Project Concept Note & Monitoring Report (PCNMR)

Project Name: Rainwater Harvesting through Storage Cum Percolation (SCP) Pond & Recycling of ETP treated wastewater at Digboi refinery, IOCL, Assam

UWR RoU Scope: RoU Scope 2, Scope 5

Monitoring Period: 01/04/2018-31/03/2025

01/04/2015- 31/03/2025

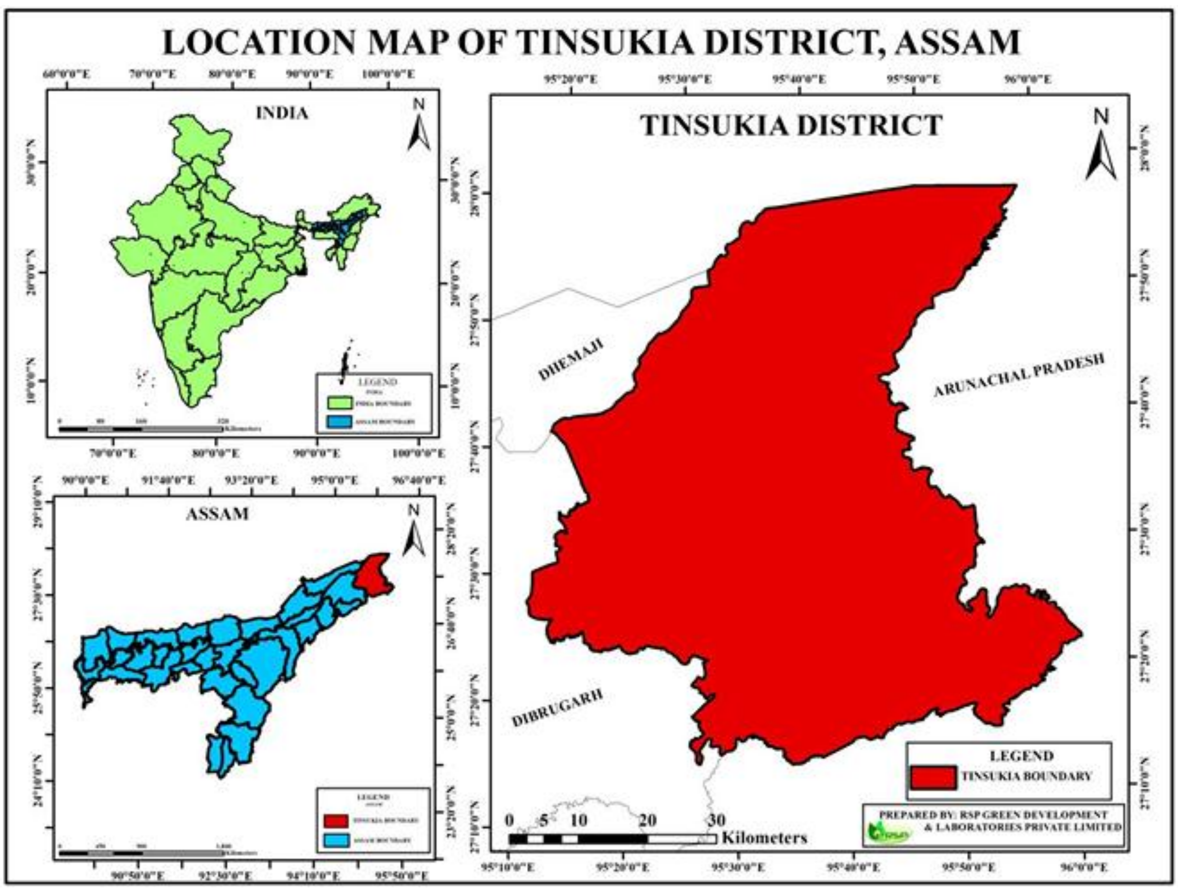
Crediting Period: 2018-2024 (Scope 2)

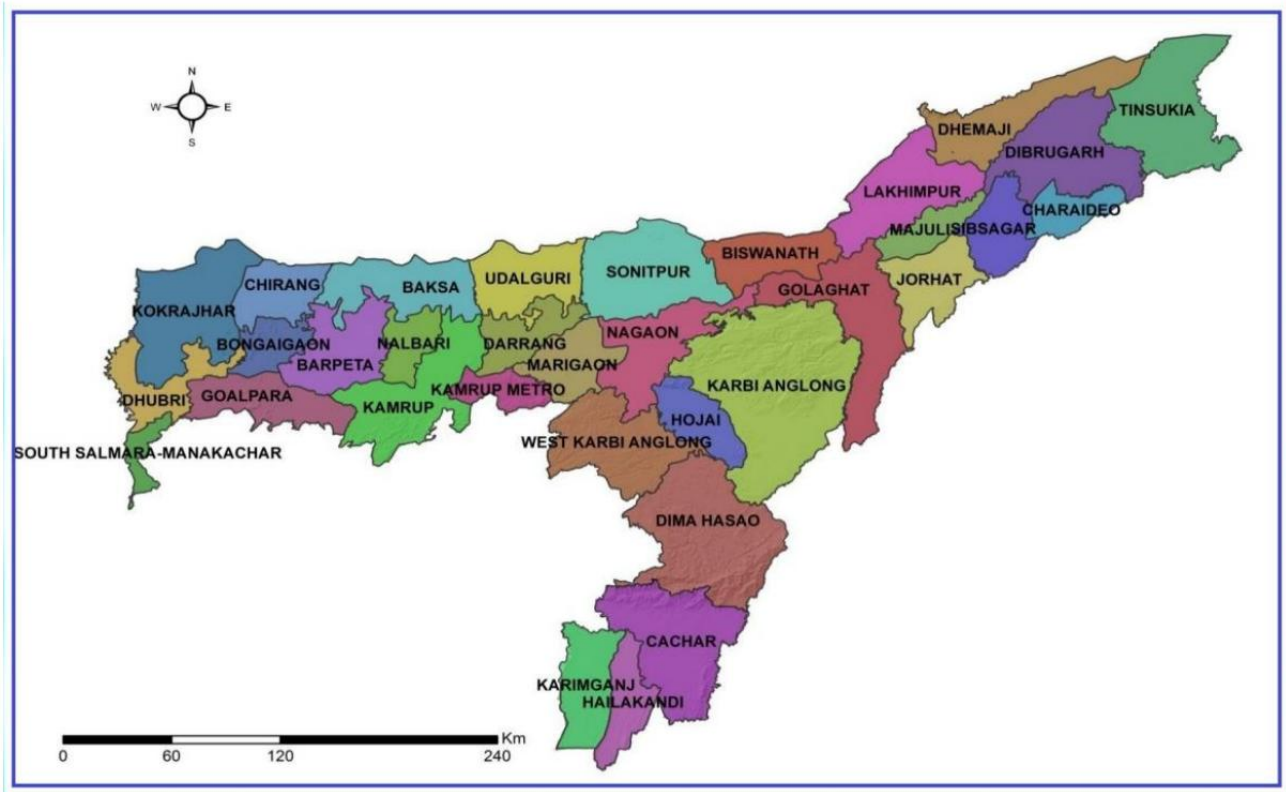
2015-2024 (Scope 5)

UNDP Human Development Indicator: 2 (India)

A.1 Location of Project Activity

Project location	Indian Oil Corporation Limited, (Assam Oil Division), Digboi Refinery
State	Assam
District	Tinsukia
Block Basin/Sub Basin/Watershed	Brahmaputra-Barak rivers Major Basin Dibru & Buridihing (Sub-basin)
Lat. & Longitude	27°14’03” and 27°48’05” North Latitudes 95°13’30” and 96°00’00” East Longitudes
Area Extent	3790 sq. km
No. of Villages/Towns	Revenue village: 253, Panchayats: 86





Map of Assam, India

The topography of Tinsukia district in Assam, India is characterized by Brahmaputra plains and hills in the south, with a gentle slope towards the northwest:

- Location: Tinsukia is located in the far northeast corner of Assam, at 27.5°N 95.37°E.
- Elevation: The average elevation of Tinsukia is 116 meters (380 feet).
- Hydrogeology: The district can be divided into two hydrogeological units: Tertiary Group of Semi-consolidated rocks and Quaternary alluvium of unconsolidated sediments.
- Major water bearing formation: Alluvium.
- Transmissivity: 760 – 19,582 m2/day.

A.2. Project owner information, key roles and responsibilities

Indian Oil Corporation Ltd. (IOCL), Assam is the Project Proponent (PP) for this specific project activity. They are actively integrating sustainability into its core business strategy, focusing on environmental protection, social progress, and economic growth. They aim to minimize their ecological footprint and actively pursue initiatives that benefit both stakeholders and the environment. Their approach is rooted in the United Nations Sustainable Development Goals (SDGs) and aims to create a more sustainable future for India and the world.

The small town of Digboi in the remote northeastern corner of the country is the birthplace of the Oil Industry in India. Commissioned in 1901, the refinery is one of the oldest operating refineries in the world. Digboi refinery is situated in the midst of pristine biodiversity.

Water stewardship is central to the ethos of Indian Oil. Their water management strategy focuses on measuring water withdrawals and consumption while implementing initiatives to enhance water efficiency at their operations.

To address freshwater needs and support groundwater replenishment, they have established rainwater harvesting (RWH) systems at Digboi Refinery. They are effectively reusing and recycling ETP treated wastewater for industry operation.

Storage Cum Percolation (SCP):

Storage Cum Percolation Pond (SCP) was commissioned in 2018 utilizing run-off water of 9 interlinked natural catchment areas around Digboi, first of its type in eastern Asia. The usage of rainwater has proven a very cost effective and environment friendly to increase the water table in Digboi area. Harvested rain water is used as Cooling Tower Make up, DM plant, Service water and fire water make up.

PP owns the water user rights for the area within the project's boundary. They also hold an uncontested legal land title for the project area within the project's boundary. They hold all necessary permits to implement the project.

Effluent Treatment Plant (ETP):

A permanent pumping system had been installed in ETP and commissioned in November'93. Recycling of treated effluent has since then been stepped up. Treated effluent is recycled into refinery and reused as fire water make up, cleaning purpose and gardening. Another scheme for reuse was commissioned in Aug'11 for use of the treated effluent make up for coke cutting water used in delayed coking unit. For increasing reuse of treated effluent in wax sector cooling tower as make up water Dual media filter was commissioned in March'14. Storm water is released to natural drain during monsoon.

Liquid effluent streams generated from various sources within refinery complex are routed to the existing effluent treatment plant (ETP) of design capacity API: 375 m3/hr, TPI: 273 M3/hr, DAF: 200 m3/hr & operating capacity is 84 – 110 m3/hr for treating the waste water from all the units/sources.

A.2.1 Project RoU Scope

PROJECT NAME	Rainwater Harvesting through Storage Cum Percolation (SCP) Pond and Recycling of ETP treated wastewater at Digboi refinery, IOCL, Assam
UWR Scope	RoU Scope 2: Measures for conservation and storage of unutilized water for future requirements including freshwater ecosystems and wetlands RoU Scope 5: Conservation measures taken to recycle and reuse water, spent wash, wastewater etc across or within specific industrial processes and systems.
Project Aggregator Name & Address	EncoraaESG 50/2, Arunoday Society, Alkapuri, Vadodara, Gujarat-390007
Date PCNMR Prepared	31.07.2025
Average annual rainfall (mm)	2,323

Type of structure	Storage Cum Percolation (SCP) pond & Effluent Treatment Plant (ETP)
RoU crediting period	2018-2024 (Scope 2), 2015-2024(Scope 5)
Run off coefficient	0.9
Evaporation and absorption losses	10%
Uncertainty factor	21%
Total RoUs Generated For the Crediting Period	Scope 2: 2018-2025: 29,97,704 RoUs Scope 5: 2015-2025: 56,69,772 RoUs

A.3. Land use and Drainage Pattern

Out of total geographical area of 379,000 hectares of land in Tinsukia district, about 29.9% of the land is not available for cultivation and 9.4% is categorized as other non- cultivated land. Further, about 34.9% is under forests. The net area shown in the district is about 24.3% of the total geographical area. The following table shows the area of land put to different uses and their percentages to the total areas.

