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Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation
जल शक्ति मंत्रालय, जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
GOVERNMENT OF INDIA
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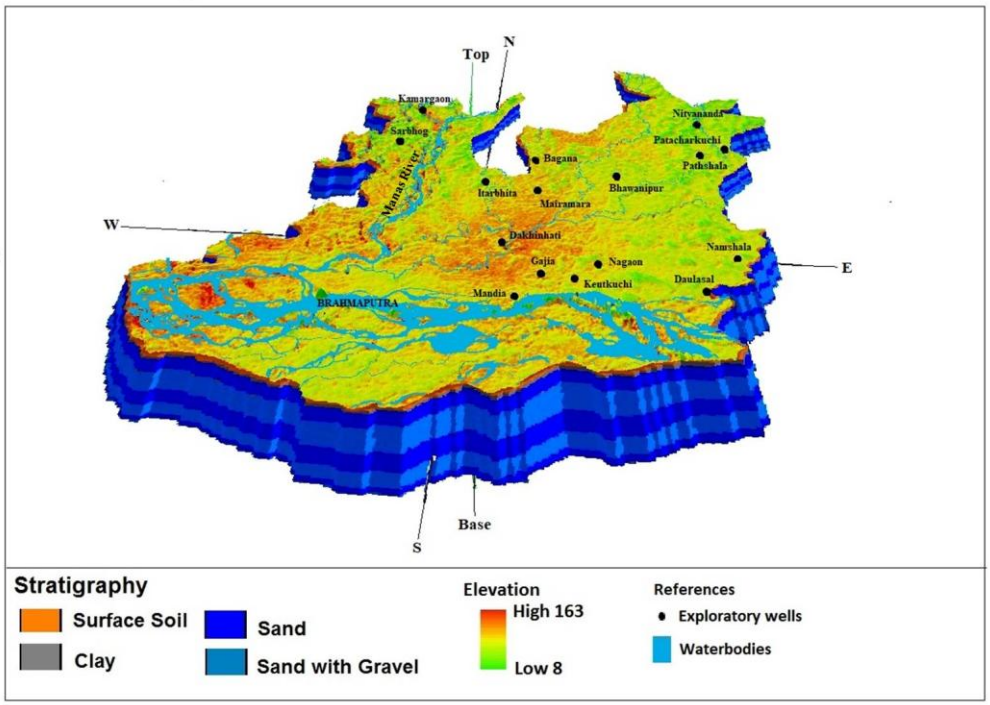

AQUIFER MAPPING AND MANAGEMENT PLAN OF BAKSA DISTRICT, ASSAM
ANNUAL ACTION PLAN, 2019-20

NORTH EASTERN REGION
उत्तर पूर्वी क्षेत्र
GUWAHATI
गुवाहाटी
July, 2022

GOVERNMENT OF INDIA

MINISTRY OF JAL SHAKTI, DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

REPORT
ON
"AQUIFER MAPPING AND MANAGEMENT PLAN OF BARPETA DISTRICT, ASSAM"
(AAP 2021-22)

By
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North Eastern Region
Guwahati

CENTRAL GROUND WATER BOARD
NORTH EASTERN REGION
GUWAHATI
July, 2022

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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
CGWB	Central Ground Water Board
DGM	Directorate of Geology and Mining
DTWL	Depth to water table
DW	Dug Well
°C	Degree Celsius
EC	Electrical Conductivity
EW	Exploratory Well
GEC	Ground water Estimation Committee
GL	Ground Level
GIS	Geographic Information System
GSI	Geological Survey of India
Ha	Hectare
Ham	Hectare meter
IMD	Indian Meteorological Department
IPD	Investigation & Planning Division
Km	Kilometre
LPM	Litres per minute
LPS	Litres per second
m	Metre
ASTEC	Assam Science and Technology Council
Magl	Meter above ground level
mbgl	Meters below ground level
MCM	Million Cubic Meter
Mm	Milli meter
mg/l	milligram/litre
mamsl	Metre above mean sea level
MP	Measuring Point
MID	Minor Irrigation Department
µS/cm	Microsimens/centimetre
NAQUIM	National Aquifer Mapping and Management Plan
NER	North Eastern Region
OW	Observation Well
PHED	Public Health & Engineering Department
Ppm	Parts per million equivalents to mg/l
Pz	Piezometer
Sq.Km	Square Kilometre
SWL	Static water level
TDS	Total dissolved solid
TW	Tube Well
VES	Vertical Electrical Sounding
WRD	Water Resources Department

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CHAPTER -1

1. Introduction

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in Barpeta district, Assam during AAP 2021-22 covering **2496 sq.km** out of total geographical area of **2645** 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 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 approachon 1:50,000 scale and finally formulate a complete, sustainable and effective management plan for ground water development.

1.2 Scope of the Study:

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

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

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

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

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

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

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

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

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

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

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

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

1.4 AreaDetails:

Aquifer mapping and management programme has been taken up during Annual Action Plan 2021-22 in Barpeta District covering Manida Dev. Block, Rupashi Dev. Block, Gumafulbari Dev Block, Gobardhana Dev. Block , Bajali Dev. Block, Barpeta Dev. block, Bhawanipur Dev Block, Chakachaka Dev. Block, Chenga Dev. Block, Paka Betbari Dev. Block , Sarukhetri Dev. Block in order to delineate the available aquifers. The district headquarter of Barpeta district is Barpeta. The district covers an area of **2645** Square Kilometer. As per Census 2011, the Barpeta district is having a total population of **1693622** out of which **826618** are female, **95320** are SC population and **27344** are ST population.

The district lies in the northern bank of the riverBrahmaputra. **Barpeta** district is surrounded by the river Brahmaputra to the South, Barpeta and Chirang district to the North, Nalbari district to the east and Bongaigaon district to the west and is confined within North Latitudes $26^{\circ}38'$ and $26^{\circ}05'$ and East Longitudes of $90^{\circ}38'$ and $91^{\circ}17'$. The area is falling mainly and partly in the Survey of India Toposheets bearing nos. 78J/11, 78J/12, 78J/14, 78J/15, 78N/02, 78N/03, 78N/04, 78N/06, 78N/06, 78N/07 and 78N/08.Fig-1 depicts the base map of the NAQUIM area. The district is well connected with rail, road and air. The District Head Quarter of Barpeta is located at Barpeta Town. The Head Quarter Barpeta is connected to NH-31 via Howly, connected to State High Way through Jania-Bongaigaon. a) Barpeta Daulasal Rampur road b) Barpeta Chenga Bahari c) Barpeta Nagaon Sarthebari d) Tihu-PatacharkuchiSimlaguri (NH-31) e) Patacharkuchi Anchali road f) Bilashipara Bazar to Chalikanda Bazar g) SorbhogOdalguri Road h) PalhaziPatbaushi road i) Kalgachia to Moinbari road j) BarpetaBaghbar Road k) Chenga Bahari Road.

Length of Railway in the district is 47 KM and there are 6 nos. of Railway Station in the district viz. Sorbhog, Barpeta road, Guwagacha, Sarupeta, Pathsala and Niz Sariha. Barpeta Road Railway Station is the major Railway Station of the district.

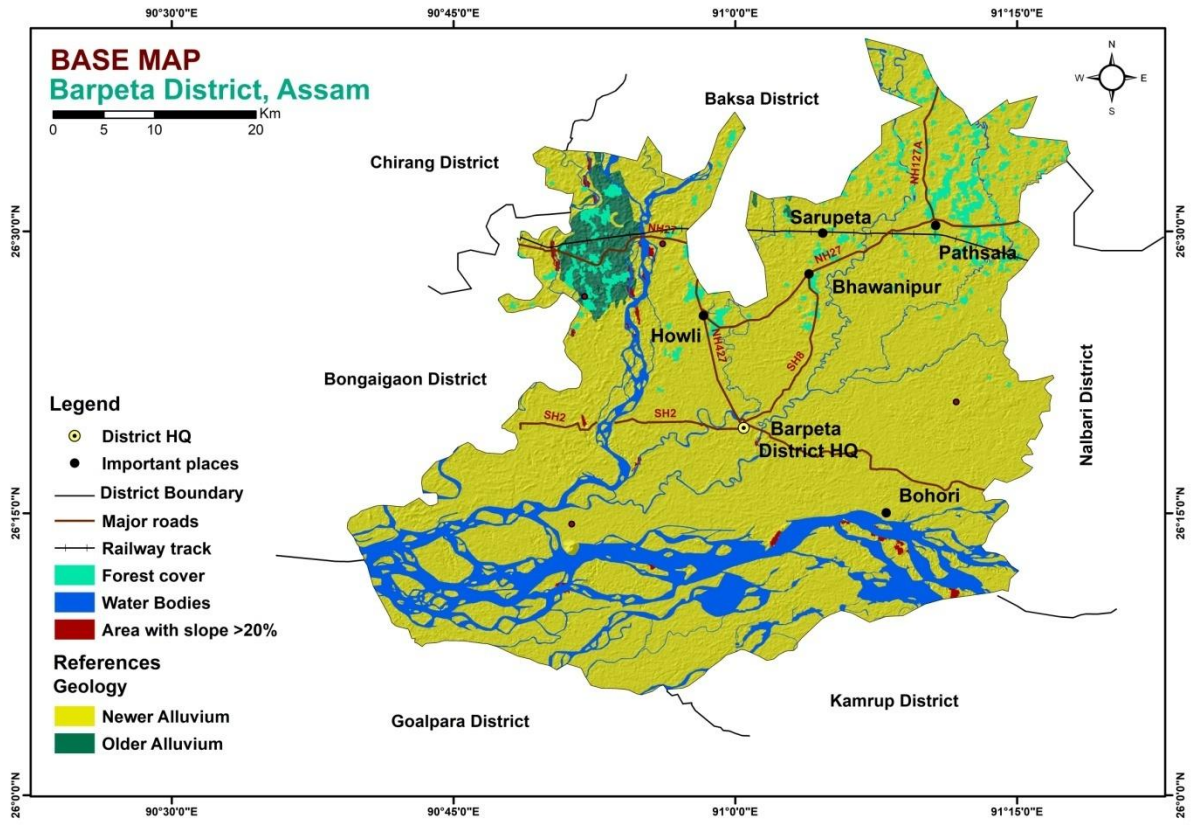


Fig 1: Base Map of Barpeta District, Assam

1.5 Data Availability & Data Adequacy before conducting Aquifer Mapping:

After plotting the available data on the map prepared by MapInfo it was found that there is not much data gap in the district. Hydrogeological, geophysical and ground water exploration data available in the district are as follows:

- **Exploration Data**: CGWB has constructed 13 (Ten) exploratory wells, 4(Four) observation wells and 1 Piezometera in Barpeta district. Details of drilling operation, aquifer parameters are furnished in Annexure – 4. State govt. has also drilled several wells.

- **Geophysical Survey (VES) Data**: CGWB has conducted any 50 VES survey in this district till date.

Ground Water Level Monitoring Data: CGWB has 5 (Five) GWM wells at Bhawanipur, Sarupeta, Sorbhog, Ujanborbori, Nityanada OW and Patacharkuchi where water levels are measured 4 times in a year. State ground water user departments like PHED, Irrigation department etc. do not have any ground water monitoring station.

- **Ground Water Quality Monitoring Data**: Chemical quality is also monitored in these 4 (Four) GWMS once in a year. Pre- Monsoon samples are collected from these monitoring wells and analysis is done at Regional Chemical Laboratory of CGWB, NER, Guwahati.

1.6 Data Gap Analysis & Data Generation:

1.6.1 Data Gap Analysis:

- **Exploration Data Gap :**

There is existing 13 (Thirteen) Exploratory well, 4(Four) Observation Well and 1Piezometer in Barpeta district. Hence there is very less no exploration data gap in the district. Five Exploratory well sites were selected at Howly, Dakkhinhati, Sarbhog, Dimapur and

- **VES and Profiling Data Gap :**

CGWB has conducted any 50VES survey in this district till date. Hence there is no Geophysical data gap in the district

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

5 (Five) GWM wells at Bhawanipur, Sarupeta, Sorbhog, Ujanborbori, Nityanada OW and Patacharkuchi which is not sufficient. As such establishment of new key well has been proposed.

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

As there are only 5 (Five) GWMS in the district. Out of which 4(four) is monitored for quality analysis. There is a huge data gap in the district in terms of Chemical quality. Collection of water samples from new key wells and analysis of the same has been proposed.

The Data Gap is shown in Fig.1.2 and Data Requirement, Data Availability and Data Gap Analysis are presented in table 1.1

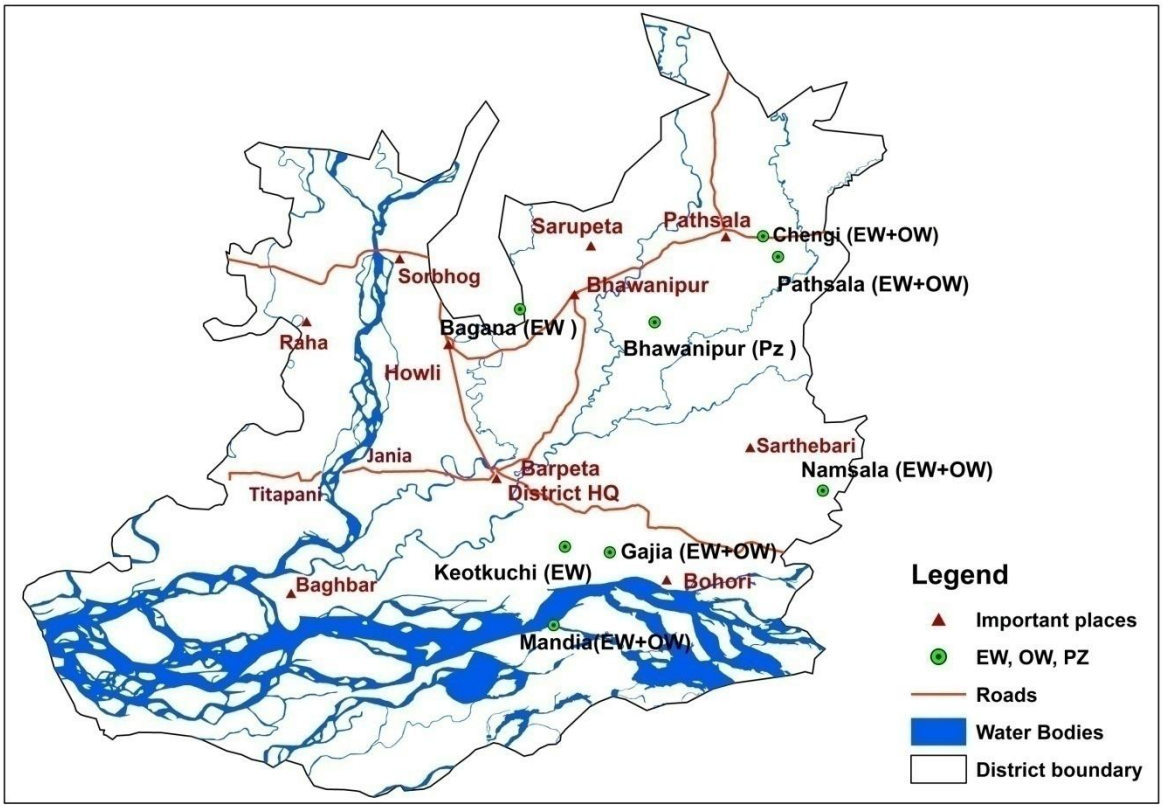


Fig 1.2: Data gap and Availability Map of Barpeta District

Table1.1 Data Availability and Data Gap Analysis in Aquifer Mapping Studies Area

Sl. No.	Items	Data Requirement	Data Availability	Data Gap
1	Ground Water Exploration Data	At least 20 (Twenty)no.s of exploration wells are required to obtain exploration data	13 EW 4 OW 1 Pz	5 No of EW
2	Geophysics	Geophysical data of the Study area	50 VES	2 Nos
3	Ground Water Monitoring Regime	Representative Monitoring Wells well distributed over the Study Area.	5	22 No.s
4	Ground Water Quality	Representative Monitoring Wells well distributed over the Study Area.	4	22 No.s
5	Climate	Season-wise Rainfall pattern	Nil	Monthly rainfall data for the past 10 years.
6	Soil	Soil map and Soil Infiltration Rate	0	3 nos. of soil Infiltration studies
7	Land use	Latest Land Use pattern	0	NA

1.6 Rainfall and Climate: The district enjoys sub-tropical humid climate. Average annual rainfall in the district is 2,051 mm. About 60 to 65% of the annual precipitation is received during south-west monsoon from June to September. The pattern of rainfall varies in the district, from south to north, the intensity of rainfall increases and the maximum rainfall is recorded in the north eastern parts of the district.

Table1.3 Rainfall Data of Last Five Years

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2015	7.6	5.4	37.3	208.4	466	907.4	341.6	861.7	328.6	21	22.8	11.1
2016	7.8	0.5	52	340.1	340.7	580.8	712.8	122.7	363	112.7	0	0
2017	0	41.5	56.8	352.3	215.1	542.6	391	679.9	645.8	204.3	10.2	0
2018	0.3	13.6	84.5	157.6	458.2	522.1	1148.6	1385.1	747	63.4	22.9	12.7
2019	0.34	16.46	49.76	255.35	497.91	330.1	587.64	186.27	260.54	120.59	4.92	0

Note :(1) The District Rainfall in millimeters shown above are the arithmetic averages of Rainfall of Stations under the District. (Source: India Metrological Department)

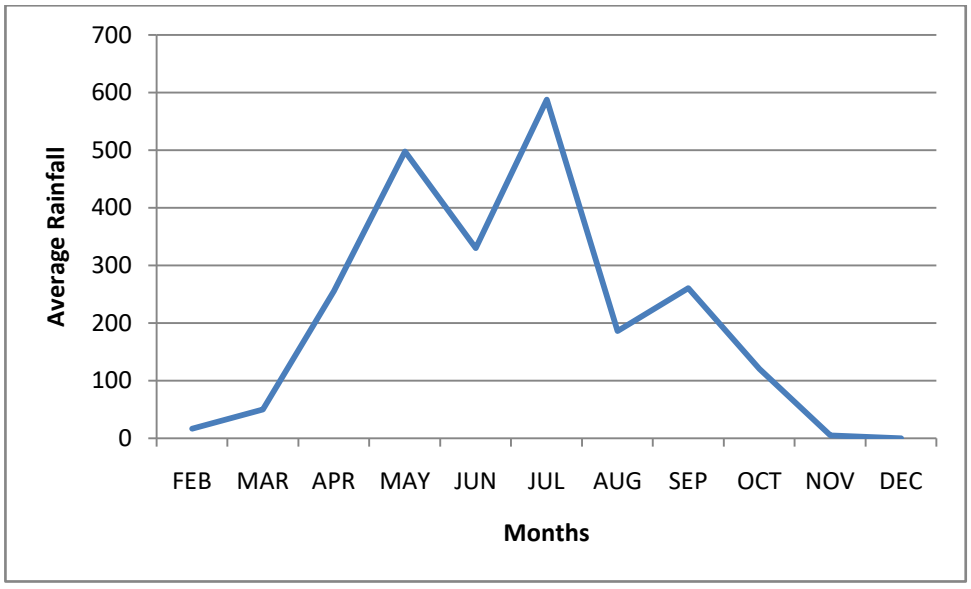


Fig 1.3: Rainfall Hydrograph of Barpeta District

Portion of the graph showing June to September represents monsoon season, January to May represents pre-monsoon season and September to December represents post monsoon season.

