DISTRICT SURVEY REPORT,ASSAM

NAGAON

As per Sustainable Sand Mining Management Guidelines, 2016 and Enforcement & Monitoring Guidelines for Sand Mining, 2020, Ministry of Environment, Forest and Climate Change (MoEF & CC)

SEPTEMBER 2024

Prepared by:

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CONFIDENTIALITY CLAUSE

This District Survey Report (DSR) of Nagaon District has been prepared by RSP Green Development and Laboratories Pvt. Ltd., Howrah, West Bengal, India. The report covers diversified ranges of subject matters relevant to project objectives and survey based information/ data, therefore, this 'Confidentiality Clause' is a legally binding section that is anticipating that, any employee who are directly and/or indirectly involved in the project will not disclose any significant confidential information or any duplicate copies to any third parties without legalized written consent of 'No Objection' from company authority and Concerned department of Government of Assam, not even for the specific purpose for which the report has been prepared

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LIABILITY CLAUSE

Limitation of Liability

RSP Green Development & Laboratories PVT.LTD undertakes the technical responsibility for the entire report. All the authenticated Secondary data included in the report has been obtained from the Various Government departments and all the report verifying by Sub-Divisional Committee

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*The organization is accredited as **Category-B** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –*

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Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SAAC minutes dated May 6, 2022 and supplementary minutes dated July 8, 2022 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/22/2519 dated September 15, 2022. The accreditation needs to be renewed before the expiry date by RSP Green Development & Laboratories Pvt. Ltd, following due process of assessment.

Sr. Director, NABET
Dated: September 15, 2022

Certificate No.
NABET/EIA/2124/SA 0176

Valid up to
Feb 9, 2024

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Sub.: Extension of Validity of Accreditation till September 17, 2024– regarding
Ref.. 1. Certificate no NABET/EIA/2124/SA 0176
2. Request mail June 15, 2024

Dear Sir/Madam

This has reference to the accreditation of your organization under QCI-NABET EIA Scheme, the validity **RSP Green Development & Laboratories Pvt. Ltd.** is hereby extended till September 17, 2024, or completion of the assessment process, whichever is earlier.

The above extension is subject to the submitted documents/required information with respect to your application and timely submission and closure of NC/Obs during the process of assessment.

You are requested not to use this letter after the expiry of the above-stated date.

With best regards.

(A K Jha)
Sr. Director, NABET

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ABBREVIATION

ABBREVIATIONS & SYMBOLS USED	:	FULL FORMS
%	**:**	Percent
′	**:**	Minute
″	**:**	Second
<	**:**	less than (strict inequality)
=	**:**	Equal to (strict equality)
>	**:**	greater than (strict inequality)
≈	**:**	approximately equal
°	**:**	Degree
°C	**:**	Degree Centigrade
°F	**:**	Degree Fahrenheit
ArcGIS	**:**	ArcGIS is a GIS for working with maps and geographic information maintained by the ESRI.
CD blocks	**:**	Community development blocks
cm	**:**	Centimeter
cum	**:**	Cubic meter
Dec	**:**	December
DEIAA	**:**	District Level Environment Impact Assessment Authority
DSR	**:**	District Survey Report
E	**:**	East
e.g.,	**:**	*'exempli gratia'*(Latin phrase) means 'for example'
EC	**:**	Environmental Clearance
et.al.,	**:**	*'et alia'* (Latin phrase) means 'and others'
G:2 stage	**:**	General Exploration (stage of exploration as per UNFC norms)
G:3 stage	**:**	Prospecting (stage of exploration as per UNFC norms)
GIS	**:**	Geographical Information System
Govt.	**:**	Government
GPS	**:**	Global Positioning System
Ha	**:**	Hectare
i.e.,	**:**	*'id est'* (Latin phrase) means 'that is'/'in other words'
ICAR	**:**	Indian Council of Agricultural Research

ABBREVIATIONS & SYMBOLS USED	:	FULL FORMS
Inch	**:**	inches
kg/ha	**:**	Kilogram per hectare
km	**:**	kilometer
km/ hour	**:**	Kilometer per hour
km2	**:**	kilometer square
LANDSAT	**:**	Land Satellite stands for Low Altitude Satellite
LULC	**:**	Land use and land cover
m	**:**	Meter
Mar	**:**	March
Max.	**:**	Maximum
mbgl	**:**	Meter Below Ground Level
Min.	**:**	Minimum
mm	**:**	Millimeter
MoEF&CC	**:**	Ministry of Environment, Forest and Climate Change
N	**:**	North
NH	**:**	National Highways
No.(s)	**:**	Number(s)
RI value	**:**	River Index value
S	**:**	South
SEIAA	**:**	State Environment Impact Assessment Authority
Sept	**:**	September
sp.	**:**	species
sq.km	**:**	Square kilometer
Temp	**:**	Temperature
viz.,	**:**	Latin phrase *'videre licet'*, and is used as a synonym for "namely",
W	**:**	West

CHAPTER 1: PREFACE

The need for District Survey Report (DSR) has been necessitated by MoEF & CC vide their Notification No. 125 (Extraordinary, Part II Section 3, and Sub-section ii), S.O. 141 (E), dated 15th January 2016. The notification was made to bring certain amendments with respect to the EIA notification 2006 and in order to have better control over the legislation, district level committees for introduction into the system. Preparation of District Survey Reports has been introduced as a part of the above notification. Subsequently, MOEF & CC has published Notification No. 3611 (E), DT. 25th July 2018 regarding the inclusion of the "Minerals Other than Sand" and specified the format of the DSR. Monitoring Guidelines for Sand Mining (EMGSM) January 2020, issued by the Ministry of Environment, Forest and Climate Change is prepared in consideration of various orders/directions issued by Hon'ble NGT in matters pertaining to illegal sand mining and based on the reports submitted by expert committees and investigation teams. This DSR has been prepared in conformity with the S O 141 (E), S O 3611 (E), and other sand mining guidelines published by MOEF & CC from time to time as well as the requirement specified in Assam Minor Mineral Concession rule 2013, (AMMCR), 2013.

The purpose of the District Survey Report (DSR) is to identify the areas of deposition where mining can be permitted and also, to identify the areas where mining will not be permitted due to proximity to infrastructural structures and installations and areas of erosion. The DSR would also help to calculate the total amount of replenishment.

Preparation of this DSR required both primary and secondary data generation. The primary data generation involved the site inspection, survey, ground truthing etc. while secondary data has been acquired through various authenticated sources and satellite imagery studies. The secondary data related to district profile, local geology, mineralization and other activities are available in rather a piecemeal fashion. The district survey report of Nagaon district also describes the general geographical profile of the district, distribution of natural resources, livelihood, climatic condition, inventory of minor minerals and revenue generation.

The state of Assam itself is very rich in mineral resources. Here "liquid gold" (fuel oil) and other natural resources are found. During the last 70 years, the mineral sector has grown considerably in Assam. In spite of this, the economic growth of this state has been slow. In order to expedite the development process, exploitation of available mineral resources by developing mines & establishment of mineral-based value- added industries has an imperative upshot. Developments achieved in the mining & mineral industries so far, availability of resources & existing trend would offer a glimpse of the future of the mineral sector in the state.

Minor minerals include building stones, gravel, ordinary clay, ordinary sand, limestone used for lime burning, boulders, kankar, morrum, brick earth, bentonite, road metals, slate marble, and stones used for making household utensils. But sand is used for stowing purposes. Coal is considered a major mineral. In the case of Assam, exploitation of minor minerals comes under Rule, 2013 52 (1) of the Assam Minor Minerals Concession Rule. Therefore, this District Survey Report (DSR) will give authentic field data sets and relevant information about the presence of riverbed sand deposits, ordinary earth & brick earth along with river bed boulder and/or fossilized channel deposits which in turn will bestow excellent guidance for systematic and scientific utilization of mineral resources, so that present and future generation may be benefitted at large.

It is also mentioned here that the procedure of preparation of this District Survey Report is as per notification guidelines issued by the Ministry of Environment, Forests and Climate Change (MoEFCC), SO No. 141(E), Dated 15.01.2016, and the format given by SO No. 3611(E), New Delhi, dated 25 July 2018 regarding the preparation of District survey report of mining and other minor minerals as specified in appendix 10 of the notification. The district Nagaon has an extremely remarkable value from the geological aspect. In mining, this district has been made to cover minor mineral mining locations, areas, and an overview of mining activity in the district with all its relevant features pertaining to geology & mineral wealth. From this point of view, minor minerals are slightly different from other districts of Assam. Far-reaching geological fieldwork and thorough study of different minerals along with inselbergs and geostatistical studies of different mineralogical attributes of different minerals, the mines, and their proprietors have been undertaken to find out the plausible causes for proper documentation of the geological history of the total Nagaon district. Some precious minerals that are found in Assam is Platinum (Pt), Gold (Au), etc. this report also contains details of the forest, drainage, land use & land cover, etc.

CHAPTER 2: INTRODUCTION

The District Survey Report of Nagaon District has been prepared as per the guide line of Ministry of Environment, Forests and Climate Change (MoEF& CC), Government of India vide Notification S.O.-1533(E) dated 14th Sept, 2006 and subsequent MoEF& CC Notification S.O. 141(E) dated 15th Jan, 2016. This report shall guide systematic and scientific utilization of natural resources, so that present and future generation may be benefitted at large. Further, MoEF& CC published a notification S.O. 3611(E) Dated 25th July, 2018 and recommended the format for District Survey Report.

The main objective of DSR is identification of areas of aggradations or deposition where mining can be allowed; and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area. The DSR would also help to calculate the annual rate of replenishment wherever applicable and allow time for replenishment. Besides sand mining, the DSR also include the potential development scope of in-situ minor minerals.

The objectives of the District Survey Report are as follows:

1. To identify and quantify minor mineral resources for its optimal utilization.
2. To regulate sand and gravel mining, identification of site-specific end-use consumers and reduction in demand and supply gaps.
3. To facilitate use information technology (IT) for surveillance of the sand mining at each step.
4. To enable environmental clearance for cluster of sand and gravel mines.
5. To restrict illegal mining.
6. To reduce occurrences of flood in the area.
7. To maintain the aquatic habitats.
8. To protect ground water in the area by limiting extraction of material in riverbeds to an elevation above the base flow.
9. To maintain data records viz. details of mineral resource, potential area, lease, approved mining plan, co-ordinates of lease hold areas, and revenue generation.
10. To design a scientific mining plan and estimate ultimate pit limit.
11. To frame a comprehensive guideline for mining of sand and other minor minerals.

The District Survey Report (DSR) comprises secondary data on geology, mineral resources, climate, topography, land form, forest, rivers, soil, agriculture, road, transportation, and irrigation etc. of the district collected from various published and un-published literatures and reports as well as various websites. Data on lease and mining activities in the district, revenue etc. have been collected from the DL&LRO office of the district and from Government of Assam Mines & Minerals Directorate of Geology & Mining.

2.1 Statutory Framework:

Ministry of Environment, Forest, and Climate Change (MoEF& CC) has published several notifications time to time to formulate and implement the District Survey Report (DSR) for every district. Statutory Framework and its legal aspect with respect to DSR is tabulated in Table 01.

Table 01: Statutory Framework and guidelines on DSR with time scale

Year	Particulars
1957	Mines and Minerals (Development and Regulation) act, 1957 Act is the principal Act for regulation of mines and development of minerals.
1986	The environment (Protection) act, 1986 was enacted in 1986 by the Ministry of Environment and Forests with the objective of providing for the protection and improvement of the environment
1994	The Ministry of Environment, Forest & Climate Change (MoEF&CC) published Environmental Impact Assessment Notification 1994 which is only applicable for the Major Minerals more than 5 ha.
2006	In order to cover the minor minerals also into the purview of EIA, the MoEF & CC has issued EIA Notification SO 1533 (E), dated 14th September 2006, made mandatory to obtain environmental clearance for both Major & Minor Mineral more than 5 Ha.
2012	Further, Hon'ble Supreme Court wide order dated the 27th February, 2012 in I.A. No.12- 13 of 2011 in Special Leave Petition (C) No.19628-19629 of 2009, in the matter of Deepak Kumar etc. Vs. State of Haryana and Others etc., ordered that "leases of minor minerals including their renewal for an area of less than five hectares be granted by the States/Union Territories only after getting environmental clearance from MoEF"; and Hon'ble National Green Tribunal, order dated the 13th January, 2015 in the matter regarding sand mining has directed for making a policy on environmental clearance for mining leases in cluster for minor Minerals.
2013	Assam Minor Mineral Concession rule 2013 recommended rules for regulating the grant of various forms of mineral concessions to prevent illegal mining in the district, The Rules detail restrictions on mining operations near villages, highways, and other structures, and the process for granting mining leases and contracts through competitive bidding or auctions and payments. It also covers General conditions to grant any mineral concession, regulation and control of mining operations, Restoration and Rehabilitation fund, illegal or un-authorised Mining and its consequences. It highlights the significance of scientific mining, detailed reporting, and adherence to environmental and safety regulations. Overall, the Rules aim to ensure responsible mineral extraction, prevent unauthorized activities, and promote sustainable mining practices in Assam, while providing a structured framework for granting and managing mineral concessions in the region.

March 2015	The Mines and Minerals (Development and Regulation) Amendment Act,2015 is an act to amend the Mines and Minerals (Development and Regulation) Act, 1957 which enacted on March 26, 2015,and become effective from January 12, 2015,it introduced several key amendments, including the establishment of Special Courts for mining-related offenses, the requirement for prior approval from the Central Government for certain mining permits, and the extension of mining leases for captive purposes until March 31, 2030. It also revised provisions regarding the auctioning of expired leases and introduced new clauses related to the District Mineral Foundation payments. Additionally, the Act amended definitions and parameters related to mineral content and the powers of the Central Government in regulating mining activity
September 2015	Ministry of Mines notification on 17th September,2015 focuses on exercise of the powers conferred by sub-sections (5) and (6) of Section 9B of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957), the notification focused on specific rules made by Central Government specifying the amount to be paid by holder of a mining lease or a prospecting license-cum-mining lease, in addition to the royalty, to the District Mineral foundation of the district established by the concerned State Government through notification.
2016	The MoEF&CC in compliance of above Hon'ble Supreme Court's and NGT'S order has prepared "Sustainable Sand Mining Guidelines (SSMG), 2016" in consultation with State governments, detailing the provisions on environmental clearance (EC) for cluster, creation of District Environment Impact Assessment Authority, preparation of District survey report and proper monitoring of minor mineral. There by issued Notification dated 15.01.2016 for making certain amendments in the EIA Notification, 2006, and made mandatory to obtain EC for all minor minerals. Provisions have been made for the preparation of District survey report (DSR) for River bed mining and other minor minerals.
2018	MoEF& CC published a notification S.O. 3611(E) Dated 25th July, 2018 and recommended the format for District Survey Report. The notification stated about the objective of DSR i.e. "Identification of areas of aggradations or deposition where mining can be allowed; and identification of areas of erosion and proximity to infrastructural structures and installations where mining should be prohibited and calculation of annual rate of replenishment and allowing time for replenishment after mining in that area."
2020	Enforcement & Monitoring Guidelines for Sand Mining (EMGSM) 2020 has been published modifying Sustainable sand Mining Guidelines, 2016 by MoEF& CC for effective enforcement of regulatory provisions and their monitoring. The EMGSM 2020 directed the states to carry out river audits, put detailed survey reports of all mining areas online and in the public domain, conduct replenishment studies of river beds, constantly monitor mining with drones, aerial surveys, ground surveys and set up dedicated task forces at district levels. The guidelines also push for online sales and purchase of sand and other riverbed materials to make the process transparent. They propose night surveillance of mining activity through night-vision drones.
October 2020	(In IA No 40/2020 41/2020, 46/2020, 47/2020) and vide order dated 14th October 2020 NGT also mandates that DSR/Replenishment Study should be

	prepared by a consultant having accreditation from NABET which further should be appraised by SEAC and approved by SEIAA. The consultant must follow procedure laid down under SSMMG-2016 and EMGSM-2020 during preparation of DSR.
February 2021	Government of Assam through Assam Minerals regulation and dealers' rule 2020 proposed rules to regulate the possession, storage, trading and transport of minerals and mineral products to check evasion of royalty or seigniorage fee, to stop illegal mining and transportation in the state of Assam. The rule is applicable to all Minerals Dealers and all industries/ factories connected with the sale, purchase, transportation, processing and consumption of minerals for commercial purpose in the state of assam.
October 2021	Assam Minor Mineral Concession (Amendment) Rules, 2021 notified on October 7th, 2021, it focuses to reorganize the royalty payment process for minor minerals utilized by government departments and agencies. It establishes specific rates of royalties based on the project cost, excluding taxes, and mandates that these royalties be deducted at the time of payment to contractors or suppliers. Additionally, the rules introduce a structured collection process for urban local bodies, requiring royalties to be collected in installments throughout the construction phase, thereby ensuring compliance and proper financial management in the use of minor minerals.