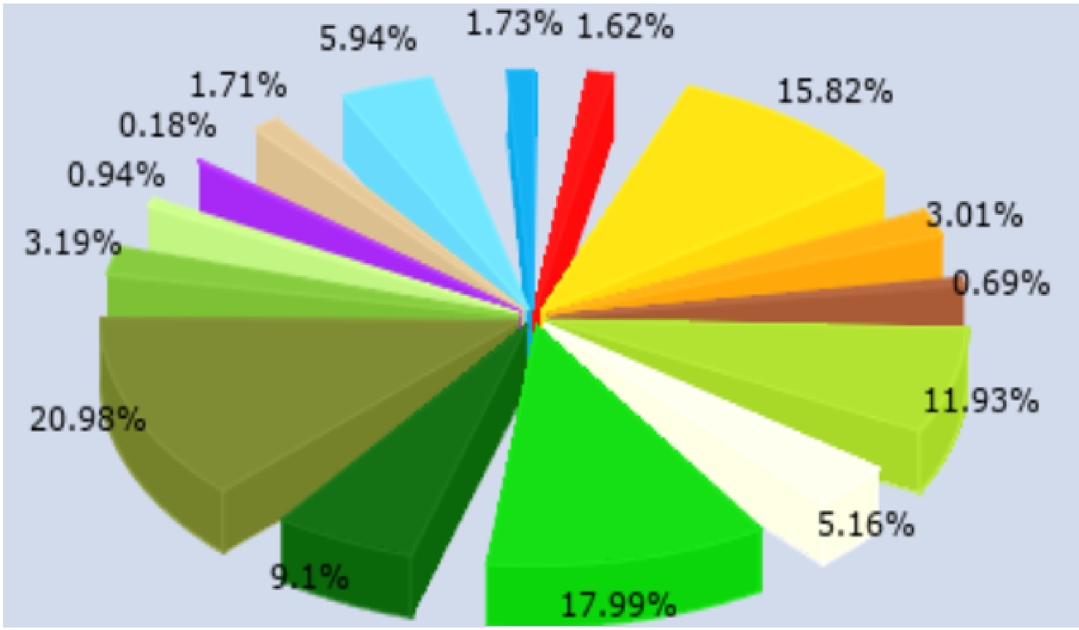
LAND USE (Sq.Km.)	
a) Forest Area	1,345.52
b) Net area sown	999.45
c) Cultivable area	1,452.33

Land use statistics in Tinsukia

Name of Block	Area Under Agriculture				Area under Forest (Ha)	Area under Waste land (Ha)	Area under other uses (Ha)
	Gross Cropped Area	Net Sown Area	Area Sown more than once	CI (%)			
Sadiya	28600	25929	2671	110	12575.2	1022	65449.2

Saikhowa	17053	13154	3899	129.6	1062	907	39281
Hapjan	14004.4	11260.5	2744	124	23650	423	16731
Kakapathar	19810	17173	2637	115.3	87	4993	78120
Guijan	7920	6133	1787	129.1	225	364	20407
Itakhuli	11343	8577	2766	132	7703	415	30642
Margherita	24279.4	18704.2	5575.17	129.8	0	2438	113899
Total	**123010**	**100931**	**22079.2**	**122**	**45302.2**	**10562**	**364529.2**

Source: District irrigation Plan, Tinsukia (2015)



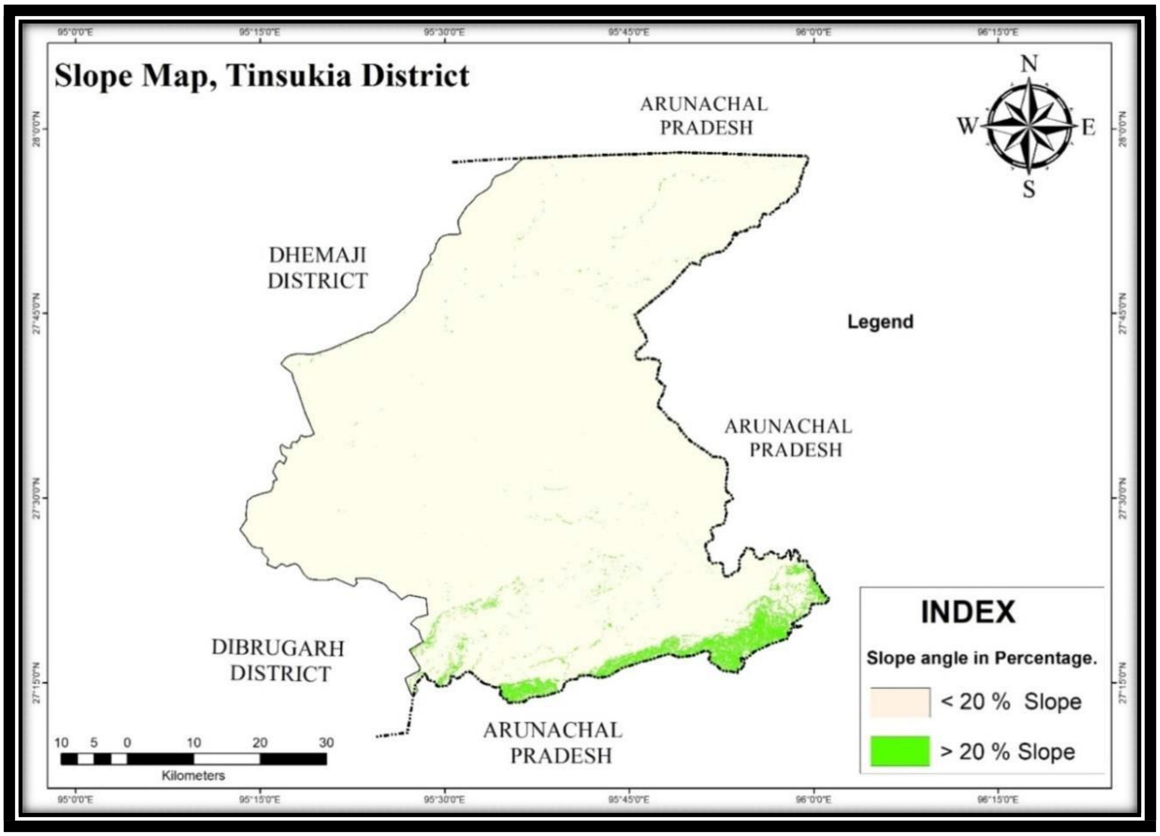
LULC Class	Area (L ha)	LULC Class	Area (L ha)
Built-up	1.27	Kharif Crop	12.41
Rabi Crop	2.36	Zaid Crop	0.54
Double/Triple/Annual Crop	9.36	Current Fallow	4.05
Plantation/Orchard	14.11	Evergreen/Semi-Evergreen woodland	7.14
Deciduous woodland	16.46	Degraded woodland	2.5
Littoral/Swamp/Mangroves	0	Grassland	0.74
Shifting Cultivation	0.14	Wasteland	1.34
Waterbodies max spread	4.66	Waterbodies min spread	1.36
Snow Cover/Glacial areas	0		
Total			**78.44**

Land Use Land Cover (LULC) Information (2023-24) for ASSAM

Total Geographical Area : 78.44 L ha

Physiographic Setup

The district physiographically divided into four distinct parts i.e. (i) the flood plains, (ii) younger and older alluvium plains, (iii) the terrace deposit at the foothills in the south and south eastern parts and (iv) Hillocks of the tertiary groups in the south and south western side. The flood plain and the alluvial plains only show gentle undulations at places. The elevation of the plains only ranges from 87 to 152 meters above mean sea level. Tea gardens are developed in the higher Terrace deposit plains than the adjoining cultivated flood plain areas. In the southern and south eastern parts, the elevation of the land and hill ranges varies from 115 to 350 meters mean sea level.

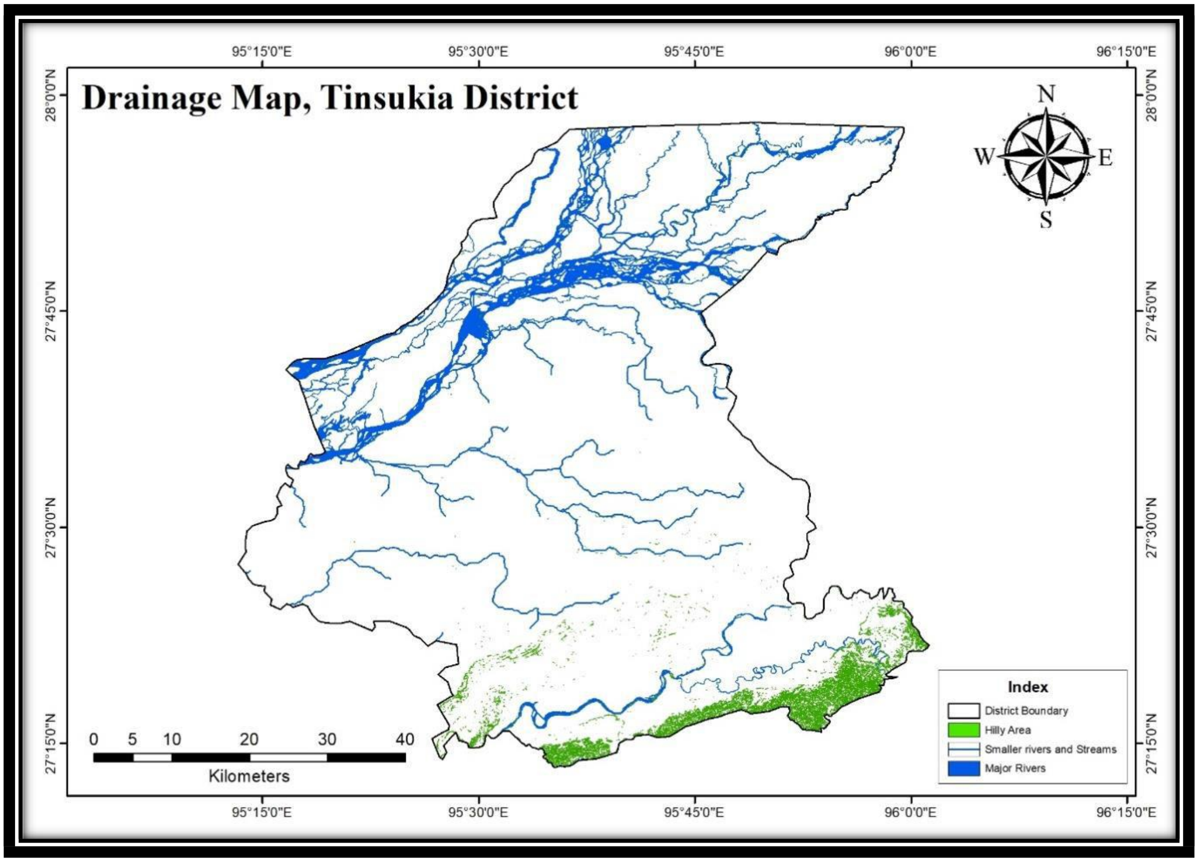


Slope Map, Tinsukia District

Drainage and Morphometry

The drainage of the area is formed by the Brahmaputra River and its numerous tributaries originating from Naga-Patkai range located at the north, drains the district and flows towards west and southwest direction. The important river is Buri-Dihing in the south. High degree of meandering of the Buri-Dihing river give rise to ox-bow lakes, point bars and channel bars. Floods and bank erosion are common features in these rivers. The entire area covering Lakhimpur, Lohit and

Tirap. Tinsukia and Dibrugarh districts have been affected by neotectonics movements, which remain active even today. These movements give rise to dynamics for extensive bank erosion by rivers.