A bar diagram showing average annual rainfall in last 5 years has been shown in the **Fig 1.4** below.

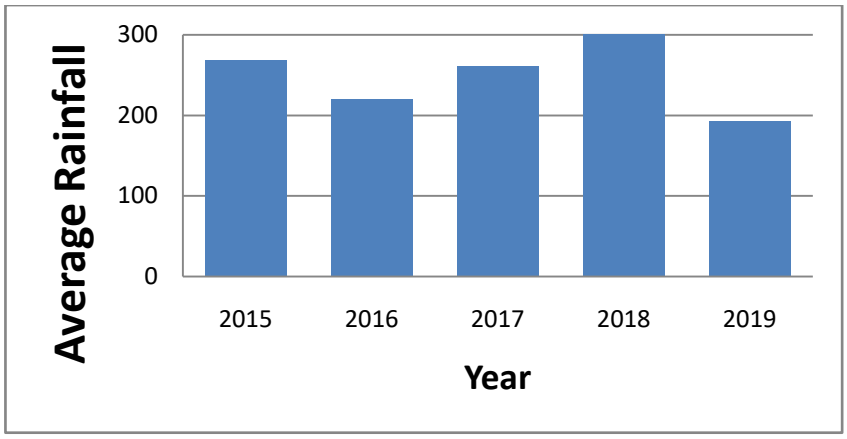


Fig 1.4: Average annual rainfall from 2015 to 2019

The average temperature ranges from 15 ºC to 30ºC. The winter season starts by November and continues till February. December/January is the coldest and July/August is the hottest period. The air is highly humid throughout the year and during rainy season relative humidity is about 90 percent.

1.7 Physiography:

Physiographically almost the entire district is occupied by an alluvial deposit with flattopographyand there isavery gentle slope towards the Brahmaputra River,which makesthe southern boundary of the district.

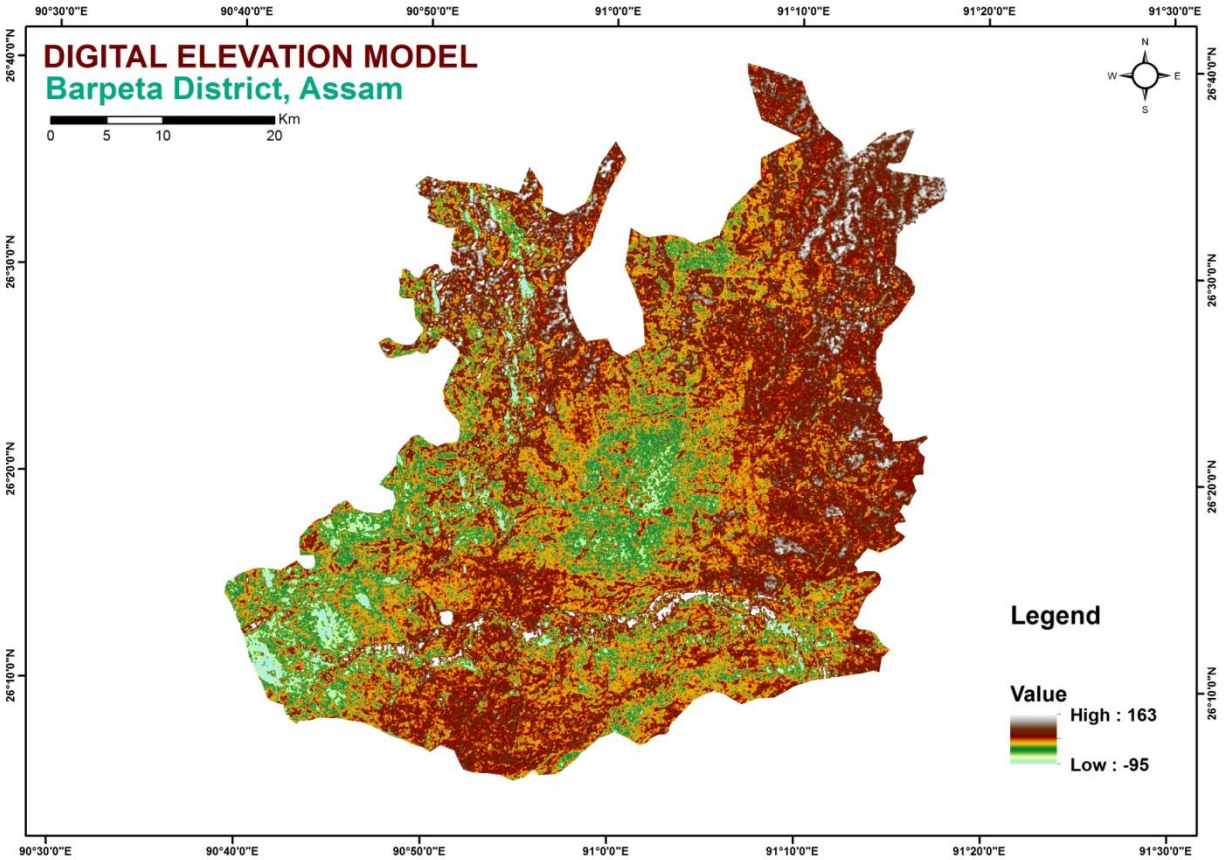


Fig 1.5: Digital Elevation Model of Barpeta District

1.8 Geomorphology:

The study area forms a part of the vast alluvial plains of Brahmaputra River system and sub-basin of River Manas. Physiographically, the area is characterized by different land forms resulting from denudo- structural hills and alluvial flood plains. The low mounded hillocks are covered by a thick lateritic mantle and these are occupied by evergreen mixed forests. The alluvial plains comprise of Older and Newer alluvium.

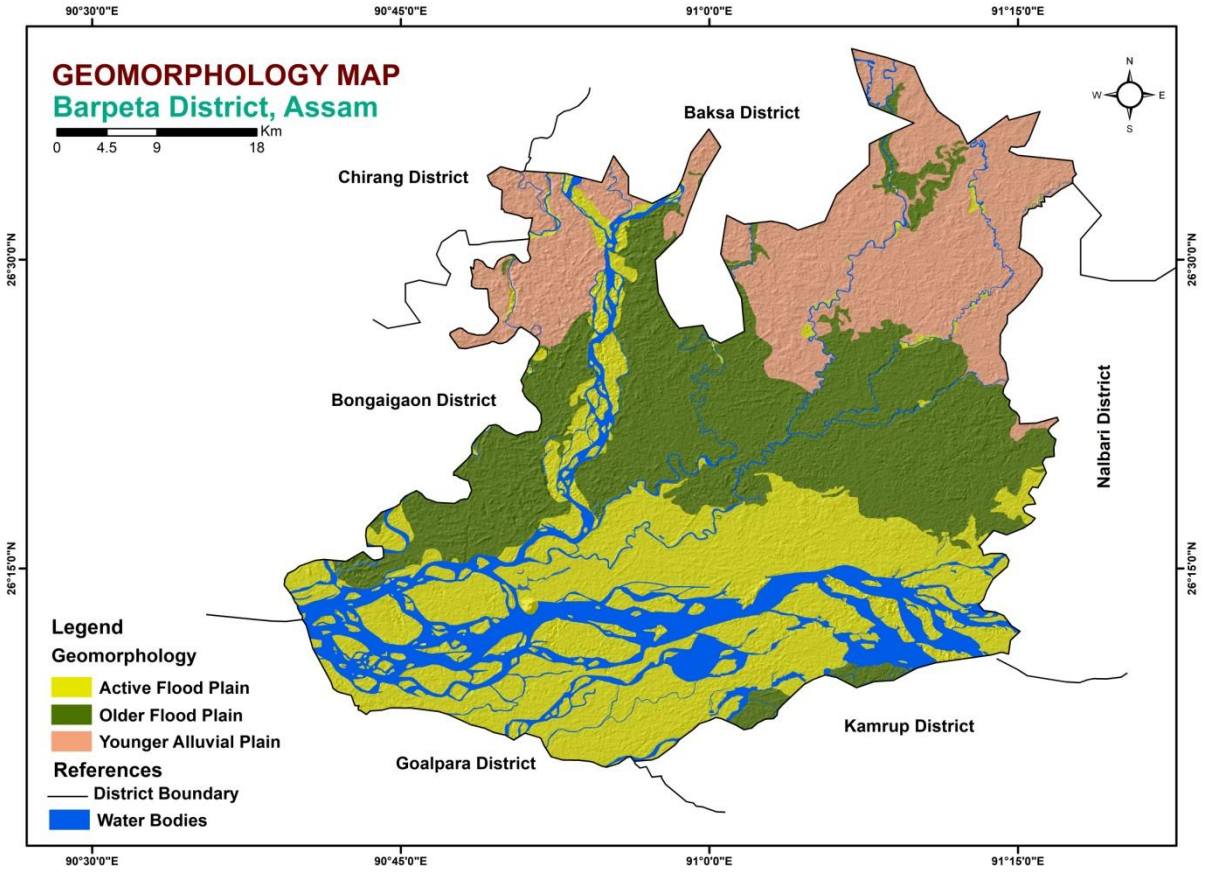


Fig 1.6: Geomorphological Map of Barpeta District

1.9 Land Use:

Based on the land utilization, the total area is divided into various types of landforms such as Total geographical area of the district is 2,32,597.8 ha. Net area under cultivation of different crops is1,53,881ha. Theshareofnet areasownto total geographical areais 66percent.

Table1.3 : Land utilization of the Barpeta District

Name of theBlock	TotalGeographicalarea(ha)	Areaunder Agriculture(inha)			Cropping ngIntensity(%)	Areain ha.		
		Grossedcroppedarea(1)	Netsownarea(2)	Area sownmore thanonce (1-2)		Areaunder forest	Areaunder Wasteland	Areaunder otheruses
RupshiBlock	16411.84	27902	13033	14869	214	0	798	1975.5
Gobardhana Block	6029	9961	4376	5585	2280	0	1653	
Chakchaka Block	14260	14052	10400	3652	135	170	853	2263
MondiaBlock	60477	79757	41740	38017	191	104	0	14186
Pakabetbari Block	14591	15043	10095	4948	149	35	460	4317
Sarukhetri Block	11452	12838	8080	4758	159	0	406	2960
Gumafulbari Block	22570	12889	9611	3278	134	0	21	70
ChengaBlock	16233	17382	8891	8491	196	37	52	133
BarpetaBlock	26027	24019	17389	6630	138	0	0	3895
BajaliBlock	20925	21678	14647	7031	148	0	0	6277
Bhawanipur Block	23622	24414	15619	8795	156	116	948	4494
Total	**232597.8**	**259935**	**153881**	**106054**	**169**	**462**	**3538**	**42224**

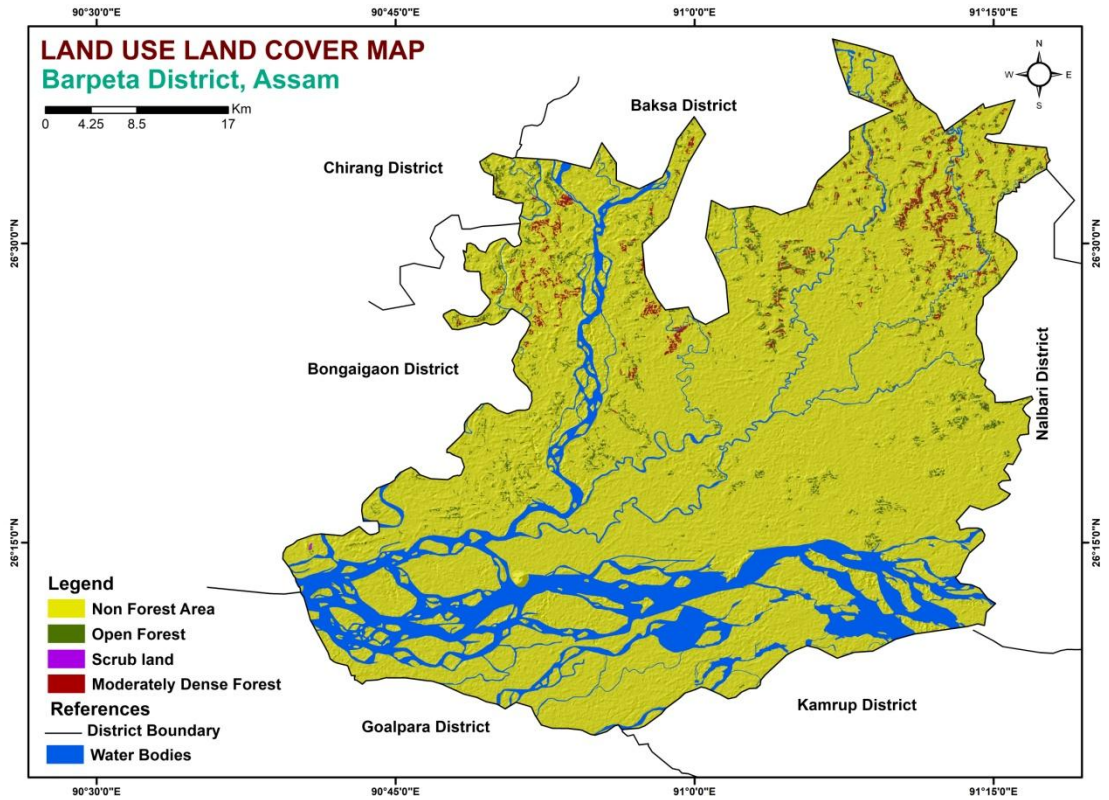


Fig 1.7: Land Use Land Cover Map of Barpeta District

1.10 Soil:

The district has soil cover of younger and older alluvial soil which has undergonediversified pedagogical changes. The soils are characterized by mediumto high organiccarbon and low to medium phosphorous and potash contents. Deep red coloured soil isdeveloped in forested and foothill areas in the extreme northern region and the texture ofthesesoils rangesfromclay tosandy loam.

The alluvial soils are light yellow to light grey in colour of Recent age. The texture ofthesoilrangesfromsandy loamtosilty loaninnature.

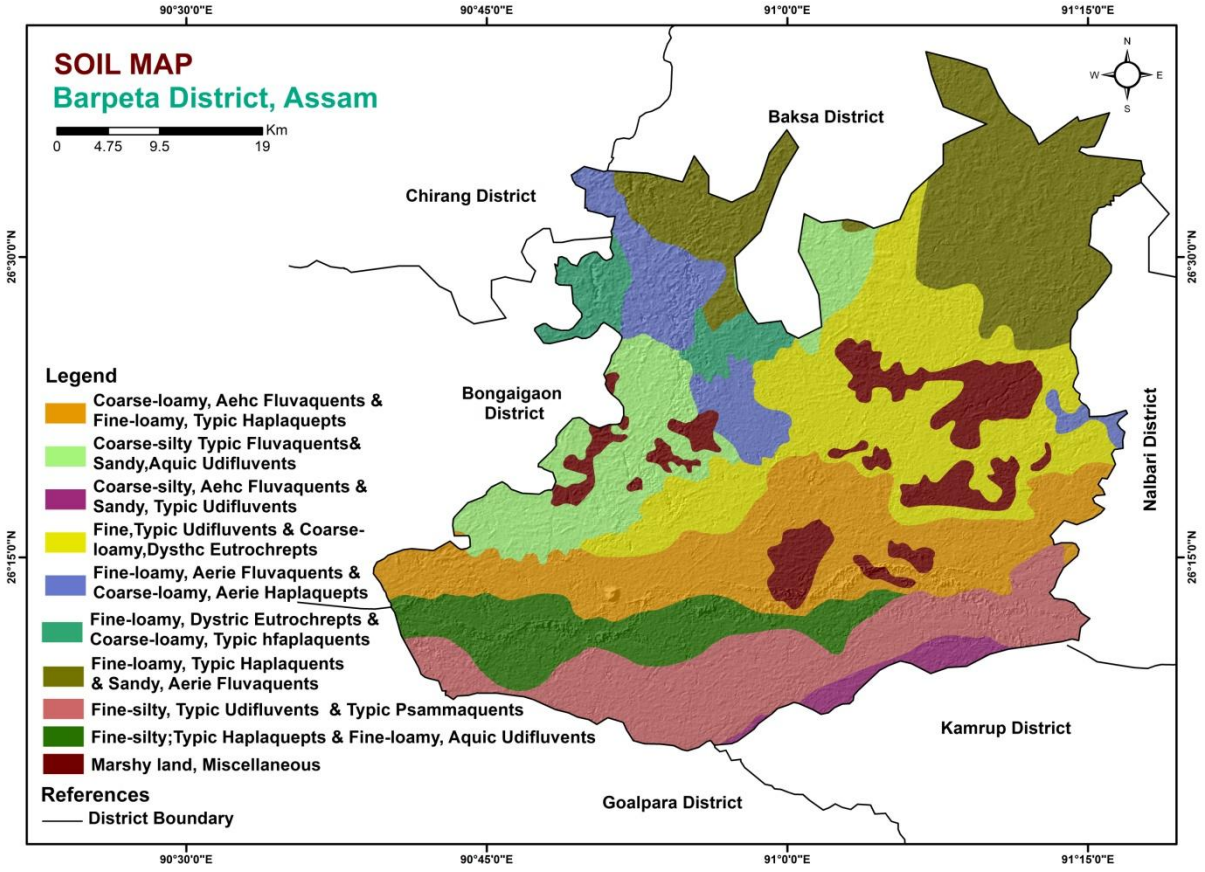


Fig 1.7: Soil Map of Barpeta District

1.11.1 Ponds, Tanks and other Water Conservation Structures

There are few numbers of small ponds available in the district. These ponds are used mainly for fish cultivation and also used for domestic purpose like washing, bathing, water for cattle's etc. Farmers rarely use these ponds for irrigation.