Important statutory provisions of Assam Minor Mineral Concession rule:

Mining operation under mining a mineral concession.

- No person shall undertake any prospecting or mining operation activity in respect of any minerals in any part of the State, except under and in accordance with the terms and conditions of a permit or a prospecting licence or a mining lease or a mining contract or a permit, or a concession in any other form, as the case may be, granted:

- Provided that nothing in this sub-rule shall apply to any prospecting operation undertaken by the Geological Survey of India, the Indian Bureau of Mines, and the Atomic Minerals Directorate for Exploration and Research of the Central Government, the Directorate of Geology & Mining, Assam or the Mineral Exploration Corporation Limited.

Restriction on grant of mining lease/contract/ permit.

I. No mining lease/contract /permit shall be granted in respect of any land within a distance of: -

(i) Fifty metres from the outer periphery of the defined limits of any village habitation, National Highway, State Highway and other roads where such excavation does not required use of explosives.

(ii) Two hundred fifty metres for the outer periphery of the defined limits of any village habitation, National Highway, State Highway and other roads where use of explosives if required.

(iii)Five hundred metres from major structures like R.C.C. Bridge, Guide bund etc.

Provided that the Government may relax the above distance parameters, wherever required in the interest of working, mineral conservation or for any unforeseen reasons subject to such condition as may be imposed under the said relaxation.

(2) No mining lease/contract/permit or any other mineral concession shall be granted in respect of any such minor mineral or in respect of any specific or general area which the Government may notify.

Condition on which the Permit for mining/quarrying shall be granted

I. Any mining operation in the case of mining of brick earth or ordinary clay or alluvial deposit below a depth of 1.5 metre shall necessarily require formation of benches for safe mining. The benches would be formed in a manner that the width of the bench is not lesser than the height of the bench.

II. Any quarrying permit granted under these rules shall contain information with regard to the following:

a) Manner, mode and place of payment of rent, royalties, permit money, Rehabilitation and Restoration Fund amount and interest on delayed payments or any other dues as admissible under these rules.

b) Particulars of the receipt heads of the Government to which the payments are to be credited.

c) Grant, compensation of damage to the land owner for the land covered by the permit.

d) Felling the trees, pumping of ground water.

e) Restriction of surface operations in any area provided by any authority.

f) Entering and working in any forest area.

g) Reporting all accidents, use of explosives.

h) Indemnity to the Government against claim of third parties.

i) Mineral to be stacked, measured and dispatched.

j) Applicability of the provisions of all other statutes/rules framed by the Central and State Government.

k) Reclamation or restoration of the mining areas and security thereof.

l) Development and conservation of minerals and environment and ecology of the area.

m) Extent of the area or land from where the minor mineral shall be extracted.

n) Period within which the minor mineral shall be extracted and removed and delivery of possession of land on the expiry of such period or on removal of the quantity of the minor mineral for which the permit is valid/granted.

o) Release of security by the authority issuing permit after having satisfied that the permit holder has fulfilled all the conditions of the permit satisfactorily.

p) Any other condition, as may be found expedient by the competent authority to grant the permit, may be imposed in the interest of scientific mining, mineral conservation and mineral development.

III. In case of the permit holder is not able to remove the whole or any part of the mineral for which he obtained the permit within the permissible time for any reason, whatsoever, he shall not be entitled to claim the refund of permit amount/ royalty or any part thereof.

IV. The permit holders for the brick kilns shall furnish a solvent surety within fifteen days of the issue of the permit by submitting an undertaking of such surety that he would be responsible for deposit of all dues in case the permit holder fails to deposit the same.

Special conditions for river-bed

Following condition shall be application for excavation of minor mineral (s) from river beds in other to ensure safety of river-beds, structures and the adjoining areas:

- No mining would be permissible in a river-bed up to a distance of five times of the span of the bridge on up-stream side and ten times the span of such bridge on down-stream side, subject to minimum of 250 meters on the up-stream side and 500 meters on the down-stream side.

- There shall be maintained an un-mined block of 50 meters width after every block of 1000 meters over which mining is undertaking or at such distance as may be directed by the competent authority.

- The maximum depth of mining in the river-bed shall not exceed three meters measured from the un-mined bed level at any point of time with proper bench formation.

- Mining shall be restricted within the central 3/4th width of the river/ rivulet.

- No mining shall be permissible in an area up to a width specified by the competent authority from the action edges of embankments.

- Any others condition as may be required by the competent authority in public interest.

- **Sustainable Sand Mining Management Guidelines (SSMMG), 2016by MoEF& CC.**

The sustainable sand Mining Management Guidelines 2016 has been prepared after extensive consultation with the States and Stakeholders over a period of one year. The main objective of the Guideline is to ensure sustainable sand mining and environment friendly management practices in order to restore and maintain the ecology of river and other sand sources.

1. Parts of the river reach that experience deposition or aggradation shall be identified first. The Lease holder/ Environmental Clearance holder may be allowed to extract the sand and gravel deposit in these locations to manage aggradation problem.

2. The distance between sites for sand and gravel mining shall depend on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand and gravel.

3. Sand and gravel may be extracted across the entire active channel during the dry season.

4. Abandoned stream channels on terrace and inactive flood plains be preferred rather than active channels and their deltas and flood plains. Stream should not be diverted to form inactive channel.

5. Layers of sand and gravel which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river.

6. Sand and gravel shall not be allowed to be extracted where erosion may occur, such as at the concave bank.

7. Segments of braided river system should be used preferably falling within the lateral migration area of the river regime that enhances the feasibility of sediment replenishment.

8. Sand and gravel shall not be extracted within 200 to 500 meters from any crucial hydraulic structure such as pumping station, water intakes, and bridges. The exact distance should be ascertained by the local authorities based on local situation. The cross-section survey should cover a minimum distance of 1.0 km upstream and 1.0 km downstream of the potential reach for extraction. The sediment sampling should include the bed material and bed material load before, during and after extraction period. Develop a sediment rating curve at the upstream end of the potential reach using the surveyed cross- section. Using the historical or gauged flow rating curve, determine the suitable period of high flow that can replenish the extracted volume. Calculate the extraction volume based on the sediment rating curve and high flow period after determining the allowable mining depth.

9. Sand and gravel could be extracted from the downstream of the sand bar at river bends. Retaining the upstream one to two thirds of the bar and riparian vegetation is accepted as a method to promote channel stability.

10. Flood discharge capacity of the river could be maintained in areas where there are significant flood hazard to existing structures or infrastructure. Sand and gravel mining may be allowed to maintain the natural flow capacity based on surveyed cross- section history.

11. Alternatively, off-channel or floodplain extraction is recommended to allow rivers to replenish the quantity taken out during mining.

12. The Piedmont Zone (Bhabhar area) particularly in the Himalayan foothills, where riverbed material is mined, and this sandy-gravelly track constitutes excellent conduits and holds the greater potential for ground water recharge. Mining in such areas should be preferred in locations selected away from the channel bank stretches.

13. Mining depth should be restricted to 3 meter and distance from the bank should be 3 meters or 10 percent of the river width whichever less.

14. The borrow area should preferably be located on the river side of the proposed embankment, because they get silted up in course of time. For low embankment less than 6 m in height, borrow area should not be selected within 25 m from the toe/heel of the embankment. In case of higher embankment, the distance should not be less than 50 m. In

order to obviate development of flow parallel to embankment, cross bars of width eight times the depth of borrow pits spaced 50 to 60 meters centre-to-centre should be left in the borrow pits.

15. Demarcation of mining area with pillars and geo-referencing should be done prior to start of mining.

- **Enforcement & Monitoring Guidelines for sand Mining, 2020 (MoEF& CC)**

Ministry of Environment Forest & Climate Change formulated the Sustainable Sand Management Guidelines 2016 which focuses on the Management of Sand Mining in the Country. But in the recent past, it has been observed that apart from management and systematic mining practices there is an urgent need to have a guideline for effective enforcement of regulatory provision and their monitoring. Section 23 C of MMDR, Act 1957 empowered the State Government to make rules for preventing illegal mining, transportation and storage of minerals. But in the recent past, it has been observed that there was large number of illegal mining cases in the Country and in some cases, many of the officers lost their lives while executing their duties for curbing illegal mining incidence. The illegal and uncontrolled illegal mining leads to loss of revenue to the State and degradation of the environment.

1. Parts of the river reach that experience deposition or aggradation shall be identified. The Leaseholder/ Environmental Clearance holder may be allowed to extract the sand and gravel deposit in these locations to manage aggradation problem.

2. The distance between sites for sand and gravel mining shall depend on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand and gravel.

3. Sand and gravel may be extracted across the entire active channel during the dry season.

4. Abandoned stream channels on the terrace and inactive floodplains be preferred rather than active channels and their deltas and flood plains. The stream should not be diverted to form the inactive channel.

5. Layers of sand and gravel which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river.

6. Sand and gravel shall not be allowed to be extracted where erosion may occur, such as at the concave bank.

7. Segments of the braided river system should be used preferably falling within the lateral migration area of the river regime that enhances the feasibility of sediment replenishment.

8. Sand and gravel shall not be extracted up to a distance of 1kilometre (1 km) from major bridges and highways on both sides, or five times (5x) of the span (x) of a bridge/public civil structure (including water intake points) on up-stream side and ten times (10x) the span of such bridge on down-stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.

9. The sediment sampling should include the bed material and bed material load before, during and after the extraction period. Develop a sediment rating curve at the upstream

end of the potential reach using the surveyed cross-section. Using the historical or gauged flow rating curve, determine the suitable period of high flow that can replenish the extracted volume.

10. Calculate the extraction volume based on the sediment rating curve and high flow period after determining the allowable mining depth.

11. Sand and gravel could be extracted from the downstream of the sand bar at river bends. Retaining the upstream one to two-thirds of the bar and riparian vegetation is accepted as a method to promote channel stability.

12. The flood discharge capacity of the river could be maintained in areas where there is a significant flood hazard to existing structures or infrastructure. Sand and gravel mining may be allowed to maintain the natural flow capacity based on surveyed cross-section history. Alternatively, off-channel or floodplain extraction is recommended to allow rivers to replenish the quantity taken out during mining.

13. The Piedmont Zone (Bhabhar area) particularly in the Himalayan foothills, where riverbed material is mined, and this sandy-gravelly track constitutes excellent conduits and holds the greater potential for groundwater recharge. Mining in such areas should be preferred in locations selected away from the channel bank stretches.

14. Mining depth should be restricted to 3 meters and distance from the bank should be ¼th or river width and should not be less than 7.5 meters.

15. The borrow area should preferably be located on the riverside of the proposed embankment because they get silted in the course of time. For low embankment, less than 6 m in height, borrow area should not be selected within 25 m from the toe/heel of the embankment. In the case of the higher embankment, the distance should not be less than 50 m. In order to obviate the development of flow parallels to the embankment, crossbars of width eight times the depth of borrow pits spaced 50-to-60-meter centre-to-centre should be left in the borrow pits.

16. Demarcation of mining area with pillars and geo-referencing should be done prior to the start of mining.

17. A buffer distance /un-mined block of 50 meters after every block of 1000 meter over which mining is undertaken or at such distance as may be the directed/prescribed by the regulatory authority shall be maintained.

18. A buffer distance /unmined block of 50 meters after every block of 1000 meters over which mining is undertaken or at such distance as may be the directed/prescribed by the regulatory authority shall be maintained.

19. River bed sand mining shall be restricted within the central 3/4th width of the river/rivulet or 7.5 meters (inward) from river banks but up to 10% of the width of the river, as the case may be and decided by regulatory authority while granting environmental clearance in consultation with irrigation department. Regulating authority while regulating the zone of river bed mining shall ensure that th objective to minimize the effects of riverbank erosion and consequential channel migration are achieved to the extent possible. In general, the area for removal of minerals shall not exceed 60% of the

mine lease area, and any deviation or relaxation in this regard shall be adequately supported by the scientific report.

20. Mining Plan for the mining leases (non-government) on agricultural fields/Patta land shall only be approved if there is a possibility of replenishment of the mineral or when there is no riverbed mining possibility within 5 KM of the Patta land/Khatedari land. For government projects mining could be allowed on Patta land/Khatedari land but the mining should only be done by the Government agency and material should not be used for sale in the open market.

The minerals reserve for riverbed area is calculated on the basis of maximum depth of 3 meters and margins, width and other dimensions as mentioned in para (s) above. The area multiplied by dept gives the volume and volume multiplied with bulk density gives the quantity in Metric Ton. In case of riverbed, mineable material per hectare area available for actual mining shall not exceed the maximum quantity of 60,000 MT per annum.

- **Demand and Utilisation of Sand**

Sand is a multi-purpose topographical material. It is known as one of the three fundamental ingredients in concrete. The composition of sand is diverse. Mostly sand is made of silica which is a common element. It can also come from another source of minerals like quartz, limestone, or gypsum.

From beds to flood plains to coastlines- we can find the sand at almost everywhere. The robustness of sand has played a significant role in everyday life. We use sand practically every other day.

Sand extraction from river beds and brick earth mining for making raw bricks are the main mining activities in the district. With a spurt in construction of real estate sectors and various govt. sponsored projects, the demand for both sand and bricks has increased manifold. The extraction of sand is carried out either manually or through semi- mechanized system. The depth of mining for both river bed sand and brick earth is restricted due to statutory provision in the regulations pertaining to conservation and development of minor minerals.

River sand mining is a common practice as habitation concentrates along the rivers and the mining locations are preferred near the markets or along the transportation route, for reducing the transportation cost.

In the real world, there are a lot of situations where we can find uses of sand. Followings are the common sand uses.

1. While bunging metal, we can mix sand with clay binder for frameworks used in the foundries.

2. Sand can be used for cleaning up oil leak or any spill by dredging sand on that spill. The material will form clumps by soaking up, and we can quickly clean the mess.

