22.4	0.1	1.4	0.3	0.15	
110	20		22.3	0.1	1.5	0.3	0.15	
130	20		22.1	0.2	1.7	0.6	0.45	
170	40		22	0.1	1.8	0.15	0	
210	40		21.9	0.1	1.9	0.15	0	
250	40		21.8	0.1	2	0.15	0	

14. Location - Laitdiengsai

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		20.5		0	0	f0= 0.6 from the curve	ft	
1	1		20.5	0	0	0	-0.6	
2	1		20.4	0.1	0.1	6	5.4	
3	1		20.4	0	0.1	0	-0.6	
4	1		20.4	0	0.1	0	-0.6	
5	1		20.3	0.1	0.2	6	5.4	
6	1		20.3	0	0.2	0	-0.6	
7	1		20.3	0	0.2	0	-0.6	
8	1		20.3	0	0.2	0	-0.6	
9	1		20.3	0	0.2	0	-0.6	
10	1		20.2	0.1	0.3	6	5.4	
15	5		20.1	0.1	0.4	1.2	0.6	
20	5		20	0.1	0.5	1.2	0.6	
30	10		19.8	0.2	0.7	1.2	0.6	
40	10		19.7	0.1	0.8	0.6	0	
50	10		19.5	0.2	1	1.2	0.6	
60	10		19.4	0.1	1.1	0.6	0	
80	20		19.1	0.3	1.4	0.9	0.3	
100	20		18.9	0.2	1.6	0.6	0	
120	20		18.7	0.2	1.8	0.6	0	
140	20		18.5	0.2	2	0.6	0	

15. Location – Golf links

	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		25.5		0	0	f0 =5.4 from the curve	ft	
1	1		25	0.5	0.5	30	24.6	
2	1		24.6	0.4	0.9	24	18.6	
3	1		24.3	0.3	1.2	18	12.6	
4	1		24	0.3	1.5	18	12.6	
5	1		23.8	0.2	1.7	12	6.6	
6	1		23.5	0.3	2	18	12.6	
7	1	25	23.2	0.3	2.3	18	12.6	Refilled
8	1		24.7	0.3	2.6	18	12.6	
9	1		24.4	0.3	2.9	18	12.6	
10	1	24.3	24.1	0.3	3.2	18	12.6	Refilled
12	2		23.9	0.4	3.6	12	6.6	
14	2	26	23.5	0.4	4	12	6.6	Refilled
16	2		25.5	0.5	4.5	15	9.6	
18	2		25	0.5	5	15	9.6	
20	2		24.5	0.5	5.5	15	9.6	
25	5		24	0.5	6	6	0.6	
30	5	25	23.5	0.5	6.5	6	0.6	Refilled
35	5		24.5	0.5	7	6	0.6	
40	5	25	24	0.5	7.5	6	0.6	
50	10		24	1	8.5	6	0.6	Refilled
60	10	25	24	1	9.5	6	0.6	Refilled
70	10		23	1	10.5	6	0.6	
80	10	25	22.1	0.9	11.4	5.4	0	Refilled
100	20		23.1	1.9	13.3	5.7	0.3	
120	20	25	21.3	1.8	15.1	5.4	0	Refilled
140	20		23.2	1.8	16.9	5.4	0	
160	20	25	21.4	1.8	18.7	5.4	0	Refilled
180	20		23.2	1.8	20.5	5.4	0	
200	20		21.4	1.8	22.3	5.4	0	