1.11.2 Drainage:

The mighty river Brahmaputra flows from east to west in its extreme southern parts exhibiting numerous sand bars and point bars with wide variations in its channel width. Rivers

like Manas, Beki, Kaladiyan, Karekhowa, Palla and Pohumara emerging from the Bhutan Himalayas flow from north to south and join the river Brahmaputra.

The general course of these rivers in the Bhaber zone remains more or less straight and starts meandering in the Terrai and flood plain areas. Stream channels which come out from these rivers often empty into huge marshy places, clogging of stream channels by detritus brought down from upper reaches are common features; as a result, a number of abandoned channels are thus formed in the flood plain areas. Flow of these streams and rivers during heavy monsoon period cause flooding of low-lying areas.

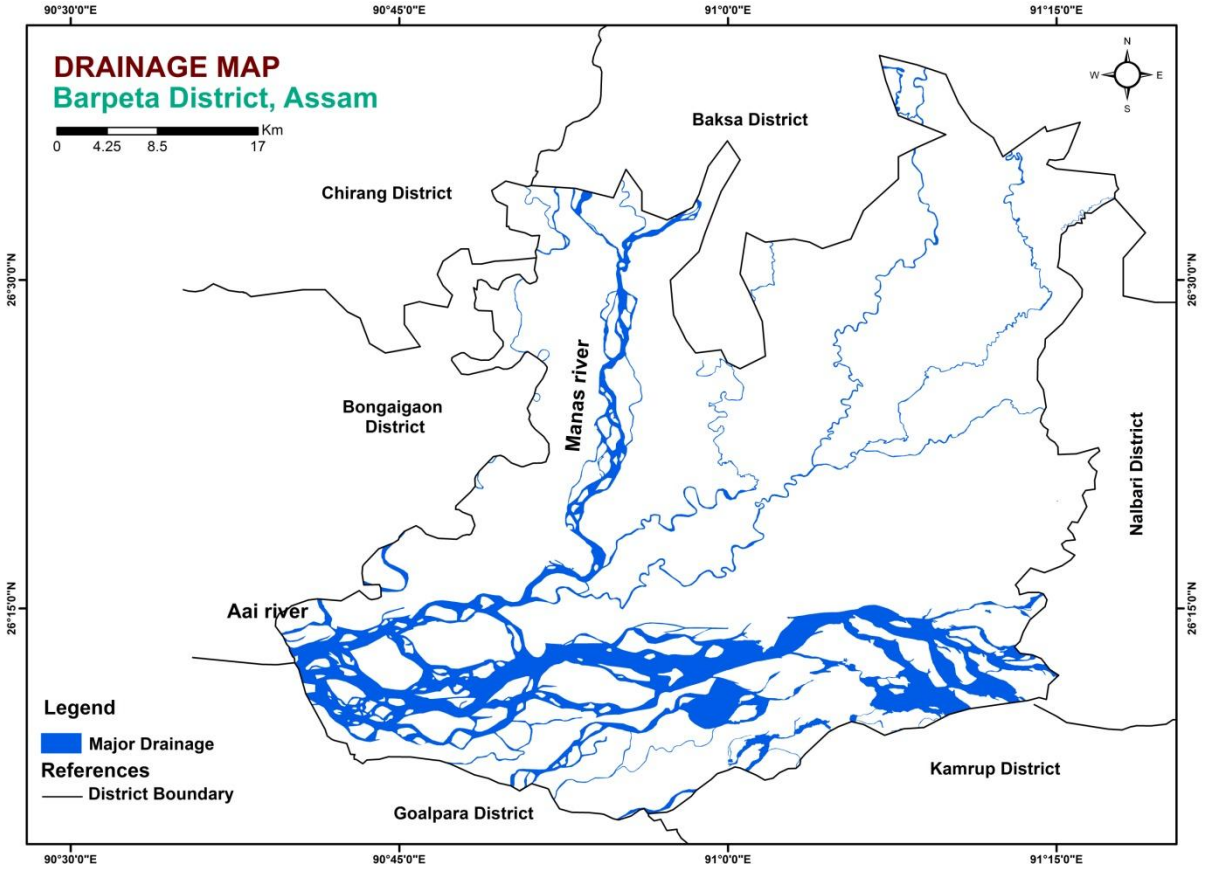


Fig 1.5: Drainage Map of Barpeta District, Assam

1.13 Agriculture:

Agriculture in Barpeta district depends mainly on the timely monsoon. Fertile soils of the valleys and the abundant rainfall are very conducive to grow agricultural and horticultural crops. Net area under cultivation of different crops is1,53,881ha. Theshareofnet areasownto total geographical areais 66percent.

TheeconomyofBarpetadistrictisagriculture-based.
Riceisthemostdominantcropfollowedby vegetables, pulses, oilseeds, tuber crops in the district. The productivity of all these crops are not satisfactoryandbelownationalaverage,AmongthehorticulturalcropsBanana,Citrus,Pineapple, Arecanut and Coconut are grown by the farmers in the extensive area. Apart from agricultural crops sericulture food plants also covering a sizable area. Generally Sali rice, Ginger, turmeric, sericulture fodder plants, sugarcane etc. are practiced in monoculture in majority parts of the district.

Table 1.4: Production and Productivity of Major Crops

Season	Rainfed				Irrigated			
	Area (Ha)	Production (qtl/ yr)	Productivity (kg/ha)	Cost of cultivation (Rs/ha)	Area (ha)	Production (qtl/yr)	Productivity (kg/ha)	Cost of cultivation (Rs/ha)
Kharif Cereals	**62819**	**1409856.8**	**24172**	**187188**	**4336**	**237675**	**27300**	**158625**
Kharif Course Cereals	**3581**	**59419.82**	**23836**	**227750**	**54**	**0**	**0**	**0**
Kharif Pulses	**2868**	**25232**	**23720**	**273000**	**102**	**1125**	**5700**	**56250**
Kharif Oil seed	**982**	**12709**	**15375**	**123000**	**12**	**0**	**0**	**0**
KharifFabre crop	**21141**	**366783**	**20090**	**193750**	**0**	**0**	**0**	**0**
Rabi Pulses	**25767**	**224158.75**	**19253**	**130000**	**1211**	**34504**	**16300**	**70000**
Rabi Cereals	**1273**	**32915**	**12270**	**45000**	**128**	**4219.1**	**8070**	**7500**
Rabi Oil seed	**24308**	**309134.5**	**13955**	**98125**	**2191**	**20067.3**	**8262.5**	**65625**
SummerCereal	**7284**	**142728**	**15800**	**75000**	**29697**	**1791125**	**43100**	**209985**
Horticulture & Plantation crops	**92131**	**3109300.4**	**124836**	**586600**	**19514**	**296312.5**	**65793**	**383856**

Cropping Pattern:

Paddy is the main cereal crop of the District during Kharif and summer season while maize is grown in both Kharif and summer season. Pulse crops like arahar, black gram are grown as secondary crop during Kharif while pulse crops like pea and lentil and oil seed crops such as mustard, sesame and linseed are major Rabi crops of the District. Major area in the Barpeta district is under rainfed condition. During summer some area is covered with summer paddy in irrigated condition.

1.14 Irrigation:

The economy of Barpetadistrict is agriculture-based. Tea, rice and sugar cane are the main agriculturalcrops grown in thedistrict,with teabeingis thelargest agricultural industry.

Rice is the most dominant crop followed by vegetables, pulses, oilseeds, tuber crops in the district. Theproductivity of all these crops are not satisfactory and below national average, Among the horticulturalcrops Banana, Citrus, Pineapple, Arecanut and Coconut are grown by

the farmers in the extensive area.Apart from agricultural crops sericulture food plants also covering a sizable area. Generally Sali rice,Ginger, turmeric, sericulture fodder plants, sugarcane etc. are practiced in monoculture in majority partsofthedistrict.

The district has net and gross cropped areas of 1,53,881 hectares and 2,59,935 hectares respectively, thenet cropped area being 66 percent of the total geographical area. The crop wise irrigated and rainfed areasownin differentseasonslikeKharif, Rabiand Summerin thedistrictforeachblock isgiven inIrrigated area under different crops in Barpeta District (Area in Ha) is shown in Table 1.6

Table 1.6 :Irrigation basedclassification

Blocks	Total IrrigatedArea (InHa)	Total Rainfed Area(InHa)
Rupsi	6046	21856
Gobardhana	4175	5786
Chakckakha	4412	9640
Mondia	14208	65549
Pakabetbari	3998	11045
Sarukhetri	3701	9137
Gaumafulbari	3296	9593
ChengaBlock	7407	9975
BarpetaBlock	5015	19004
Bajali Block	2751	18927
Bhawanipur	5037	19377
Total	**60046**	**199889**

Table 1.7: Area wise Crop wise Irrigation Status

Dev. Block	Kharif (area in Ha)		Rabi (Area In Ha)		Summer Crop (area in Ha)		Total Area In Ha		Horticulture & Plantation Crop (area in Ha)	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Rupashi Dev. Block	**0**	**9346**	**496**	**8379**	**5470**	**2713**	**5966**	**20438**	**80**	**1418**
Govardhana Dev. Block	**2043**	**3494**	**1567**	**640**	**390**	**975**	**4000**	**5009**	**175**	**777**
Chakchaka Dev. Block	**110**	**7767**	**2363**	**1138**	**1545**	**210**	**4018**	**9115**	**394**	**525**
Mondia Dev. Block	**804**	**16889**	**315**	**30493**	**13089**	**700**	**14208**	**48082**	**0**	**17467**
Pakabetbari Dev. Block	**0**	**5875**	**102**	**3469**	**3691**	**1015**	**3793**	**10359**	**205**	**686**
Sarukhetri Dev. Block	**0**	**6614**	**1241**	**1423**	**1920**	**660**	**3161**	**8697**	**540**	**440**
Gumafulbari Dev. Block	**664**	**4288**	**1767**	**2906**	**500**	**1649**	**2931**	**8843**	**365**	**750**
Chenga Dev. Block	**1291**	**4356**	**2434**	**3674**	**1799**	**1135**	**5524**	**9165**	**1883**	**810**
Barpeta Dev. Block	**220**	**7155**	**510**	**6944**	**4000**	**1625**	**4730**	**15724**	**285**	**3280**
Bajali Dev. Block	**0**	**13591**	**1292**	**3647**	**0**	**767**	**1292**	**18005**		**922**

Bhawanipur Dev. Block	**0**	**14997**	**14997**	**475**	**3005**	**3480**	**4562**	**450**	**5012**	**5037**
Total	**5132**	**94372**	**27084**	**63188**	**35409**	**14929**	**54185**	**153887**	**8939**	**32112**

1.17 GENERAL GEOLOGY:

Geologically, the area represents the southern extremity of Shillong Plateau covered by Recent to Sub-Recent alluvial sediments of Brahmaputra River. Brahmaputra River occupies the southern part of the study area. Barpeta is covered by alluvial deposits of recent and sub-recent origin. The older alluvium is being carried down by the Himalayan originated rivers and deposited along the original inundation area which has later been raised to its present condition The new alluvium covering the major part of the district consists of loosely consolidated sands, clays.

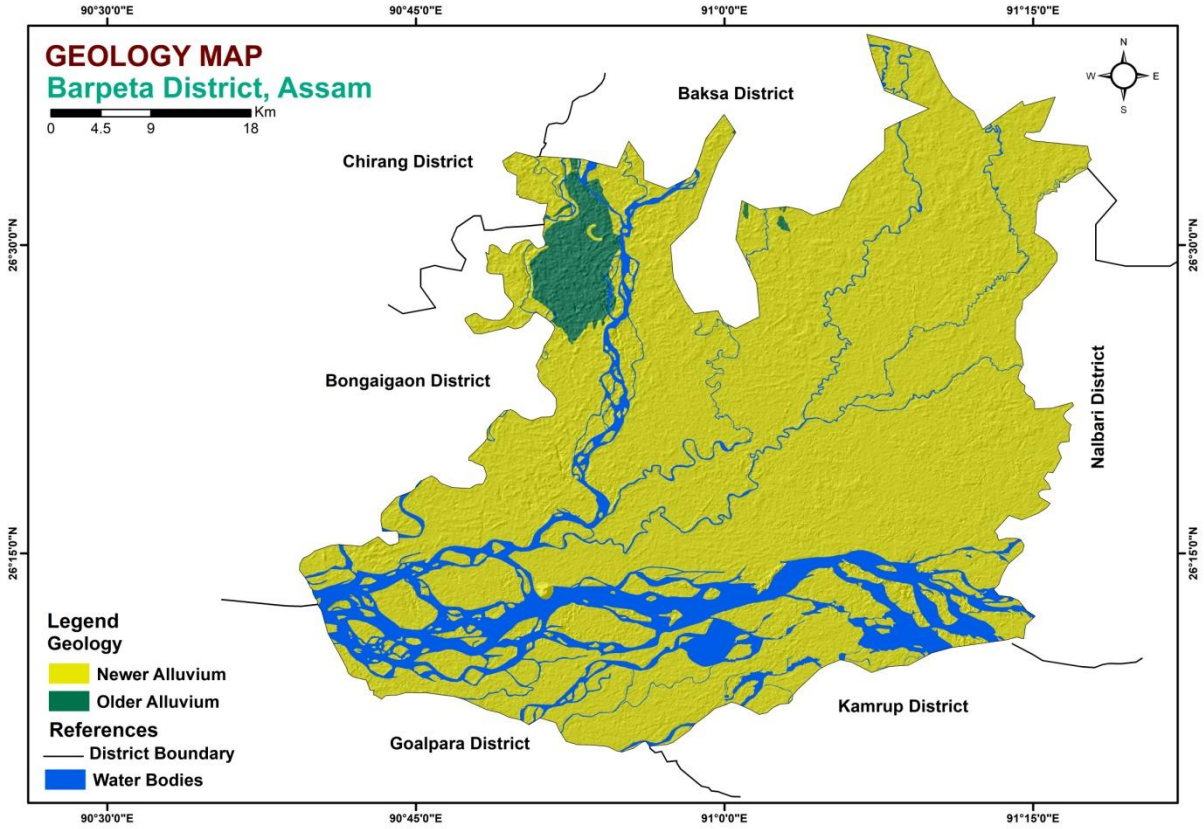


Fig 1.6: Geological Map of Barpeta District, Assam

CHAPTER -2

DATA COLLECTION & GENERATION

2.1 Data Collection

Exploration: Central Ground Water Board (CGWB), North Eastern Region had constructed 3 nos. of exploratory wells were constructed in the district (Table. 2.1).

Table 2.1: Details of earlier constructed wells in Barpeta District.

Location	Latitude	Longitude	Depth Drilled (mbgl	Constr. Depth (mbgl)	Discharge (m^3/hr)	Draw Down (m)	Zones Encountered	T (m2/ day	Permeability (m/day)	Specific Capacity
Keotkuchi	26.2708	91.0167	299.92	169	124.44	3.26	43-52 56-62 73-88 88-100 120-126 154-166	9941.8		544.8
Pathsala	26.4903	91.2167	40.99	38	35.64	0.75	22-25 28-37	5223.8		792
Bagana EW	26.4514	91.0250	201.3	140	43.33	4.38	52-65 68-75 82-90 98-103 110-118 128-136			164.88
Bhawanipur Pz	26.4417	91.1250	28.9	28	-	-	21-27	-	-	-
Mairamara EW	26.4056	91.0417	48.1	46.5	52.33	1.90	26-32 41-45	4591.21		458.18
Gajja	26.275	91.0083	57.9	57	47.70	0.04	24-31 36-41 48-55	12229		19875
Namsala	26.317	91.2500	202	111	46.56	0.87	45-65 66-72 102-108	16071		892
M.K.College Chenga	26.500	91.1083	200	121	46.5	1.87	67-85 100-118	-	-	-
Mandia	26.2167	91.0500	203.25	176.70	46.5	1.27	107-119 149-155	-	-	-
Nagaon	26.2950	91.1130	68.10	64.0	28	-	-	-	-	-
Daulasal	26.2696	91.2217	204.15	130.00	53	2.15	45-57 63-75 79-91 109-129	4238	-	-
Bhawanipur	26.2950	91.1131	40.9	38.0	28	-	28-35	-	-	-
Pata-charkuchi	26.5056	91.2475	200.75	78.0	28		45-57 63-75			
Nitya Nada	26.5519	91.21444	152.95	117.66	-		48-60 72-90 102-114	-	-	-

Geo-physical Survey: 50 VES survey was conducted in this district till date.

Water Level Monitoring Stations and Water Quality: CGWB has 5 (Five) GWM wells at Goraimari, Nityananda, Patacharkuchi, Sarupeta and Sorbhog

Table 2.2 : Details of NHNS in Barpeta District.

Location	Latitude	Longitude	Depth of well (mbgl	Dia (m)	MP	RL	Pre-Monsson Water level (m)	Post Monsson Water Level (m)
Goraimari	26.6111	91.1166	5.15				2.01	
Nityananda	26.5519	91.2144	111.6	0.152	0.70	42.00	3.66	2.59
Patacharkuchi	26.5062	91.2448	76.00	0.152	1.00	42.00	2.75	1.91
Sarupeta	26.4480	91.0748	5.99	0.70	0.76	45.00	4.28	2.30
Sorbhog	26.4724	90.8806	5.75	0.80	0.82	42.00	2.57	1.48

CGWB collects water samples from the only GWM well and carried out chemical analysis in its regional laboratory at Guwahati once in a year.

2.2 Data Generation

Exploration:

CGWB has constructed 2(Two) EWs and 1(One) down to a depth of 301 m. These exploratory wells were constructed through departmental rig and outsourcing (Table-2.1 and Fig.3.1).