3. Sand can be used as a road base which is a protective layer underneath all roads

4. Industrial sand is used to make glass, as foundry sand and as abrasive sand.

5. One creative usage of sand is serving as a candle holder. We can try putting some sand before pouring tea light or any candle in a glass. It holds the candle still and refrain the candle from rolling by giving it an excellent decoration.
6. Adds texture and aesthetic appeal to space.
7. Sand is mostly pure to handle, promptly available and economically wise.
8. We use sand in aquariums, fabricating artificial fringing reefs, and in human-made beaches
9. Sandy soils are ideal for growing crops, fruits and vegetables like watermelon, peaches, peanuts, etc.
10. Sand can light a path by filling mason jars with sand and tea light which is another inexpensive way to make a walkway glow.
11. Sand helps to improve resistance (and thus traffic safety) in icy or snowy conditions.
12. We need sand in the beaches where tides, storms or any form of preconceived changes to the shoreline crumble the first sand.
13. Sand containing silica is used for making glass in the automobile and food industry-even household products for the kitchen.
14. Sand is a strong strand which is used for plaster, mortar, concrete, and asphalt.
15. The usual bricks formulated of clay only are way weaker and lesser in weight than blocks made of clay mixed with sand.

2.2 Methodology of DSR Preparation

The steps followed during the preparation of District Survey Report are given in Figure 2.1. The individual steps are discussed in following paragraphs.

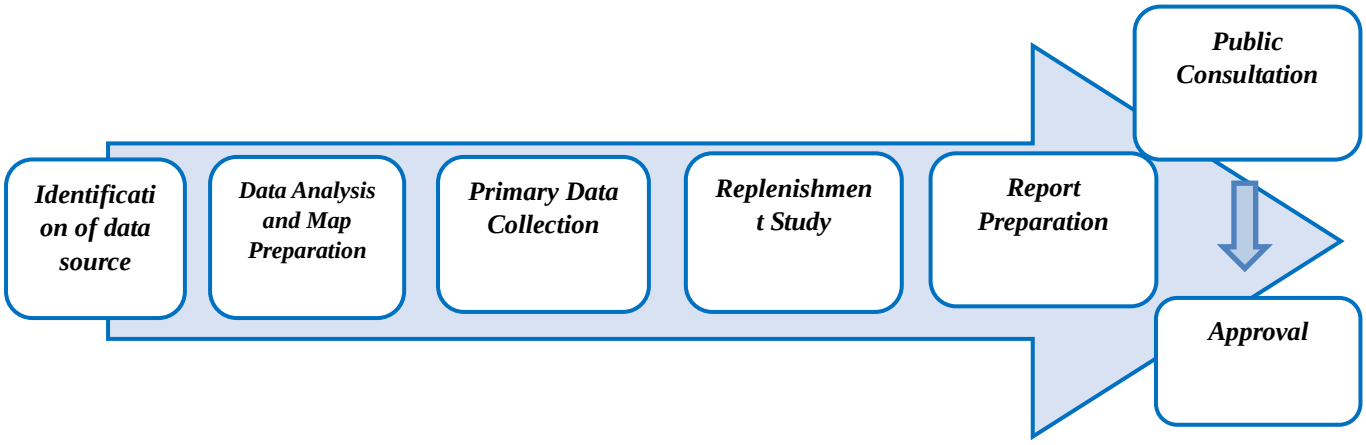
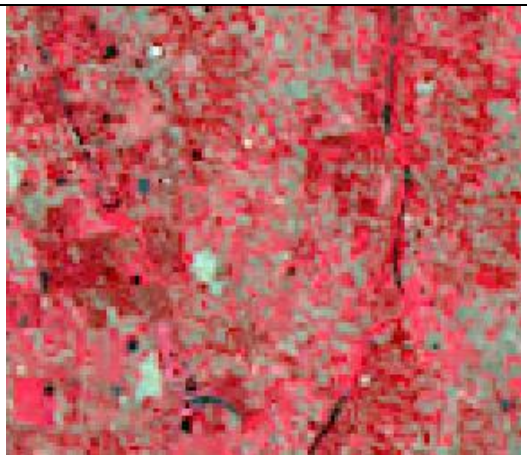


Figure 01: Steps followed in preparation of DSR

Data source Identification: District Survey Report has been prepared based on the primary data base and secondary data base collected and collated from different sources. It is very critical to identify authentic data sources before compiling the data set. The secondary data sources which are used in this DSR are mostly taken from public domain or from the published report in reputed journals. Information related to district profile has been taken from District Census Report, 2011 and District Statistical Handbook published by the Govt. of Assam. Potential mineral resources of the district have been described based on the published report of Geological Survey of India (GSI) or any other govt. agencies like MECL etc. List of mining lease, name of lease holder, lease/block area, resource in already allotted mining lease, revenue from minor mineral sector etc. have been collected from the concern DL & LRO offices of the district. Satellite images have been used for map preparation related to physiography and land use/land cover of the district.

Data Analysis and Map Preparation: To prepare the Maps of the district, we have collected the data set which are captured during the report preparation. They have gone through detail analysis work. District Survey Report involves the analytical implication of captured dataset to prepare relevant maps. Methodology adopted for preparation of relevant maps is explained below:

Land Use and Land Cover Map: Land Use and Land Cover classification is a complex process and requires consideration of many factors. The major steps of image classification include determination of a suitable classification system via Visual Image Interpretation, selection of training samples, Satellite image (FCC-False Color Composite) pre-processing, selection of suitable classification approaches, post classification processing, and accuracy assessment. Here LISS-III satellite imagery has been taken for supervised classification as supervised classification can be much more accurate than unsupervised classification, but depends heavily on the training sites, the skill of the individual processing the image, and the spectral distinctness of the classes in broader scale. According to the Visual Image Interpretation (Tone, Pattern, Texture, Shape, Color etc.) training set of the pixel has been taken. Pictorial descriptions of Land Use classification are explained in Figure 01.

	
Agricultural Land - Based on their Geometrical shape, Red and Pink color tone, Agricultural Land has been identified.	Vegetation Covered Area - Area with continuous Red color tone, Vegetation Covered Area has been classified.

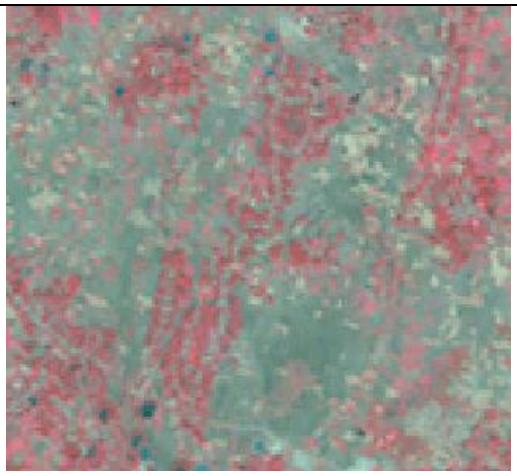
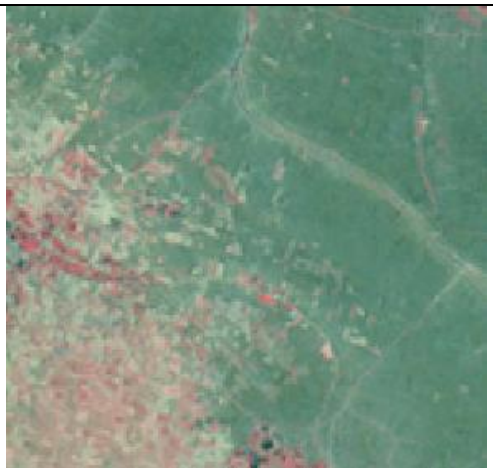
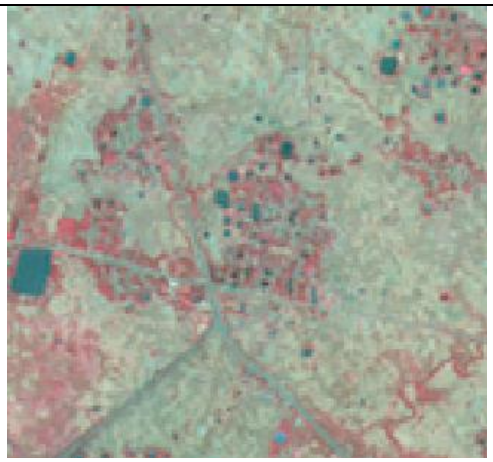
	
Agricultural Fallow Land - Based on their Geometrical shape, Yellowish green color tone, Agricultural Fallow Land has been identified.	Badland Topography- Area with Non geometrical shape and Yellowish green color tone has been identified as Bad Land Topography.
	
Settlement – Area with some geometrical shape in a Linear Pattern including Light Cyan Color has been recognized as Settlement Area.	Water Bodies – Area with Blue color has been classified as Water Bodies.

Figure 02: Pictorial description of Land Use Classification methods

Geomorphological Map: The major step of preparing Geomorphological Map is identifying features like – Alluvial Fan, Alluvial Plain, Hilly Region etc. from Satellite Imagery (FCC-False Colour Composite) via Visual Image Interpretation and then digitisation has been taken into the consideration to prepare map including all the Geomorphological features according to their location. Pictorial descriptions of Geomorphological unit's classification are explained in Figure 03.

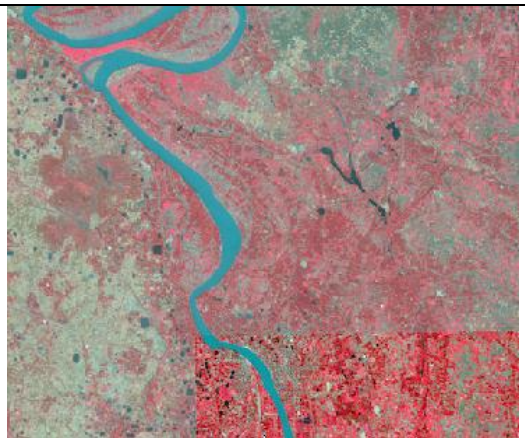
	
Flood plain-Flood plain is a generally flat area of land next to a river or stream. It stretches from the banks of the river to the outer edges of the valley.	OX-BOW Lake- An ox-bow lake starts out as a curve, or meander, in a river. This "U" shaped body of water identified as Ox- Box Lake from Satellite Imagery.

Figure 03: Pictorial description of Geomorphological Units Classification methods

Physiographical Map: The major step of preparing Physiographical Map is generating contour at a specific interval to show the elevation of the area using Cartosat DEM.

Block Map/Transportation Map/Drainage Map:

- Raw Data collected from National Informatics Centre (NIC Website) during May 2024.
- Data has been geo-referenced using GIS software.
- Digitization of block boundary, district boundary, state boundary, international boundary, and district headquarter, sub–district headquarter, places, road, railway, river, nala etc.
- Road name, River name, Railway name has been filled in attribute table of the Layers
- Final layout has been prepared by giving scale, legend, north arrow, etc.

Earthquake Map:

- Raw data collected from Ministry of Earth Science.
- Data has been geo-referenced using GIS software.
- Digitization of Earthquake zone and superimposed it over Block Boundary.
- Zone name has been filled in attribute table of the Layers
- Final layout has been prepared by giving scale, legend, north arrow, etc.

Soil Map:

- Raw data collected from National Bureau of Soil Survey and Land Use Planning during May 2024.
- Data has been geo-referenced using GIS software.
- Digitization of Soil classification zone and superimposed it over District Boundary.
- Soil classification has been filled in attribute table of the Layers.
- Final layout has been prepared by giving scale, legend, north arrow, etc.

Wildlife Sanctuary and National Park location Map:

- Raw data obtained from ENVIS Centre on Wildlife & Protected Areas during August 2020.
- Data has been geo-referenced using GIS software.
- Digitization of Wildlife Sanctuary and National Park and superimposed it over Block Boundary.
- Wildlife Sanctuary & National Park name has been filled in attribute table of the Layers Final layout has been prepared by giving scale, legend, north arrow, etc.

Primary Data Collection: To prepare DSR, primary data has been collected and field work has also been carried out for the district. Field study involves assessment of the mineral resources of the district by means of pitting / trenching in specific interval. This provides clear picture of mineral matters characterization and their distribution over the area.

Replenishment study: One of the principal causes of environmental impacts of river bed mining is the removal of more sediment than the system can replenish. Therefore, there is a need for replenishment study for riverbed sand in order to nullify the adverse impacts arising due to excess sand extraction. We have conducted Physical survey by the help of DGPS to define the topography, contours and offsets of the riverbed. The surveys clearly depict the important attributes of the stretch of the river and its nearby important civil and other feature of importance. This information will provide the eligible spatial area for mining. The annual rate of replenishment carried out on every river of the district to have proper assessment of the sand reserve for mining purposes. The surveys clearly depict the important attributes of the stretch of the river and its nearby important civil and other feature of importance. This information will provide the eligible spatial area for mining.

Report Preparation: The district survey report portrays general profile, geomorphology, land use pattern and geology of the district. The report then describes the availability and distribution of riverbed sands and other minor minerals in the district. Apart from delineation the potential mining blocks, the report also includes Inventorisation of the minerals, recent trends of production of minor minerals and revenue generation there from. Annual replenishment of the riverbed sand has been estimated using field observation, satellite imagery and empirical formula. The road network connecting arterial road to potential mining blocks has been identified. Potential environmental impacts of mining of these minerals, their mitigation measures along with risk assessment and disaster management plan have also been discussed. Finally, the reclamation strategy for already mined out areas is also chalked out.

Public Consultation & Approval: In accordance with the Enforcement and Monitoring Guidelines for Sand Mining, the UT Government would look for public feedback on the list of mining zones that will be placed up for auction. The DSR, which includes the list of zones will be advertised in local and national newspapers as well as in district administration website. The public will have one month to provide their input or any comment which will then be considered by the district committee. Sand mining zones, including clusters and contiguous clusters, will be defined in the final DSR. The final list of sand mining areas, including riverbed, Patta land, Khatedari, desiltation locations and M-sand Plants will be defined in the final DSR, following the public hearing as per Annexure-V. Details regarding clusters and contiguous clusters will be provided in Annexure-VI and Annexure-VII. The process flow diagram is as follows:

Figure 04: Schematic Representation of Public Consultation

CHAPTER 3: GENERAL PROFILE OF THE DISTRICT

a) General information:

Nagaon is a centrally located district in Assam, situated on the Southern bank of the Brahmaputra River between 25°45’ to 26°45’ North latitudes and 91°50’ and 93°20’ East longitude. It is bounded by Sonitpur and the Brahmaputra to the North, West Karbi Anglong, Hojai and Dima Hasao to the South, East Karbi Anglong and Golaghat to the East and Morigaon to the West. Total geographical area of this district is 2287 sq.km. The district is covered by Survey of India Degree Sheet No. 83B/ 10,11,12,14,15,16,6,7,8, 83C/9, F/3, G/1, G/2.