16. Location - Lapalang

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 = 2.4from the curve	ft	
1	1		21.5	0.5	0.5	30	-12	
2	1		21.1	0.4	0.9	24	-18	
3	1		20.8	0.3	1.2	18	-24	
4	1		20.5	0.3	1.5	18	-24	
5	1		20.2	0.3	1.8	18	-24	
6	1		19.8	0.4	2.2	24	-18	
7	1	20.2	19.5	0.3	2.5	18	-24	Refilled
8	1		20	0.2	2.7	12	-30	
9	1		20	0	2.7	0	-42	
10	1		19.8	0.2	2.9	12	-30	
12	2		19.4	0.4	3.3	12	-30	
14	2		19.2	0.2	3.5	6	-36	
16	2		19.1	0.1	3.6	3	-39	
18	2		19	0.1	3.7	3	-39	
19	1		18.9	0.1	3.8	3	-39	
20	1		18.8	0.1	3.9	1.2	-40.8	
25	2	20	18.3	0.5	4.4	6	-36	Refilled
30	5		19.5	0.5	4.9	3	-39	
35	5		19.1	0.4	5.3	2.4	-39.6	
40	10		18.7	0.4	5.7	2.4	-39.6	
50	10		18.2	0.6	6.3	3.6	-38.4	
60	10		17.5	0.6	6.9	3.6	-38.4	
70	20		16.9	0.6	7.5	3.6	-38.4	
80	10	22	16.3	0.6	8.1	1.8	-40.2	Refilled
100	20		21.1	0.9	9	5.4	-36.6	
120	20	22	20.2	0.9	9.9	2.7	-39.3	Refilled
140	20	22	21.1	0.9	10.8	2.7	-39.3	Refilled
180	40		20.4	1.6	12.4	4.8	-37.2	
220	40	22	18.8	1.6	14	2.4	-39.6	Refilled
260	40		20.4	1.6	15.6	2.4		

17. Location – Madan Sangmein

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		26		0	0	f0 = 42 from the curve	ft	
1	1		25.2	0.8	0.8	48	43.5	
2	1		25	0.2	1	12	7.5	
3	1		24	1	2	60	55.5	
4	1		23.5	0.5	2.5	30	25.5	
5	1		23.3	0.2	2.7	12	7.5	
6	1		23	0.3	3	18	13.5	
7	1	26	22.6	0.4	3.4	24	19.5	Refilled
8	1		25.5	0.5	3.9	30	25.5	
9	1		25.2	0.3	4.2	18	13.5	
10	1		25	0.2	4.4	12	7.5	
11	1		24.8	0.2	4.6	12	7.5	
12	1		24.6	0.2	4.8	12	7.5	
13	1		24.4	0.2	5	12	7.5	
14	1		24.2	0.2	5.2	12	7.5	
15	1		24	0.2	5.4	12	7.5	
20	1	26	23.4	0.6	6	36	31.5	Refilled
25	5		23.4	0.6	6.6	7.2	2.7	
30	5		22.7	0.7	7.3	8.4	3.9	
35	5		22.1	0.6	7.9	7.2	2.7	
40	5		21.5	0.6	8.5	7.2	2.7	
50	10	22	20.5	1	9.5	6	1.5	Refilled
60	10		21	1	10.5	6	1.5	
70	10		20.2	0.8	11.3	4.8	0.3	
80	10	23	19.4	0.8	12.1	4.8	0.3	Refilled
90	10		22.2	0.8	12.9	4.8	0.3	
100	10		21.4	0.8	13.7	4.8	0.3	
110	10		20.6	0.8	14.5	4.8	0.3	
130	20	26	19.1	1.5	16	4.5	0	Refilled
150	20		23.5	1.5	17.5	4.5	0	
170	20	26	21	1.5	19	4.5	0	Refilled
190	20		23.5	1.5	20.5	4.5	0	
210	20		21	1.5	22	4.5	0	

18. Location -Pynursla

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		0	0	f0 = 8.1from the curve	ft	
1	1		22.5	0.5	0.5	30	21.9	
2	1		22.3	0.2	0.7	12	3.9	
3	1		22	0.3	1	18	9.9	
4	1		21.8	0.2	1.2	12	3.9	
5	1		21.6	0.2	1.4	12	3.9	
6	1		21.4	0.2	1.6	12	3.9	
7	1		21.2	0.2	1.8	12	3.9	
8	1	23	21	0.2	2	12	3.9	Refilled
9	1		22.8	0.2	2.2	12	3.9	
10	1		22.6	0.2	2.4	12	3.9	
12	2	23	22.2	0.4	2.8	12	3.9	Refilled
14	2		22.5	0.5	3.3	15	6.9	
16	2		22.1	0.4	3.7	12	3.9	
18	2		21.7	0.4	4.1	12	3.9	
20	2		21.3	0.4	4.5	12	3.9	
25	5	23	20.4	0.9	5.4	10.8	2.7	Refilled
30	5		22.1	0.9	6.3	10.8	2.7	
35	5	23	21	1.1	7.4	13.2	5.1	Refilled
40	5		22	1	8.4	12	3.9	
45	5		21.2	0.8	9.2	9.6	1.5	
50	5	23	20.3	0.9	10.1	10.8	2.7	Refilled
55	5		22	1	11.1	12	3.9	
60	5	23	21	1	12.1	12	3.9	
70	10		21.4	1.6	13.7	9.6	1.5	
80	10	23	20	1.4	15.1	8.4	0.3	Refilled
90	10		21.6	1.4	16.5	8.4	0.3	
100	10	23	20.2	1.4	17.9	8.4	0.3	Refilled
120	20		20.4	2.6	20.5	7.8	-0.3	
140	20	23	17.7	2.7	23.2	8.1	0	Refilled
160	20		20.3	2.7	25.9	8.1	0	
180	20		17.6	2.7	28.6	8.1	0	