Table 2.2: Details of the Wells

Sl No.	Location	Block	Topo sheet No.	Latitude	Longitude	Depth Drilled/ Depth of Construction	Aquifer Tapped (m,bgl)	SWL (m bmp)	Discharge m^3 /hr	Draw Down	Transmissivity m^2/day	**Storability**
1	Dakkhinhati (In house)	Barpeta Dev. Block	**78N/3**	26°19′6.102″	91°0′51.84″	**57.00/56.00**	**33.00 -39.00** **45.00-54.00**	4.2	14.4	1.09		
2	Itarbhita (Howly) (In house)	Bhawanipur Dev Block	**78J/15**	26°24′57″	90°59′0.6″	**24.00/17.00**	**09.00 -15.00**	2.27	22.68	1.45	1664.12	

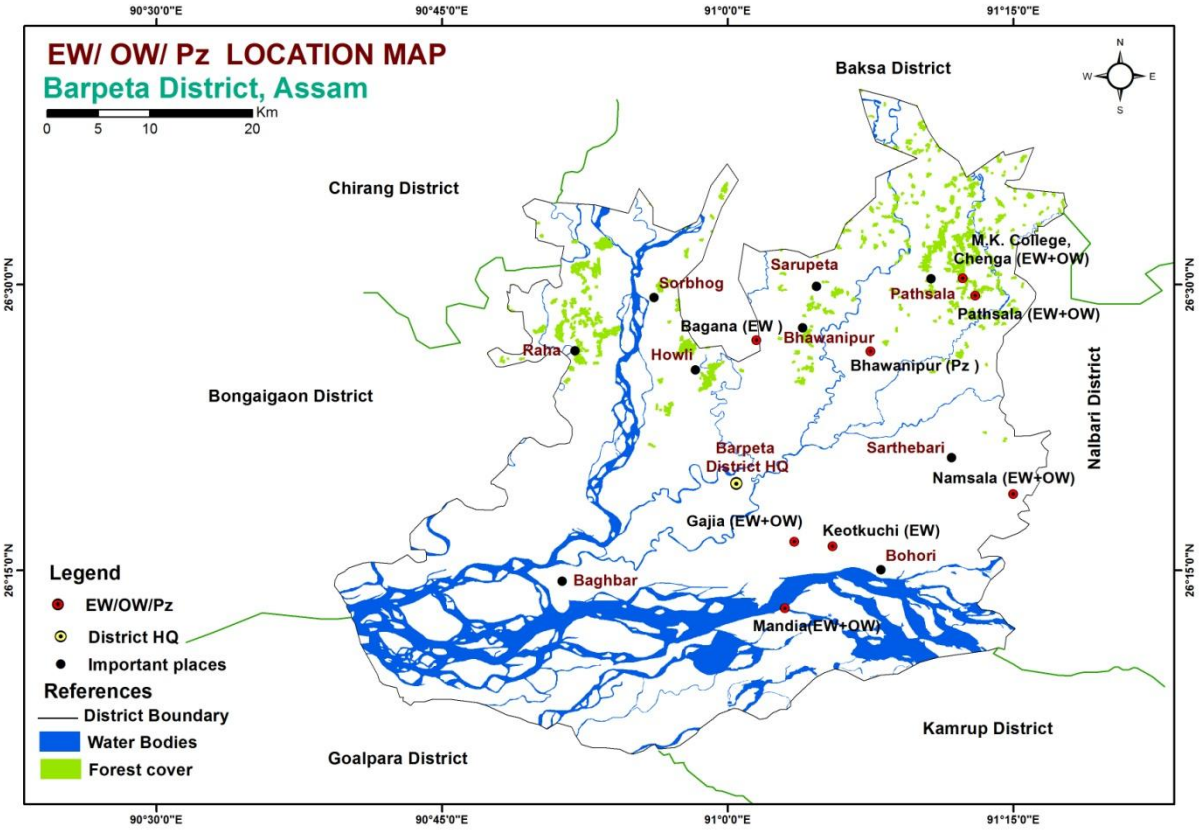


Fig 3.2.1: Map Showing Position of Deep tube Wells drilled by CGWB

Geo-physical Survey:

No Geophysical survey was conducted.

Water Level Monitoring Stations:

During aquifer mapping, 24 nos. of key wells were established to monitor ground water regime of the district (Fig 2.1)

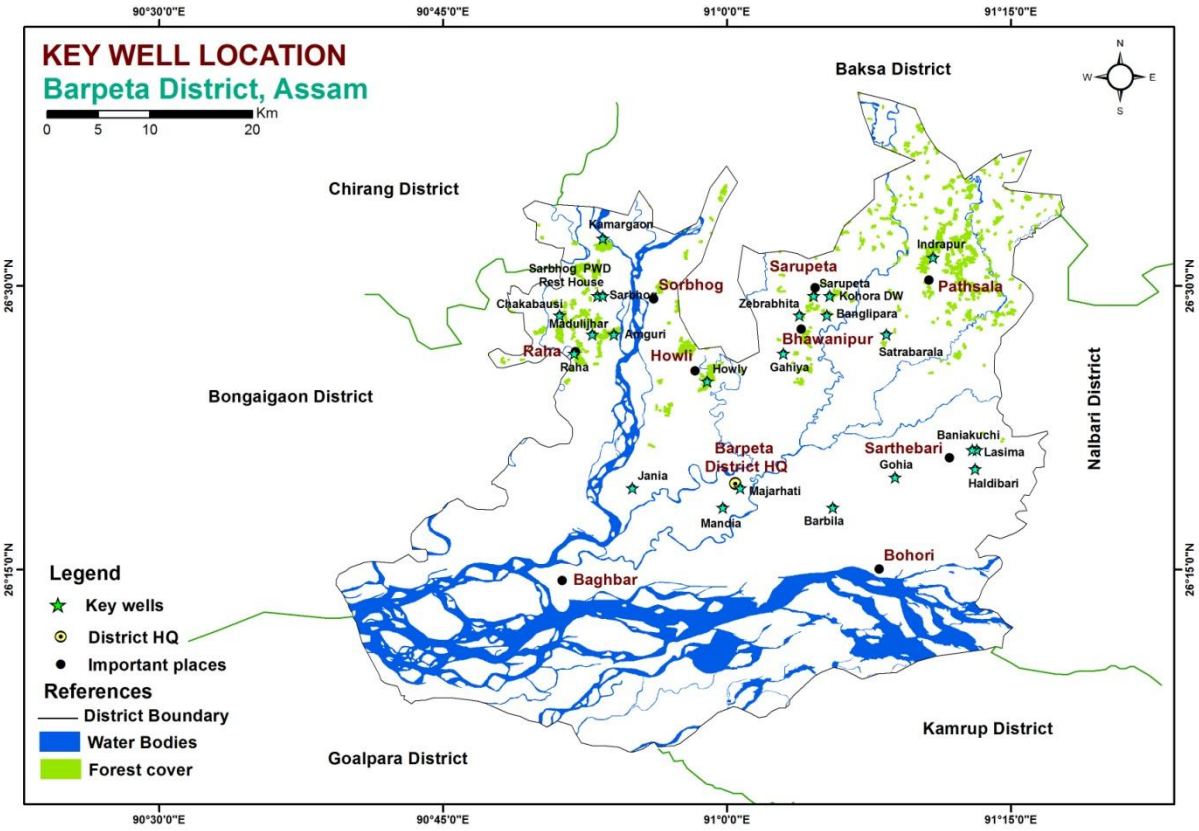


Fig 2.1: Key Well Location Map of Barpeta District

Water Quality:

Groundwater samples were collected from shallow aquifers and also from exploratory wells. Ground water samples were analyzed in the regional chemical laboratory, Central Ground Water Board, North Eastern Region, Guwahati for 17 parameters. The analytical data are given in Annexure 4.

CHAPTER-3

DATA INTERPRETATION, INTEGRATION AND AQUIFERMAPPING

3.1.0 Data Interpretation

Central Ground Water Board, North Eastern Region, Guwahati has drilled sixteen exploratory wells in the area. From the examination of this lithologs it is observed that down to a maximum explored depth of 176.70 m the sequence is dominated by gravel, sand, clay and boulders. The principal aquifer identified in the district is alluvium.

Table 3.1: Summary result of Litholog Study

Depth (mbgl)	Lithology
0 to 5	Top soil: Surface clay, greyish brown, sticky
5 to 50	Saturated formation : Sands, clays with pebbles etc.
50 to 176.70	Saturated formation: medium to coarse sand, clay, gravel, etc.

3.1.1 Aquifer Geometry

Brahmaputra River occupies the southern part of the study area. Barpeta is covered by alluvial deposits of recent and sub-recent origin. The older alluvium is being carried down by the Himalayan originated rivers and deposited along the original inundation area which has later been raised to its present condition The new alluvium covering the major part of the district consists of loosely consolidated sands, clays.

The aquifer disposition in 2D is illustrated by two sections, viz., NE –SW section and another is East-West section in thesouthernpart of the district.

(i) NE-SW Section: The section is drawn from Keotkuchi to Nityananda (Fig. 3.1.1). The significant features of the section are:

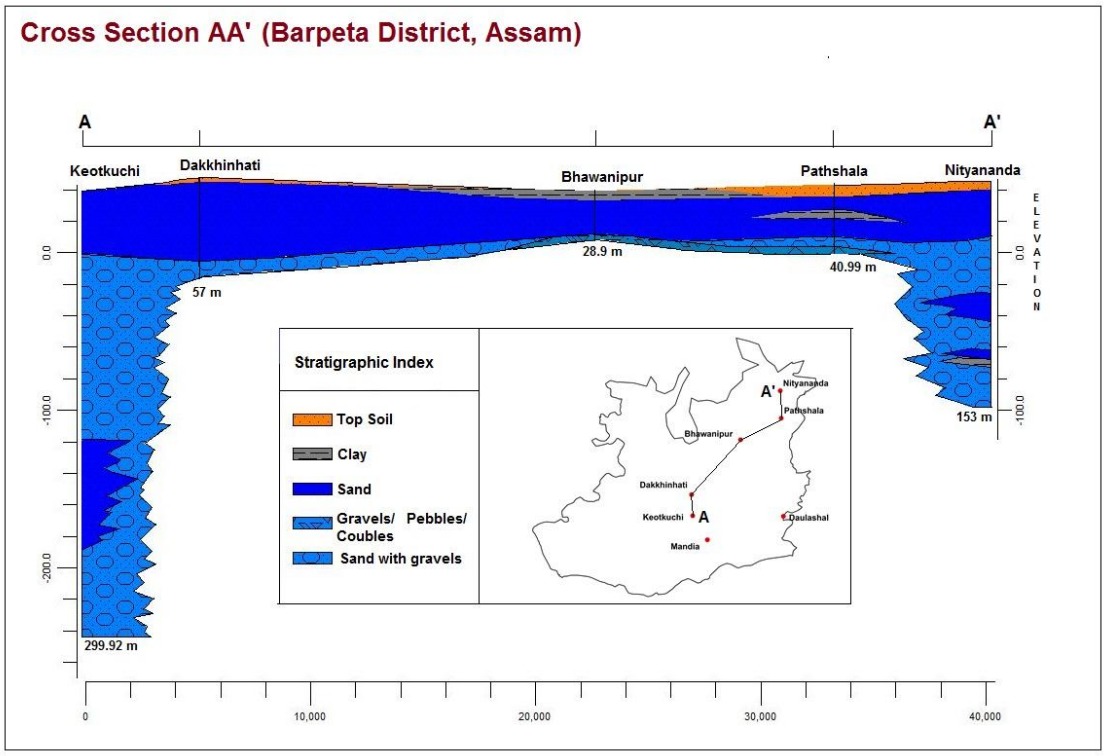


Fig 3.1.1: Section Diagram of Keotkuchi - Nityananda Section

A predominantly sand zone is encountered near the surface along the Northeast-Southwest direction of the district. This zone is thicker towards Dakkhinhati and thinner towards the Pathshala- Nityananda region. A sandy gravel zone is encountered 30m below the sand zone. A thin sandy clay zone is found uniformlyalong the entire section just below the surface soil. A clay zone having thickness of about 6 m is found towards the NE part of the section i.e. towards Pathshala.

(ii) East- West section: The section is drawn along east west direction in the southern part of the district. i.e.,from Keotkuchi to Daulashal (Fig. 3.1.2). The significant features of the section are:

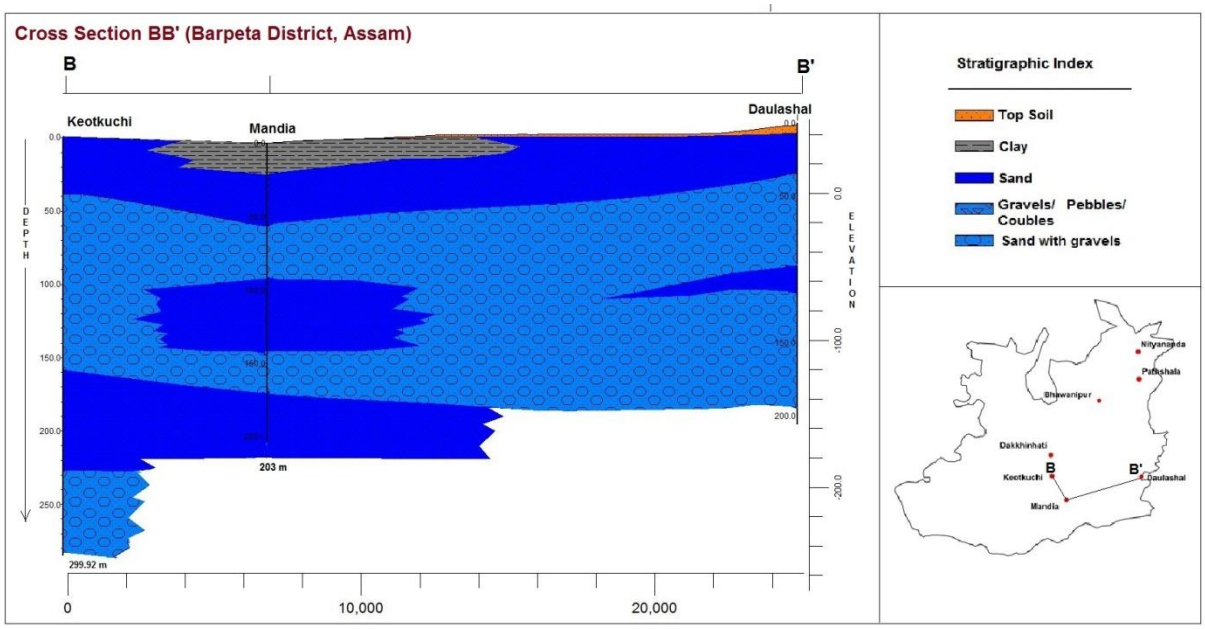


Fig 3.1.2: Section of Keotkuchi – Daulashal Section

Sand zone is detected near surface in this East-West section and the zone is encountered within 20m depth towards the southeastern part of the district. Thickness of this zone ranges between 27 m to 54 m. A uniformly distributed gravelly sand zone is encountered below the sand zone with a thickness ranging between 93-147 metres. Within this gravelly sand zone, a lens of sand is also found from Mandia to Daulashal with thickness rangingfrom 19mto 50m. Beneath this gravelly sand zone a sand zone of thickness varying from 53m to 85m.