Drainage Map, Tinsukia District

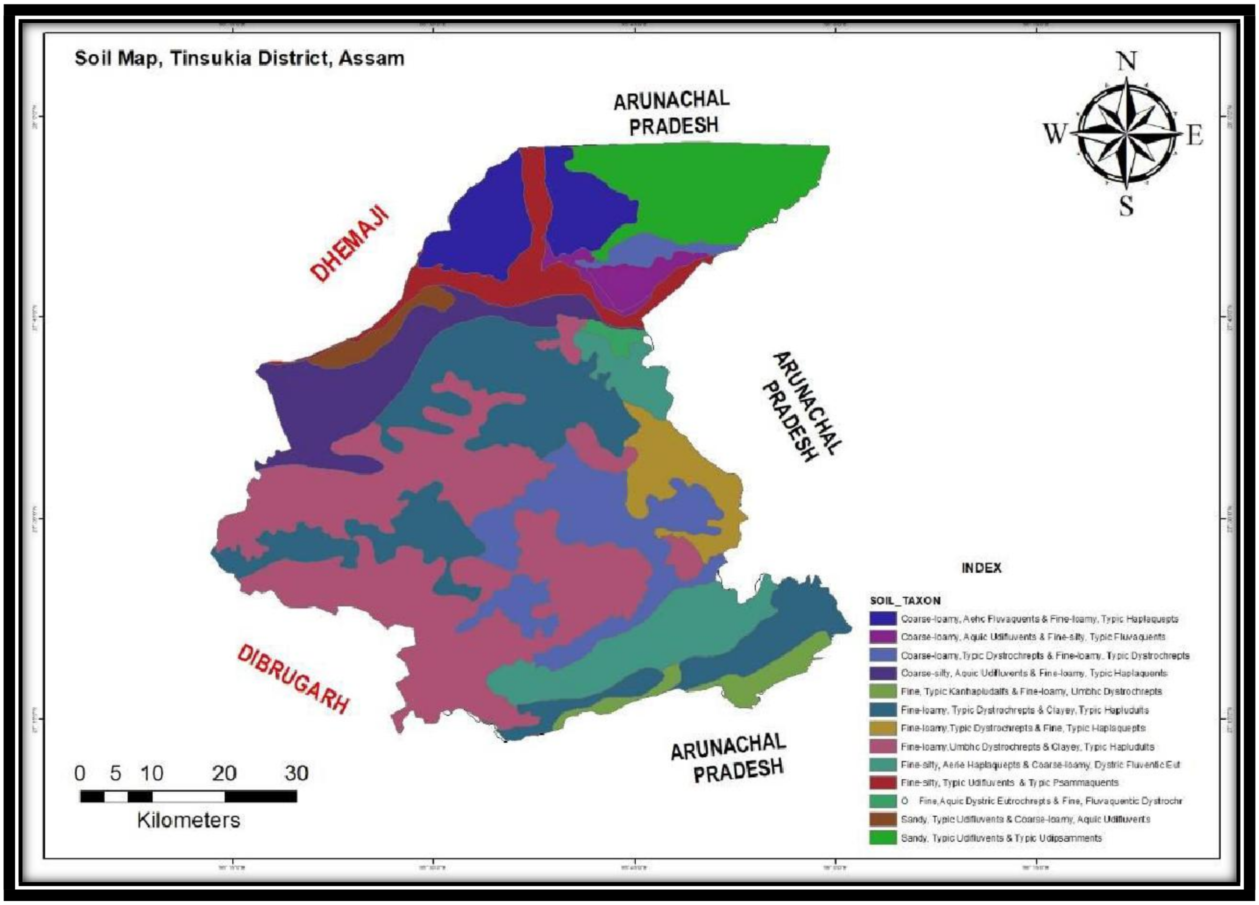
Soil Type:

The soil in the area may be grouped into three broad categories depending upon the origin and occurrence. These are given below :

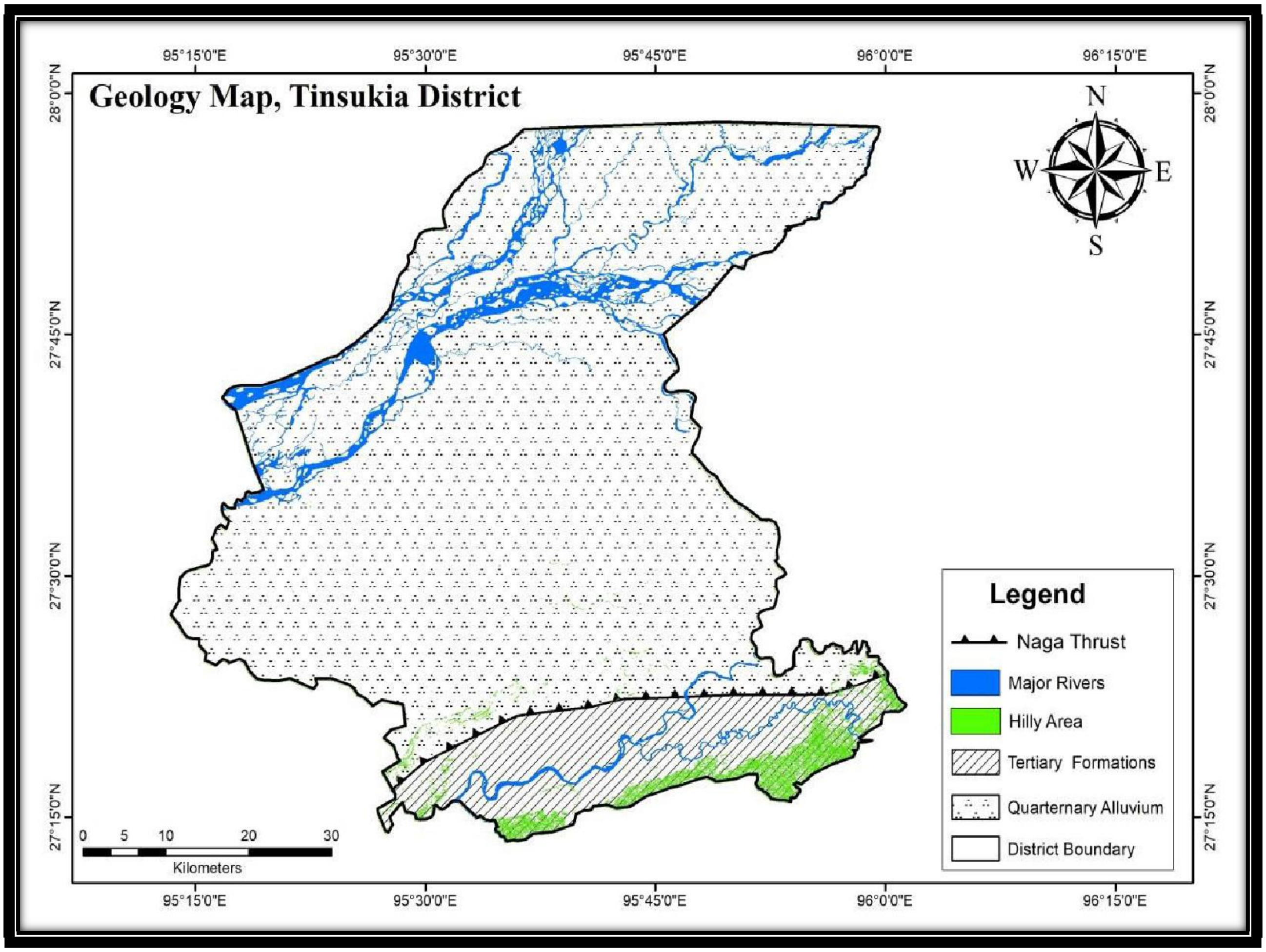
(a) Newer alluvial Soil : Flood plain areas of River Brahmaputra and the tributaries in the northern part are characterized by light grey clay with sand and silt.

(b) Older alluvial Soil : It occurs mainly in the central part with limonite yellow to reddish yellow clay.

(c) Soil cover in forest and hilly areas : It is deep reddish in colour and occurs over the older geological formation in the southern most part of the district.



Soil Map, Tinsukia District



Geological Map, Tinsukia District, Assam

1.13 Geomorphology

Major part of the district is underlain by thick alluvial deposits and Tertiary sedimentary formation occurs in southern and south-eastern parts. The topography is generally flat with a gentle slope toward north. The gradient plain is relatively steeper in the northern part of the district immediately below the foothill of the Himalayas. The gradient of the terrain becomes gentler in the central and southern parts of the district. The general slope of the area is towards SSW. Based on different criteria, the physiography of the state can be grouped into the following distinct physiographic and geomorphic units.

i. Active Flood Plain

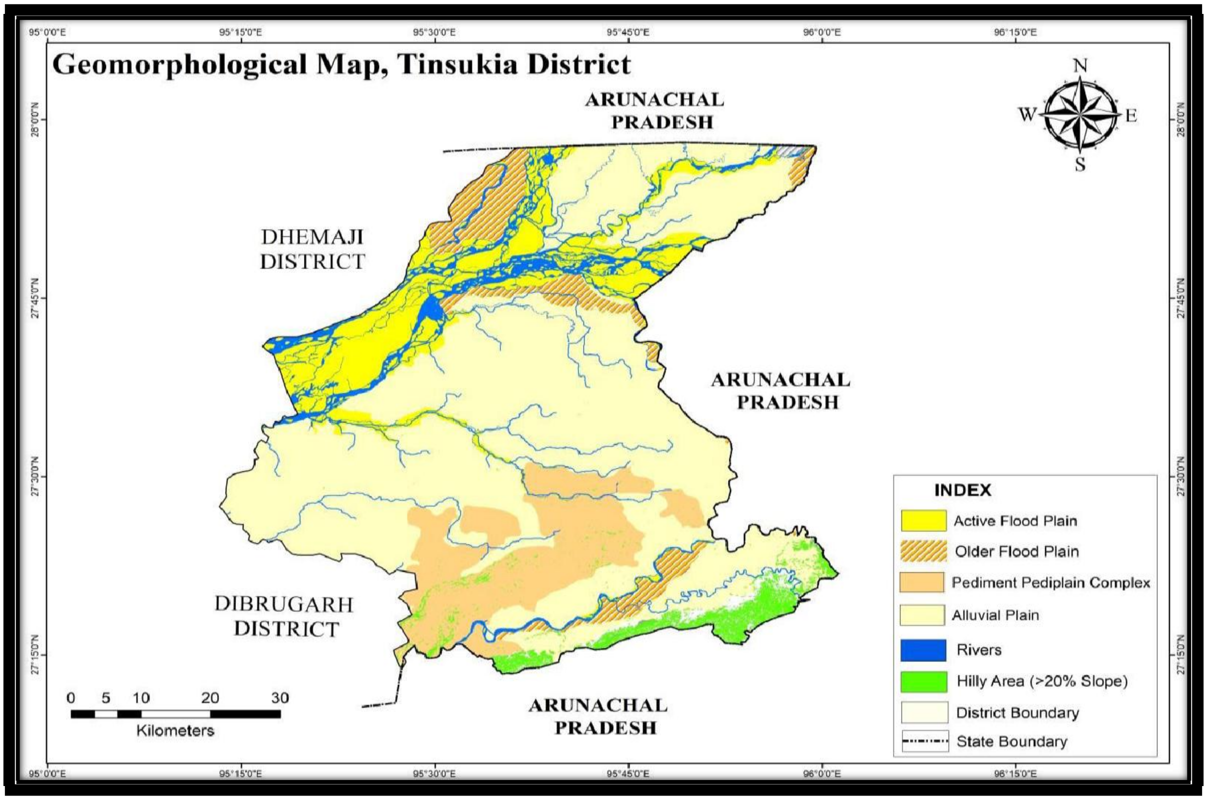
ii. Older Flood Plain

iii. Younger Alluvial Plain

iv. Pediment Pediplain Complex

v. Structural Hills and Valleys

The flood plain and the alluvial plains only show gentle undulations at places. The elevation of the plains only ranges from 87 to 152 meters above mean sea level. Tea gardens are developed in the higher Terrace deposit plains than the adjoining cultivated flood plain areas. In the southern and south-eastern parts, the elevation of the land and hill ranges varies from 115 to 350 meters mean sea level.