19. Location : Lawsohtun

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 = 10.5 from the curve	ft	
1	1		21.4	0.6	0.6	36	25.5	
2	1		20.7	0.7	1.3	42	31.5	
3	1		20.2	0.5	1.8	30	19.5	
4	1		19.8	0.4	2.2	24	13.5	
5	1		19.4	0.4	2.6	24	13.5	
6	1		18.9	0.5	3.1	30	19.5	
7	1		18.4	0.5	3.6	30	19.5	
8	1		17.9	0.5	4.1	30	19.5	
9	1		17.4	0.5	4.6	30	19.5	
10	1		16.9	0.5	5.1	30	19.5	
12	2		19.2	0.8	5.9	24	13.5	
14	2		18.4	0.8	6.7	24	13.5	
16	2		17.6	0.8	7.5	24	13.5	
18	2		16.8	0.8	8.3	24	13.5	
20	2	22	15.4	0.8	9.1	24	13.5	Refilled
25	5		20.5	1.5	10.6	18	7.5	
30	5	22	19.1	1.4	12	16.8	6.3	Refilled
35	5		20.5	1.5	13.5	18	7.5	
40	5	22	19	1.5	15	18	7.5	Refilled
50	5		19.5	2.5	17.5	30	19.5	
60	5	22	17.2	2.3	19.8	27.6	17.1	Refilled
70	5		19.7	2.3	22.1	27.6	17.1	Refilled
80	5	22	19.6	2.3	24.4	27.6	17.1	Refilled
100	20		18.5	3.5	27.9	10.5	0	
120	20		15.1	3.4	31.3	10.2	-0.3	
140	20	22	16.1	3.5	34.8	10.5	0	Refilled
160	20		18.5	3.5	38.3	10.5	0	
180	20		15	3.5	41.8	10.5	0	

20. Location: Laban

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		0	0	f0 = 16.8 from the curve	ft	
1	1		24.5	0.5	0.5	30	13.2	
2	1		24	0.5	1	30	13.2	
3	1		23.5	0.5	1.5	30	13.2	
4	1		23	0.5	2	30	13.2	
5	1		22.6	0.4	2.4	24	7.2	
6	1		22.1	0.5	2.9	30	13.2	
7	1		21.6	0.5	3.4	30	13.2	
8	1	25	21.2	0.4	3.8	24	7.2	Refilled
9	1		24.5	0.5	4.3	30	13.2	
10	1		24	0.5	4.8	30	13.2	
12	2		23.1	0.9	5.7	27	10.2	
14	2	25	22.2	0.9	6.6	27	10.2	Refilled
16	2		24	1	7.6	30	13.2	
18	2		23	1	8.6	30	13.2	
20	2	25	22.1	0.9	9.5	27	10.2	Refilled
25	5		23.3	1.7	11.2	20.4	3.6	
30	5	25	21.8	1.5	12.7	18	1.2	Refilled
35	5		23.4	1.6	14.3	19.2	2.4	
40	5	25	21.8	1.6	15.9	19.2	2.4	Refilled
50	5		21.9	3.1	19	37.2	20.4	
60	5	25	18.9	3	22	36	19.2	Refilled
70	5		21.9	3.1	25.1	37.2	20.4	
80	5	25	18.9	3	28.1	36	19.2	Refilled
90	10		21.9	3.1	31.2	18.6	1.8	
100	10		18.9	3	34.2	18	1.2	
120	20	25	13.1	5.8	40	17.4	0.6	Refilled
140	20	25	19.4	5.6	45.6	16.8	0	Refilled
160	20		19.4	5.6	51.2	16.8	0	
180	20		13.8	5.6	56.8	16.8	0	