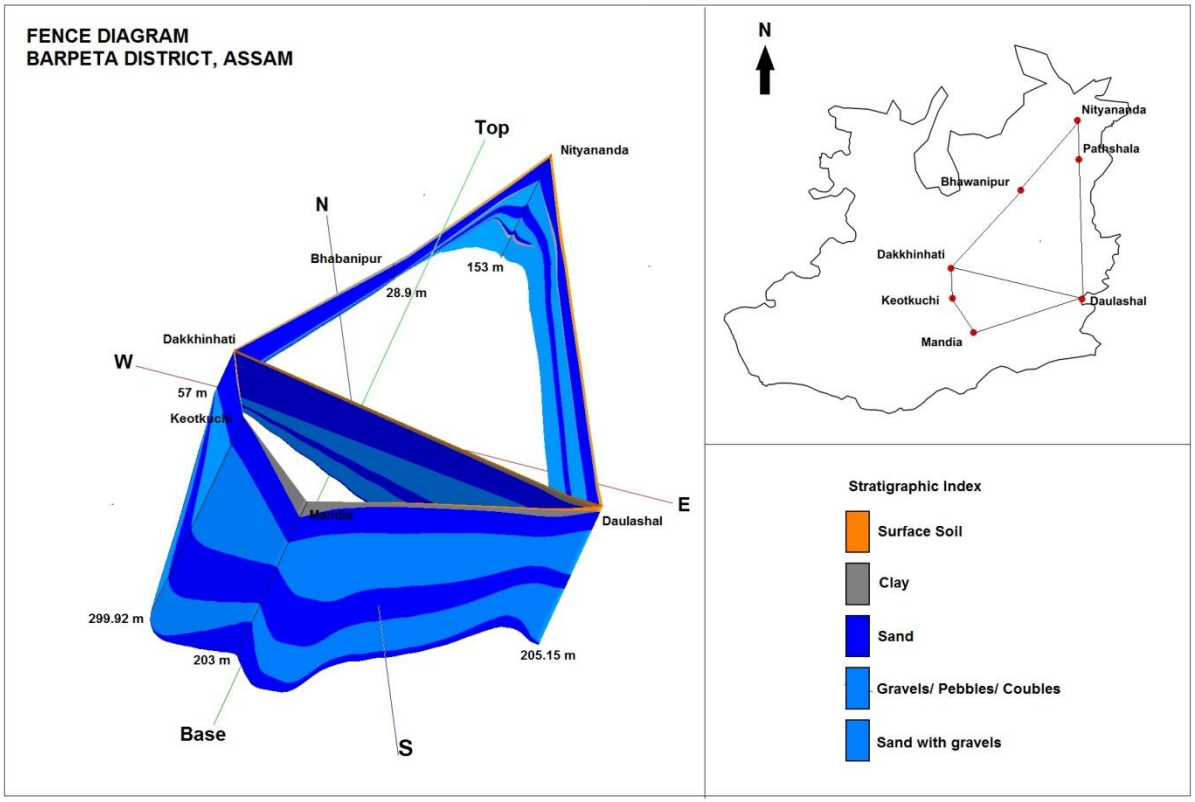


Fig 3.1.3: Fence diagram of Barpeta District

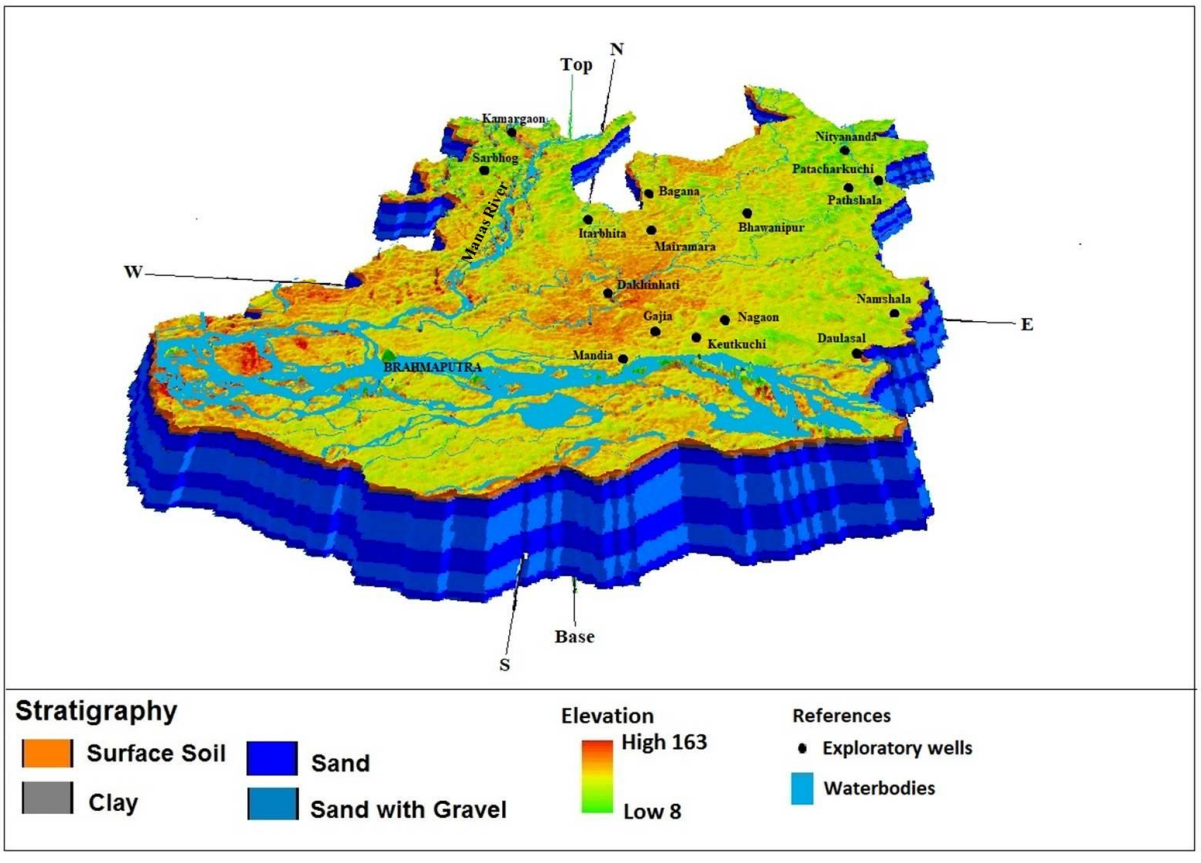


Fig 3.1.4: 3DStratigraphic Model of Barpeta District

Aquifer Characterization: Unconsolidated alluvial aquifer consists of older and younger alluvium. Older alluvial aquifer is found towards northern part of the district. The alluvial aquifer is characterized by coarse grained materials ranging in size from sand to gravel. 2D disposition of aquifer clearly indicates that sandy gravel zone is found in the sub-surface near the surface. The thickness of sand is more in south western part of the district and decreases towards north eastern part. Below this zone, sand mixed with gravel zone is found. Thickness of this zone is more towards eastern part of thedistrictand is reduced as we move towards eastern part. Broadly the aquifer in the district can be classified into two groups for ground water extraction purposes, viz., shallow aquifer zone and deeper aquifer zone. Shallow aquifer zone depth limit is 50m and below which deeper aquifer zone exists. The characteristic features of shallow and deeper aquifer zones are given in Table 3.2.

Table 3.3: Distribution and Characteristics of Aquifer System of Barpeta District

Principal Aquifer Delineated	Zones Encountered (m bgl)	Zones Tapped (m bgl)	Discharge (m^3 /hr)	Drawdown (m)	Transmissivity m^2/day
Alluvium	**Shallow** 6-15 21-27 28-35 41-45 **Deeper** 52-65 67-72 73-88 88-100 100-129 129-154 154-166	**Shallow** 9-15 22-25 28-35 41-45 **Deeper** 53-65 68-71 75-87 90-99 101-128 129-154 167-153	**Shallow** 22.68- 35.64 **Deeper** 28-124.44	**Shallow** 0.75-1.90 **Deeper** 0.04-4.38	**Shallow** 1664.12- 5223.8 **Deeper** 16071-4238

3.1.2: Depth to water level: Depth to water level monitored from dug wells (unconfined Aquifer) during November, 2021 ranges from 1.41 m to 5.78 mbgl while in March,2022 depth to water level ranges from 2.01 m to 6.80 m bgl. Depth to Water Level Map of Barpeta District during pre- monsoon and Post-Most Monsoon is shown in the Fig 3.1.1 and Fig 3.1.2 respectively. Fluctuation of water level ranges from 0.46 to5.09mbgl.

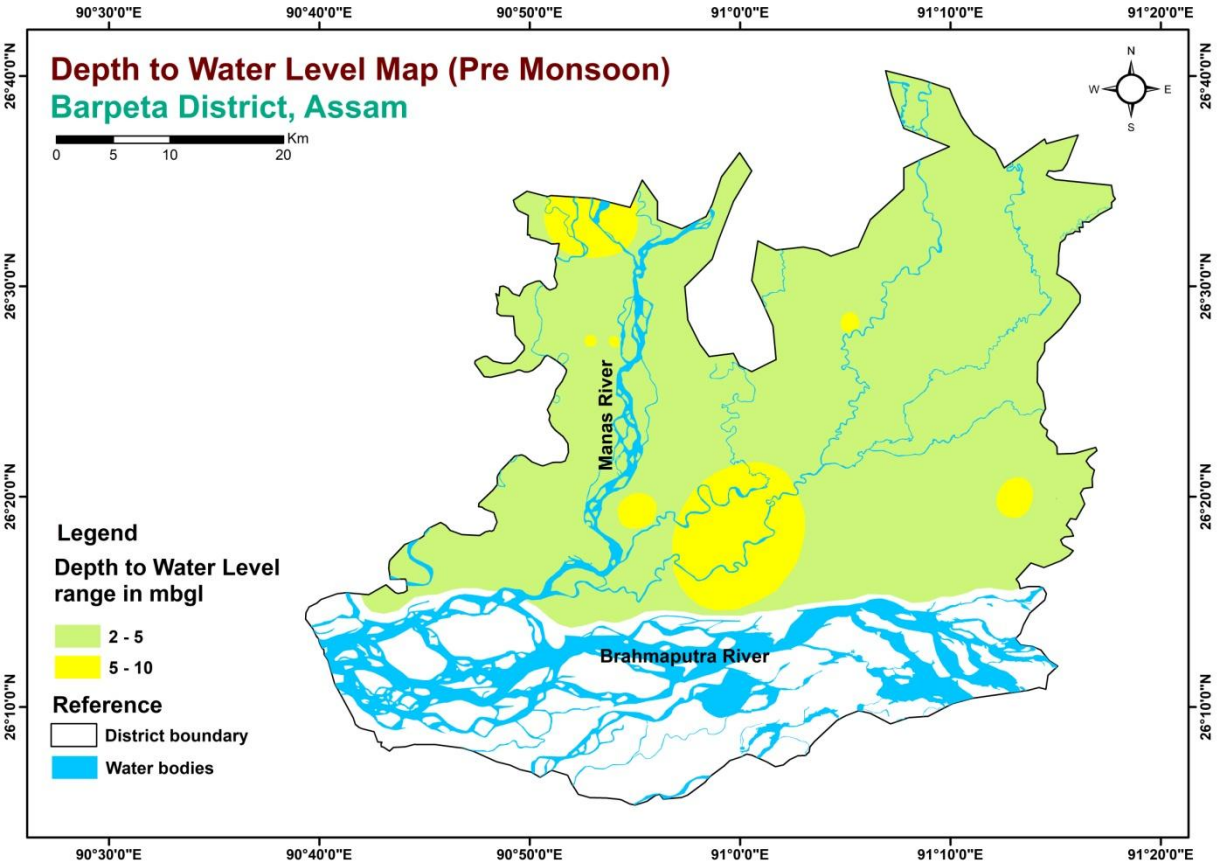


Fig 3.1.3: Pre Monsoon Water Level Map of Barpeta District

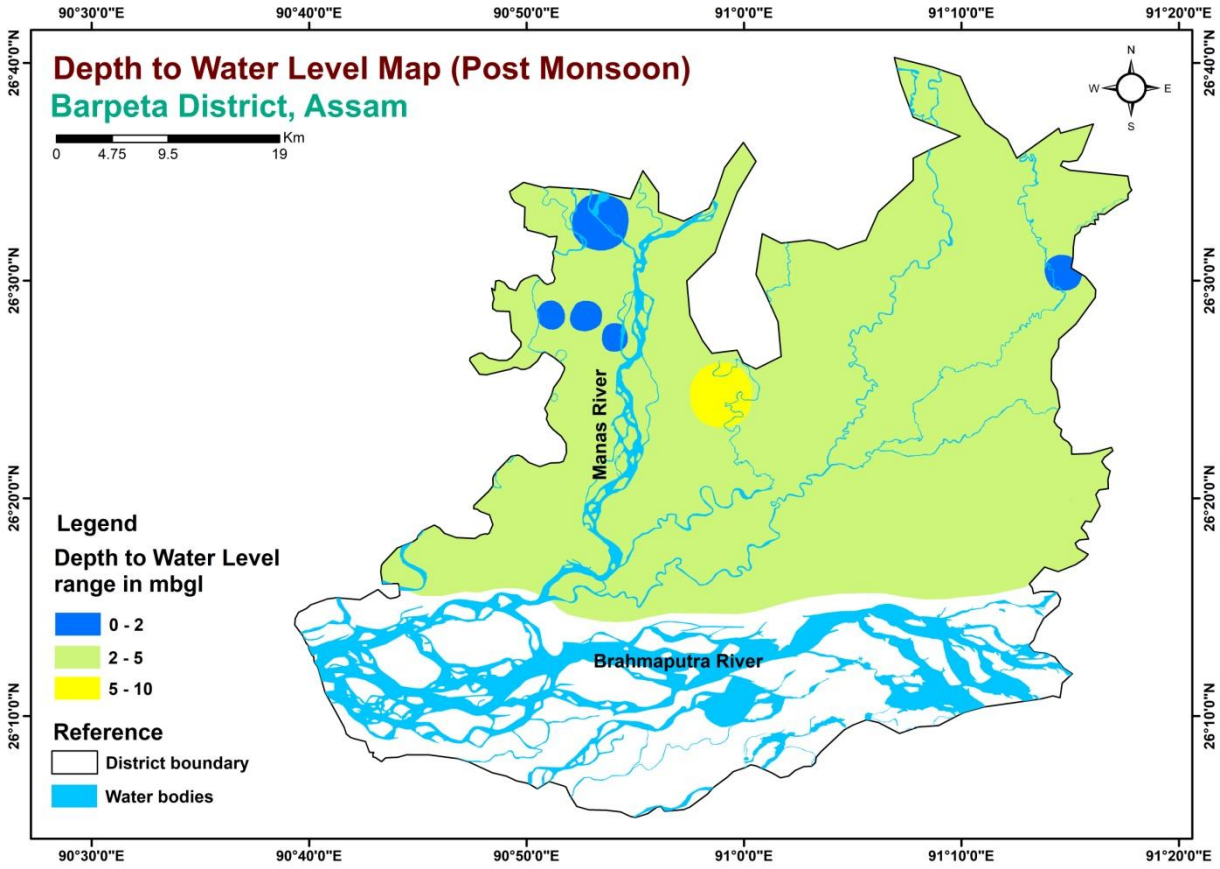


Fig 3.1.4: Post- Monsoon Water Level Map of Barpeta District

Groundwater Movement: The recharge zone of the district lies towards northern part of district. The groundwater flow is from north to south. The aquifer is contributing to the river (Fig.3.1.8).

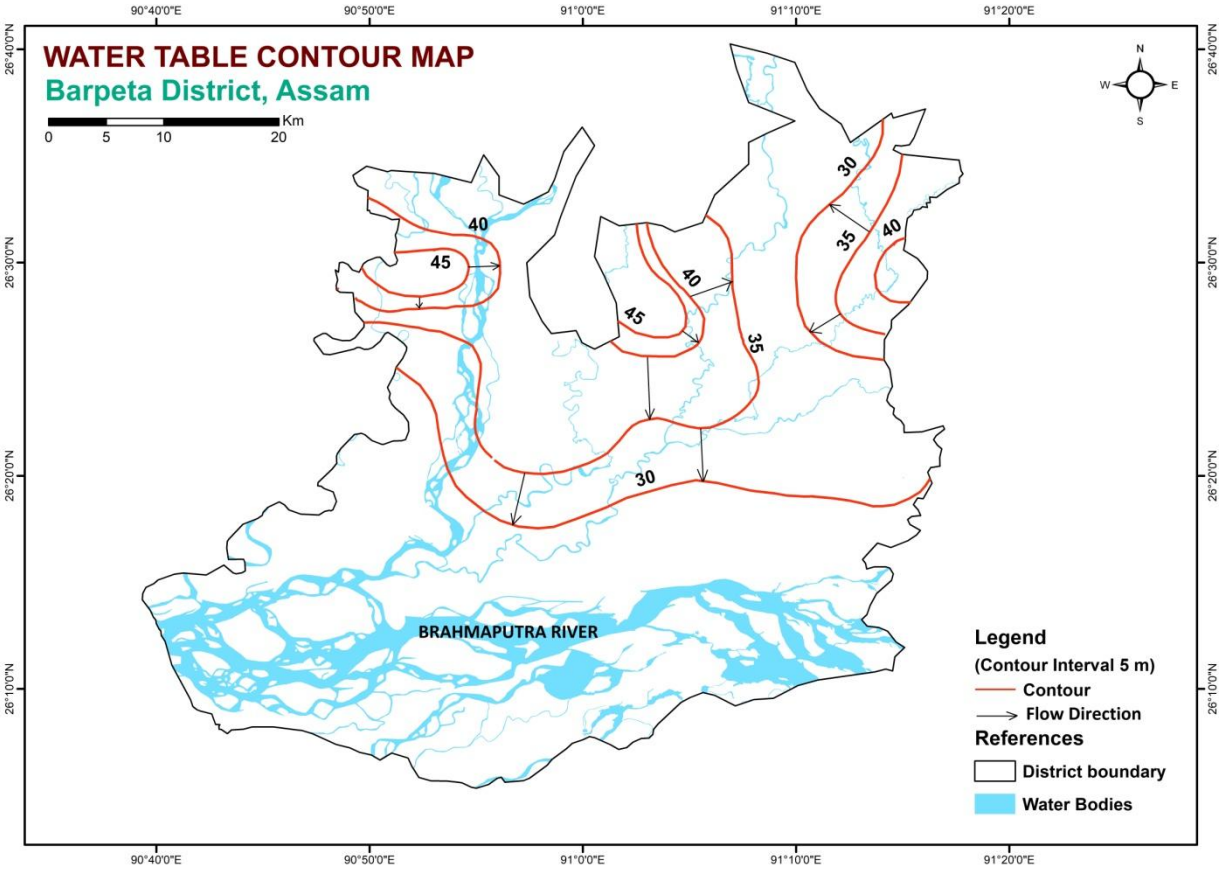


Fig 3.1.8: Water table contour map of Barpeta District

The entire northern part forms the recharge zone for the entire area. Ground water flow is from the higher elevation in northern towards the southern part. The highest water table is 70 m above mean sea level in the district while lowest contour is 20 m towards south.

3.1.3 Ground water quality

During Pre- Monsoon: The pH value in ground water in dug during pre monsoon wells ranges from 6.70 to 8.43. EC value and TDS concentration varies from 128.40 to 937.80 µmhos/cm and 84.74 to 618.95 mg/l respectively. The concentration of Cl^- is from 17.73 to 86.63 mg/l and that of SO_4 is 2.86 to33.90 mg/l. Ca and Mg concentration ranges from 8.01 to 76.06 mg/l and 2.41 to 88.58 mg/l respectively with a total hardness of 60 to 430 mg/l. Chemical constituents of ground water of dug wells are within permissible limit of drinking, agricultural and industrial water standard set by BIS. However, iron (Fe) content beyond permissible limit has been observed in some places. Arsenic i.e. As is also within the permissible limit and ranges between BDL to 8.228 mg/l.

During Post Monsoon:

The pH value in ground water in dug during post monsoon wells ranges from 7.18 to 8.37. EC value and TDS concentration varies from 106.30 to 1270 µmhos/cm and 70.16 to 838.20 mg/l

respectively. The concentration of Cl^- is from 14.18 to 251.70 mg/l and that of SO_4 is 3.06 to 65.03mg/l. Ca and Mg concentration ranges from 16.01 to 82.07 mg/l and 2.41 to 88.58 mg/l respectively with a total hardness of 60 to 430 mg/l. Chemical constituents of ground water of dug wells are within permissible limit of drinking, agricultural and industrial water standard set by BIS. However, iron (Fe) content beyond permissible limit has been observed in some places.

Deeper Aquifer Zone: The pH value of ground water in deeper aquifer zone ranges from 7.61 to 8.41, while the EC value and TDS concentration varies from 458.60 to 763.60 µmhos/cm and 302.54 to 503.98 mg/l respectively. The concentration of SO_4 is 5.96 to 33.90 mg/l. Ca and Mg concentration ranges from 18.01 to 100.08 mg/l and 23.03 to 48.53 mg/l respectively with a total hardness of 240 to 410.

Iron distribution in both shallow and deeper aquifers is shown in Fig 3.1.9.