Figure 05: Location Map of Nagaon

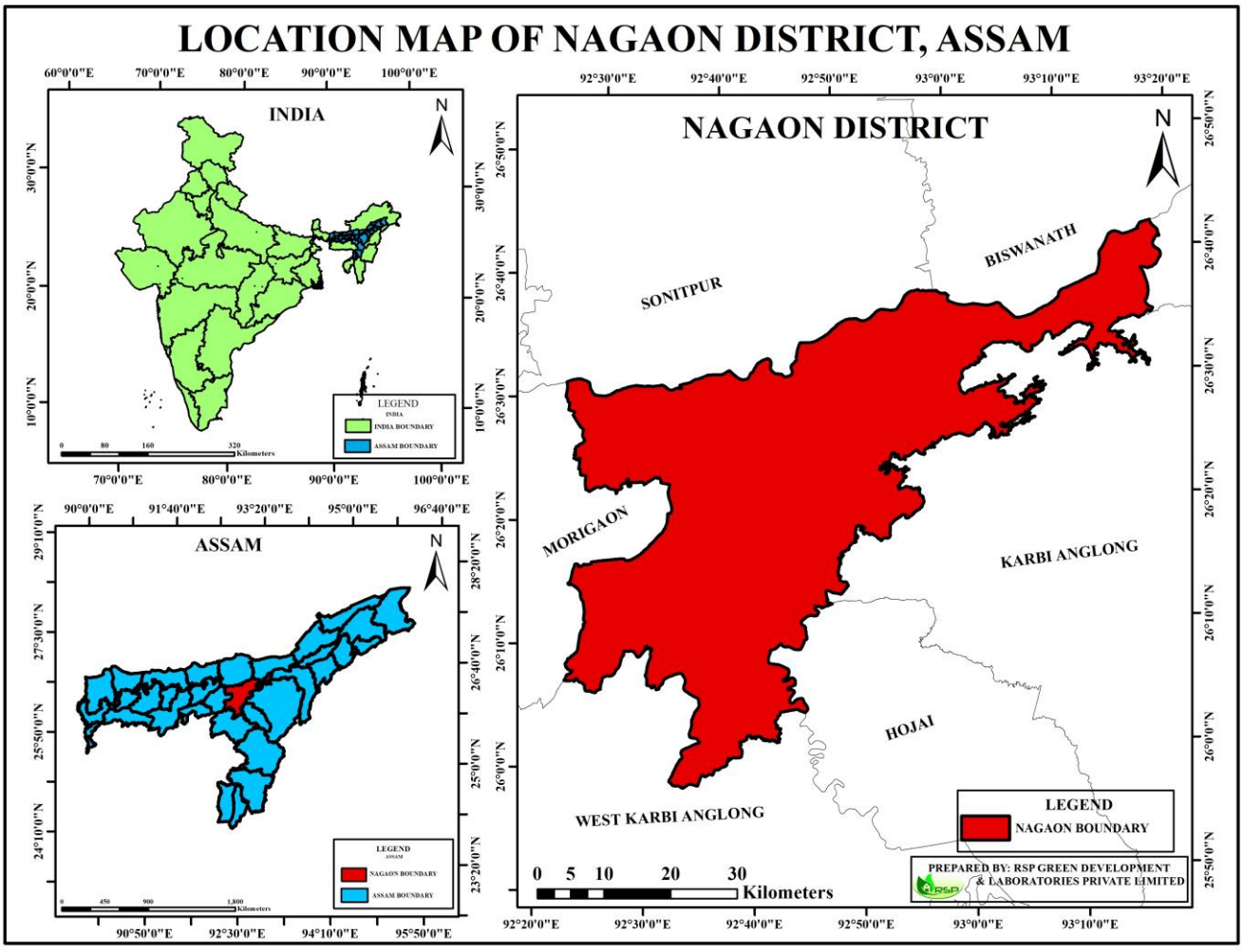


Table No 02: Administrative units of the Nagaon District

Sl. No.	ADMINISTRATIVE UNITS	STATISTICS
1	District Head Quarter	Nagaon
2	Sub divisions	02
3	Parliamentary Constituency	08
4	Legislative Assembly Constituency	08
5	Revenue Villages	960
6	No. of CD Blocks	13
7	Central Information Commission	-
8	Revenue Circles	07
9	Mouza	29
10	Police station	15
		Source: *https://nagaon.assam.gov.in*

Table No. 03: Sub-Division-Wise Development Block and its headquarters of Nagaon

NAME OF SUB-DIVISION	NAME OF BLOCKS
Nagaon Sub-Division	Khagorijan
	Pakhimoria
	Dolonghat
	Raha
	Batadraba
	Juria
	Ruphihut
Kaliabor Sub- Division	Bajiagaon
	Pachim Kaliabor
	Kaliabor
	Lowkhowa
	Barhampur
	Kathiatoli

Table No. 04: Sub-Division-wise Revenue Circle and it's Headquarters of Nagaon

SUB-DIVISION	NAME OF REVENUE CIRCLE	HEADQUARTERS
Nagaon Sub-Division	Nagaon	Nagaon
	Raha	Raha
	Kampur	Kampur
	Dhing	Dhing
Kaliabor Sub- Division	Rupahi	Rupahi
	Samaguri	Rupahi
	Kaliabor	Kaliabor

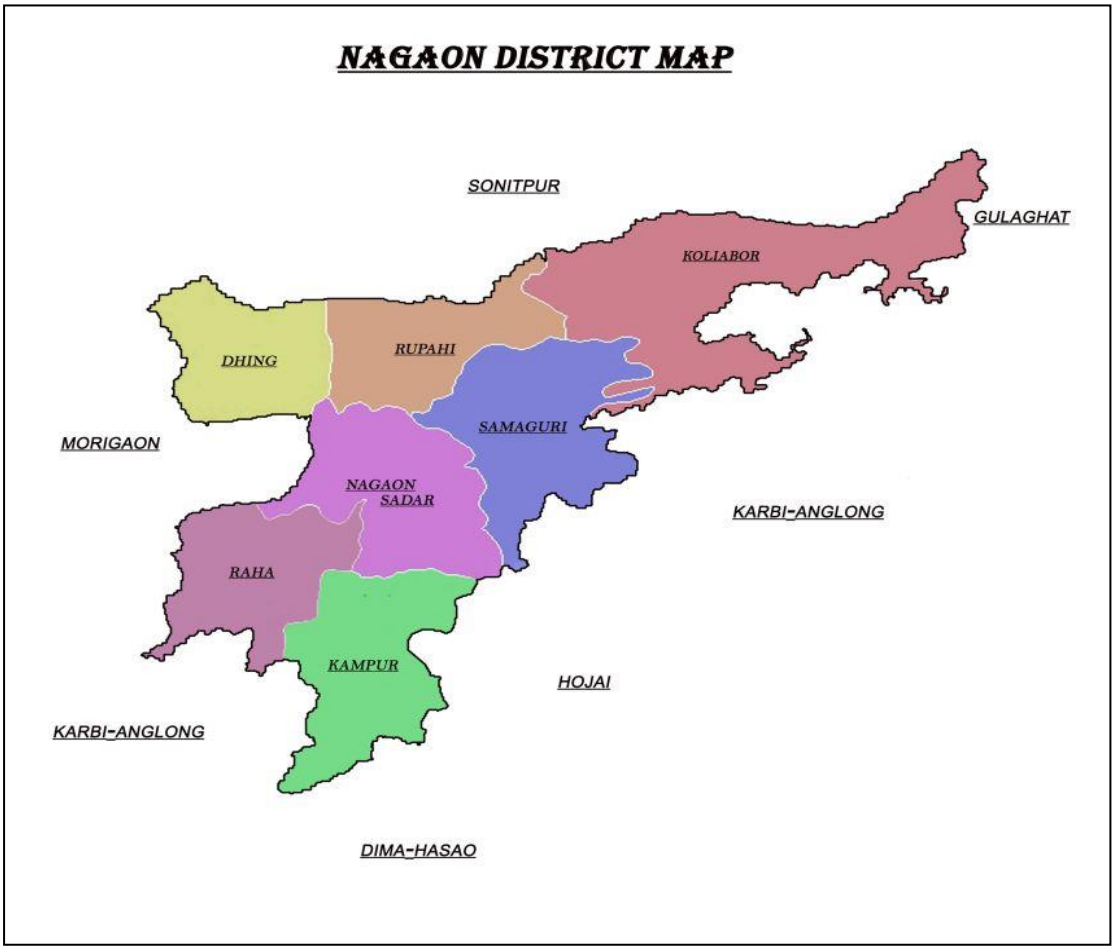
Table No. 05: Revenue Circle-wise Mouza of Nagaon

Sl. No	Name of Revenue Circle	Mouza
1	Dhing	Alitangani
2		Dhing
3		Batadrava
4	Kaliabor	Barbhagia
5		Dwarsalona
6		Chatial
7		Pubtharia
8	Kampur	Jarabari
9		Kathiatoli
10		Kampur
11		Garubat
12	Raha	Raha
13		Jagial
14		Sahari
15		Jarabari
16	Rupahi	Juria
17		Saidoria
18	Nagaon	Niz Sahar
19		Singia Putani
20		Kandali
21		Kiachamari
22		Hatichong
23		Pakhimoria
24	Samaguri	Lawkhowa
25		Khatowal
26		Chalchali
27		Khatowal
28		Bheleuguri
29		Rangagara

Table No.06: 3-Autonomous District (ST) Parliamentary and Legislative Assembly Constituency

Sl. No.	Parliamentary Constituency
1.	82-Raha
2.	83-Dhing
3.	84-Batadraba
4.	85-Rupahihat
5.	86- Nagaon
6.	87-Barhampur
7.	88-Samaguri
8.	89-Kaliabor

Figure 06: Administrative Map of Nagaon district



b) Climatic Condition

Mother Nature is undeniably very benevolent to this district with diversified climate due to different types of topography. The zone blended with hills and plains and experiences different climates indifferent parts. The average Temperature of Nagaon is around 23°C although it vary from around 17°C during Winter (January) to 28°C during the Monsoon (August). The hottest month of the year is August with temperature varies from 24.5°C to 35.4°C. The coolest month is of the year is January, with temperature varies from 10.6°C to 23.6°C.

Winter

The average daily maximum temperature is about 25°C and the minimum is 11°C, with temperatures ranging from 10.6°C to 23.6°C.

Summer

The average daily maximum temperature is 34°C and the minimum is 24°C, with temperatures ranging from 24.5°C to 35.4°C in August, the hottest month of the year.

Monsoon

Relative humidity increases from 76% to 84% during the southwest monsoon season, and rainfall is mainly confined to this time.

Table No.07 he minimum, maximum and average °C Temperature over the year in Nagaon.

Month	Temperature		
	Minimum	Maximum	Average
January	10.6	23.6	16.5
February	13.4	26.0	18.8
March	16.2	28.7	21.8
April	18.7	31.5	24.0
May	19.7	32.6	25.2
June	23.6	35.3	27.7
July	24.4	35.6	28.0
August	24.5	35.4	28.3
September	24.4	34.1	27.6
October	19.4	31.4	24.2
November	15.3	29.5	20.6
December	11.1	25.0	17.3

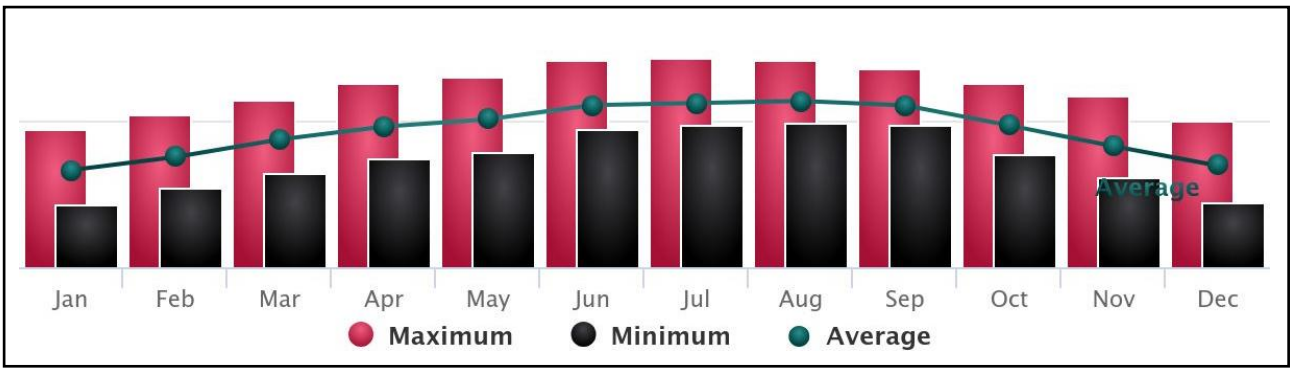


Figure 07: Nagaon Average Temperature

(***Source:*** *https://weatherandclimate.com)*

c) Rainfall: Monthwise

Nagaon district is a hot sub tropical humid climate. Hot humid pre-monsoon time is from March to mid May, a prolonged southwest monsoon or rainy season from mid May to sptember, a pleasent post-monsoon or retreting monsoon from October to November and a cold pleasent winter from December to February are the charecteristics of the general climate. Summer runs concurrently with the later part of the pre-monsoon season and continues throughout the monsoon season.

The four climatic seasons viz pre-monsoon, monsoon, post-monsoon and winter could be considered as comprising of the following months:

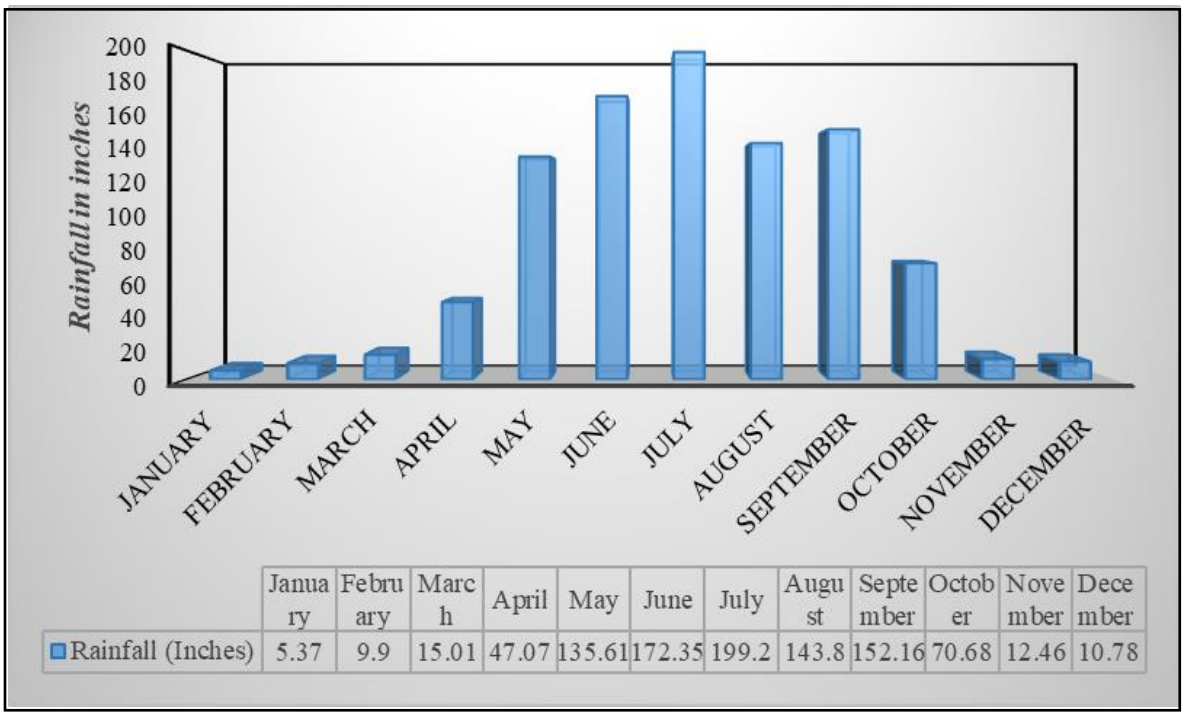
i. Pre-monsoon: March, April, and May

ii. Monsoon: June, July, August and September.

iii. Post-monsoon: October and Novemebr

iv. Winter: December, January, and February

Sometimes, the monsoon commences in mid-May and ends in mid-September. Therefore, the boundaries between the seasons are not very rigid. The months October, November and December are considered to be representative study period.



	January	February	March	April	May	June	July	August	September	October	November	December
Rainfall (Inches)	5.37	9.9	15.01	47.07	135.61	172.35	199.2	143.8	152.16	70.68	12.46	10.78

Figure 08: Rainfall Graph of Nagaon District

(Source: https://weatherandclimate.com)

d) Topography & Terrain:

Nagaon district is geographically situated at the central part of Assam. The area of this district is 2287 sq.km. agaon is bounded on the north by the Sonitpur district and the Brahmaputra River. On the south, it borders the West Karbi Anglong district, Dima Hasao and Hojai District. On the east it is bounded by the Karbi Anglong district and the Golaghat district, while on the west it neighbours the Marigaon district. The average elevation of the district is 64 m. Nagaon is topographically flat plains with minor undulation.