21 . Location: Mawryngkneng

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		27		0	0	f0 = 17.1 from the curve	ft	
1	1		26	1	1	60	42.9	
2	1		25.2	0.8	1.8	48	30.9	
3	1	27	24.6	0.6	2.4	36	18.9	
4	1		26.5	0.5	2.9	30	12.9	
5	1		26	0.5	3.4	30	12.9	
6	1		23.4	0.6	4	36	18.9	
7	1		22.9	0.5	4.5	30	12.9	
8	1	27	22.3	0.6	5.1	36	18.9	
9	1		26.5	0.5	5.6	30	12.9	
10	1		26	0.5	6.1	30	12.9	
12	2		25	1	7.1	30	12.9	
14	2		24	1	8.1	30	12.9	
16	2	27	23.2	0.8	8.9	24	6.9	Refilled
18	2		26.2	0.8	9.7	24	6.9	
20	2		25.6	0.8	10.5	24	6.9	
22	2		25.1	0.5	11	15	-2.1	
24	2		24.5	0.6	11.6	18	0.9	
26	2		23.7	0.8	12.4	24	6.9	
28	2	27	22.9	0.8	13.2	24	6.9	Refilled
30	2		26.2	0.8	14	24	6.9	
35	5		24.2	2	16	24	6.9	
40	5		22.4	1.8	17.8	21.6	4.5	
45	5	27	21	1.4	19.2	16.8	-0.3	Refilled
50	5	27	25.6	1.4	20.6	16.8	-0.3	Refilled
55	5		25.6	1.4	22	16.8	-0.3	
60	5	27	24.2	1.4	23.4	16.8	-0.3	Refilled
70	10	27	24.1	2.9	26.3	17.4	0.3	Refilled
80	10		24.2	2.8	29.1	16.8	-0.3	
90	10	27	21.4	2.8	31.9	16.8	-0.3	Refilled
100	10	27	24.2	2.8	34.7	16.8	-0.3	Refilled
120	20	27	21.5	5.5	40.2	16.5	-0.6	Refilled
140	20	27	21.3	5.7	45.9	17.1	0	Refilled
160	20	27	21.3	5.7	51.6	17.1	0	Refilled
180	20		21.3	5.7	57.3	17.1	0	

22 . Location : Umphyrnai

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		0	0	f0 = 37.5 from the curve	ft	
1	1		24	1	1	60	22.5	
2	1		24.1	0.9	1.9	54	16.5	
3	1		23.1	1	2.9	60	22.5	
4	1		22.1	1	3.9	60	22.5	
5	1	25	21.2	0.9	4.8	54	16.5	Refilled
6	1		24	1	5.8	60	22.5	
7	1		23	1	6.8	60	22.5	
8	1		22.1	0.9	7.7	54	16.5	
9	1	25	21.2	0.9	8.6	54	16.5	Refilled
10	1		24.1	0.9	9.5	54	16.5	
12	2		22.3	1.8	11.3	54	16.5	Refilled
14	2	25	20.6	1.7	13	51	13.5	Refilled
16	2		23.4	1.6	14.6	48	10.5	
18	2	25	21.8	1.6	16.2	48	10.5	Refilled
20	2		23.4	1.6	17.8	48	10.5	
25	5	25	19.5	3.9	21.7	46.8	9.3	Refilled
30	5		21.3	3.7	25.4	44.4	6.9	
35	5	25	19.4	3.7	29.1	44.4	6.9	Refilled
40	5		21.4	3.6	32.7	43.2	5.7	
45	5	25	19.5	3.6	36.3	43.2	5.7	Refilled
50	5		21.4	3.6	39.9	43.2	5.7	
55	5	25	17.8	3.6	43.5	43.2	5.7	Refilled
60	5	25	21.4	3.6	47.1	43.2	5.7	Refilled
70	10	25	17.8	7.2	54.3	43.2	5.7	Refilled
80	10	25	18	7	61.3	42	4.5	Refilled
90	10	25	18	7	68.3	42	4.5	Refilled
100	10	25	18	7	75.3	42	4.5	Refilled
120	20	25	12.2	12.8	88.1	38.4	0.9	Refilled
140	20	25	12.4	12.6	100.7	37.8	0.3	Refilled
160	20	25	12.5	12.5	113.2	37.5	0	Refilled
180	20		12.5	12.5	125.7	37.5	0	