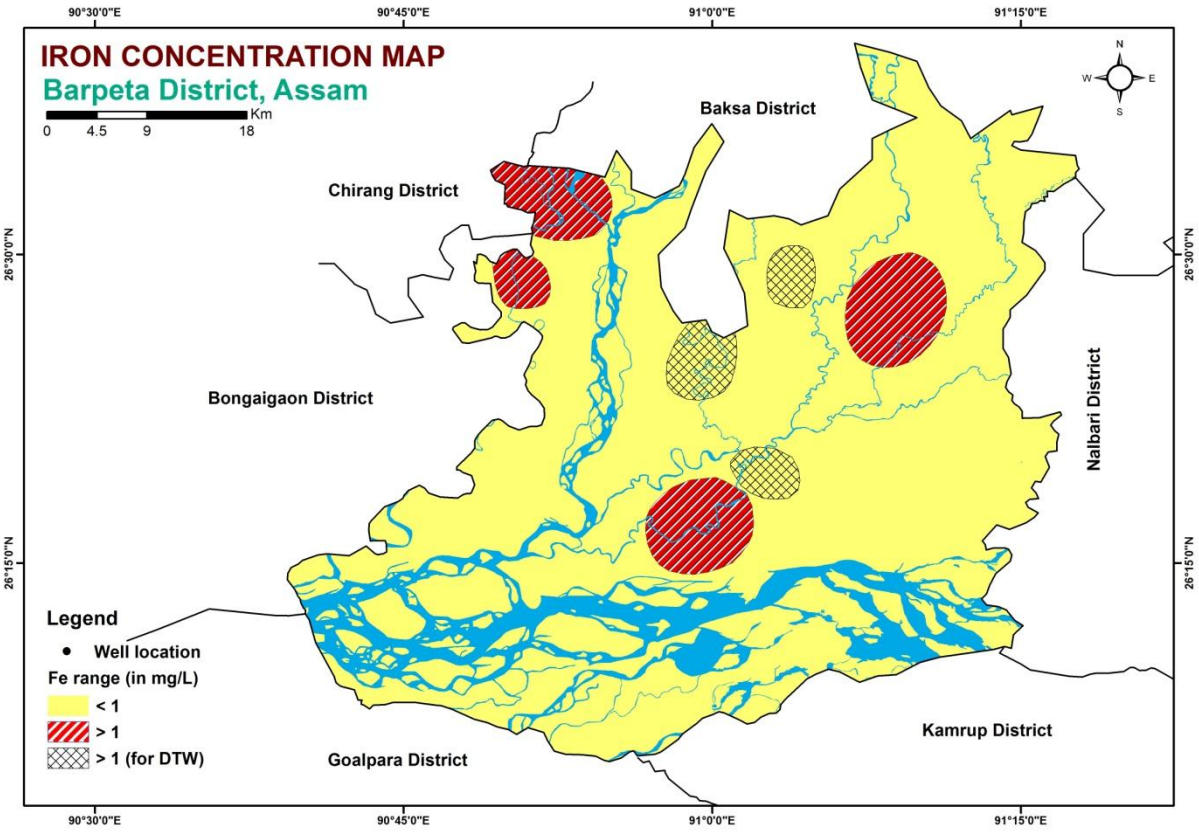


Fig 3.1.9: Iron Concentration map of Barpeta District

Piper Diagram

Piper trilinear diagram is an effective graphical procedure to segregate the analytical data to understand the sources of the dissolved constituent in water. In chemical equilibrium cations and anions are present in the water.

Pre-Monsoon: The analyzed sample falls under the magnesium bicarbonate type, one sample fall under mixed type origin and only one sample in the calcium chloride type. From the plot in the cation triangle, we can see most of the samples from pre monsoon are falling under no dominant type and magnesium. In the anion triangle all the pre-monsoon samples are falling under bicarbonate type and only one sample falls under chloride type.

By the extrapolation of cations and anions in to the diamond field, the hydro-chemical facies of groundwater samples can be analysed. The facies reflect the response of chemical processes operation within the lithologic framework and flow pattern. This diagram represents that samples fall under Magnesium bicarbonate type.

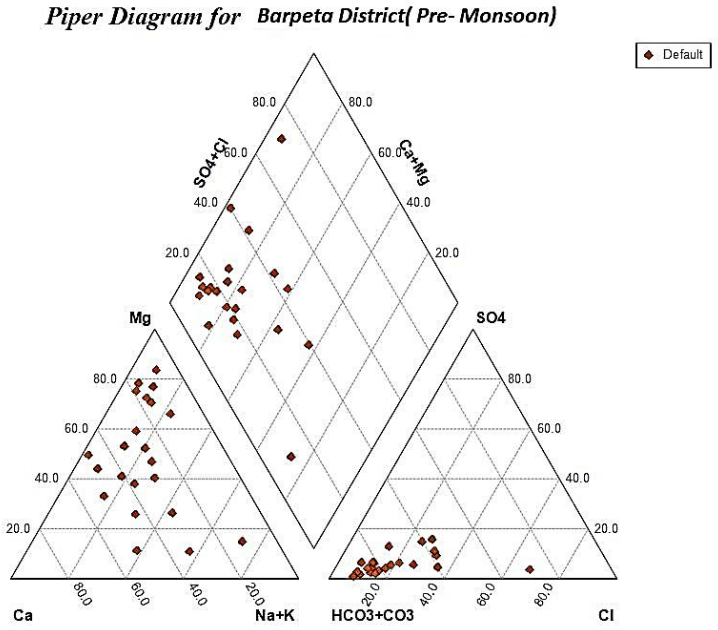


Figure 3.1.10 Piper trilinear Diagram (Pre-Monsoon)

Post Monsoon:

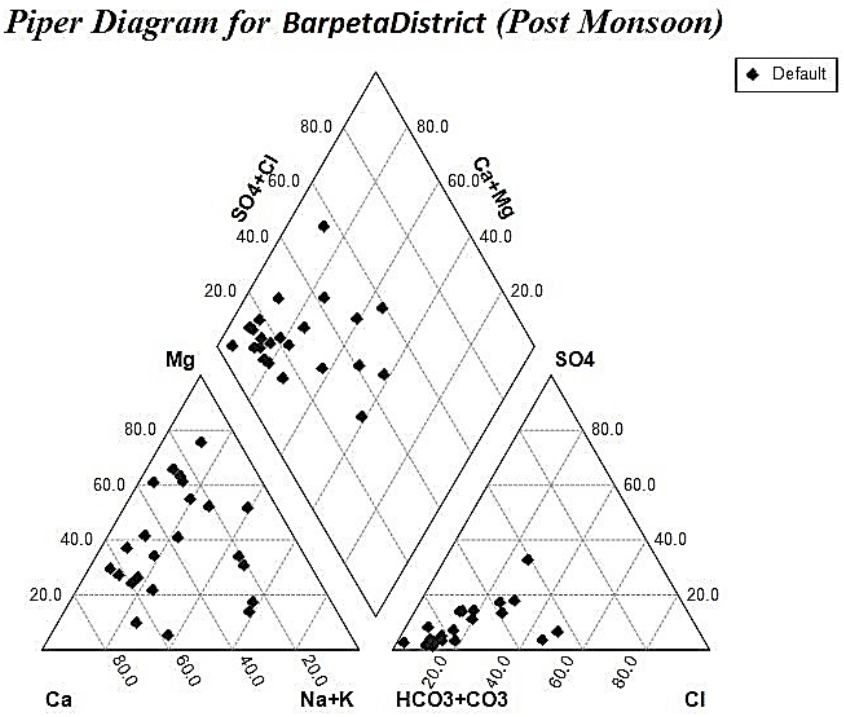


Figure 3.1.11 Piper trilinear Diagram (Post-Monsoon)

The analyzed sample falls under the magnesium bicarbonate type, four samples fall under mixed type origin. From the plot in the cation triangle, we can see most of the samples from post monsoon are falling under calcium dominant type and magnesium type. Four samples fall under non dominant type. In the anion triangle all the post-monsoon samples are falling under bicarbonate type and only two sample falls under non dominant type. By the extrapolation of cations and anions in to the diamond field, the hydro-chemical facies of groundwater samples can be analysed. The facies reflect the response of chemical processes operation within the lithologic framework and flow pattern. This diagram represents that post monsoon samples are falling under Magnesium bicarbonate type.

Wilcox diagram

Pre-Monsoon: According to Wilcox diagram (US Salinity Laboratory's diagram) in Figure 3.1.12, salinity and alkalinity hazard class of water samples were determined. The result shows that a majority of the ground water samples possess medium salinity with low sodium (C1–S1) and (C2-S1) field. Only two samples from pre monsoon season falls in the (C3-S1) field. Samples falling under (C1–S1) field shows that this water can be used directly for irrigation purpose. However, water samples falling in medium salinity and low sodium class (C2-S1) and (C3-S) should be treated before using for irrigation purposes.

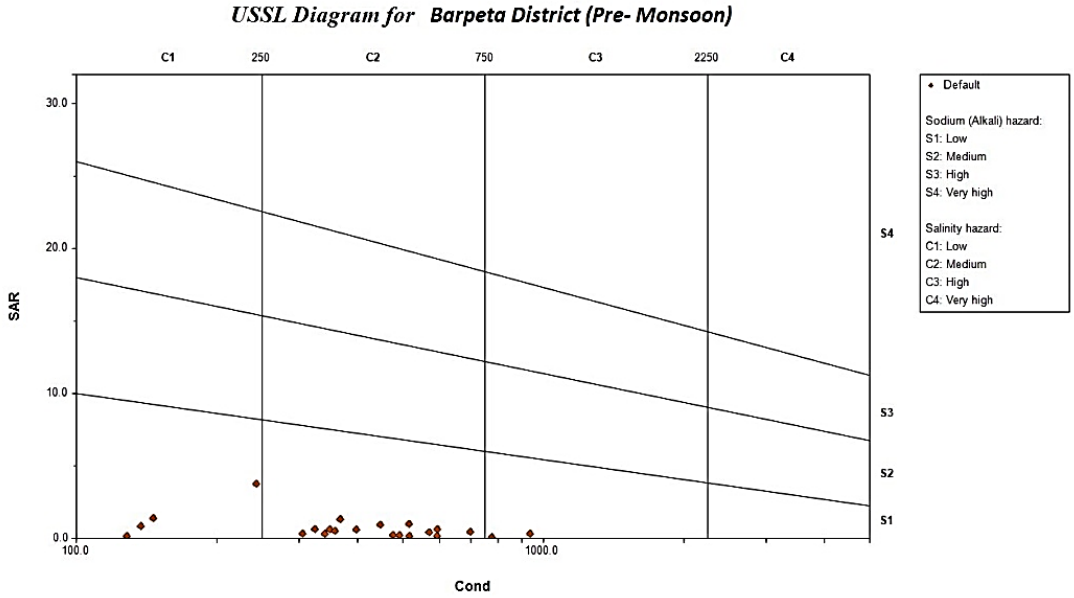


Figure 3.1.12 Wilcox Diagram, Wilcox, L.V. (1955)

Post-Monsoon: According to Wilcox diagram (US Salinity Laboratory's diagram) in Figure 3.1.12, salinity and alkalinity hazard class of water samples were determined. The result shows that a majority of the ground water samples possess medium salinity with low sodium (C1–S1) and (C2-S1) field. Only one sample from pre monsoon season falls in the (C3-S1) field. Samples falling under (C1–S1) field shows that this water can be used directly for irrigation purpose. However, water samples falling in medium salinity and low sodium class (C2-S1) and (C3-S) should be treated before using for irrigation purposes.

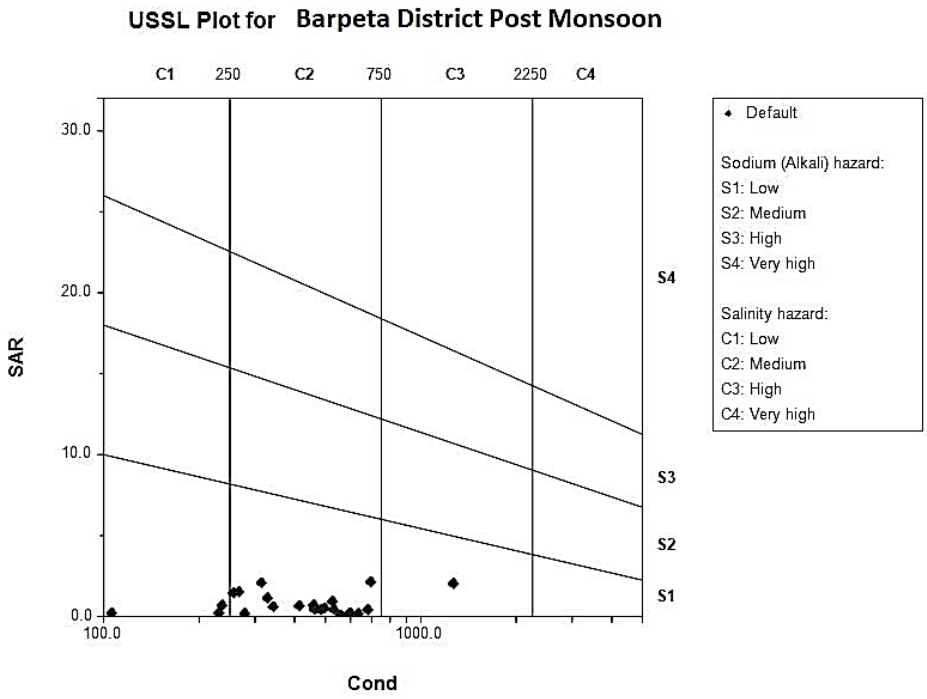


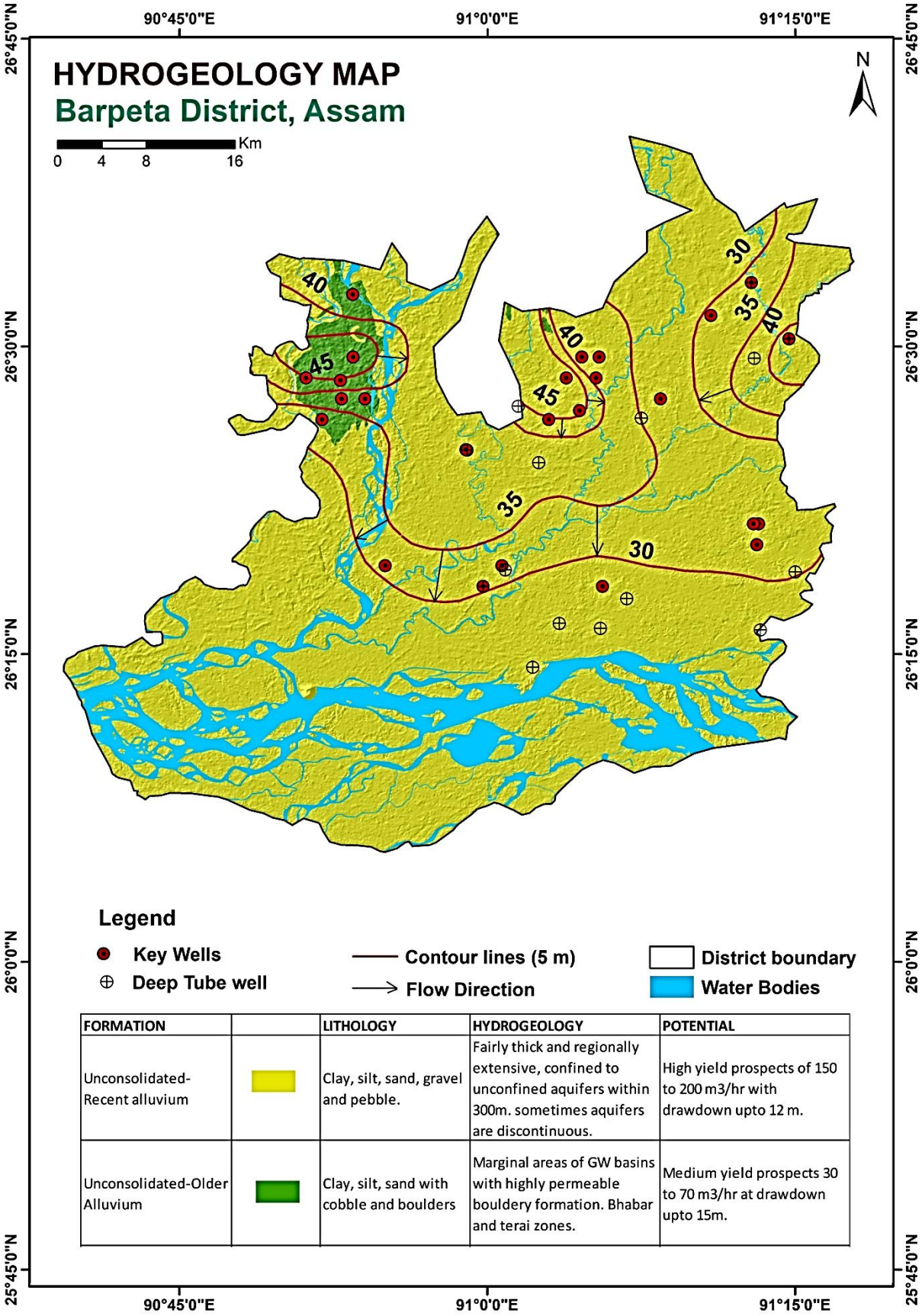
Figure 3.1.13 Wilcox Diagram, Wilcox, L.V. (1955)

Based on the hydrogeomorphic set up, the area can broadly be identified as alluvial plain. The characteristic feature of these zone are enumerated in the following table

Table 3.2: Division of study area based on geomorphology and its characteristic features

FORMATION	LITHOLOGY	HYDROGEOLOGY	POTENTIAL
Unconsolidated-Recent alluvium	Clay, silt, sand, gravel and pebble.	Fairly thick and regionally extensive, confined to unconfined aquifers within 300m. sometimes aquifers are discontinuous.	High yield prospects of 150 to 200 m3/hr with drawdown up to 12 m.
Unconsolidated-Older Alluvium	Clay, silt, sand with cobble and boulders	Marginal areas of GW basins with highly permeable boulder formation. Bhabar and terai zones.	Medium yield prospects 30 to 70 m3/hr at drawdown up to 15m.
Consolidated formations- Meta sedimentary/ Basal	Gneissic complex with acidic and basic intrusive	Fissured formation, local discontinuous. unconfined to semi-confined aquifers. GW restricted to 50 m depth in weathered residuum.	Very low yield prospect upto 5 m3/hr

The aquifer disposition of the area in panel diagram indicates existence of a single aquifer in the area.



FORMATION		LITHOLOGY	HYDROGEOLOGY	POTENTIAL
Unconsolidated-Recent alluvium		Clay, silt, sand, gravel and pebble.	Fairly thick and regionally extensive, confined to unconfined aquifers within 300m. sometimes aquifers are discontinuous.	High yield prospects of 150 to 200 m3/hr with drawdown upto 12 m.
Unconsolidated-Older Alluvium		Clay, silt, sand with cobble and boulders	Marginal areas of GW basins with highly permeable bouldery formation. Bhabar and terai zones.	Medium yield prospects 30 to 70 m3/hr at drawdown upto 15m.

Fig 3.2: Hydrogeological Map of Barpeta District

CHAPTER-4

GROUNDWATERRESOURCES

The computation of ground water resources available in the district has been carried out using GEC 2015 methodology. The assessment unit in the present assessment is district due to paucity of block-wise data. The summarised result is presented in Table 4.1.

Data and assumptions used in the assessment: Following data and assumptions are used in the assessment:

1) Rainfall recharge has been computed by RIF method. In RIF method, rainfall infiltration factor has been taken as 0.22 for major aquifer like valley fill.

2) Last ten years rainfall data is considered for groundwater resource calculation.

3) Water level data has been considered for 2021-22. Water level fluctuation based on data of March (Pre monsoon) and November (post monsoon) has been considered since deepest water levels are recorded during the month of March.

The average of pre- and post-monsoon water level of Barpeta district is 4.35 m,bgl and 3 m,bgl.

4) The population figures were collected from Census, 2011and projected to 2020. The per capita domestic requirement for the rural population has been considered as 60 lpcd and for urban population, it is 135 lpcd.