Geomorphological Map, Tinsukia District

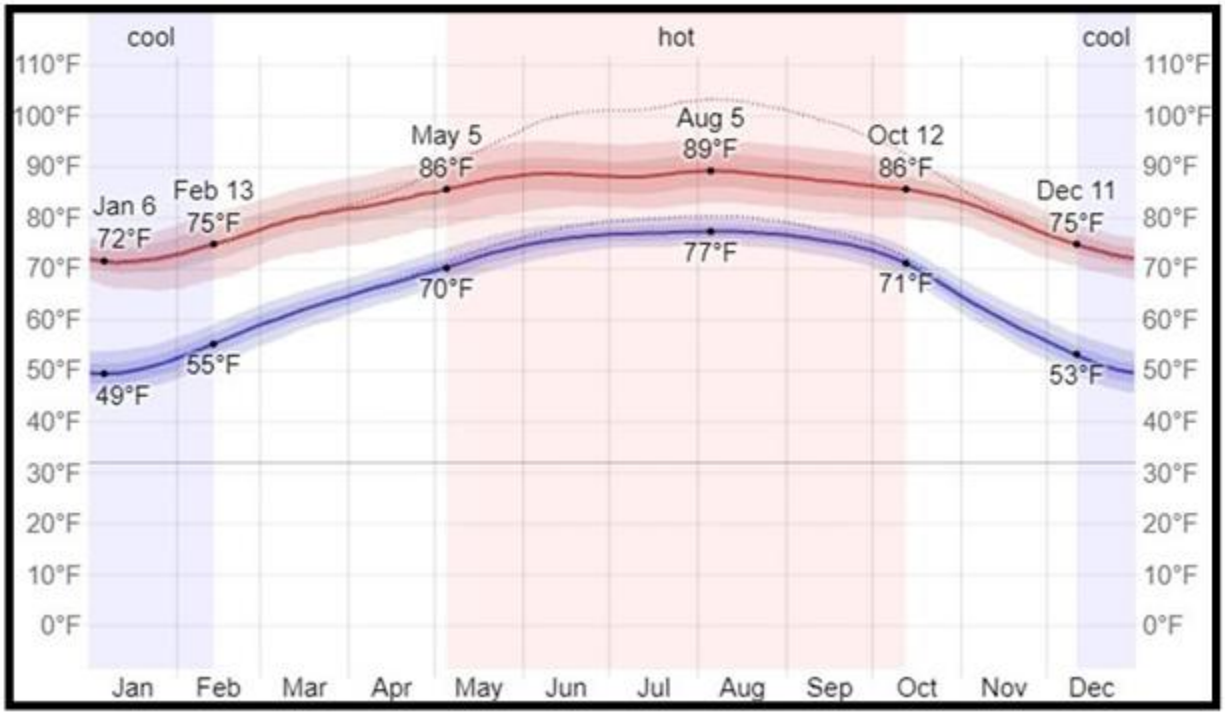
A.4. Climate

The district experiences sub-tropical humid climate where winter temperature goes up to 37^{o} C. The maximum temperature in summer days is as high as 96°F. The climate of the district is characterized by the absence of a dry hot summer season; the highest temperatures being experienced during the monsoon season along with abundant rains. Winter starts from December and end in February which is followed by a season of thunder storms from March to May. From June to the beginning of October is the season of south-west monsoon and October and November are marked as post monsoon season.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	17.5 °C (63.5) °F	19.4 °C (66.9) °F	21.9 °C (71.4) °F	23.6 °C (74.5) °F	26.1 °C (78.9) °F	27.6 °C (81.7) °F	27.7 °C (81.8) °F	27.9 °C (82.3) °F	27.3 °C (81.2) °F	25.3 °C (77.5) °F	21.8 °C (71.2) °F	18.6 °C (65.5) °F
Min. Temperature °C (°F)	12.8 °C (55) °F	14.7 °C (58.5) °F	17.3 °C (63.2) °F	19.9 °C (67.7) °F	22.7 °C (72.9) °F	24.9 °C (76.9) °F	25.3 °C (77.5) °F	25.2 °C (77.4) °F	24.5 °C (76) °F	21.8 °C (71.3) °F	17.5 °C (63.5) °F	14 °C (57.1) °F
Max. Temperature °C (°F)	22.3 °C (72.2) °F	24.2 °C (75.5) °F	26.5 °C (79.7) °F	27.6 °C (81.6) °F	29.7 °C (85.5) °F	30.7 °C (87.3) °F	30.6 °C (87) °F	31 °C (87.9) °F	30.6 °C (87.1) °F	28.9 °C (84) °F	26.1 °C (79) °F	23.3 °C (74) °F
Precipitation / Rainfall mm (in)	38 (1)	80 (3)	200 (7)	348 (13)	342 (13)	403 (15)	438 (17)	391 (15)	314 (12)	115 (4)	16 (0)	14 (0)
Humidity(%)	71%	67%	66%	75%	78%	82%	85%	84%	83%	80%	74%	72%
Rainy days (d)	4	6	10	13	16	19	20	20	17	8	2	2
avg. Sun hours (hours)	8.0	8.9	9.4	9.1	9.9	10.1	9.4	9.0	9.3	9.1	8.7	8.1

Month wise average weather, Tinsukia district

With the tropical monsoon climate, Assam is temperate (summer max. at 35-38 degree Celcius and winter min. at 6-8 degree Celcius) and experiences heavy rainfall and high humidity. The climate is characterised by heavy monsoon downpours reducing summer temperatures and affecting foggy nights and mornings in winters, frequent during the afternoons. Spring (March-April) and autumn (September-October) are usually pleasant with moderate rainfall and temperature. Assam's agriculture usually depends on the south-west monsoon rains.



Tinsukia Average Temperature

A.5. Rainfall

Assam is renowned for its abundant rainfall, which significantly shapes its geography, culture, and economy. Nestled in the foothills of the Eastern Himalayas, Assam enjoys a tropical monsoon climate, characterized by heavy and prolonged rainfall during the monsoon season, typically spanning from June to October. This rainfall is a result of the southwest monsoon winds that bring moisture-laden clouds from the Bay of Bengal. The average annual rainfall in Assam ranges between 1,800 mm to 2,500 mm, making it one of the wettest regions in India. However, certain pockets in neighboring state of Meghalaya, such as areas near Cherrapunji and Mawsynram, receive even higher rainfall, contributing to the state's lush greenery. The Brahmaputra River and its tributaries play a pivotal role in distributing this rainfall, nourishing the fertile alluvial plains and supporting extensive agricultural activities. Rainfall is the primary source of groundwater recharge in Assam. The abundant precipitation infiltrates the soil, replenishing aquifers and sustaining the state's groundwater levels. The alluvial plains of Assam, particularly in the Brahmaputra and Barak Valley regions, are composed of highly permeable soil, facilitating rapid infiltration. This ensures that even during periods of high-water demand, groundwater remains a reliable resource for irrigation, domestic use, and industry. However, the relationship between rainfall and groundwater is not without challenges. Excessive rainfall often leads to water logging and floods, which disrupt the natural recharge process. In flood prone areas, stagnant water can cause surface contamination, rendering groundwater unsafe for consumption. Moreover, the erosion of topsoil during heavy rains reduces the soil's capacity to retain water, indirectly affecting groundwater recharge rates over time. The uneven distribution of rainfall within Assam also plays a role. While some regions receive adequate rainfall to sustain groundwater levels, others, especially the hilly areas, experience rapid runoff due to steep slopes, leaving less water available for infiltration. This regional disparity can lead to localized water scarcity, particularly in periods of delayed monsoons or prolonged dry spells. The rainfall in Assam, while being a source of life and prosperity, also demands resilience and adaptation from its people. Efforts to harness its benefits while mitigating its adverse effects are ongoing, ensuring that the state continues to thrive amidst its unique climatic conditions.

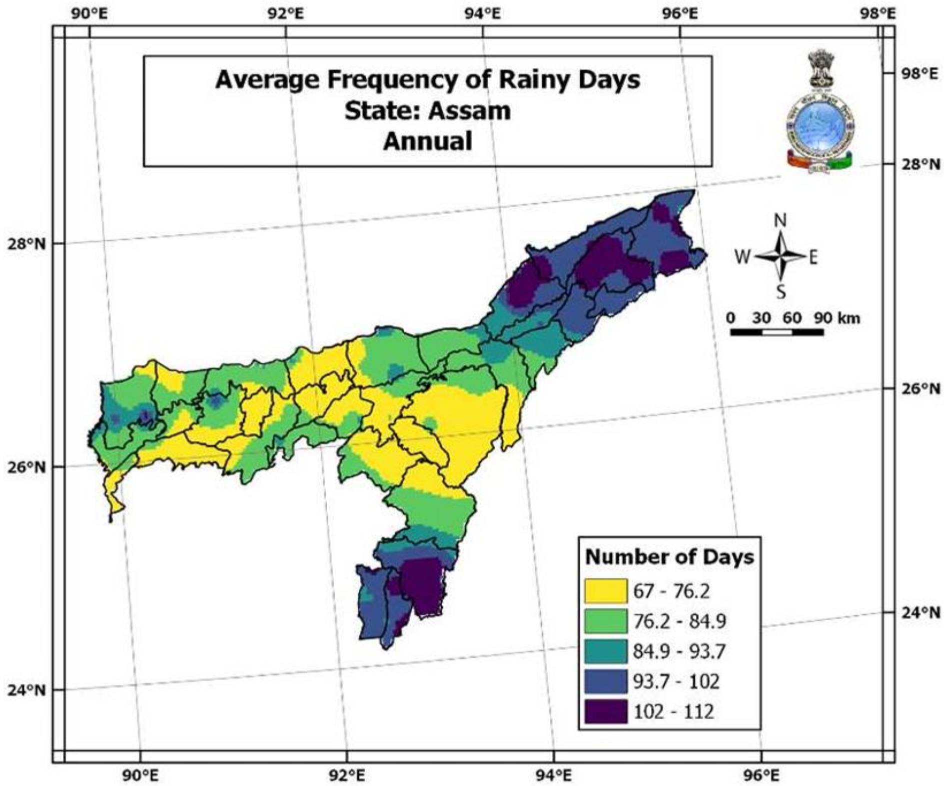
Tinsukia district endowed with high rainfall during all the months in a year. The South West monsoon sets in the month of June and lasts up to September. Out of 2323 mm normal annual rainfall, about 65 percent rain is received from monsoon.

State	**District wise normal rainfall in mm**													
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Monsoon	Non Monsoon	Total
Assam	55.99	63.67	109.05	205.19	341.95	412.66	404.17	328.24	276.35	160.60	62.08	50.21	1582.03	888.15	2470.18

DISTRICT	District wise Normal rainfall in mm														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mon soon	Non mon soon	Total
Baksa															3274.6
Barpeta	10	22.7	54.7	192.2	358.5	356.6	437.6	229.1	258	106.5	15.6	9.9	1387.8	663.6	2051.4
Bongaigaon	15.1	16.3	77.7	223.3	525.1	668.2	600.4	369.4	413	155.6	28.5	9.8	2206.6	895.8	3102.4
Cachar	17.3	47.4	151.7	312.3	453.2	639.1	564.9	492.2	357.1	220.7	44.7	11.3	2274	1037.9	3311.9
Chirang															3218.7
Darrang	13.8	20.6	56.7	173	312.7	407.6	350.1	273.2	223.1	92.3	17.2	10.9	1346.3	604.9	1951.2
Dhemaji															2859.3
Dhubri	10.5	13	45.9	159	408.6	623.7	532.6	416.9	359.2	161	18.3	4.1	2093.4	659.4	2752.8
Dibrugarh	36.1	56.2	103.8	222.6	313	416.6	531.6	439.8	329.5	153.7	26.7	19.8	1871.2	778.2	2649.4
Dima Hasao	19.4	36.5	138.3	236.9	486.2	567.6	417.3	360.1	291.9	197.4	34	6.2	1834.3	957.5	2791.8
Goalpara	15.7	13.1	55.5	189.7	475.8	594.2	444.6	330.6	294.4	150.3	16.1	3.2	1814.1	769.1	2583.2
Golaghat	18.5	29	71.6	144.6	267	253.3	303	300	203.9	125.9	21.7	13.2	1186.1	565.6	1751.7
Hailakandi	14	32.5	141.6	311.2	495.3	507.8	479.3	333.5	304	174.7	34.6	9.8	1799.3	1039	2838.3
Jorhat	26.7	34.8	97.1	238.4	312.5	330	381.6	372.7	299.5	132.1	24.2	15.7	1515.9	749.4	2265.3
Kamrup	13	15.7	60.5	170.7	291.1	387.4	346.9	273.5	195.9	114.7	16.7	10.1	1318.4	577.8	1896.2
Kamrup Metropolitan															1813.40
Karbi Anglong	8.5	14.4	30.5	87.6	127.5	196.8	226.6	167.2	128	104.4	17.6	13.1	823	299.2	1122.2
Karimganj	15.6	34.9	145.2	385.7	671	711.4	613	462	406.7	220.2	77.2	8.1	2413.3	1337.7	3751
Kokrajhar	15.1	16.3	77.7	223.3	525.1	668.2	600.4	369.4	413	155.6	28.5	9.8	2206.6	895.8	3102.4
Lakhimpur	30.9	53	89.8	209.9	494.3	635.6	597.4	472	435.5	194.8	30.7	26.4	2335.3	935	3270.3
Marigaon	13.6	18.3	53.8	128	203.7	333.9	389.8	343.4	238	132.8	20.1	9.4	1437.9	446.9	1884.8
Nagaon	13.6	18.3	53.8	128	203.7	333.9	389.8	343.4	238	132.8	20.1	9.4	1437.9	446.9	1884.8
Nalbari	13	15.7	60.5	170.7	291.1	387.4	346.9	273.5	195.9	114.7	16.7	10.1	1318.4	577.8	1896.2
Sivasagar	29.9	42.7	97.4	220.2	350.2	352.8	430.9	402.7	289	144.8	32.6	19.2	1620.2	792.2	2412.4
Sonitpur	21.1	22.4	52.3	147.6	290.4	354.7	375.9	322.2	237.9	116.2	24	14	1406.9	571.8	1978.7
Tinsukia	46.8	51.7	134.7	171.6	282.9	321.5	458.4	422	256.3	141.4	16.7	18.6	1599.6	723	2322.6
Udalguri															1957.8

District wise Normal rainfall in mm

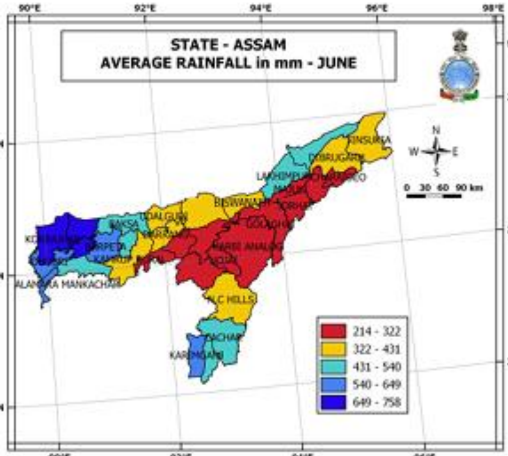
Previous records show that the rainfall occurs almost in every month of a year. The month November to December has the minimum number of rainy days in any year and the period June to September has maximum number of rainy days.