Topographically, the district Nagaon is a heterogeneous land composed of both high hills, low lands and level plains like that of other districts of Assam. Across the centre of the plain there are wide fields of cultivated land extending from Silghat on the North- East to Jaji on the south- west. There are wide expanses of grassland on the north- west and of forest and hills on the south and east. The general appearance of the district is extremely picturesque. On every side there are swamps and rivers, hills and woods, which depict variety of scene. The land bordering the south bank of the Brahmaputra is low-lying area and is deeply flooded during the rainy seasons. For the greater part of the year the area is covered with grasses and reeds such as Khagari, Ekra and Nal (reed) which grow from three to six meters high. The higher land produces Ulu and other kinds of shorter grasses used for thatching. Nepali grazers generally keep large herds of Buffaloes and Cows on the chars or sand banks, which are formed by the Brahmaputra. The South of the Kopili between Dharamatul and the hills is also low lying areas It is also subject to flood and is covered with high grasses.

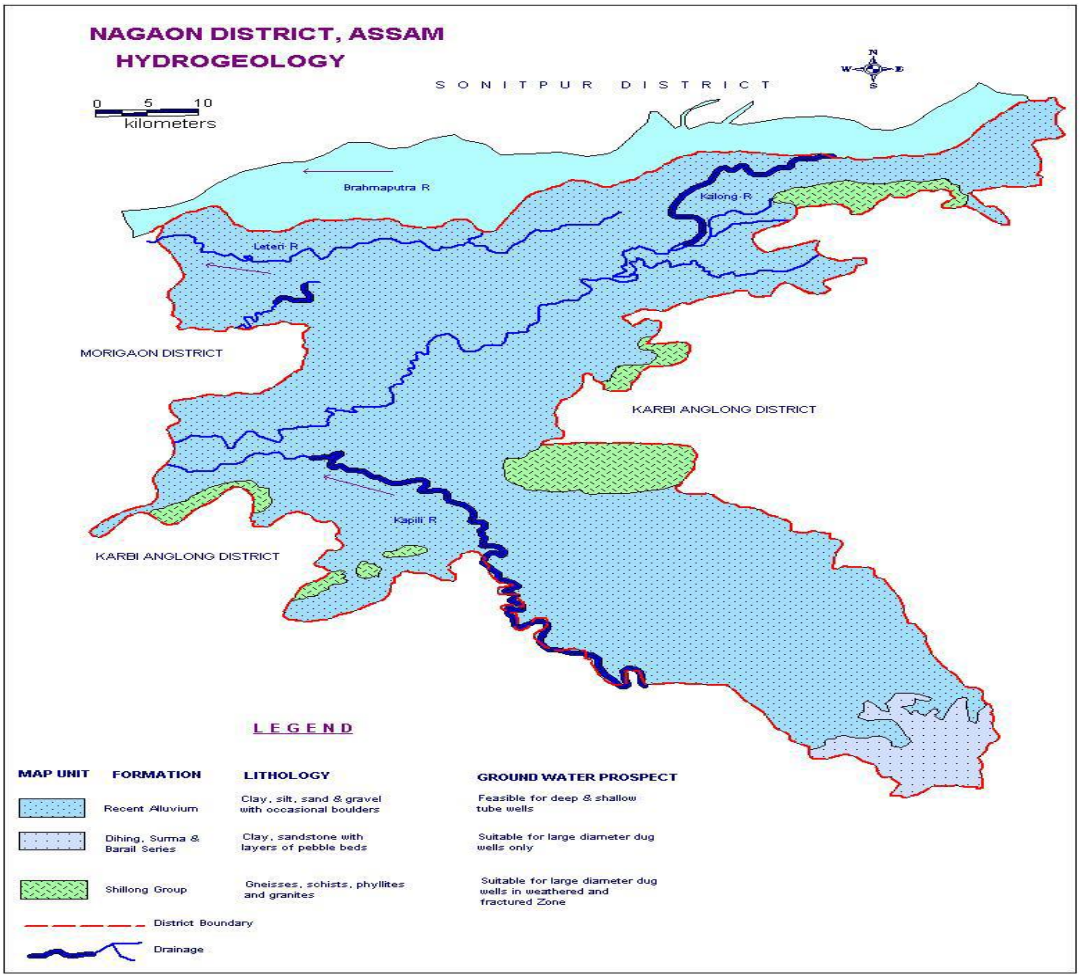
e) Water Course & Hydrology:

Hydrological condition at a particular point is guided by topography, geology, and rainfall of the region. Central Ground Water Board (CGWB) has carried out detail hydrogeological investigation of the district.

Hydrology of an area describes all the elements of the water cycle i.e., evapotranspiration, precipitation, all the watercourses e.g., runoff, river, lakes including the river basins and soil moisture, ground water, sea etc. These are interdependent elements and are the basic hydrological units. The watercourse arrangement of Nagaon principally moulded by the rivers Kopili, Killing, Kollong and some portion of Bramhaputra Rivers. Hydro geologically the district is proved to be potential. The geologic formation of the district can be divided into four part; Archaean, Pre-Cambrian, Tertiary and Quaternary periods. The Archaean rocks comprise the metamorphic rock types of gneisses and schists which are introduced by younger acidic and basic intrusive. Rest part of the study area is made up partly of early Tertiary sedimentary deposits and Quaternary alluvial deposits. The sediments are mostly shale, sandstone, limestone and conglomerate.

Two main rivers of the study area are Kopili and Jamuna. After entering Assam the Kopili separates the Karbi Anglong district from the Dima Hasao North Cachar Hills district and flows into the Nagaon district in a north-westerly direction. While Jamuna River with a catchment of 3960 km2 flows to the Kopili at Jamunamukh. The Kopili River finally flows to Kalang, a spill channel of Brahmaputra, near Hatimukh after traversing a distance of 290 km2. The total catchment of Kopili River is about 16,421km^2.

Figure 09: Hydrogeology Map of Nagaon district



***Source**: Central Ground Water Board*

f) Ground Water Development:

Hydro geologically the district is proved to be potential. Ground water in Nagaon district occurs in secondary porosity like fractures, fissures of Precambrian rocks and in the semi consolidated and unconsolidated formations of Tertiary and Quaternary age respectively. While the greater part of the district falls in Kalang sub-basin. In the Kalang sub-basin the alluvial formations show two characteristic features. In the northern part of the district particularly north of Sonai river, the alluvium comprising medium to coarse sand with gravel and pebbles from a single aquifer system of massive thickness. But in the south central and southern parts, which is broadly underlain by older alluvium, the clay proportion increases markedly. The clay beds act as confining layers. Thus ground water occurs both under confined, semi-confined and unconfined conditions.

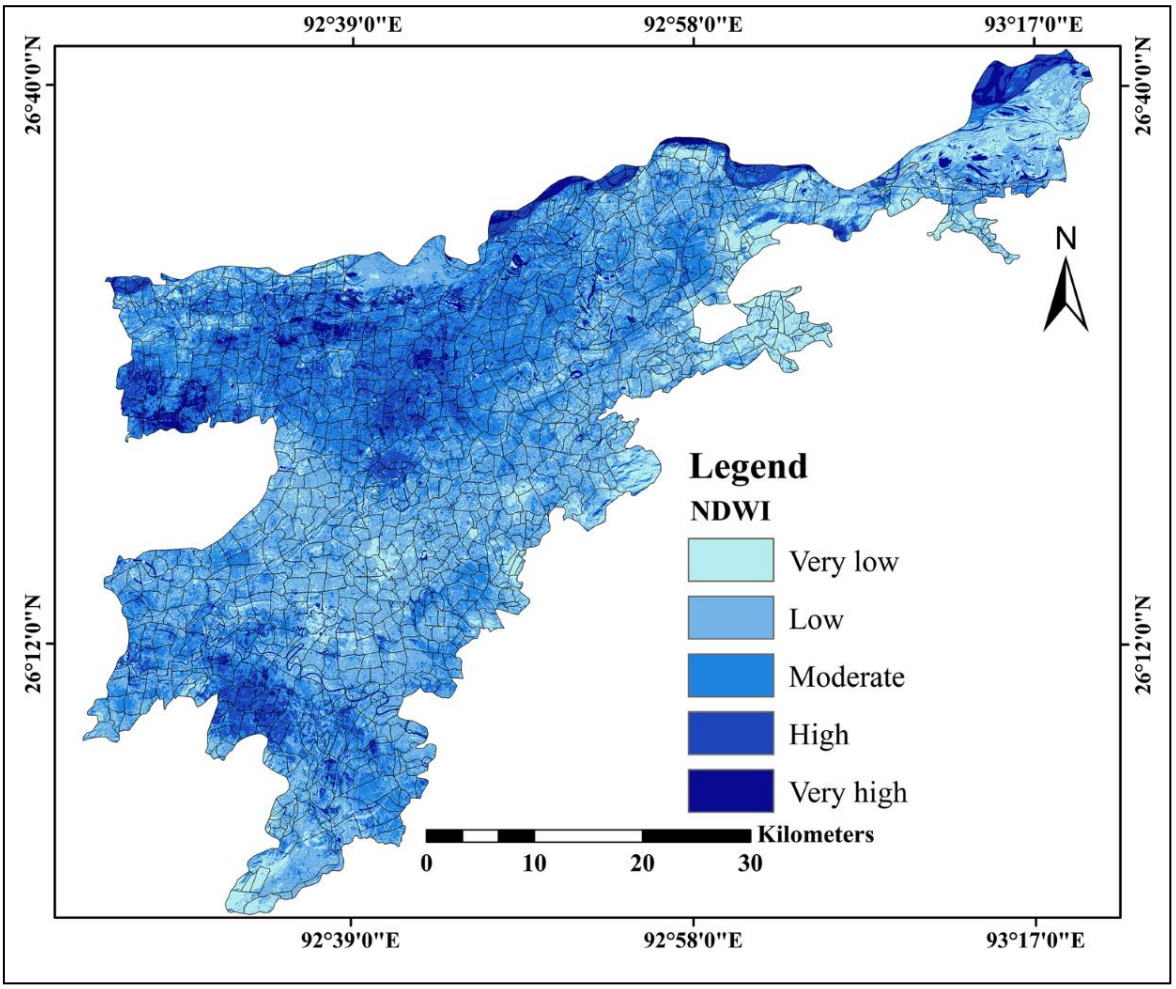
Hydrogeological survey aided by exploratory drilling carried out by CGWB revealed the existence of potential aquifer zones down to the depth of 200m. The thickness of the granular zones which mainly constitute sands of various grades, clay and occasional gravel occurs in the Recent to Sub-recent alluvial formations which spread out the whole district from southern part of the river Brahmaputra to the areas around Lanka on south. The granular zones of this unconsolidated formation have higher thickness on northern part and gradually decrease

towards south with interfringering of the clay lenses. Based on the exploration data, the aquifers can broadly divided into two groups -

i. 0.0 to 50 mbgl : Shallow aquifer zone

ii. 50 to 280 mbgl : Deep aquifer zone

Figure 10: Depth of Water Level Map of Nagaon district



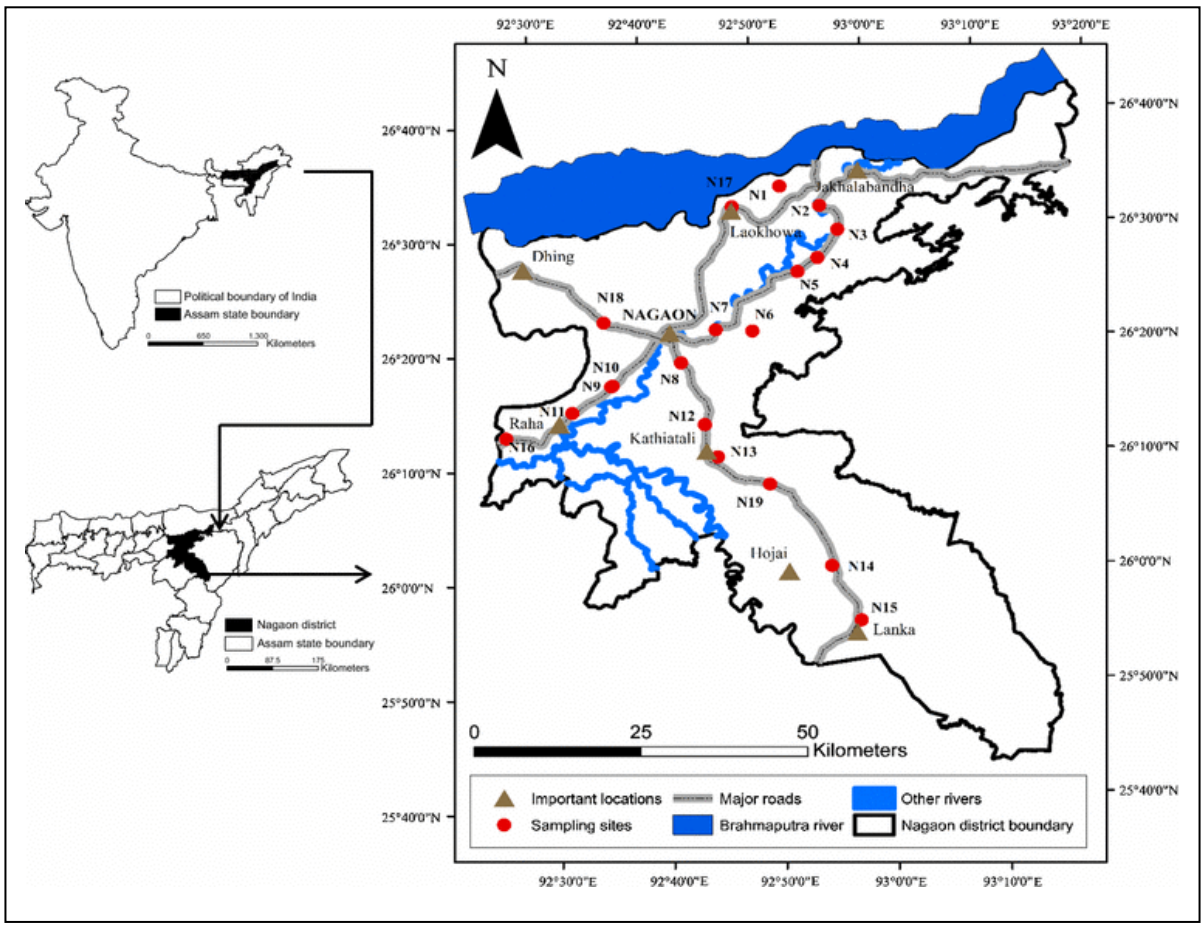
g) Drainage System (general):

Nagaon district is situated where the Brahmaputra River is flowing like a coronet of the district. The main river is the Brahmaputra flowing on the northern part of the district from east to west with its tributaries Kopili, Kalong and Sonai rivers. Among these, Kopili is the major river originating in the hills of Karbi Anglong to the south and flows on north-westerly direction and meet with Diyang River near Dhing. It follows north-westerly direction from Dhing to the same north-westerly trend up to Kampur and deflects towards west. Kalong, the tributary of Kopili joins the later near Jagiroad.

Together with Morigaon district, it has the shape of a broken dish. The north and the south are uplands. The general slope of the district is towards the west. The eastern, north eastern and the south eastern parts are hilly terrains.

The major river is the Kalong which divides the town into two halves - Haibargaon and Nagaon. Haibargaon slopes down towards the west and then to the south west towards the Sonai. Nagaon slopes down first towards the south east and then southwards to the beels and then towards Kalong.