5) The dependency on ground water resource for domestic and industrial water supply in rural areas is considered as 91% and for urban areas, the dependency is 79%.

6) The command area of the district is 72767 ha as per data provided by the Irrigation Department, Govt. of Assam.

7) In order to calculate the canal seepage, the data on length of the drainage channels are taken from the Irrigation Department, Govt. of Assam. The factor for return flow from surface water irrigation has been taken as 0.50 (paddy) and 0.30 (non-paddy) and for Ground water irrigation it has been taken as 0.45 (paddy) and 0.25 (non-paddy). Recharge from tanks and ponds are calculated based on the norms suggested in GEC'2015.

8) Recharge from water conservation structure has been taken as nil.

4.1 Recharge

The aquifers of the study area are recharged through a) infiltration of rainfall on the outcrop b) seepage from the tanks and ponds c) subsurface inflow across the up dip margin. The area experiences south-east monsoon. Monsoon rainfall contributes approximately 81 percent of total rainfall (May, June, July, August, September) while share of post and pre monsoon rainfall are approximately 13 and 6 percent each.

The rainfall recharge in the command area is 126786.04 ham while recharge from other sources is 12,157.31 ham. In the command area recharge from rainfall is 114628.73 ham and recharge from other sources 5818.54 ham. Total ground water recharge is 126786.04 ham.

4.2 Ground Water Extraction

The ground water extraction of unconsolidated aquifer is created by natural discharge like seepages and draft created by human interference, viz., (a) withdrawals for irrigation and industry and (b) public-supply wells.

In the district natural discharge is 12678.6 ham of the total groundwater recharge, i.e., 12678.60 ham. Total irrigation extraction is 24276 hams, for industry 11.92 ham and extraction for domestic uses is 3910.42 ham. Total groundwater extraction for all uses is only 28198.42 ham.

4.3 Allocation of resources up to 2025

The net ground water resource allocated for domestic sector is 4461.22 ham while 84377.2 ham resource is available for future use.

4.4 Stage of Ground Water Extraction

The area has very little irrigation facilities. Similarly industrial development in the area is practically less. Groundwater is mainly utilized for domestic purposes. The stage of groundwater extraction in the district is 24.93%

Table 4.1: Dynamic GW resources of Barpeta District, Assam

Monsoon recharge	Non-monsoon Recharge	Total annual ground water recharge	Total Natural Discharges (Ham)	Net Ground Water Availability for future use (Ham)
94313.06	32472.98	126786.04	12678.6	84377.2

Table 4.2: Categorization of ground water resources (ham)

Annual Extractable GW Resources	Annual GW extraction				Allocation for Domestic use up to 2025	Stage of ground water extraction (%)
	Irrigation	Domestic extraction	Industrial extraction	Total		
113126.34	24276	3910.41	11.92	28198.34	4461.22	24.93

Groundwater Resources – Recharge for Various Seasons

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 4.3

Table 4.3: Recharge from various sources (ham).

District	Recharge from Rainfall during monsoon season	Recharge from rainfall during non-monsoon season	Recharge from other sources during monsoon Season	Recharge from other sources during non-monsoon Season	Total Annual Ground Water Recharge	Annual Extractable GW Resources
Barpeta	87974.29	26654.44	6338.77	5818.54	126786.04	113126.34

Recharge from rainfall in the district is 126786.04 hams. Comparison of monsoon & non-monsoon rainfall recharge shows that monsoon recharge accounts for 69 %. Recharge from other sources is 12157.31 ham. Comparison of recharge from rainfall, to recharge from sources other than rainfall shows that the later accounts for only about 9.5 % of the total recharge.

Groundwater Extraction for VariousPurposes

Domestic Extraction

Groundwater extraction for domestic use has been estimated on projected population for 2025, based 2011 Census data of number of households using groundwater as "Main source of drinking water". Groundwater extraction for irrigation is 24276 whereas for domestic and industrial supply it is 3910.41 ham and 11.92 in the district. Hence, groundwater extraction for all uses in the district is 28198.34ham. Provision for allocation of domestic requirement of water supply to 2025 is 4461.22 ham. Net Ground Water Availability for future development in the district is 84377.2 ham.

Stage of Groundwater Development &Categorization of the Blocks

The stage of Ground Water development is defined as the ratio between the existing gross ground water drafts for all uses by net annual ground water availability multiplied by 100. The various units of assessment are categorized based on the stages of Ground Water development and long term trend of pre and post monsoon water level. The stage of ground water development for Barpeta district is 24.93 %. Based on the stages and development and long-term water level trend analysis the district can be categorized under **safe** category.

CHAPTER-5

Groundwater Issues

Major groundwater issues in the district are:

a) Low stage of groundwater extraction
b) Water quality problem pertaining to high concentration of iron above permissible limit in some pockets

a) Low Stage of Ground Water Extraction

As per ground water resource estimation, the stage of ground water development is just 24.93% and share of ground water in irrigation is very less. The irrigated area of the district is only 13.37% of the net cropped area.

One major obstacle in accelerating ground water irrigation is the presence of boulder pebble and cobble zone in the aquifer which creates difficulty in drilling operations.

b) Drilling Problems

The construction of tube wells is difficult due to encounter of boulder formation after certain depth.

c) **Water Quality problems**

Iron above permissible limit is detected in some shallow as well as deep wells in the younger alluvial plain. Except high iron content, the ground water of the district is suitable and safe for drinking and other uses.

In deeper aquifer it ranges from 1.74 to 7.05 ppm.

CHAPTER-6

GROUND WATER MANAGEMENT STRATEGY

As per dynamic ground water resource estimation of Barpeta district for 2019-20, net ground water availability is 84377.2 ham and stage of extraction is only 24.93 %. If an irrigation plan is made to develop 60% of the balance dynamic ground water resources available, then **50626.32** ham of groundwater resources is available in the district for the future irrigation uses. From this available resource,**21094.3** nos. of shallow tube wells (considering a unit draft of 2.4 ham/year) can be constructed. Therefore, there is enough scope for future development of ground water in the district to bring more area under irrigation practice.

During Kharif season, land under cultivation (field crops only) in the district is 64550 ha (District Irrigation Plan, 2016-20). After kharif crops are over, whole of this cultivable area remains fallow during Rabi season. Gap between area cultivated during kharif season and rabi season is 64550 ha. The intention of this plan is to utilize this fallow land of about 64550 ha under assured irrigation during Rabi season which will help to increase gross cropped area to 129100 ha. This will help to increase gross cropped area and thereby increase cropping intensity up to 200%. Since stage of dynamic ground water is only 24.93 %, this area of 64550 ha can easily be covered by constructing ground water based irrigation projects. To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. A suitable cropping plan for the district was prepared and is presented in Table 6.1

Table 6.1: Cropping Pattern Data of BarpetaDistrict (*Source: CROPWAT)*

CROPPING PATTERN DATA

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

Cropping pattern name: Baksa_Rice

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...Data\CROPWAT\data	Rice	05/06	02/10	20
2	...Data\CROPWAT\data	Rice	10/06	07/10	20
3	...Data\CROPWAT\data	Rice	20/06	17/10	20
4	...Data\CROPWAT\data	Rice	25/06	22/10	20
5	...Data\CROPWAT\data	Rice	30/06	27/10	10
6	...Data\CROPWAT\data	Rice	10/07	06/11	10

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

Table 6.2: Proposed cropping pattern of Vegetables & Rice in Barpeta district

Cropping Pattern				
Early Summer Rice-Late Winter Rice	Present Cultivated area	Area to be cultivated	Area to be cultivated (**ha**)	Irrigation requirement (**ha m**)
Summer vegetables- Late Winter Rice	(**ha**)	(**%**)		
Pulses-Late Winter Rice-Potato/Vegetables/Wheat				
Net cultivated area	**57577**			
	1	2 (= % of 1)	3	4
Rice (main crop)	64550		64550	
Winter Rice (main crop)	64550	50	64550	10784.04575
Potato		8	10328	1775.386795
Pulses		8	10328	1352.48373
Mustard		12	15492	3252.236845
Winter vegetables		5	6455	784.486625
Summer vegetables		5	6455	850.124405
Wheat		2	2582	721.151925
Maize		10	12910	2118.8336
Gross cultivated area (Paddy/+Maize/+Wheat+ Pulses+Vegetables)			**129100**	21638.74968
Total irrigation requirement (70% irrigation efficiency)				**30912**
Cropping intensity			**200% (Intended)**	

Source: CROPWAT

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been estimated from CROPWAT after giving necessary meteorological, soil, crop plan inputs and the same has been shown in Table 6.4. Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in Table 6.5.

The total area of rice cultivation is comprised of **64550** ha. During kharif season, rice is cultivated from June to mid-July. Since this huge area cannot be cultivated in a single day (one planting date), so it is considered/ planned to cultivate rice in two to four stages during this period. It is planned to utilize rice fallow of **64550**ha for the cultivation of pulses, potato, mustard and vegetables. It is considered to cultivate the proposed crops 10328 ha,10328 ha,15492 ha,6455 ha, 6455 ha ,2582 ha and 12910 ha each. The peak water requirement for irrigation for rice is in the months of May-June, for mustard and pulses it is in the month of January, for potato it is in the month of March and for vegetables it is during February.

Table 6.4: Crop-wise and month-wise precipitation deficit (mm) using CROPWAT 8 for BarpetaDistrict.

Precipitation deficit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Potato	60.9	37.1	0	0	0	0	0	0	0	0	29.5	62
2. Potato	62.1	64	31.6	0	0	0	0	0	0	0	16.1	39.8
3. Pulses	53.5	4.4	0	0	0	0	0	0	0	1.3	24.5	62
4. Pulses	61.5	18.9	0	0	0	0	0	0	0	2.4	14.2	55.6
5. Pulses	62.4	40.2	0	0	0	0	0	0	0	0	10.9	43.2
6. Mustard	49.8	51.9	58.4	7.4	0	1.4	0	0	0	2.4	20.4	50
7. Mustard	49.8	51.9	58.4	7.4	0	0	0	0	0	0	16.2	47.6
8. Mustard	49.8	51.9	58.4	7.4	0	0	2.8	0	0	0	6.1	36.3
9. Small Vegetables	20.1	0	0	0	0	0	0	0	0	6.5	46.3	57.2
10. Small Vegetables	45.5	0	0	0	0	0	0	0	0	5.2	36.2	55.5
11. Small Vegetables	48.1	59.3	28.9	0	0	0	0	0	0	0	0	26.9
12. Small Vegetables	44.9	59.3	40.9	0	0	0	0	0	0	0	0	20.6
13. Winter Wheat	42.8	50.1	65.5	24.7	2.2	0	0	0	0	0	26.7	38.5
14. MAIZE (Grain)	57.1	69.1	34.5	0	0	0	0	0	0	0	2	19.2
15. MAIZE (Grain)	46.2	69.2	58.4	0	0	0	0	0	0	0	0	12.4

Table 6.5: Actual monthly water requirement for different crops in Barpeta district, Assam

Crop	Area (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total IWR (Ham)
Winter Rice		0	0	0	0	**949.53**	**336.31**	**0**	0	**0**	40.02	**0**	**0**	1325.86
Winter Rice		0	0	0	0	**475.41**	**948.89**	**0**	0	**0**	68.75	**0**	**0**	1493.04
Winter Rice		0	0	0	0	**782.67**	**1581.48**	**0**	0	**0**	29.05	**0**	**0**	2393.19
Winter Rice		0	0	0	0	**6.46**	**1891.32**	**0**	0	**0**	156.21	**0**	**0**	2053.98
Winter Rice		0	0	0	0	0.00	1897.77	0	0	0	331.79	34.86	0	2264.41
Winter Rice		0	0	0	0	0.00	316.30	632.59	0	0	189.78	114.90	0	1253.56
1. Potato	20	**196.55**	**119.74**	**0**	**0**	**0.00**	**0.00**	**0**	0	**0**	0.00	**95.21**	**200.11**	611.61
2. Potato	20	**400.86**	**413.12**	**203.98**	**0**	**0.00**	**0.00**	**0**	0	**0**	0.00	**103.93**	**256.91**	1378.79
3. Pulses	20	**172.67**	**14.20**	**0.00**	**0**	**0.00**	**0.00**	**0**	0	**0**	4.20	**79.07**	**200.11**	470.25
4. Pulses	20	**198.49**	**61.00**	**0.00**	**0**	**0.00**	**0.00**	**0**	0	**0**	7.75	**45.83**	**179.45**	492.52
5. Pulses	10	**201.40**	**129.75**	**0.00**	**0**	**0.00**	**0.00**	**0**	0	**0**	0.00	**35.18**	**139.43**	505.75
6. Mustard	10	**160.73**	**167.51**	**188.49**	**23.88**	**0.00**	**4.52**	**0**	0	**0**	7.75	**65.84**	**161.38**	780.09
7. Mustard		**321.46**	**335.01**	**376.97**	**47.77**	**0.00**	**0.00**	**0**	0	**0**	0.00	**104.57**	**307.26**	1493.04
8. Mustard		**321.46**	**335.01**	**376.97**	**47.77**	**0.00**	**0.00**	**18.07**	0	**0**	0.00	**39.38**	**234.32**	1372.98
9. Small Vegetables		**64.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**	0	**0**	20.98	**149.43**	**184.61**	419.90
10. Small Vegetables		**146.85**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**	0	**0**	16.78	**116.84**	**179.13**	459.60
11. Small Vegetables		155.24	191.39	93.27	0.00	0.00	0.00	0	0	0	0.00	0.00	86.82	526.73
12. Small Vegetables		144.91	191.39	132.00	0.00	0.00	0.00	0	0	0	0.00	0.00	66.49	534.80
13. Winter Wheat f.f.		138.14	161.70	211.40	79.72	7.10	0.00	0	0	0	0.00	86.17	124.26	808.49
14. MAIZE (Grain)		368.58	446.04	222.70	0.00	0.00	0.00	0	0	0	0.00	12.91	123.94	1174.16
15. MAIZE (Grain)		298.22	446.69	376.97	0.00	0.00	0.00	0	0	0	0.00	0.00	80.04	1201.92
Total		**3290.44**	**3012.55**	**2182.76**	**199.14**	**2221.17**	**6976.56**	**650.66**	**0**	**0**	**873.04**	**1084.12**	**2524.23**	**23014.66**

As part of the ground water exploration programme, CGWB has drilled 14 nos. DTWs down to the depth of 299 m bgl and one shallow tube well. It is observed that tube wells constructed down to a depth from 299 m and tapping 3 – 27 m cumulative thickness of aquifer are capable to yield 28 to 124.44 m^3/hr for a maximum drawdown up to 5.6 m. The transmissivity of the aquifer is calculated as 4238 to 16071 m^2/day and can be sustainably developed and use for irrigation purpose. Shallow tube wells within 40m depth can be constructed through 150/100mm diameter well assembly tapping 30–55m granular zones having 25m housing and 15-30 m slotted portion. The annular space between the borehole and the well assembly should be shrouded preferably with 100mm thick zone of pea gravels.

A shallow tube well in the district is expected to yield 30 m^3/hr. If such a tube well runs for 8 hrs/day for 120 days, then it will create a draft of 2.88 ham.

Annual irrigation water requirement is **30912 hams**. However, proportionate dynamic groundwater resources available for future irrigation use in the district is **50626.32** ham. Therefore, this rice fallow area can be irrigated by constructing ground water abstraction structures and can bring under double cropped area. This amount of groundwater resources can be harnessed by constructing **10733** tube wells. It is also proposed to construct water harvesting structures at suitable places. As per available ground water resources (60% availability) **10733** nos. of tube wells can be constructed.

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

ANNEXURE 1: WATER LEVEL DATA OF KEY WELLS OFBARPETA (Nov, 2021)

S.N	District*	Block*	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Dia*	Water Level (m bmp) Nov-2021
STATE : ASSAM											
1	Barpeta	Nuntola	Kamargaon	26.5422	90.89056	DUG	0.82	38	7.11	1.25	4.96
2	Barpeta	Chakachak	Amguri	26.4575	90.90039	DUG	1.02	41	6.34	0.78	2.25
3	Barpeta	Chakachak	Chakabausi	26.4744	90.85269	DUG	0.95	43	6.1	0.7	1.45
4	Barpeta	Chakachak	Madulijhar	26.4575	90.88147	DUG	0.97	36	4.7	1.51	2.01
5	Barpeta	Rupashi	Raha	26.4406	90.86567	DUG	0.67	36	5.8	0.74	1.04
6	Barpeta	Mandia	Jania	26.3219	90.91685	DUG	1.13	39	7.46	0.8	2.43
7	Barpeta	Mandia	Mandia	26.3050	90.99639	DUG	1.2	33	5.37	1.2	2.7
8	Barpeta	Sarthebari	Gahiya	26.4406	91.04969	DUG	0.73	39	5.38	0.73	3.66
9	Barpeta	Bhawanipur	Banglipara	26.4744	91.08818	DUG	0.8	41	6.44	1.02	2.64
10	Barpeta	Sarthebari	Baniakuchi	26.3558	91.22025	DUG	0.83	27	6.07	0.92	2.49
11	Barpeta	Saruhetri	Haldibari	26.3389	91.21864	DUG	0.96	31	7.17	1.22	3.54
12	Barpeta	Sarukhetri	Lasima	26.3558	91.21603	DUG	0.94	40	5.6	0.9	2.5
13	Barpeta	Barpeta	Satrabarala	26.4575	91.14055	DUG	1.1	34	5.6	1.06	1.52
14	Barpeta	Bhawanipur	Kohora DW	26.4914	91.09067	DUG	0.77	45	5.97	0.79	1.91
15	Barpeta	Bhawanipur	Sarupeta	26.4914	91.07653	DUG	0.6	37	5.67	1.08	1.85
16	Barpeta	Bhawanipur	Indrapur	26.5253	91.18139	DUG	0.83	32	7.55	0.83	1.62
17	Barpeta	Bhawanipur	Zebrabhita	26.4744	91.06399	DUG	0.68	57	5.09	0.67	1.2
18	Barpeta	Chakchaka	Sarbhog	26.4914	90.89071	DUG	0.79	56	6.4	0.76	1.88
19	Barpeta	Barpeta	Majarhati	26.3219	91.01182	DUG	0.8	37	8.4	0.82	4.1
20	Barpeta		Barbila	26.3050	91.09333	DUG	0.82	38	7.11	1.25	4.9

ANNEXURE 2 : WATER LEVEL DATA OF KEY WELLS OF BARPETA (March, 2022)