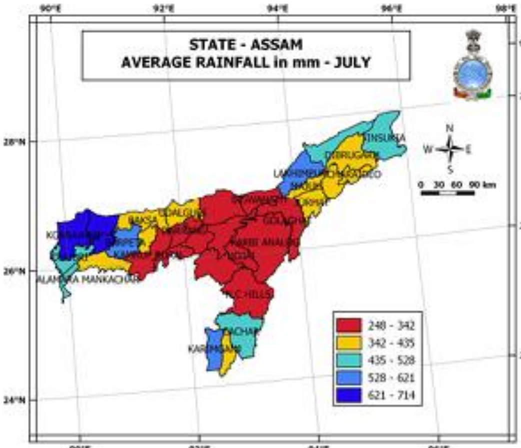
Average frequency of rainy days: Annual

During the entire year the maximum number of rainy days lies in the range of 102 to 112 days especially in some parts of Cachar, Hailakandi, Lakhimpur, Dhemaji, Dibrugarh and Tinsukia districts.

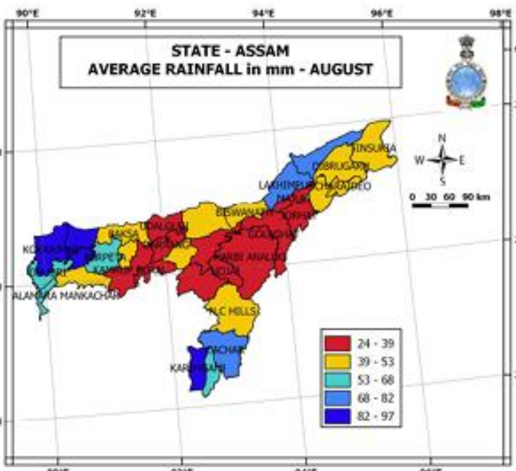
Mean rainfall pattern over districts of Assam is as shown in the following figures



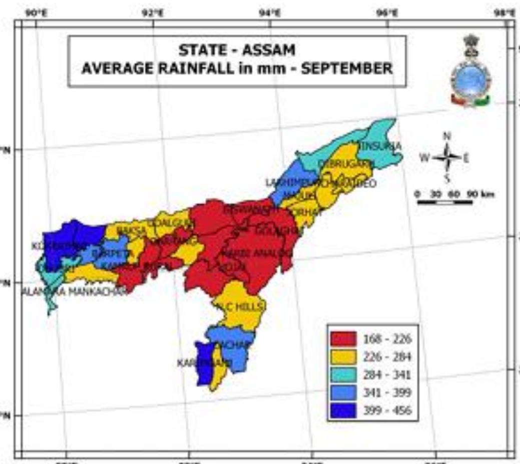
STATE - ASSAM
AVERAGE RAINFALL in mm - JUNE
214 - 322
322 - 431
431 - 540
540 - 649
649 - 758



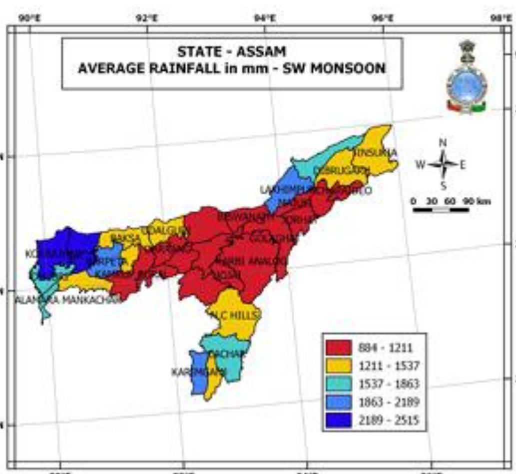
STATE - ASSAM
AVERAGE RAINFALL in mm - JULY
248 - 342
342 - 435
435 - 528
528 - 621
621 - 714



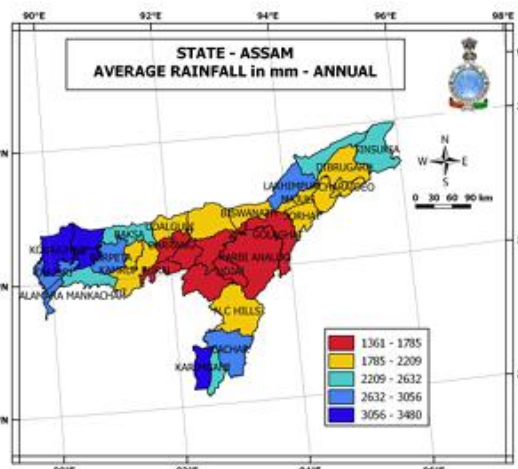
STATE - ASSAM
AVERAGE RAINFALL in mm - AUGUST
24 - 39
39 - 53
53 - 68
68 - 82
82 - 97



STATE - ASSAM
AVERAGE RAINFALL in mm - SEPTEMBER
168 - 226
226 - 284
284 - 341
341 - 399
399 - 456



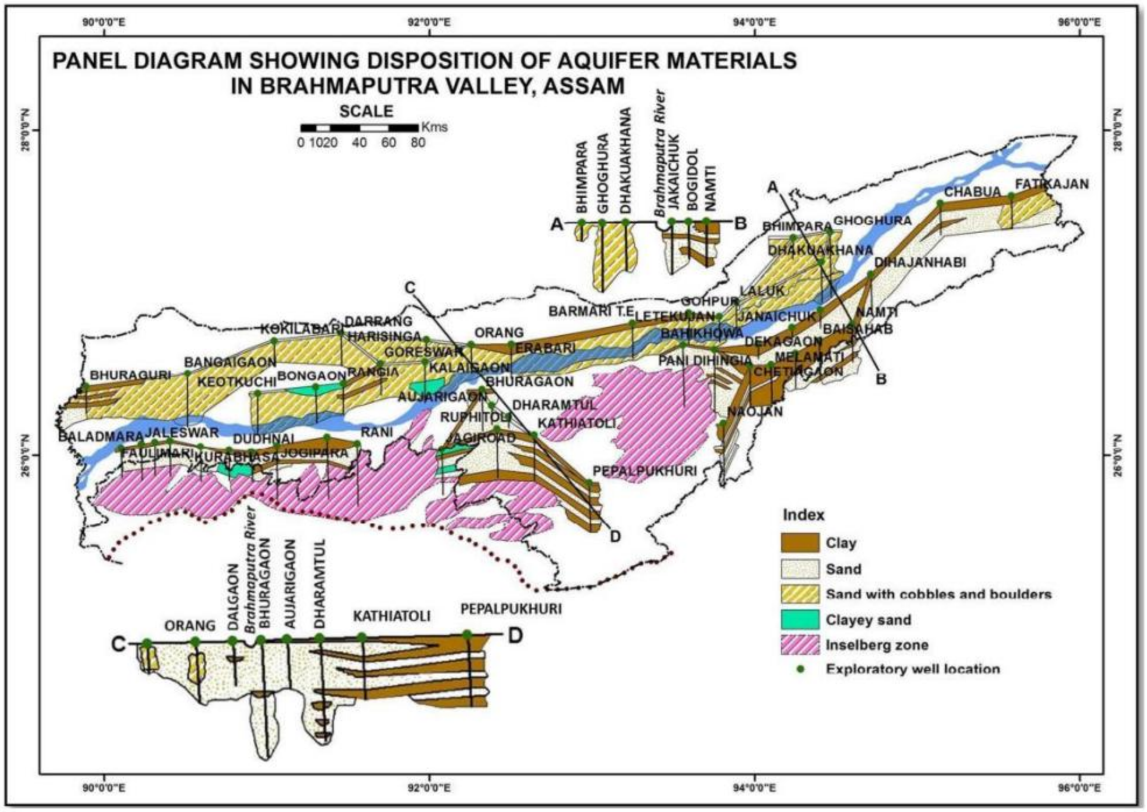
STATE - ASSAM
AVERAGE RAINFALL in mm - SW MONSOON
884 - 1211
1211 - 1537
1537 - 1863
1863 - 2189
2189 - 2515



STATE - ASSAM
AVERAGE RAINFALL in mm - ANNUAL
1361 - 1785
1785 - 2209
2209 - 2632
2632 - 3056
3056 - 3480

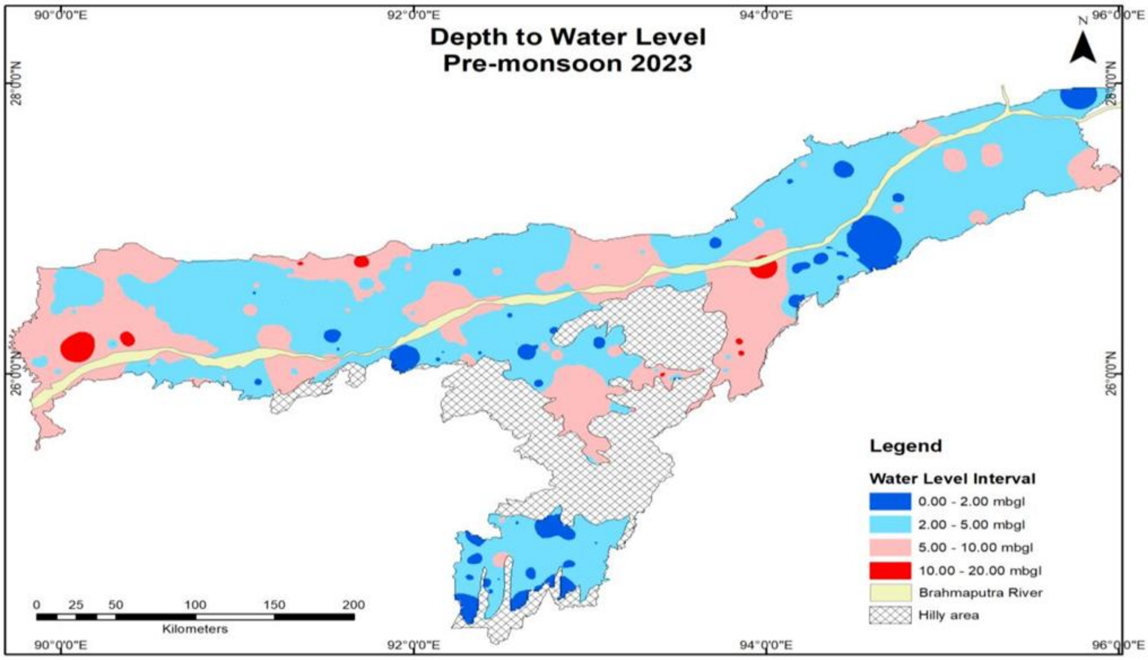
A.6. Ground Water

The district can be sub-divided into two broad hydrogeological Units (1) Tertiary Group of Semi-consolidated rocks (2) Quaternary alluvium of Unconsolidated sediments.