Figure 11: Drainage Network Map of the Nagaon district



h) Demography:

As per census 2011 area of Nagaon district is 2287 sq.km.

Table No: 08 Demographic data table

Considerations	**Statistical Data**
Area of Nagaon	2287 sq.km
Total No. of villages	960
Total Population	2,823,768

Male	1,439,112
Female	1,384,656
Density of Population	711/ sq.km
Sex Ratio (Adult)	962 females/1000 males
Sex Ratio (Child)	964 females/1000 males
Population growth rate (%)	22.00

(Source: https://www.census2011.co.in)

Table No 09: Town wise Population, Literacy rate:

Description	**Rural**	**Urban**
Population (%)	86.91 %	13.09 %
Total Population	2,454,234	369,534
Male Population	1,250,985	188,127
Female Population	1,203,249	181,407
Sex Ration	962	964
Child Sex Ration (0-6)	964	961
Child Population (0-6)	420,813	39,127
Male Child (0-6)	214,248	19,955
Female Child (0-6)	206,565	19,172
Child Percentage (0-6)	17.15 %	10.59 %
Male Child Percentage	17.13 %	10.61 %
Female Child Percentage	17.17 %	10.57 %
Literates	1,422,500	288,216
Male Literates	769,517	152,333
Female Literates	652,983	135,883
Average Literacy	69.96 %	87.23 %
Male Literacy	74.22 %	90.58 %
Female Literacy	65.52 %	83.76 %

***(Source:** www.census2011.co.in)*

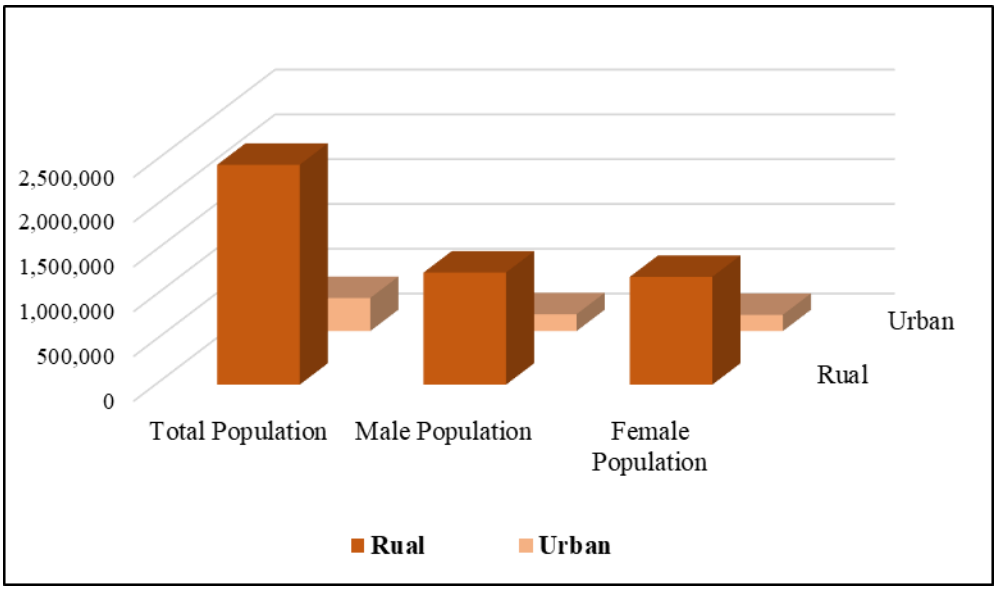


Figure 12: Distribution of male & female population (Urban and Rural) of Nagaon District

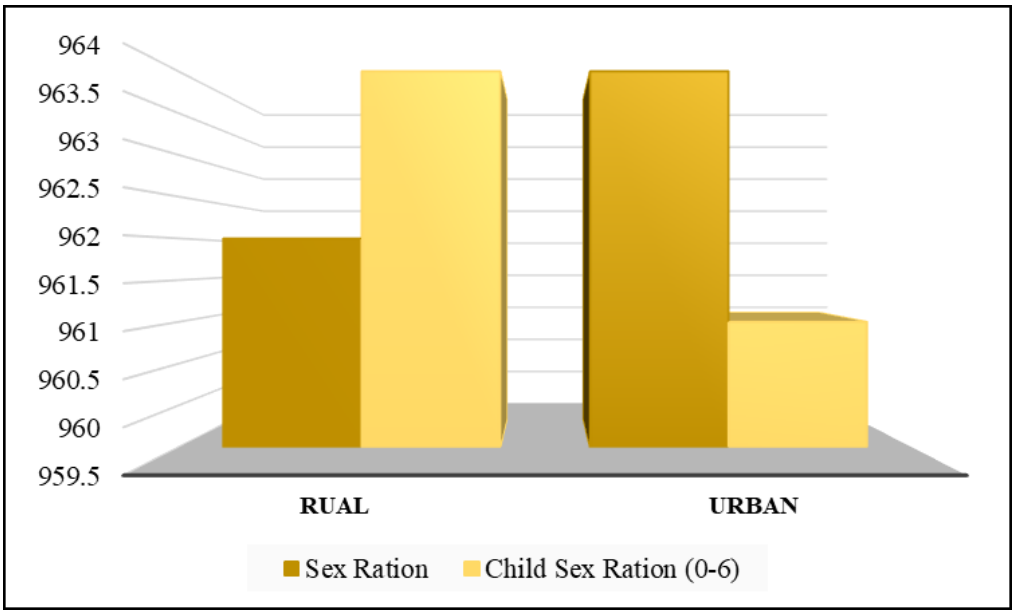


Figure 13: Sex ratio of population of Nagaon District

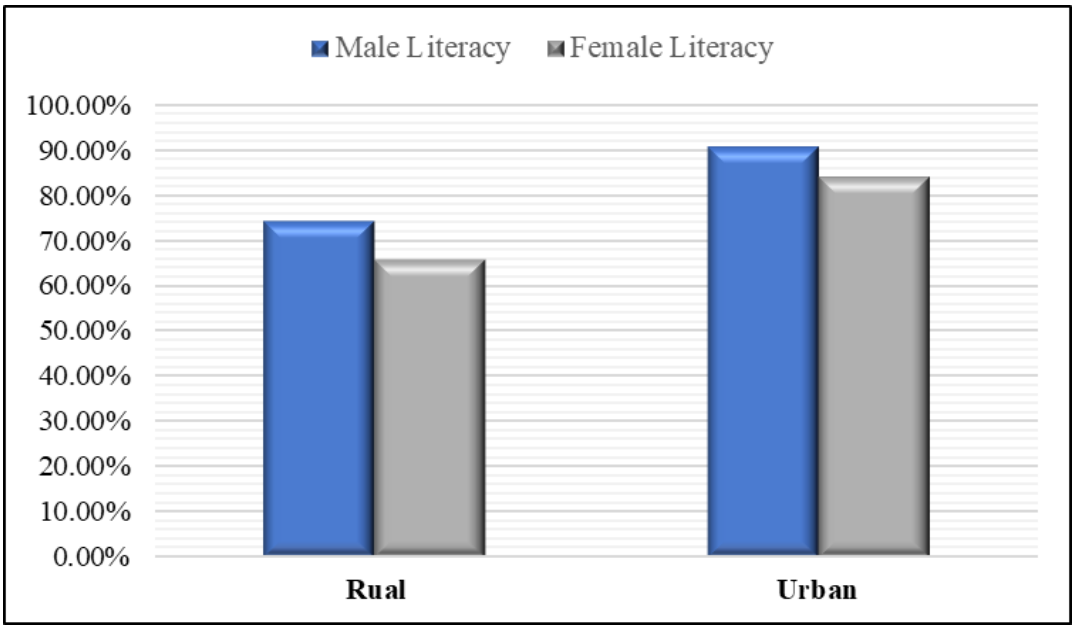


Figure 14: Town-wise male & female literacy rate of Nagaon District

Table 10 : Religion data of the Nagaon district

Sl. No.	Description	Percentage	Population
1.	Hindu	43.39 %	1,225,246
2.	Muslim	55.36 %	1,563,203
3.	Christian	0.95 %	26,844
4.	Sikh	0.11 %	3,036
5.	Buddhist	0.04 %	1,073
6.	Jain	0.04 %	1,162
7.	Other	0.00 %	61
8.	Not Stated	0.11 %	3,143

*(**Source:** www.census2011.co.in)*

i) Cropping Pattern:

Nagaon district is primarily dependent on agriculture and forest products. Main source of income is paddy with surplus production. Rice, wheat, jute, maize, sugarcane are major crops of the district. The district has net and gross cropped areas of 2,17,805 hectares and 417218 hectares respectively, the net cropped area being 57 percent of the total geographical area. About 1,47,410 hectares (63.5%) out of the net cropped areas is put under multiple cropping with an average cropping intensity 192 percent as against 152.43 percent for the state. Besides rice, jute and sugarcane, mustard seed, vegetables etc. are other important agricultural products of the area. Dhing town is surrounded by a fertile area of land which produces jute, rice and mustard seeds abundantly.

Table 11 : Agricultural landuse data of the Nagaon district

Crop	2015-16	2016-17	2017-18	2018-19
Rice	198698	196850	196292	197935
Wheat	2198	1868	1598	1249
Maiza	579	598	614	638
Sugarcane	6233	6312	6398	6434
Jute	10123	10109	9994	9954

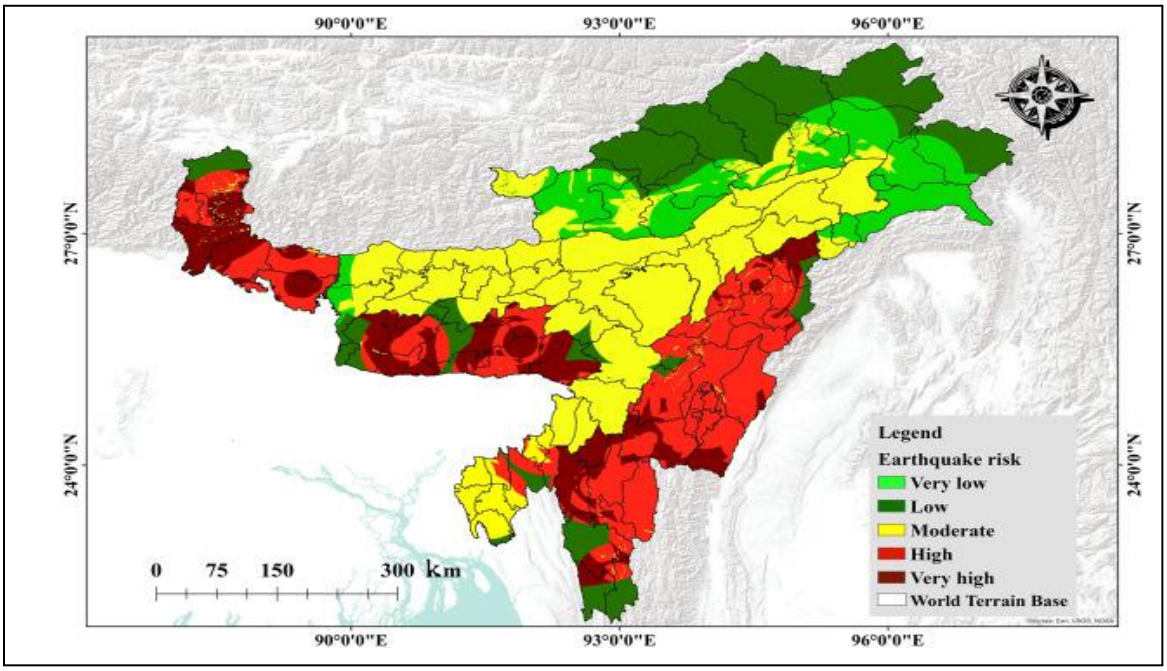
(***Source:*** *Director of Agriculture and Economics office, Nagaon)*

j) Land Form and Seismicity:

The district Nagaon is situated with various landform scenario. The north and south portion is upland of the district. The general slope of the district is towards the west. The eastern, north eastern and the south eastern parts are hilly terrains.

Nagaon district is situated in the Kopili Fault Zone (KF). The KF is a 300 km long and 50 km wide fault zone runs from the western part of Manipur to the tri-junction of Bhutan, Arunachal Pradesh and Assam. KF zone is a zone of fractures or a fracture between two pieces of rock. This zone is a seismically active area and falls into the highest Seismic Hazard Zone V. Thus, making the region the most earthquake-prone zone in North East India. A tectonic depression filled up by the alluvium of the Kopilli river and its tributaries, the Kopili fault zone has witnessed many seismic activities in the past including the 1869 earthquake (7.8 magnitude) and the 1943 earthquake (7.3 magnitude). A study attributed the January 4, 2016 earthquake in the Imphal Valley to the Kopili fracture although later research contradicted this conclusion.

Figure 15: Seismic map of Assam and North East Part



k) Major Flora of Nagaon:

Biodiversity refers to the variety of life forms at all levels of organization, from gene through species to higher taxonomic forms and also includes the variety of ecosystems and habitats as well the processes occurring therein. Biodiversity is fundamental to the fulfillment of human needs; a biodiversity rich region offers wide options and opportunities for sustaining human welfare including adoption to changes. India is one of the 17 Mega bio-diverse countries in the world and accounts for 7-8% of the recorded species. Nagaon district is bounded by Sonitpur district and the Brahmaputra River in the north, West Karbi Anglong and North Cachar Hills in the south, East Karbi Anglong and Golaghat district in the east. The major rivers are The Brahmaputra, Kalong, Sonai, Nanoi, Jamuna, Kopili and Barpani. There are several beels, marshy lands and swamps are there, these are in reality old abandone channels of Kalong and Kopili rivers of Nagaon district. These are Marikalong, Potakalong/Haribhanga, Jongalbalahu, Samoguri beel, Urigadang and Nawbhanga. These beels are major unused resources of the district. There are nearly more than two hundred numerous marshy land exist here which should be used for development of the area.