S.N	District*	Block*	Village	Lat*	Long*	Well* Type	MP*	RL*	Depth*	Dia*	Water Level (m bmp) March-2022
STATE : ASSAM											
1	Barpeta	Nuntola	Kamargaon	26.5422	90.89056	DUG	0.82	38	7.11	1.25	5.98
2	Barpeta	Chakachak	Amguri	26.4575	90.90039	DUG	1.02	41	6.34	0.78	4.01
3	Barpeta	Chakachak	Chakabausi	26.4744	90.85269	DUG	0.95	43	6.1	0.7	3.27
4	Barpeta	Chakachak	Madulijhar	26.4575	90.88147	DUG	0.97	36	4.7	1.51	4.06
5	Barpeta	Rupashi	Raha	26.4406	90.86567	DUG	0.67	36	5.8	0.74	2.54
6	Barpeta	Mandia	Jania	26.3219	90.91685	DUG	1.13	39	7.46	0.8	3.92
7	Barpeta	Mandia	Mandia	26.3050	90.99639	DUG	1.2	33	5.37	1.2	4.13
8	Barpeta	Sarthebari	Gahiya	26.4406	91.04969	DUG	0.73	39	5.38	0.73	4.3
9	Barpeta	Bhawanipur	Banglipara	26.4744	91.08818	DUG	0.8	41	6.44	1.02	4.21
10	Barpeta	Sarthebari	Baniakuchi	26.3558	91.22025	DUG	0.83	27	6.07	0.92	3.35
11	Barpeta	Saruhetri	Haldibari	26.3389	91.21864	DUG	0.96	31	7.17	1.22	4.2
12	Barpeta	Sarukhetri	Lasima	26.3558	91.21603	DUG	0.94	40	5.6	0.9	3.58
13	Barpeta	Barpeta	Satrabarala	26.4575	91.14055	DUG	1.1	34	5.6	1.06	2.68
14	Barpeta	Bhawanipur	Kohora DW	26.4914	91.09067	DUG	0.77	45	5.97	0.79	3.55
15	Barpeta	Bhawanipur	Sarupeta	26.4914	91.07653	DUG	0.6	37	5.67	1.08	3.56
16	Barpeta	Bhawanipur	Indrapur	26.5253	91.18139	DUG	0.83	32	7.55	0.83	3.25
17	Barpeta	Bhawanipur	Zebrabhita	26.4744	91.06399	DUG	0.68	57	5.09	0.67	2.77
18	Barpeta	Chakchaka	Sarbhog	26.4914	90.89071	DUG	0.79	56	6.4	0.76	3.82
19	Barpeta	Barpeta	Majarhati	26.3219	91.01182	DUG	0.8	37	8.4	0.82	4.99
20	Barpeta		Barbila	26.3050	91.09333	DUG	0.82	38	7.11	1.25	1.54

Annexure 3: WATER QUALITY DATA OF SHALLOW AQUIFER ZONE, BARPETA DISTRCT (Pre- Monsoon)

Sl. No.	Village/ Location	Type of well	p^H	EC (µS/cm)	TRBD (NTU)	TDS	CO_3	HCO_3	TA	Cl^-	SO_4^{-2}	NO_3^-	F^-	Ca^{+2}	Mg^{+2}	TH	Na^+	K^+	Fe	As
								(mg/lt)												µg/L
1.	Kamargaon	DW	7.75	106.30	BDL	84.74	BDL	61.05	61.05	85.08	5.98	7.38	0.01	14.01	33.97	175.00	4.33	1.61	1.366	BDL
2.	Sarbhog PWD Rest House	TW	8.02	257.20	BDL	201.56	BDL	140.41	140.41	46.08	17.50	20.48	BDL	32.03	30.32	205.00	10.28	6.65	0.304	0.34
3.	Amguri	DW	8.05	315.40	BDL	242.75	12.00	177.04	189.04	46.08	12.91	6.20	0.01	28.02	14.55	130.00	34.32	18.58	0.410	1.50
4.	Chakabausi	DW	8.37	279.10	BDL	90.82	BDL	61.05	61.05	17.73	13.34	7.07	0.02	18.01	2.42	55.00	14.18	2.57	0.283	0.73
5.	Madulijhar	DW	7.36	237.20	0.20	96.56	BDL	73.26	73.26	17.73	14.12	6.48	0.01	12.01	2.42	40.00	20.05	7.01	1.554	0.60
6.	Raha	DW	7.87	599.20	0.10	618.95	15.00	415.13	430.13	24.82	26.12	4.15	BDL	76.06	42.44	365.00	13.56	3.00	0.559	1.12
7.	Jania	DW	7.51	533.30	BDL	512.36	36.00	183.15	219.15	88.63	15.18	8.21	0.01	76.06	47.29	385.00	3.11	2.05	0.410	2.41
8.	Mandia	DW	7.18	231.50	BDL	160.51	6.00	427.34	433.34	24.82	10.42	3.61	0.05	18.01	13.34	100.00	86.16	65.70	0.756	7.01
9..	Gahiya	DW	7.57	1270	BDL	214.24	6.00	183.15	189.15	17.73	11.51	3.93	0.03	20.02	20.62	135.00	16.68	8.13	0.538	1.89
10.	Banglipara	DW	7.66	559.20	BDL	376.33	9.00	268.61	277.61	24.82	17.84	4.64	0.02	30.02	40.03	240.00	14.53	6.20	0.367	1.63
11.	Baniakuchi	DW	7.87	329.30	0.10	236.48	BDL	164.83	164.83	28.36	11.16	4.99	0.02	8.01	27.91	135.00	13.33	8.23	0.474	1.50
12.	Haldibari	DW	8.00	343.50	BDL	230.54	9.00	170.94	179.94	24.82	7.60	5.58	0.07	28.02	16.98	140.00	16.46	6.88	0.516	1.25
13.	Lasima	DW	7.85	267.50	BDL	224.93	BDL	146.52	146.52	21.27	8.27	5.59	0.03	34.03	13.33	140.00	8.04	7.24	0.474	2.42
14.	Satrabarala	DW	7.98	414.80	BDL	262.68	12.00	225.88	237.88	28.36	7.41	5.71	0.03	26.02	30.33	190.00	18.70	7.04	1.320	8.23
15.	Kohora DW	DW	8.12	682.60	BDL	341.35	BDL	268.61	268.61	21.27	10.20	7.88	0.02	18.01	52.18	260.00	5.70	1.98	0.495	3.15
16.	Sarupeta	DW	8.05	485.00	BDL	325.18	BDL	231.99	231.99	21.27	5.10	3.76	0.02	16.01	42.47	215.00	6.93	9.21	1.091	0.48
17.	Indrapur	DW	8.15	462.20	BDL	340.82	18.00	262.51	280.51	31.91	5.35	23.77	0.20	34.03	27.90	200.00	31.84	12.72	1.483	4.19
18.	Zebrabhita	DW	7.96	636.30	BDL	391.31	BDL	268.61	268.61	17.73	3.80	4.57	0.30	8.01	53.39	240.00	5.50	9.09	0.646	1.50
19.	Sarbhog	DW	7.86	697.00	BDL	295.75	BDL	146.52	146.52	46.09	21.88	8.42	0.30	34.03	12.12	135.00	24.83	4.20	0.452	0.68
20.	Majarhati	DW	8.27	498.00	BDL	391.78	24.00	360.19	384.19	21.27	2.86	22.69	0.06	58.05	35.17	290.00	24.22	9.25	0.734	1.09
21.	Barbila	DW	8.22	527.80	BDL	314.82	BDL	195.36	195.36	17.73	7.88	3.54	0.06	10.01	38.83	185.00	6.77	6.69	1.390	0.78
22.	Kohora TW	TW	8.27	463.30	BDL	461.01	BDL	244.20	244.20	28.36	33.90	3.00	0.07	18.01	48.53	245.00	15.67	3.95	1.744	1.60

Annexure 4: WATER QUALITY DATA OF SHALLOW AQUIFER ZONE, BARPETA DISTRCT(Post-Monsoon)

Sl. No.	Village/ Location	Type of well	p^H	EC (µS/cm)	TRBD (NTU)	TDS	CO_3	HCO_3	TA	Cl^-	SO_4^{-2}	NO_3^{-1}	F^-	Ca^{+2}	Mg^{+2}	TH	Na^+	K^+	Fe	U
							(mg/lt)													
1.	Kamargaon	DW	6.70	128.40	BDL	70.16	BDL	61.05	61.05	38.99	10.61	BDL	0.44	26.02	20.62	150	14.37	2.06	BDL	BDL
2.	Sarbhog PWD Rest House	TW	6.94	305.40	BDL	169.75	BDL	103.78	103.78	38.99	19.02	BDL	0.24	20.02	9.70	90.	12.20	5.38	3.050	BDL
3.	Amguri	DW	8.35	367.80	BDL	208.16	BDL	140.41	140.41	46.09	12.08	BDL	0.14	8.01	6.06	45	5.72	3.17	0.002	0.0033
4.	Chakabausi	DW	8.04	137.60	BDL	184.21	6.00	177.04	183.04	17.73	21.65	BDL	0.23	32.03	15.76	145	6.38	6.39	BDL	BDL
5.	Madulijhar	DW	7.83	146.30	BDL	156.55	BDL	109.89	109.89	28.36	20.72	BDL	0.41	22.02	7.27	85	10.08	9.48	BDL	6.1443
6.	Raha	DW	8.42	937.80	BDL	395.47	BDL	366.29	366.29	24.82	18.61	BDL	0.33	32.03	42.46	255	4.09	1.66	BDL	0.1401
7.	Jania	DW	8.37	776.30	BDL	351.98	BDL	427.34	427.34	21.27	26.08	BDL	0.25	40.03	31.53	230	4.80	3.62	BDL	BDL
8.	Mandia	DW	8.34	243.20	BDL	152.79	BDL	122.10	122.10	14.18	31.50	BDL	0.21	46.04	32.74	250	4.87	2.22	BDL	1.5568
9..	Gahiya	DW	8.42	324.60	BDL	838.20	BDL	482.29	482.29	251.70	26.54	BDL	0.24	36.03	38.82	250	4.23	2.17	BDL	1.565
10.	Banglipara	DW	8.43	570.20	BDL	369.07	BDL	946.26	946.26	14.18	19.60	BDL	0.10	30.02	24.26	175	15.85	8.19	0.53	0.4015
11.	Baniakuchi	DW	7.29	358.30	BDL	217.34	BDL	170.94	170.94	21.27	7.81	BDL	0.15	14.01	7.27	65	3.97	3.49	BDL	1.6198
12.	Haldibari	DW	8.38	349.30	BDL	226.71	BDL	170.94	170.94	28.36	12.24	BDL	0.16	14.01	6.06	60	19.89	3.07	BDL	0.6286
13.	Lasima	DW	7.23	340.80	BDL	176.55	BDL	109.89	109.89	17.73	10.70	BDL	0.14	18.01	3.63	60	9.49	7.27	1.24	0.1889
14.	Satrabarala	DW	8.38	398.00	BDL	273.77	BDL	238.09	238.09	28.36	21.97	BDL	0.22	22.02	6.06	80	38.44	16.76	0.331	0.4512
15.	Kohora DW	DW	7.75	517.20	BDL	450.52	BDL	421.24	421.24	28.36	9.16	BDL	0.14	14.01	6.06	60	11.79	3.93	BDL	0.1689
16.	Sarupeta	DW	7.90	492.70	BDL	320.10	BDL	329.66	329.66	21.27	29.80	BDL	0.17	22.02	9.70	95	41.51	15.19	0.524	0.1985
17.	Indrapur	DW	8.31	516.40	BDL	305.05	BDL	250.30	250.30	24.82	12.04	BDL	0.13	26.02	12.12	115	6.86	2.48	BDL	1.7613
18.	Jania DTW	DW	7.58	592.90	BDL	419.96	BDL	311.35	311.35	24.82	19.39	BDL	0.13	22.02	4.84	75	11.97	4.72	BDL	0.5078
19.	Sarbhog	DW	7.15	448.10	0.20	460.02	BDL	280.82	280.82	77.99	11.72	BDL	0.20	26.02	6.06	90	7.59	5.37	BDL	0.5945
20.	Howly	DW	8.34	593.60	BDL	328.68	BDL	262.51	262.51	35.45	14.49	BDL	0.21	24.02	7.27	90	16.04	22.20	BDL	BDL
21.	Kohora TW	TW	7.76	477.00	BDL	348.35	BDL	335.77	335.77	28.36	2.92	BDL	0.25	20.02	3.63	65	1.99	2.10	1.652	BDL
23.	Kamargaon	DW	6.70	128.40	BDL	303.93	15.00	299.14	314.14	24.82	21.10	0.00	0.29	24.97	6.06	60	9.65	3.80	3.44	0.0107

Annexure 5: WATER QUALITY DATA OF DEEPER AQUIFER IN BARPETA DISTRCT FOR THE YEAR 2022

Sl. No.	Village/ Location	Type of Well	p^H	EC (µS/cm)	TDS	CO_3	HCO_3	Cl^-	SO_4^{-2}	NO_3^-	F^-	Ca^{+2}	Mg^{+2}	TH	Na^+	K^+	Fe	As
1	Dakkhinhati	DTW	8.36	458.40	302.54	12.00	286.93	302.54	18.60	BDL	BDL	58.05	23.03	240.00	31.47	12.88	2.95	N/A
3	Itarbhita	STW	8.41	763.60	503.98	18.00	518.91	503.98	5.96	BDL	BDL	100.08	38.79	410.00	22.55	10.84	7.05	N/A
4	Kohora DTW	DTW	7.61	698.50	BDL	BDL	244.20	28.36	33.90	3.00	0.07	18.01	48.53	245.00	15.67	3.95	1.744	1.598

ANNEXURE 6: LITHOLOG

Litholog ofDaulashal EW

Coordinates:

91.2217	26.2696

Depth Range	Thickness	Description
0.00-6.50	6.50	SurfaceSoil, Light Brown
6.50-32.00	25.50	Sand, fine to medium grain
32.00-101.00	69.00	Sand ,Medium to fine with little coarse sand and occasional gravel (1-2mm) , grey
101.00-107.50	6.50	Clayey Sand fine to medium
107.50-120.00	12.50	Sand, medium to fine, Grey
120.00-126.00	6.00	Sand, medium to fine, Grey with little gravel (3-6 mm)
126.00-204.15	78.16	Sand, medium to fine with little coarse sand and occasional gravel (2-3 mm), rounded to sub-rounded

Litholog ofBhawanipur EW

Coordinates:

91.1131	26.2950

Depth Range	Thickness	Description
0.00-6.10	6.10	Clay, Grey, Plastic
6.10-9.10	3.00	Sand grey fine tocoarse with Mica flakes
9.10-21.30	12.20	Sand, clayey, Grey, fine tocoarse with 2-8 mm, fragmented gravels of Quartz, feldspar, chart interlayered with clay
21.30-27.40	6.10	Sand grey fine to coarse with mica and fragments of quartz and feldspar
27.40-28.90	1.50	Gravels pebbles. cobbles 5-4mm, subrounded, subangular, gravels, pebbles of Quartzite and chart

Litholog ofPathshala EW

Coordinates:

91.2167	26.4903

Depth Range	Thickness	Description
0.00-5.85	5.85	Surface clay, greyish brown, sticky
5.85-7.70	1.85	Clay sandy, Grey, clay with fine sand
7.70-14.25	6.55	Sand, grey, fine grained
14.25-20.63	5.38	Clay, Grey with fine to Medium
20.63-30.96	10.33	Sand, grey, fine to medium
30.96-33.96	3.00	Sand , Grey, Medium to coarse with granite pieces
33.96-37.99	4.03	Gravel , grey 2mmto3mm gravel
37.99-40.99	3.00	Gravel made up of Granite pieces 3 to 8 mm size

Litholog of Keotkuchi EW

Coordinates:

91.0167	26.2708

Depth Range	Thickness	Description
0.00-7.70	7.70	Sand, brownish , fine grained, sub translucent, sub angular to sub rounded
7.70-11.25	3.55	Sand, grayish, fine grained to medium grained.
11.25-38.00	26.75	Sand, same as above with gravel of 2 to 6 mm size of quartz and granite
38.00-45.00	7.00	Gravel dirty white, sub rounded 2 to 6 mm size.
45.00-54.00	9.00	Gravel same as above with medium to coarse sand
54.00-65.00	11.00	Gravel same as above with less sand
65.00-81.00	16.00	Gravel , grey 2 mm to 3 mm gravel
81.00-101.00	20.00	Gravel with fine to coarse sand
101.00-131.00	30.00	Sand, grey, fine to coarse grained with fine gravel of 1 to 2 mm
131.00-167.00	36.00	Sand, grey fine to medium grained with pieces of gravel
167.00-172.00	5.00	Sand, grey, fine grained with admixture of clay
172.00-193.00	21.00	Sand Grey Medium to Coarse
193.00-196.00	3.00	Sand grey fine with admixture of clay
196.00-220.00	24.00	Sand Grey, fine to medium grained with little admixture of clay
220.00-242.00	22.00	Sand, grey very fine with more clay
242.00-299.92	57.92	Sand, grey, fine to medium grained with admixture of clay and occasional gravel

Litholog ofDakkhinhati

Coordinates:

91.0167	26.2708

Depth(m)	Formation	Remarks
0-3	Topsoil mixed with clay	Brown in colour
3-12	FineSand	Grey in Colour
12-24	Medium grained Sand	Grey in colour
24-54	**Coarse grained Sand**	**GreyinColour**
54-57	**Coarse grained Sand mixed with pebble cut**	**Grey in Colur**

Nityananda

Coordinates:

91.21444	26.5519

Depth(m)	Formation	Remarks
0-6	Top Soil	Brown in colour
6-22	FineSand	Grey in Colour
22-38	Medium grained Sand	Grey in colour
38-75	**Gravel Mixed With Sand**	**GreyinColour**
75-94	**Coarse grained Sand mixed with sand**	**Grey in Colur**
94-114	**Gravel Mixed with Sand**	**Grey in Colour**
114-120	**Coarse sand**	**Grey in Colour**
120-125	**Clay**	**Grey in colour**
125-151	**Gravel with sand**	**Grey in colour**
151-153	**Pebble/ Cobble**	**Grey in Colour**

Mandia

Coordinates:

91.0500	26.2167

Depth(m)	Formation	Remarks
0-25	Clay	Grey
25-30	Medium Grained Sand	Grey in Colour
30-34	FineSand	Grey in colour
34-60	**Medium Grained Sand**	**Greyin Colour**
60-81	**Gravel with Sand**	**Grey in Colur**
81-130	**Medium Grained Sand**	**Grey in Colour**
130-150	**Coarse Sand mixed with Gravel**	**Grey in Colour**
150-203	**Medium Grained Sand**	**Grey in colour**

FIELD PHOTOGRAPHS