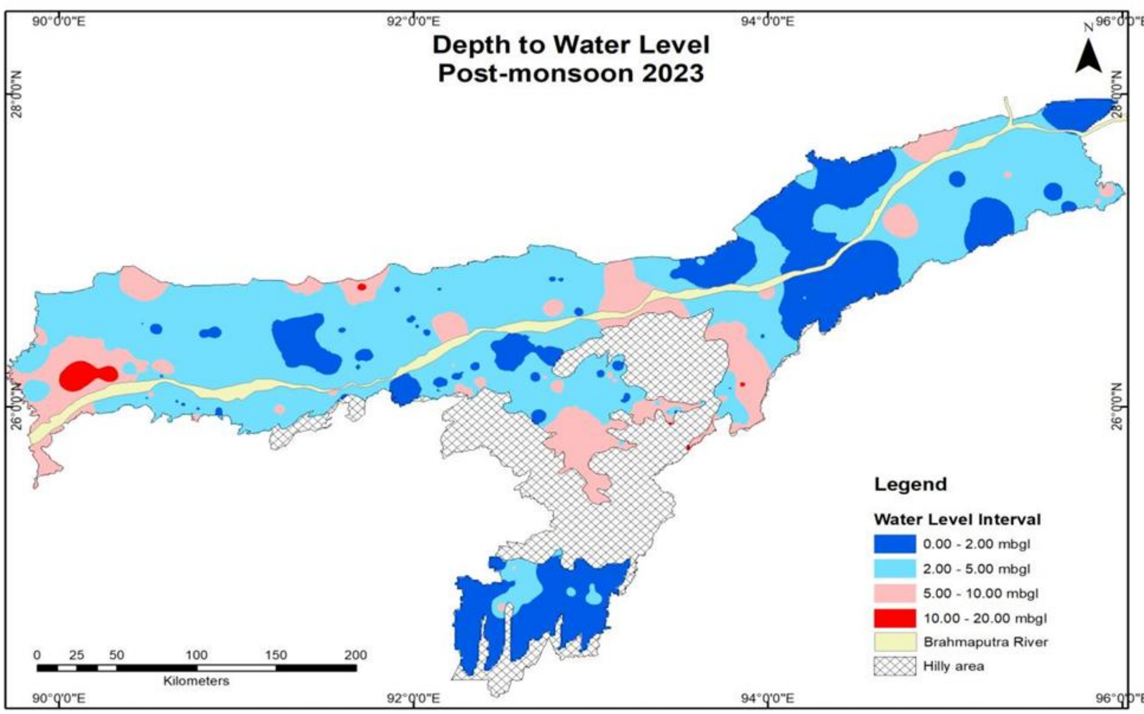
Disposition of aquifer materials in Brahmaputra Valley, Assam

Tertiary group of sedimentary rocks are confined to the southernmost part of the area where ground water occurs in the shallow weathered zone and this may be developed through large diameter open wells. Ground water occurs in deeper aquifer consisting of Tipam sandstone and in boulders and gravel beds of Dihing group which are suitable for development through deep tube wells. Alluvial plain covers major part of the district. Ground water occurs in regionally extensive aquifers down to explored depth of 250 m with a very good yield prospect. The aquifers are consisting of sands of various grades and are suitable for both shallow and deep tube wells. Ground water rests at shallow depth and in major part of the district, depth to water level varies from 2 to 5 m bgl during pre-monsoon period and from 1.68 to 4.5 m bgl during post monsoon period. The long tern water level trend study shows no significant change of water level in the last 10 years. The shallow tube wells tapping aquifers within 50 m depth are capable of yielding 20 – 50 m3 /hr at drawdown of less than 3 m. Medium to heavy duty tube wells constructed down to 100 – 150 m depth tapping 25 – 30 m of granular zones are yielding 50 – 100 m3 /hr.

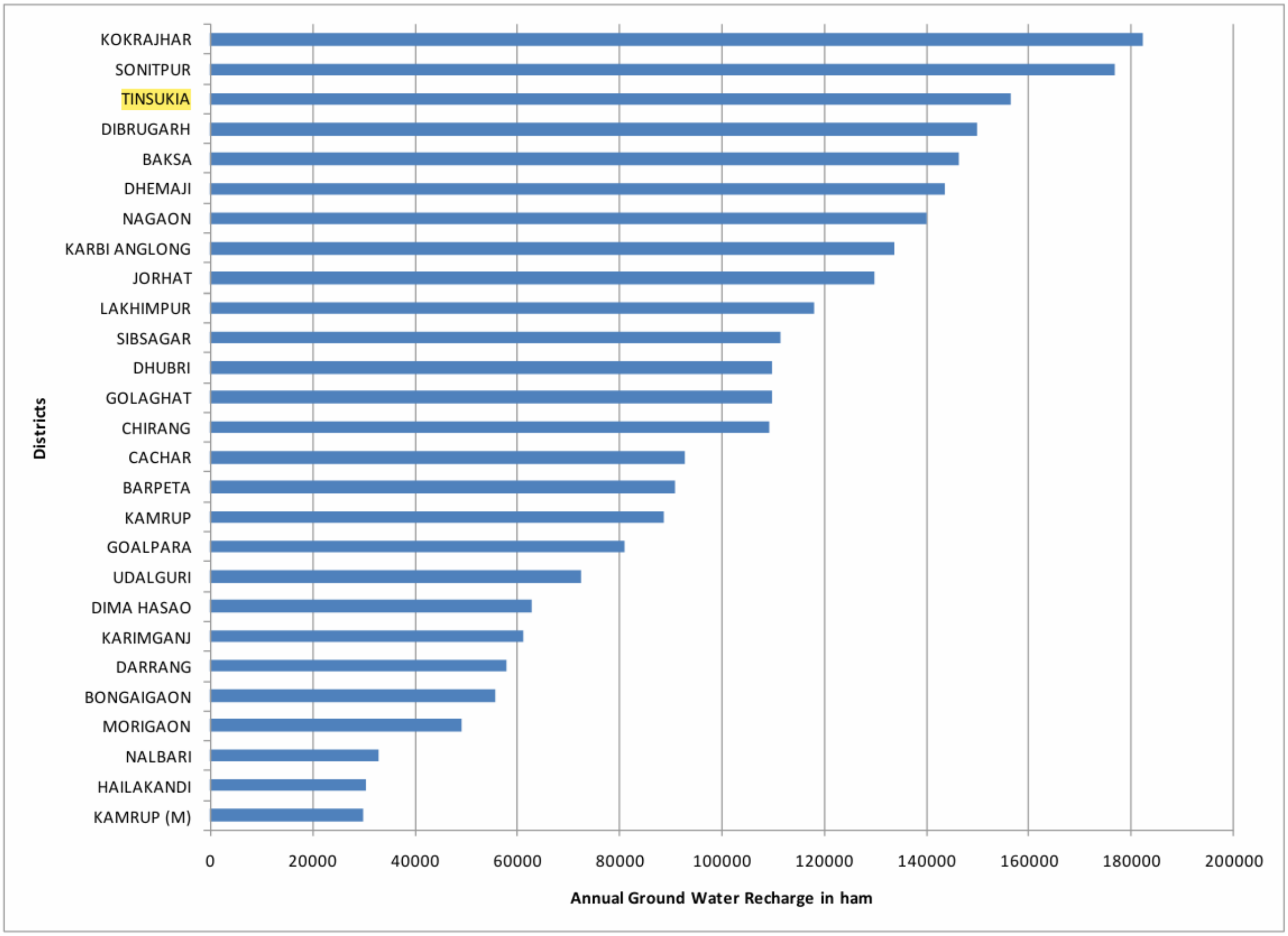


Pre-monsoon 2023 map of Depth to Water Level Assam

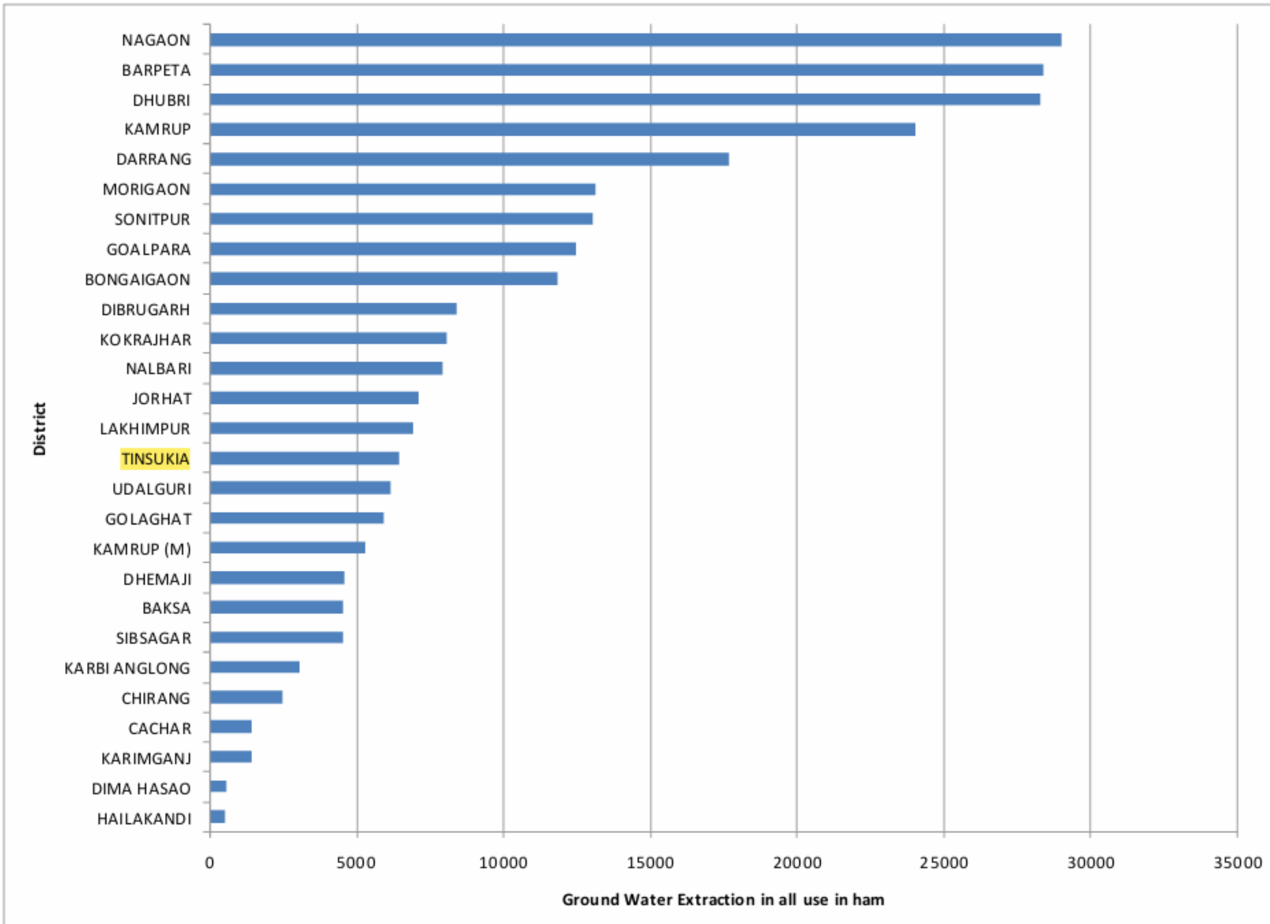
It is clear from the map that for Tinsukia district, pre-monsoon depth of water level ranges 0 to 10 mbgl



Post-monsoon 2023 map of Depth to Water Level Assam



Showing district wise ground water recharge in ham



District wise stage of extraction

A.7. Alternate methods

DYNAMIC GROUND WATER RESOURCES OF ASSAM STATE, 2024

AT A GLANCE

1. Total annual griund water recharge : 27.21 bcm
2. Annual extractable ground water resources : 20.89 bcm
3. Annual ground water extraction : 2.64 bcm
4. Stage of ground water eatraction : 12.61 %

CATEGORIZATION OF ASSESSMENT UNITS

(Blocks/ Mandals/ Taluks)