Table No 12: The predominant floral species in Nagaon District {Aquatic and wetland vascular plants recorded from the Nagaon district of Assam [Abbreviations used: Eph = Epihydate; Hel = Helophyte; Hyp = Hyperhydate; Pla = Plankton; Ple = Pleustophyte; Ros = Rosulate; Ten = Tenagophyte; Vit = Vittate]}

Scientific name [Family]; Local name; Exsciccatae	**Locality**	**Growth form**	**Flowering & Fruiting**
Acmella paniculata (Wallich ex DC.) K.K. Jansen [Asteraceae]; Suhoni-bon; S. Hazarika 178	Sulung	Hel	April – May
Acorus calamus Linnaeus [Acoraceae]; Boch; S.Hazarika 360	Hojai	Hel/Hyp	May – December
Actinoscirpus grossus (Linneaus f.) Goetgh & D.A. Simpson [Cyperaceae]; Ghugol; S.Hazarika 250	Samaguri beel	Hyp/Ten	September – December
Aeschynomene aspera Linnaeus [Fabaceae]; Kunhila; S.Hazarika 241	Batadrawa	Hel/Ten/ Hyp	July – November
Aeschynomene indica Linnaeus [Fabaceae]; Bor Kunhila; S.Hazarika 195	Batadrawa	Hel/Ten/ Hyp	September – November
Alocasia fornicata (Roxburgh) Schott [Araceae]; Kochu; S.Hazarika 261	Chaparmukh	Hel	May – December
Alpinia nigra (Gaertner) B.L. Burt [Zingiberaceae]; Bogi-tora; S. Hazarika 315	Kaziranga	Hyp	June – September
Alternanthera paronychioides A. St. Hillaire [Amaranthaceae]; S. Hazarika 29	Kampur	Hel	Round the year
Alternanthera philoxeroides (Martius) Grisebach [Amaranthaceae]; Neuthoni-sak; S. Hazarika 48	Uria gaon	Hyp	May – August

Alternanthera sessilis (Linnaeus) R. Brown ex DC. [Amaranthaceae]; Matikaduri; S. Hazarika 164	Rupohi	Hel	Round the year
Aponogeton undulatus Roxburgh [Aponogetonaceae]; Ghachelu; S.Hazarika 169	Hatichung	Ros/Eph	May – September
Arundo donax Linneaus [Poaceae]; Nol; S.Hazarika 17	Kaziranga	Hel	August – December
Azolla pinnata R. Brown [Salviniaceae]; Xaru puni, S. Hazarika 91	Morikolong beel	Ple	November – February
Bacopa monnieri (Linnaeus) Wettstein [Plantaginaceae]; Brahmi-sak; S. Hazarika 361	Panigaon	Hel	January – December
Barringtonia acutangula (Linnaeus) Gaertner [Lecythidaceae]; Hijol; S. Hazarika 118	Amoni	Hel	June – October
Blyxa aubertii Richard [Hydrocharitaceae]; S. Hazarika 366	Kolong	Ros	February – March
Blyxa japonica (Miquel) Maximovicz ex Ascherson et Gurke [Hydrocharitaceae]; S. Hazarika 159	Kolong	Vit	July – October
Butomopsis latifolia (D. Don) Kunth [Alismataceae]; Chamos pat; S.Hazarika 265	Jamuguri	Hyp	September – November
Canna indica Linnaeus [Cannaceae]; Parijat; S. Hazarika 356	Hojai	Hel	Round the year
Centella asiatica (Linnaeuas) Urban [Apiaceae]; Bor-manimuni; S. Hazarika 74	Na-mati	Hel	Throughout the year
Centipeda minima (Linnaeus) A. Braun & Ascherson (Asteraceae); S. Hazarika 358	Hojai	Hel	February – June
Ceratophyllum demersum Linnaeus [Ceratophyllceae]; Jal-khar; S. Hazarika 42	Jalah beel	Pla/Vit	January – June
Ceratopteris thalictroides (Linnaeus) Brongniart [Pteridaceae]; S. Hazarika 176	Missa	Ple/Hyp	November – February
Chrysopogon zizanioides (Linnaeus) Roberty [Poaceae]; Birina; S. Hazarika 148	Hatichung	Hel	August – November
Cleome gynandra Linnaeus [Cleomaceae]; S. Hazarika 289	Puranigudam	Hel	June – September

Cleome rutidosperma DC. [Cleomaceae]; S. Hazarika 288	Amoni	Hel	August – November
Coix lacryma-jobi Linneaus [Poaceae]; Kauri- moni; S.Hazarika 281	Bebejia	Hel	July – September
Coldenia procumbens Linnaeus [Boraginaceae]; S. Hazarika 233	Mohadeusal	Hel	February – May
Colocasia esculenta (Linnaeus) Schott [Araceae]; Kochu; S.Hazarika 364	Chaparmukh	Hel/Eph	June – September
Commelina benghalensis Linnaeus [Commelinaceae]; Kona-simolu; S.Hazarika 290	Raha	Hel	July – December
Commelina diffusa N.L. Burman [Commelinaceae]; Kona-simolu; S.Hazarika 343	Koliabor	Hel	January – June
Crataeva religiosa G. Forst [Capparaceae]; Borun; S.Hazarika 120	Kaliabor	Hel	April – July
Cyanotis axillaris (Linnaeus) D. Don ex Sweet [Commelinaceae]; S.Hazarika 308	Pathori	Hel	July – December
Cyclosorus interruptus (Willdenow) H. Ito [Thelypteridaceae]; S. Hazarika 216	Morikolong beel	Ple/Hyp	November – January
Cyperus compactus Retzius [Cyperaceae]; S.Hazarika 238	Dighali-ati	Hel	June – November
Cyperus compressus Linnaeus [Cyperaceae]; Muthi-bon; S.Hazarika 137	Samaguri beel	Ten/Hel	May – December
Cyperus corymbosus Rottboøll [Cyperaceae]; S.Hazarika 240	Dighali-atil	Ten/Hel	May – January
Cyperus digitatus Roxburgh [Cyperaceae]; S.Hazarika 150	Rowmari beel;	Ten/Hel	June – October
Cyperus platystylis R. Brown [Cyperaceae]; S.Hazarika 243	Hanhila beel	Hyp/Ple	May – December
Drymaria cordata (Linnaeus) Willdenow ex Schultes [Caryophyllaceae]; Laijabori; S. Hazarika 84	Morikolong	Hel	March – September
Duchesnea indica (Andrews) Focke [Rosaceae]; S. Hazarika 227	Kaziranga	Hel	January – April

Dysophylla auricularia (Linnaeus) Blume [Lamiaceae]; S. Hazarika 221	Morikolong	Hel/Hyp	November – January
Echinochloa colona (Linnaeus) Link [Poaceae]; S. Hazarika 248	Phuloguri	Hel	July – November
Echinochloa crus-galli (Linnaeus) Palisot de Beauvois [Poaceae]; S.Hazarika 249	Phuloguri	Hel	July – November
Echinochloa crus-pavonis (Kunth) Schultes [Poaceae]; S.Hazarika 131	Dimou beel	Hyp	August – December
Eclipta prostrata (Linnaeus) Linnaeus [Asteraceae]; Kenhraj; S. Hazarika 166	Deura beel	Hyp	Throughout the year
Eichhornia crassipes (Martius) Solms [Pontederiaceae]; Meteka; S.Hazarika 104	Setali beel	Ple/Hyp	May – September
Eleocharis acutangula (Roxburgh) Schultes [Cyperaceae] ; Mitmiti-bon; S.Hazarika 185	kenduguri beel	Hyp/Ten	July – October
Eleocharis congesta D. Don [Cyperaceae]; Mitmiti-bon; S.Hazarika 246	Ghanhi	Hyp/Hel	July – October
Eleocharis dulcis (N.L. Burman) Trinius ex Henschel [Cyperaceae]; Mitmiti-bon; S.Hazarika 116	Upor-Pathori	Hyp/Ten	September – December
Enydra fluctuans DC. [Asteraceae]; Helachi; S. Hazarika 134	Samoguri	Hel/Hyp	April – May
Euryle ferox Salisbury [Nymphaeaceae]; Nikori; S. Hazarika 287	Hanhila beel	Eph	August – November
Evolvulus numularius (Linnaeus) Linnaeus [Convolvulaceae]; S. Hazarika 230	Raidongia	Hel	Round the year
Ficus heterophylla Linnaeus f. [Moraceae]; S. Hazarika 365	Koliabor	Hel	April – November
Fimbristylis dichotoma (Linnaeus) Vahl [Cyperaceae]; S.Hazarika 163	Deora beel	Hel	March – December
Fimbristylis dipsacea (Rottboøll) C.B. Clarke [Cyperaceae]; S.Hazarika 293	Deora	Hel/Ten	April – August
Fimbristylis littoralis Gaudichaud [Cyperaceae]; S.Hazarika 239	Raha	Ten/Hel	June – December
Fimbristylis tetragona R. Brown [Cyperaceae]; S.Hazarika 247	Ghanhi	Ten/Hel	September – December
Floscopa scandens Loureiro [Commelinaceae];	Koliabor	Hel	August – December

S.Hazarika 347			
Fuirena ciliaris (Linnaeus) Roxburgh [Cyperaceae]; S.Hazarika 350	Era-Kolong	Ten/Hel	October – January
Fuirena umbellata Rottboøll [Cyperaceae]; S.Hazarika 191	Morikolong beel	Ten /Hel	October – January
Grangea maderaspatana (Linnaeus) Poiret [Asteraceae]; Bali-babori; S. Hazarika 127	Dimou beel	Hel	May – November
Hedychium coronarium J. Koenig [Zingiberaceae]; S. Hazarika 371	Sikoni	Hel	June – November
Heliotropium indicum Linnaeus [Boraginaceae]; Hati-suria; S. Hazarika 297	Morikolong	Hel	April – August
Houttuynia cordata Thunberg [Saururaceae]; Masandari; S. Hazarika 363	Amolapatty	Hel	April – August
Hydrilla verticillata (Linnaeus f.) Royle [Hydrocharitaceae]; S. Hazarika 138, 179	Sulung, Jalah beel	Vit	September – December
Hydrocera triflora (Linnaeus) Wight & Arnott [Balsaminaceae]; S. Hazarika 190	Raha	Hyp	June – August
Hydrocotyle sibthorpioides Lamarck [Araliaceae]; Xaru- manimuni; S. Hazarika 89	Senchua	Hel	April – May
Hydrolea zeylanica (Linnaeus) Vahl [Hydroleaceae]; S. Hazarika 206	Jajori	Hel	November – March
Hygrophila erecta (Burman f.) Hochreutiner [Acanthaceae]; S. Hazarika 280	Jakhalabandha	Hyp	July – November
Hygrophila phlomoides Nees [Acanthaceae]; S. Hazarika 335	Bebejia	Hel	October – December
Hygrophila polysperma (Roxburgh) Anderson [Acanthaceae]; S. Hazarika 330	Hatichung	Vit	November – May
Hygrophila salicifolia (Vahl) Nees [Acanthaceae]; S. Hazarika 349	Digholi beel	Hel	October – January
Hygroryza aristata (Retzius) Nees ex Wight & Arnott [Poaceae]; S.Hazarika 196	Dighali ati	Ple	October – December
Ipomoea aquatica Forsskal [Convolvulaceae]; Kolmou; S. Hazarika 200	Ghanhi	Eph/Hyp/ Ten	October – April
Ipomoea carnea Jacquin ssp. fistulosa (Martius ex Choisy) Austin [Convolvulaceae]; Goch-Kolmou;	Bebejia	Hyp	September – January

S. Hazarika 199			
Isachne globosa (Thunberg) O. Kuntze [Poaceae]; S.Hazarika 41	Puta Kolong	Hel/Eph	July – December
Lasia spinosa (Linnaeus) Thwaites [Araceae]; Jeng-Kochu; S.Hazarika 361	Hojai	Hel/Eph	December – February
Lemna perpusilla Torrey [Araceae]; Xoru-puni; S.Hazarika 359	Nabhanga beel	Ple	August – October
Limnophila aromatica (Lamarck) Merrill [Plantaginaceae]; S. Hazarika 328	Hatichung	Hyp/Ten	July – December
Limnophila chinensis (Osbeck) Merrill [Plantaginaceae]; S. Hazarika 322	Chakalaghat	Hel	November – January
Limnophila heterophylla (Roxburgh) Bentham [Plantaginaceae]; S. Hazarika 184,189	Amoni Koliabor	Vit	September – January
Limnophila indica (Linnaeus) Druce [Plantaginaceae]; S. Hazarika 323	Hatichung	Vit/Hyp	July – December
Limnophila repens (Bentham) Bentham [plantaginaceae]; S. Hazarika 321	Chakalaghat	Hel	November – February
Limnophila sessiliflora (Vahl) Blume [Plantaginaceae]; S. Hazarika 204	Jajori	Vit/Hyp	September – February
Lindernia anagalis (N.L. Burman) Pennell [Linderniaceae]; S. Hazarika 160	Deura beel	Hel	September – January
Lindernia antipoda (Linnaeus) Alston [Linderniaceae]; S. Hazarika 375	Dimou beel	Hel	November – March
Lindernia crustacea (Linnaeus) F. von Mueller [Linderniaceae]; S. Hazarika 370	Dimou beel	Hel	September – January
Lindernia rotundifolia (Linnaeus) Alston [Linderniaceae]; S. Hazarika 325	Dighali beel	Hel	August – November
Lindernia ruellioides (Colsmann) Pennell [Linderniaceae]; S. Hazarika 373	Dimou beel	Hel	October – February
Lipocarpha chinensis (Osbeck) J. Kern [Cyperaceae]; S. Hazarika 201	Juria beel	Ten/Hel	August – January
Lippia javanica (Burman f.) Sprengel [Verbenaceae]; Pahusikoti; S. Hazarika 226	Kaziranga	Hel	January – September
Litsea salicifolia (Roxburgh ex Wallich) Hooker f. [Lauraceae]; Digh-loti; S. Hazarika	Kaziranga	Hel/Hyp	February – June

364			
Ludwigia adscendens (Linnaeus) H. Hara [Onagraceae]; pani-khutora; S. Hazarika 121	Kolong	Ple	March – December
Ludwigia octovalvis (Jacquin) Raven [Onagraceae]; S. Hazarika 298	Dighali beel	Hel	Throughout the year
Ludwigia perennis Linnaeus [Onagraceae]; S. Hazarika 158	Deura beel	Hel	August – December
Ludwigia peruviana (Linnaeus) Hara [Onagraceae]; S. Hazarika 186	Chapormukh	Hel/hyp/ple	Throughout the year
Marsilea minuta Linnaeus [Marsileaceae]; Pani tengechi ; S. Hazarika 117	Rupahi	Ten	November – January
Mazus pumilus (Burman f.) Steenis [Phrymaceae]; S. Hazarika 374	Dhing	Hel	Round the year
Melastoma malabathricum Linnaeus [Melastomataceae]; Phutuka; S. Hazarika 285	Kaziranga	Hel	April – October
Melochia corchorifolia Linnaeus [Malvaceae]; Soka-mora; S. Hazarika 262, 193	Chapormukh	Hyp	June – September
Monochoria hastata (Linnaeus) Solms [Pontederiaceae]; Bor-meteka; S.Hazarika 111	Gorajan beel	Ple/Hyp	May – August
Monochoria vaginalis (N.L. Burman) C. Presl ex Kunth [Pontederiaceae]; Xoru-meteka; S.Hazarika 237	Dighali beel	Hyp	May – November
Murdannia nudiflora (Linnaeus) Brenan [Commelinaceae]; S.Hazarika 260	Dighali-ati	Hel	June – January
Murdannia spirata (Linnaeus) G. Bruckner [Commelinaceae]; S.Hazarika 376	Dimou	Hel	July – December
Myriophyllum indicum Willdenow [Haloragaceae]; S. Hazarika 105	Samoguri beel,	Vit/Hyp	July – October
Myriophyllum tuberculatum Roxburgh [Haloragaceae]; S. Hazarika 152	Morikolong beel	Vit/Hyp	Round the year
Najas indica (Willdenow) Chmisso [Hydrocharitaceae]; S.Hazarika 207	Rowmari beel	Vit	August – October
Najas minor Allioni [Hydrocharitaceae]; S.Hazarika 123	Samaguri beel	Vit	July – November
Neechamandra alternifolia (Roxburgh ex R. Wight) Thwaites [Hydrocharitaceae]; S. Hazarika 93	Jamunamukh	Vit	January – June