Annexure 9(A): Location of Borewells Drilled by PHE, Shillong in Urban Shillong Area

S.No.	Location	Latitude	Longitude	Total Depth drilled	Static water level	Yield (lit/hr)
1	Mawdatbaki DTW	25.601	91.891	112	24	7000
2	Mawlai Umsohlang	25.607	91.893	110	24	7000
3	Umsohlang Treatment plant	25.608	91.893			
4	Mawlai Umsaw	25.637	91.917	110	15	7500
5	Mawpat Wahheh	25.595	91.921	140	36	2279
6	Shaw Shaw	25.595	91.923	120	13	8040
7	Wahheh(V)	25.596	91.926	125	12	16320
8	Wahheh(VI)	25.593	91.920	120	10	20700
9	Wahheh(VII)	25.593	91.920	120	8	23100
10	Wahheh(VIII)	25.984	92.546	150	30	17400
11	Ladshyiap	25.597	91.911	125	19	8500
12	Chanmari#I	25.589	91.900	80	25	5460
13	Chanmari#II	25.584	91.902	80	20	5400
14	St.Nanak	25.585	91.904	120	15	8500
15	Shiv Mandir	25.595	91.904	120	18	4000
16	Shiv Mandir	25.597	91.911	120	17	4000
17	Lankyrding	25.984	92.505	150	16	8500
18	Dog Squad	25.979	92.509	110	19	7700
19	Lad Chanmari	25.978	92.510	110	23	6900
20	Near Pynthorbah Market	25.984	92.510	126	26	8500
21	Near Shiv Mandir	25.998	92.509	105	28	5500
22	6th Furlong	25.583	91.892	70	12	4200
23	Mawpun	25.587	91.894	100	18	6900
24	Teapot	25.589	91.896	110	20	5500
25	Dog Squad	25.585	91.895	110	15.5	6000
26	Polo opp.CRP camp	25.583	91.889	110	12	5500
27	Meter Factory	25.590	91.889	80	14	6000
28	Jingthangbriew	25.587	91.881	80	14	8500
29	Radha Krishna	25.961	92.535	110	16	6500
30	R & R colony	25.953	92.527	100	15	4500
31	R & R Colony(near Bangalis Primary School	25.954	92.547	130	18	5500
32	Nongmynsong, Umkdait#IV	25.586	91.911	110	7	20400
33	Umkadait#V	25.991	92.539	120	12	16377
34	Dongkamon#VI	25.970	92.544	110	28	20400
35	Lankyrding#VII	25.585	91.907	126	24	20400
36	Lankyrding#VIII	25.585	91.906	115	12	10436
37	Dongkadiang#IX	25.968	92.516	115.5	12	20400
38	Dongkamon#X	25.968	92.510	104	10	20400
39	Umkadait#XI	25.990	92.527	126	15	20400
40	Umkadait#XII	25.992	92.509	176	24	20400
41	Near Presbyterian Church Langkyrding	25.588	91.906	100	15	6600
42	Lumnawrie	25.570	91.896	80	15	8500
43	Mawpun	25.570	91.850	71	18	3000
44	Nonglum	25.570	91.848	120	20	3000
45	Mawria	25.571	91.854	200	30	1884

46	Dongshaneng #I	25.979	92.547	154	25	9198
47	Dongshaneng #III	25.973	92.534	134	28	8047
48	Dongsurok #IV	25.862	92.540	143	14	8047
49	Dongumbah #V	25.951	92.541	82.5	24	25692
50	Dongsharum # VIII	25.965	92.523	115.5	28	28491
51	Lumdiengmet # IX	25.973	92.536	115.5	20	37598
52	Lumdiengmet # X	25.973	92.523	126.5	22	28419
53	Lumdiengmet # XI	25.969	92.519	121	28	23130
54	Mawkynrew communuty Hall	26.035	92.524	120	15	20700
55	Um jarain	26.017	92.524	120	15	23100
56	Nonghseh Rim wss	25.544	91.858	124	30	8046