Sl.No	Category	Number of Assessment Units		Recharge worthy Area		Annual Extractable Ground Water Resource	
		Number	%	in lakh sq. km	%	(in bcm)	%
1	Safe	244	99.59	68617.51	99.71	20.85	99.80
2	Semi Critical	01	0.41	200.42	0.29	0.041	0.20
3	Critical						
4	Over-Exploited						
5	Saline						
	TOTAL	**245**		**68817.93**		**20.89**	

Name of District	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for Domestic use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)
	Monsoon Season		Non-Monsoon Season		Total Annual Ground Water Recharge									
	Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources				Irrigation	Industrial	Domestic	Total			
Nalbari	23855.97	155.72	8849.97	43.15	32904.81	3290.49	29614.32	7479.36	36.9	398.28	7914.57	409	21689.03	26.73
Sibsagar	78656.97	603.47	32055.39	187.06	111502.89	17066.36	94436.53	2721.6	72.06	1759.44	4553.11	1795.6	89847.27	4.82
Sonitpur	131621.88	1919.6	42220.16	1035.05	176796.69	41902.32	134894.37	8942.64	104.12	4011.17	13057.93	4160.16	121687.45	9.68
Tinsukia	111830.01	2578.92	40135.93	1772.98	156317.84	27820.9	128496.94	4331.04	68.68	2070	6469.76	2146.38	121950.81	5.03
Udalguri	49340.16	732.15	22147.2	126.3	72345.81	23052.83	49292.98	4569.6	62.68	1528.69	6160.97	1560.71	43099.99	12.5
Total(Ham)	1944786.67	67232.78	653019.73	56094.04	2721133.22	632002.39	2089130.83	206043.6	1378.45	56099.08	263521.18	58461.77	1823247.02	12.61
Total(Bcm)	19.45	0.67	6.53	0.56	27.21	6.32	20.89	2.06	0.01	0.56	2.64	0.58	18.23	12.61

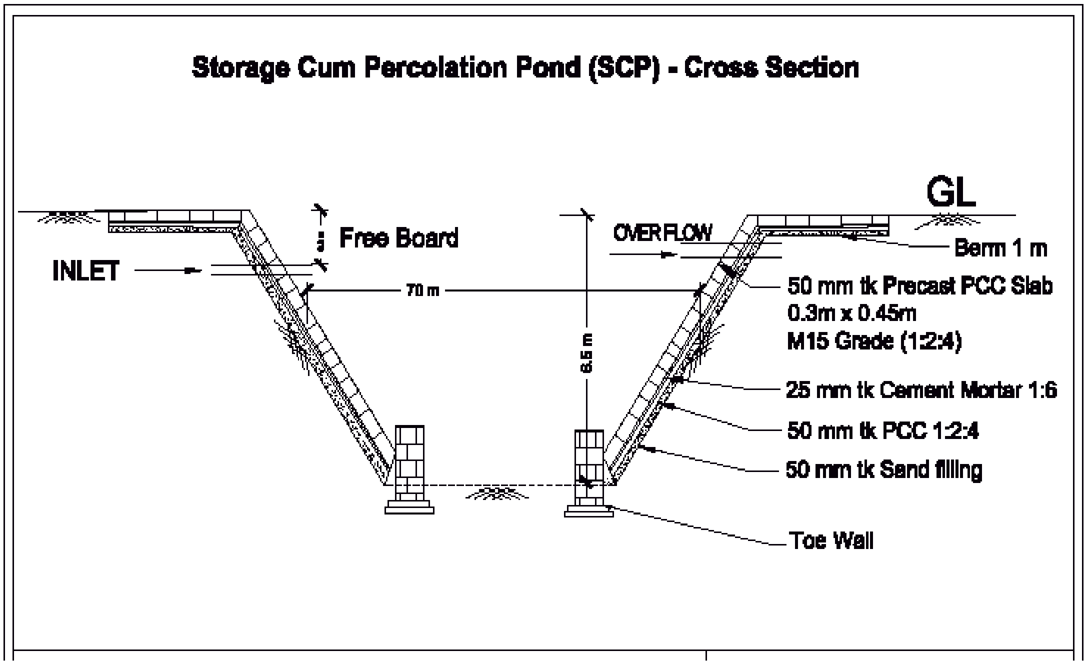
Ground water conservation management strategy, Tinsukia, Assam

Thick and extensive alluvial deposits with rich aquifer system covering major part of the district are suitable for ground water development through open wells, shallow tube well and deep tube wells. For drinking and other requirements of individual households, where limited quantities of water is required, open wells and filter point wells are feasible almost in all parts of the district. Ring wells of 0.80 m to 1.20 m diameter to depth of 5 to 10 m bgl are likely to hold sufficient quantities of water to meet the daily requirement. Filter point wells to depth of about 15 to 20 m bgl are also suitable for extraction of ground water for domestic uses.

For agricultural purpose, shallow tube wells may be constructed in the areas occupied by alluvial formation. A number of shallow tube wells constructed by State Agriculture Department and the performance of the tube wells shows that tube wells constructed to depth of about 30-40 m tapping 9-15 m of granular zones giving discharge of about 600 lpm. Based on the nature of sub-surface geology, a shallow tube well of 30 to 50 m depth, tapping about 10-15 m granular zones expected to yield more than 30 m3 /hr. A Centrifugal pump may be used to irrigate about 2-3 ha of land at an average annual draft of 0.03 mcm.

A.8. Design Specifications

Digboi refinery, Indian Oil has set up a state of an art facility for rainwater harvesting. They are practicing an integrated approach through Storage Cum Percolation (SCP) pond which receives run-off water of 9 interlinked natural catchment areas around Digboi. Prior to SCP, water passes through Settling tank (ST), Aeration Tank (AT) and Sand filter (SF). SCP is followed by a Recovery well (RW) where stored water gets collected for further utilization in refinery area. Out of nine different natural catchment areas, capacity of Dams-1,2,3 is 24 Lacs KL and Dam -C is 15 LacsKL.



Effluent Treatment Plant:

Liquid effluent streams generated from various sources within refinery complex are routed to the existing effluent treatment plant (ETP) of design capacity API: 375 m3/hr,TPI: 273 M3/hr, DAF: 200 m3/hr & operating capacity is 84 – 110 m3/hr for treating the waste water from all the units/sources. Treatment facilities are provided for treating all types of effluents generated from the project fully complying with all applicable statutory requirements. Treated ETP effluent is majorly reused inside refinery. The dewatered oily sludge is sent to secured landfill. The bio sludge after dewatering shall be sent for land fill/reuse as manure.

Effluent Treatment Facilities at the Existing ETP:

The facilities at the ETP are as follows:

a. Influent Sump with pumps b. API Separators c. Tilted Plate Interceptor d. Equalization ponds e. DAF – Dissolved Air Flotation Unit f. Trickling Filter g. Aeration Tank h. Secondary Clarifier i. Dual Media Filters j. Recirculation Sump k. Sludge Recirculation sump and pumps l. Oily sludge lagoon m. Slop Oil Pumps n. Sludge Drying Beds o. Polishing Pond p. Secured Land Fill q. VOC Reduction Facility

A.9. Implementation Benefits to Water Security

To address freshwater needs and support groundwater replenishment, IOCL group have established rainwater harvesting (RWH) systems and watershed projects at most of the locations of Indian Oil. These initiatives have effectively increased the capture and utilization of rainwater. The integration of watershed projects has further amplified rainwater collection, contributing to our sustainable water management practices.

Their refineries are taking a leading role in water optimization, by focusing on efficient management of water resources, promoting recycling of water, increasing public awareness and participation in water conservation efforts. They are implementing several storm water initiatives, such as installing a Storm Water Management System (SWMS) for rainwater treatment and reuse. This initiative helps in effective handling of heavy surface run off and prevent water logging in low-lying areas inside refinery.

Storage Cum Percolation Pond (SCP) was commissioned in 2018 utilizing run-off water of 9 interlinked natural catchment areas around Digboi, first of its type in eastern Asia. The usage of rainwater has proven a very cost effective and environment friendly to increase the water table in Digboi area.

At Digboi Refinery, their utilization of rainwater harvested from percolation ponds has led to a significant reduction in freshwater consumption.

Harvested rain water is then used as

1. Cooling Tower Make up
2. DM water feed
3. Service water
4. Fire water make up

Reuse /Recycling of Treated Effluent: A permanent pumping system had been installed in ETP and commissioned in Nov'93. Recycling of treated effluent has since then been stepped up. Approximately 97% of treated effluent is recycled into refinery and reused as Fire water make up, for cleaning purposes and gardening. A large amount of the treated effluent is reused as a cooling water make up, fire water make up, horticulture.

A9.1 Objectives vs Outcomes

Objectives of the project activities:

1. Water Conservation

- Store, recharge and reduce fresh water consumption by utilizing rainwater.
- Reduce dependency on freshwater sources.

2. Groundwater Recharge

- Enhance groundwater levels by allowing stored water to percolate into the subsurface.
- Improve the water table, especially in water-stressed regions.

3. Wastewater Management

- Recycle treated effluent from ETP for safe recycling in green belt development, fire water make up and cleaning purposes.
- Reduce the environmental impacts by achieving Zero Liquid Discharge (ZLD).

4. Pollution Reduction

- Prevent untreated or poorly treated effluents from entering rivers and lakes.
- Improve the quality of surface and groundwater through sustainable reuse.

5. Cost Savings

- Reduce the cost of water procurement for industrial and domestic purposes.
- Save on energy and operational costs associated with fresh water consumption supply chain.

6. Regulatory Compliance

- Comply with pollution control norms and environmental regulations.
- Support corporate social responsibility (CSR) and sustainability goals.

Outcomes of the project activities:

1. Increased Water Availability

- PP has ensured availability of additional water for non-potable uses which has resulted into reducing pressure on freshwater sources.
- This project activity supports consistent water supply during dry seasons.

2. Improved Groundwater Quality

- It enhances filtration through soil percolation improves treated water quality before it reaches the aquifer.

3. Reduced Environmental Footprint

- PP has contributed towards improving environmental footprints through their unique water stewardship programs.
- It is also helping local ecosystem health betterment in nearby river and groundwater zones.

4.Enhanced Sustainability Profile

- PP has ensured circular water economy by promoting reuse and recycling of water streams.
- PP has aligned their water conservation initiatives with UN Sustainable Development Goals (SDGs), especially SDG 6 (Clean Water and Sanitation).

5. Strengthened community relations

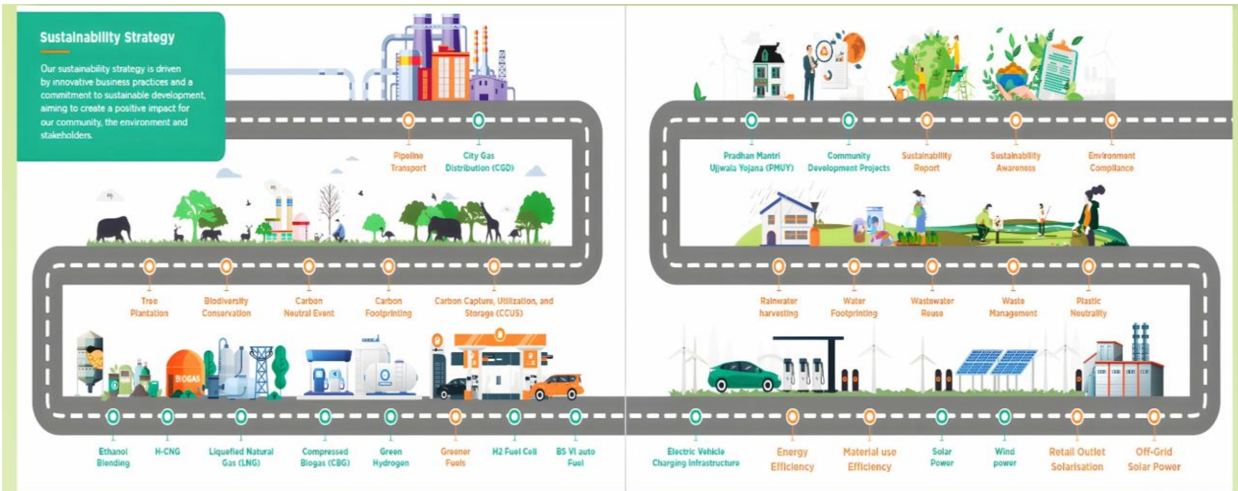
- Positive community relationships between PP and the local community through responsible practices and engagement, fostering a sense of trust and collaboration.