Annexure 9(B): Details of Private Bore wells Drilled in Urban Shillong Area

S.No.	Location	Latitude	Longitude	Total Dept Drilled	Yield(in litres/hr)
1	5th Mile Upper Shillong	25.521	91.843	100	5652
2	Umlyngka Nonglum	25.567	91.847	120	5652
3	Umlyngka Lumpongdeng	25.571	91.845	110	6788
4	Lummawbah	25.573	91.853	120	6788
5	Lummawbah	25.574	91.863	120	5652
6	Lummawbah	25.572	91.863	125	5652
7	Lummawbah	25.572	91.860	120	4638
8	Lummawbah	25.572	91.857	120	5652
9	Nongkseh-3	25.574	91.859	120	5652
10	Nongkseh-3	25.574	91.855	130	5652
11	Nongkseh Madan	25.575	91.8568	135	5652
12	Nongkseh Madan	25.576	91.8591	120	5652
13	Nongkseh Madan	25.575	91.8587	120	6788
14	Nongkseh Madan	25.577	91.8588	125	6788
15	Nongkseh Madan	25.577	91.859	125	5652
16	Nongkseh Madan	25.577	91.8583	120	5652
17	Nongkseh Madan	25.577	91.8599	120	6788
18	Nongkseh Madan	25.577	91.8597	120	6788
19	Nongkseh Madan	25.577	91.8598	125	5652
20	Nongkseh Madan	25.576	91.8595	125	6788
21	Umlyngka Nonglum	25.568	91.8579	120	6788
22	Umpling Dongsurok	25.574	91.9179	100	5652
23	R & R colony Rynjah	25.571	91.9136	100	3741
24	R & R colony Rynjah	25.571	91.9136	100	4638
25	R & R colony Rynjah	25.574	91.9155	85	4638
26	R & R colony Plot No. 151 Rynjah	25.572	91.9165	150	4638
27	R & R colony Rynjah	25.571	91.9139	150	3741
28	Circle Mawpat	25.600	91.9264	120	3741
29	Mawmuroh Mawpat	25.595	91.9219	120	4638
30	Mawmuroh Mawpat	25.594	91.9218	120	4638
31	Circle 1 Mawpat	25.597	91.9209	130	3741
32	Mawmuroh Mawpat	25.594	91.9223	125	4638
33	Circle 1 Mawpat	25.598	91.9228	120	3741
34	Shaw shaw Circle2 mawpat	25.595	91.9235	120	4638
35	Circle 1 Mawpat	25.597	91.9213	125	3741

36	Shaw Shaw Mawpat	25.595	91.9237	120	4638
37	Circle 2 Mawpat	25.600	91.9242	100	4638
38	Lankyrding Nongmynsong	25.585	91.9058	100	4638
39	Umkdait Nongmynsong	25.590	91.9150	110	5652
40	Umkdait Nongmynsong	25.587	91.9144	110	5652
41	Dongkamon Nongmynsong	25.583	91.9086	100	5652
42	Dongkamon Nongmynsong	25.582	91.9068	120	4638
43	Khliehshong Pynthorumkhrah	25.583	91.8959	140	3741
44	Pdengshnong Pynthorumkhrah	25.583	91.8957	150	4638
45	Khliehshong Pynthorumkhrah	25.600	91.8955	160	4638
46	Khliehshong Pynthorumkhrah	25.583	91.8159	120	5652
47	Khliehshong Pynthorumkhrah	25.583	91.8158	120	5652
48	Khliehshong Pynthorumkhrah	25.583	91.8968	140	5652
49	Khliehshong Pynthorumkhrah	25.583	91.8965	150	5652
50	Khliehshong Pynthorumkhrah	25.584	91.8962	145	4638
51	Pdengshnong Pynthorumkhrah	25.584	91.8948	100	4638
52	Mawlai Umsaw Mawtawar	25.634	91.9227	100	3741
53	Mawlai Umshing Mawkynroh Bl.I	25.615	91.9117	90	4638
54	Mawlai Umshing Mawkynroh Bl.I	25.615	91.912	95	3741
55	Mawlai Umshing Mawkynroh Bl.I	25.614	91.9112	91	4638
56	Mawlai Umshing Mawkynroh Bl.I	25.613	91.9107	100	4638
57	Mawlai Umshing Mawkynroh Bl.III	25.610	91.9074	91	3741
58	Mawlai Umshing Mawkynroh Bl.III	25.613	91.9061	122	4638
59	Mawlai Umshing Mawkynroh Bl.III	25.609	91.9077	90	3741
60	Mawlai Umshing Mawkynroh Bl.III	25.609	91.9057	91	3741
61	Mawlai Umshing Mawkynroh Bl.III	25.608	91.9059	105	4638
62	Mawlai Umshing Mawkynroh Bl.III	25.609	91.906	85	3741
63	Mawlai Umshing Mawkynroh Bl.III	25.609	91.9059	85	3741
64	Mawlai Umshing Mawkynroh Bl.III	25.609	91.9055	90	3741
65	Mawlai Umshing Mawkynroh Bl.III	25.609	91.909	85	5652
66	Mawlai Umshing Mawkynroh Bl.III	25.609	91.9064	90	5652
67	Mawlai Umshing Mawkynroh Bl.III	25.608	91.9066	110	3741
68	Mawlai Umshing Mawkynroh Bl.III	25.611	91.9035	90	3741

(Source: PHE, Shillong)

Annexure 10: Ground water Resources data of East Khasi Hills

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

Name of Ground Water Assessment Unit	East Khasi Hills
Type of Ground Water Assessment Unit	District
Type of rock formation	Granitic-Gneissic complex, Quartzites, Intrusives, Valleyfills and Limestone
Total area of Groundwater Assessment Unit	256764.80
Hilly area	167314.70
Command area	0
Non-command area	105261
Poor ground water quality area	0
Area considered for groundwater recharge	105261

b) Ground Water Resource Potential in East Khasi Hills district during 2017-18 (in ham)

Assessment Unit / District	East Khasi Hills
Command/ Non-Command/ Total	Total
Recharge from rainfall during monsoon season	7128.22
Recharge from other sources during monsoon season	0
Recharge from rainfall during non-monsoon season	3297.08
Recharge from other sources during non- monsoon season	206.92
Total Ground Water Recharge	10632.22
Natural discharge during non-monsoon season	1063.22
Net Annual Ground Water Availability	9569.00

c) Balance Ground Water Resources Available and Stage of Groundwater Development in the Study Area

Resource Estimation Parameters	2017-18
Net GW availability	9569.00
GW draft for irrigation	0
Gross GW extraction	234.61
Annual Allocation of ground water for domestic & industrial water supply upto 2025	469.22
Balance GW for future irrigation development	9099.78
Stage of GW Extraction	2.45%

d) Categorization for Ground Water Development of East Khasi Hills district during 2017-18

Assessment Unit/ District	East Khasi Hills
Stage Of Ground Water Development (%)	2.45%
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 11: Ground water Resources data of Urban Shillong

a) General Description of Ground Water Assessment in Greater Shillong for 2017-18 (area in ha)

Name of Ground Water Assessment Unit	Urban Shilong
Type of Ground Water Assessment Unit	City
Type of rock formation	Granitic-Gneissic complex, Quartzites, Intrusives, Valley fills
Total area of Groundwater Assessment Unit	18035.20
Hilly area	2224.30
Command area	0
Non-command area	15810.90
Poor ground water quality area	0
Area considered for groundwater recharge	15810.90

b) Balance Ground Water Resources Available (Ham) and Stage of Groundwater Development in the Study Area

Resource Estimation Parameters	2017-18
Rainfall recharge during monsoon	760.90
Rainfall recharge during non-monsoon	354.96
Recharge from other sources	0.00
Annual GW recharge	1115.86
Natural Discharge	111.59
Annual Extractable GW Resources	1004.27
GW draft for irrigation	0
Gross GW draft	167.00
Annual Allocation of ground water for domestic & industrial water supply upto 2025	334.00
Balance GW for future irrigation development	670.27
Stage of development	16.63

c) Categorization for Ground Water Development of Greater/Urban Shillong during 2017-18

Assessment Unit/ District	Greater Shillong
Stage Of Ground Water Development (%)	16.63
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

FIELD PHOTOGRAPHS

Ground Water Exploration at JNV Mawphlang

Ground Water Exploration at NIT Cherrapunjee

Ground Water Exploration at Nongpyiur

Ground Water Exploration at Water Resources Dept.

Soil Infiltration Studies

Dug well Pump test

Springs in East Khasi Hills District