A9.2 Interventions by Project Owner / Proponent / Seller

Indian Oil is actively integrating Sustainability into its core business strategy, focusing on environmental protection, social progress and economic growth. They aim to minimize their ecological footprint and actively pursue initiatives that benefit both stakeholders and the environment.

As shown in their Sustainability strategy, water conservation initiatives play a vital role in achieving their overall Sustainability targets.

At Digboi refinery, they have conceptualized the unique feature of interconnecting nine natural catchment area and created a storage cum percolation (SCP) pond having capacity of 28,000 m3. Objective of establishing SCP is to harvest, store, use, and percolate rainwater — ensuring supply augmentation, recharge of groundwater, and ecological restoration. This fundamental initiative is very crucial for Digboi area as its overall water risk is HIGH (3-4) as per aqueduct water risk atlas.



IOCL’s Sustainability strategy

A.10. Feasibility Evaluation

PP has ensured the technical feasibility evaluation of their water harvesting through Storage Cum Percolation (SCP) pond by engaging third party experts to conduct the study.

Objectives of the study is as stated below:

1. The primary objective of the feasibility study was to find out suitable rainwater harvesting systems applicable for the study site and prepare a master plan for implementation of the scheme with its economic considerations in totality for better water resources planning
2. To construct storage cum percolation pond with recovery system for withdrawal of water and use the same for various application
3. To suggest suitable desilting and filtration methods to minimize the flow of silt towards the proposed SCP
4. To reduce the increased dependence on river sources
5. To study the rainwater runoff pattern and to prevent maximum flow of water outside the premise
6. To improve the existing water bodies and improve the catchment area of the same
7. To assess the ground water condition of the study site and improve the same by rainwater harvesting and artificial recharge
8. To identify the subsurface formations and designs suitable artificial recharge structures

9. To suggest remedies for the perpetual problem of ground water stagnation at few locations within the study site
10. To stem the decline of water levels in the study area and raise the ground water table of the premises by storing adequate quantity of water in ponds and site-specific recharge structures
11. As part of Corporate Social Responsibility, IOCL certainly wants to increase the water table of the depleting aquifers of the study site and surrounding areas

After a detailed deliberation and assessments, Storage Cum Percolation (SCP) pond was designed strategically, so that it can yield sustainable quantity of water to meet the demand of the Digboi refinery, IOCL.

A.11. Ecological Aspects & Sustainable Development Goals (SDGs):

Digboi refinery's efforts towards sustainable water management and initiative thereof results into multiple ecological benefits and a strong alignment with several UN Sustainable Development Goals (SDGs).

Ecological aspects: Associated ecological aspects with PP's project activities are water table recharge, Flood Mitigation by collecting rainwater which reduces surface runoff, thereby minimizing urban flooding and soil erosion, Soil Conservation, Water Quality Improvement and Microclimate Regulation as retained water supports urban greenery and ecosystem services, contributing to cooler local temperatures and better air quality.

Digboi refinery's water stewardship is aligned with UN's Sustainable Development Goals (SDGs). Their approach is rooted in the United Nations Sustainable Development Goals (SDGs) and aims to create a more sustainable future for India and the world.

Indian Oil drives the achievement of SDGs through empowered leadership, transparent governance, and environmental stewardship. The company supports responsible consumption, clean energy, and innovative infrastructure, while minimizing environmental impact and conserving ecosystems.

1. **SDG 6: Clean Water and Sanitation:** PP's Storage Cum Percolation (SCP) based rainwater harvesting initiative directly contributes by providing an alternative, sustainable water source.
2. **SDG 11: Sustainable Cities and Communities:** Storage Cum Percolation Pond design promotes resilient infrastructure and reduces disaster risk from urban flooding. It supports the concept of climate resilient infrastructure and sustainable urban planning.

3. **SDG 13: Climate Action**: SCP based state of the art rainwater conservation is a climate adaptation measure that helps PP to deal with water stress due to erratic rainfall patterns caused by climate change.
4. **SDG 12: Responsible Consumption and Production:** PP's project activities are resulting into reduction in fresh water consumption by adopting 3Rs approach and collecting rainwater through SCP encourages efficient use of natural resources, reducing over-extraction of groundwater.
5. **SDG 15**: **Life on Land:** Collection of rainwater through Storage Cum Percolation (SCP) pond prevents soil erosion and reduces surface runoff. RWH helps preserve terrestrial ecosystems and maintain soil health.

A.12. Recharge Aspects :

A.12.1 Solving for Recharge

Ultimately, the volume of groundwater recharge benefit to the subbasin is the most critical aspect for such MAR activities. Groundwater recharge is quantified as the deep percolation of surface water applied during project implementation. Using a field-scale water budget, deep percolation can be calculated as the difference between all other inflows and outflows, as per the equation below, with each other inflow and outflow being quantified:

Recharge = Rainfall + Surface Inflow – Evapotranspiration – Surface Outflow – Change in Storage

Evapotranspiration & Other Data: https://datameet-pune.github.io/open-water-data/docs/open-water-data-paper.pdf (or available under Documents Section- Water Data Guide)

Root Zone = The root zone is comprised of the upper portion of the soil where water extraction by roots occurs, above the depth at which water infiltrates to the groundwater system. The depth to the bottom of the root zone varies by crop, but typically extends up to seven feet.

Surface Inflow= Surface inflows can be either directly measured or calculated from measured values. In fields directly served by metered lift pumps or metered gates, the volume of surface inflows to the field can be directly measured or calculated from totalized measurements. Typical accuracies of pipe flow measurements range from 1-12 percent. In fields that are indirectly supplied with surface water, surface inflows may need to be calculated from upstream and downstream flow measurements, or through theoretical or empirical equations relating available data to field surface inflows. For example, fields served from canals measured using weirs, or fields served from canals that deliver water to multiple locations downstream of a measurement device may require site-specific calculations to quantify surface inflows to a specific field. Low-cost in-field measurements can also be made by setting up flashboards at the measurement location and correlating the “runup” of an unsubmerged weir overflow on a flat weir stick to the flow rate using standardized equations. Typical accuracies of “runup” or indirect flow measurements may exceed 10 percent, depending on site conditions and the accuracy of measurement data.

To monitor surface inflows, project owners may record flow data, maintain irrigation logs, and maintain logs of any other parameters required to calculate field deliveries, depending on the unique conditions of their field. Project owners may also consider using mobile flow monitoring equipment to measure or verify surface inflows.

Surface Outflows: To monitor surface outflows, users may record flow data or water level data and maintain logs of any other parameters required to calculate outflows, depending on the unique conditions of their project activity. Pressure transducers and dataloggers may be used to automatically monitor water levels, or users may install wooden stakes to manually monitor water depths.

Change in Storage = The change in surface storage, or average ponded water depth, can be calculated from measured and observed changes in water surface levels at points throughout the project field. Over the annual project implementation period, **<u>the total change in surface storage is typically zero</u>**, provided that the surface of a field is dry and free of ponded water at the start and end of the project.

While the uncertainty of each inflow and outflow will vary based on field conditions and measurement devices, typical uncertainties associated with each water budget component are summarized in the table below. The uncertainty of deep percolation (i.e., recharge) can then be calculated from these other uncertainties, for example following the process described by Clemmens and Burt (1997). Users can use the following table to eliminate uncertainty from their estimates.

Water Budget Component	Typical Estimated Uncertainty (%)	Description
Surface Inflow	2 %	Typical range of accuracy from meters to minimum delivery accuracy requirements of delivery and diversion measurement devices.
Precipitation	2%	Typical range of accuracy from field-level rain gauges to extrapolation of local weather station data

Surface Outflow	2%	Typical range of accuracy from meters to estimated outflow relationships
Evapotranspiration	10%	Clemmens and Burt, 1997; typical accuracy based on free water surface evaporation coefficient.
Deep Percolation	5%	Typical range of calculated accuracy from field-scale water budget results (fields ranging from 56 to 125 acres)
TOTAL	**21%**	

A.13. Quantification Tools

Water Harvesting Potential

Harvesting potential or Volume of water utilized (liters) =	**Area of Catchment/Roof/Collection Zone (m^2) X Amount of rainfall (mm) X Runoff coefficient**

(A)Runoff water generated in catchment area of Dams 1,2 &3

=2510280* 2323*0.9

= 5,24,82,42,396 Liters = 52,48,242 KL (Harvesting potential)

(B) Runoff water generated in catchment area of Dams C

= 1556156* 2323* 0.9

= 3,25,34,55,349 Liters = 32,53,455 KL (Harvesting Potential)

The catchment area is taken from Google Earth as mentioned in their technical feasibility evaluation report.

Total quantity of runoff water generated = A+B = 85,01,697 KL per annum (Harvesting potential)

Uncertainty factor: 21%. Hence, Annual water harvesting potential = 67,16,340 KL per annum

However, the total volume of Storage Cum Percolation (SCP) pond is 28,000 m3. Actual rain water harvested through the integrated water management SCP design, is as mentioned in below table.

SN	Year	Actual Rainwater Harvested through SCP (KL)	RoUs generated 1 RoU = 1000 L=1 KL
1	2018-19	21415	21415
2	2019-20	230443	230443
3	2020-21	470058	470058
4	2021-22	491504	491504
5	2022-23	574459	574459
6	2023-24	547894	547894
7	2024-25	661931	661931
TOTAL RoUs GENERATED			**29,97,704 RoUs**

RoUs generated from ETP treated water recycling:

SN	Year	ETP Recycled Water (KL)	RoUs generated 1 RoU = 1000 L=1 KL
1	2015-16	399916	399916
2	2016-17	411454	411454
3	2017-18	636114	636114
4	2018-19	739072	739072
5	2019-20	460152	460152
6	2020-21	444844	444844
7	2021-22	813987	813987
8	2022-23	719289	719289
9	2023-24	540652	540652
10	2024-25	504292	504292
TOTAL RoUs GENERATED			**56,69,772 RoUs**

A.14. UWR Rainwater Offset Do No Net Harm Principles

Scientific studies have revealed that a water crisis awaits various parts of our country and the state of assam is not an exception to this phenomenon. This critical situation need not be due to lack of water as such, but definitely due to lack of sustainable water management.

Prior to implementation of SCP pond, daily water demand of Digboi refinery, IOCL was met through the supply from Nazirating river source, located 15 Kms aways from the plant. So, it was crucial for PP to have alternative feasible water source to avoid sole dependency on a single source, particularly river sources, which was ultimately not a sustainable source due to its distance from plant, cost and usage of precious energy for water pumping purpose etc.

PP's unique intervention for Sustainable water management through SCP pond is resulting into replenishing the ground water, managing the surface runoff responsibly and not disturbing the surrounding ecological and social systems. This design ensures long-term sustainability, aligns with National water management goals, and enhances IOCL's role as a responsible corporate entity in the Brahmaputra basin.

PP's water conservation has ultimately solved the issues regarding water availability because the groundwater table was gradually depleting and the yield from the water extraction structures like deep tube wells was increasing substantially. PP's project activity has resulted into increase in sustainable water yield in areas where over development has depleted the aquifer. PP's strategic design and execution has led to collection and storage of unutilized rainwater from going into storm drains or sewers. Interconnected nine natural catchment areas and SCP pond is able to conserve and store excess water for future use for industrial use. Creation of artificial water bodies are supporting local biodiversity.

A.15. Scaling Projects-Lessons Learned-Restarting Projects

IOCL's core values support their vision towards Sustainability. At Digboi, refinery, existing set up of SCP pond-based storage, collection and utilization of rainwater can be further scaled up by increasing the effective surface area/catchment area available in the refinery area and their township. Their existing ETP treated wastewater recycling scheme can be further enhanced by optimizing water usage and achieving Zero Liquid Discharge (ZLD) by adopting best available technology. These efforts will help in further reducing freshwater demand by preserving precious natural resources for future generations. It will benefit the environment by mitigating pressure on freshwater bodies and promoting a circular economy. It will support the community by creating economic opportunities through treated wastewater reuse and recycling.

The successful implementation of sustainable practices by PP serves as a model that can be replicated in other parts of Assam facing similar challenges. By demonstrating effective rainwater harvesting and community involvement strategies, other industries can adopt these methods to alleviate water scarcity issues. By implementing these strategies, projects like those at PP not only enhance operational efficiency but also contribute significantly to alleviating the water scarcity challenges faced by communities in Tinsukia and surrounding areas. Such initiatives are crucial for promoting sustainable urban management practices that prioritize environmental health and community welfare while providing a template for future projects aimed at addressing future water crisis across Assam.

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