Nelumbo nucifera Gaertner [Nelumbonaceae]; Podum; S. Hazarika 192	Dighali ati	Hyp	May – September
Nymphaea nouchali N.L. Burman f. [Nymphaeaceae]; Bhet; S.Hazarika 187, 171, 170	Raha, Samoguri	Eph	June – November
Nymphaea pubescence Willdenow [Nymphaeaceae]; Bhet, Mokua; S. Hazarika 173	Haribhanga	Eph	June – November
Nymphaea rubra Roxburgh ex Andrews [Nymphaeaceae]; Ronga bhet, S. Hazarika 122	Dighali ati	Eph	Almost round the year
Nymphoides hydrophylla (Loureiro) O. Kuntze [Menyanthaceae]; S. Hazarika 153	Jalah beel	Eph	March – November
Nymphoides indica (Linnaeus) O. Kuntze [Menyanthaceae]; S. Hazarika 177	Noltoli	Eph	July – December
Oenanthe javanica (Blume) DC. [Apiaceae]; Pani- Dhania; S. Hazarika 165	Rangolu	Hyp/Hel	May – September
Oldenlandia corymbosa Linnaeus [Rubiaceae]; S. Hazarika 205	Jajori	Hel	July – November
Oldenlandia diffusa (Willdenow) Roxburgh [Rubiaceae]; S. Hazarika 284	Kuthori	Hel	June – September
Ottelia alismoides (Linnaeus) Persoon [Hydrocharitaceae]; Pani-kol; S.Hazarika 138, 179	Sulung	Ros/Eph	June – December
Oxalis corniculata Linnaeus [Oxalidaceae]; Xoru- tengechi; S. Hazarika 89	Sulung	Hel	Round the year
Paspalidium geminatum (Forsskal) Stapf [Poaceae]; S.Hazarika 82	Jungal bolohu	Eph	August – December
Paspalum conjugatum P.J. Bergius [Poaceae]; S. Hazarika 183	Missa	Hel	June – October
Persicaria barbata (Linnaeus) H. Hara [Polygonaceae]; S. Hazarika 155,162	Deura beel, Sulung	Hel	September – March
Persicaria chinensis (Linnaeus) H. Gross [Polygonaceae]; Madhu-suleng; S. Hazarika 340	Kuthori	Hel	September – March
Persicaria glabra (Willdenow) M. Gomez de la Maza [Polygonaceae]; S. Hazarika 142	Jamuguri	Hel	March – October
Persicaria hydropiper (Linneaus) Delarbre [Polygonaceae]; Bihlongoni ; S. Hazarika 135, 181	Sulung	Hel	Round the year
Persicaria orientalis (Linneaus) Spach [Polygonaceae]; S. Hazarika	Dighali-ati	Hyp	May – September

256			
Persicaria stagnina (Buchanan-Hamilton ex Meisner) Qaiser [Polygonaceae]; S. Hazarika 198	Raha	Hel	September – March
Phragmites karka (Retzius) Trinius ex Steudel [Poaceae]; Khagori; S.Hazarika 15	Kaziranga	Hyp	September – December
Phyla nodiflora (Linnaeus) Greene [Verbenaceae]; S. Hazarika 231	Raidangia	Hel	April – August
Phyllanthus reticulatus Poiret [Phyllanthaceae]; Pani-jetuka; S. Hazarika 319	Maj-gaon	Hel/Hyp	March – September
Pistia stratiotes Linnaeus [Araceae]; Bor-puni; S.Hazarika 257	Raha	Ple	June – October
Polygonum plebeium R. Brown [Polygonaceae]; S. Hazarika 274	Dimou beel	Hel	November – May
Polygonum viscosum Buchanan-Hamilton ex D. Don [Polygonaceae]; S. Hazarika 245	Ghanhi	Hyp	June – September
Portulaca oleracea Linnaeus [Portulacaceae]; Malbhog-sak; S. Hazarika 88	Gorajan	Hel	Round the year
Potamogeton crispus Linnaeus [Potamogetonaceae]; S.Hazarika 211, 355	Warigeding beel, Kolong	Vit	December – March
Potamogeton nodosus Poiret [Potamogetonaceae]; S.Hazarika 145	Hanhila beel	Eph/Vit	Almost round the year
Potamogeton octandrus Poiret [Potamogetonaceae]; S.Hazarika 272	Kolong	Eph/Vit	Almost round the year
Pseudoraphis brunoniana (Griffith) Pilger [Poaceae]; S. Hazarika 146	Jajori	Eph/Hyp	May – September
Pseudoraphis minuta (Mez) Pilger [Poaceae]; S. Hazarika 182	Amoni	Eph/Hyp	June – October
Pycreus flavidus (Retzius) T. Koyama [Cyperaceae]; S.Hazarika 136	Samaguri beel	Hel	May – September
Ranunculus cantoniensis DC. [Ranunculaceae]; S. Hazarika 294	Morikolong beel	Hel	March – July
Ranunculus sceleratus Linnaeus [Ranunculaceae]; Panidhania; S. Hazarika 219	Kolong	Ten/Eph	March – June
Rorippa indica (Linnaeus) Hiern [Brassicaceae]; Bon-sarioh; S. Hazarika 130	Dimow beel	Hel	March – July

Rosa clinophylla Redout & Thory [Rosaceae]; Bon-golap; S. Hazarika 229	Kaziranga	Hel	February – August
Rotala rotundifolia (Buchanan-Hamilton ex Roxburgh) Koehne [Lythraceae]; S. Hazarika 126	Dimou	Hyp	November – April
Rumex dentatus Linnaeus [Polygonaceae]; S. Hazarika 357	Hojai	Hel	January – April
Rumex maritimus Linneaus [Polygonaceae]; La- borua; S. Hazarika 214	Kolong	Hel/Hyp	December – April
Saccharum spontaneum Linnaeus [Poaceae]; Kanhua; S. Hazarika 13	Kolong	Hel	September – December
Sacciolepis interrupta (Willdenow) Stapf [Poaceae]; S. Hazarika 197	Raha	Hyp/Ple	September – December
Sagittaria guayanensis Kunth subsp. lappula (D. Don) Bogin [Alismataceae]; S.Hazarika 180	Sulung	Eph	July – September
Sagittaria sagittifolia Linnaeus [Alismataceae]; Jathipotia; S.Hazarika 213	kolong	Hyp	July – September
Salvinia adnata Desvaux [Salviniaceae]; Bor puni ; S. Hazarika 139	Morikolong beel	Ple	November – February
Schoenoplectiella articulata (Linnaeus) K. Lye [Cyperaceae]; S.Hazarika 339	Samaguri beel	Hel	December – March
Schoenoplectiella juncoides (Roxburgh) K. Lye [Cyperaceae]; S.Hazarika 267	Dimow beel	Hyp/Ten	August – December
Schoenoplectiella lateriflora (J. F. Gmelin) K. Lye [Cyperaceae]; S.Hazarika 312	Tuloshi beel	Ten	September – December
Schumannianthus dichotomus (Roxburgh) Gagnepain [Marantaceae]; Patidoi; S.Hazarika 314	Kaziranga	Hel	May – September
Scorparia dulcis Linnaeus [Plantaginaceae]; S. Hazarika 362	Raha	Hel	Round the year
Sesbania bispinosa (Jacquin) W.F. Wight [Fabaceae]; Khori – goch; S.Hazarika 194	Shantijan beel	Hel	September – December
Setaria pumila (Poiret) Roemer et Schultes [Poaceae]; S. Hazarika 252	Dighali ati	Hyp	August – November

Sphenoclea zeylanica Gaertner [Sphenocleaceae]; S. Hazarika 236	Bogoriguri	Hel/Hyp	August – December
Spirodela polyrrhiza (Linnaeus) Schleiden [Araceae]; Puni; S.Hazarika 63	Morikolong beel	Ple	June – October
Stellaria media (Linnaeus) Villars [Caryophyllaceae]; Morolia; S. Hazarika 220	Mahlur	Hel	November – March
Torenia vagans Roxburgh [Linderniaceae]; S. Hazarika 133	Samoguri beel	Hel	August – November
Trapa natans var. bispinosa (Roxburgh) Makino [Trapaceae]; Singori; S. Hazarika 188	Hanhila beel	Eph	July – December
Trapa incisa Siebold & Zuccarini [Trapaceae]; Kaziranga, S. Hazarika 242	Kaziranga	Eph	July – January
Typha domingensis Persoon [Typhaceae]; S.Hazarika 278	Thekeraguri	Hyp	March – June
Utricularia aurea Loureiro [Lentibulariaceae]; S. Hazarika 144	Samoguri beel	Pla	October – February
Utricularia gibba subsp. exoleta (R. Brown) Taylor [Lentibulariaceae]; S. Hazarika 168	Noltali	Pla	April – July
Vallisnaria spiralis Linnaeus [Hydrocharitaceae]; S. Hazarika 354	Kolong	Ros	July – September
Veronica anagalis-aquatica Linnaeus [Plantaginaceae]; S. Hazarika 353	Kolong	Vit	January – April
Xanthium strumarium Linnaeus [Asteraceae]; Agora; S. Hazarika 215	Morikolong beel	Hel	July – January

l) Major Fauna of Nagaon:

Nagaon district is enrich by different kind of fauna. The Loakhowa sanctuary is containing various species of fauna; the sanctuary is an ideal habitat for Indian rhinoceros and Asiatic water buffaloes. Other animals found here are the Bengal tiger, Indian leopard, Indian boar, leopard cat, hog deer.

Table 13: Scientific names and the species types of few important animals

COMMON NAME (IN ASSAMESE/ ENGLISH)	SCIENTIFIC NAME	SPECIES TYPE
Dhekiapotia bagh/Tiger	*Panthera tigris*	Mammal
Hati/ Elephant	*Elephas maximus indicus*	Mammal
Hog Deer		Mammal
Graylag Goose	*Anser anser*	Aves
Gray-headed Swamphen	*Porphyrio poliocephalus*	
Bronze-winged Jacana	*Metopidius indicus*	
Indian Pond-Heron	*Ardeola grayii*	
Eastern Cattle Egret	*Bubulcus coromandus*	
Glossy Ibis	*Plegadis falcinellus*	
Black Drongo	*Dicrurus macrocercus*	
Greater Spotted Eagle	*Clanga clanga*	
Common Kingfisher	*Alcedo atthis*	
Large Cuckooshrike	*Coracina macei*	
Monitor lizard	*Varanus varius*	Reptilian
Python	*Python molurus*	Reptilian
Brown tortoise	*Manouria emys*	Amphibian
		Sources: *https://nagaon.assam.gov.in*

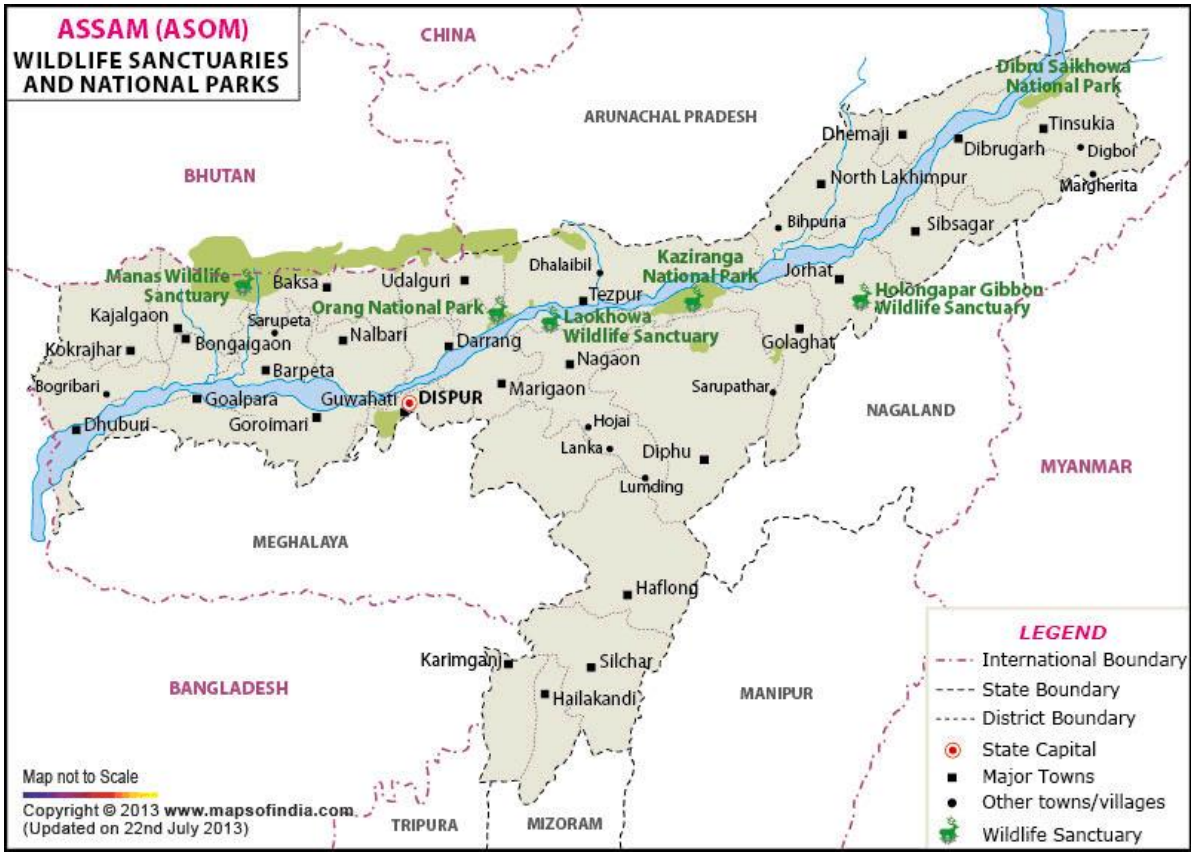
❖ Laokhowa Wildlife Sanctuary in Nagaon:

This is situated at Lowkhowa namely covering an area of 70 sq. km at a distance of 25 km from Nagaon Town. Its main attraction is the Great Indian One-horned Rhinoceros. Other animals are Tiger, Leopard, Asiatic Buffalo, Wild Boar, Civer Cat, Leopard Cat, Hog Deer etc. Various Species of birds and reptiles are also found in Laokhowa. he Laokhowa and Burhachapori Wildlife Sanctuaries are two highly significant ecosystems of the state of Assam. The PAs were historically been ideal home for various key species of endangered mammals, reptiles and birds. Large mammals like Asiatic water Buffalo, Royal Bengal Tiger and Elephants etc. are still found in these two sanctuaries. Besides, Rhinos migrating among the Kaziranga and Orang National Park and Pobitora Wildlife sanctuaries have been spotted in the Laokhowa and Burhachapori Wildlife Sanctuaries from time to time. In addition to that, wet alluvial grassland sustain a large number of herbivores like sambar, barking deer and hog deer along with nocturnal species like

pangolins, slow loris, porcupine and hare etc. Many rare and endangered species (many of them coming under the Schedule I species category under the Wildlife Protection Act. 1972) of small cats, civets and otters, reptiles like pythons, common and water monitor, turtles like Assam Roofed, Indian Roofed, Peacock Softshelled, Soft shelled Turtles, Butterflies like Birdwing, Common Map, Crimson Rose etc. are still found in abundance in these two PAs. The numerous natural and perennial wetlands are functioning as breeding ground for various kinds of local fish species and highly important bird species such as Storks like Adjutant, Lesser Adjutant, White Stork, Black Necked Stork, Black Stork besides birds like Large Whistling Teal, Herons, various kinds of Raptors, numerous grassland birds including highly endangered Bengal Florican.

Wild life images of Loakhowa Sanctuary

Figure 16: Wildlife Sanctuaries and National Parks of Assam



*(**Source**: https://www.mapsofindia.com/maps/wildlife/wildlife-assam.htm)*

CHAPTER 4: PHYSIOGRAPHY OF THE DISTRICT

4.1 General Land form:

Assam is situated extreme part of India. Three major Land form we can see here; (i) Brahmaputra Valley in the north, (ii) Barak Valley in the south and (iii) Central Assam Plateau. Nagaon district is lies upon the i and iii division. Brahmaputra division and central plateau division both are centralize into Nagaon.

There are several beels, marshy areas and swamps in the district, including the regions of Marikalong, Potakalong, Haribhanga, Jongalbalahu, Samaguri Beel, Gatanga Beel Urigadang and Nawbhanga. These wetlands are former channels of the Kolong and Kopili rivers. The district headquarters are located in Nagaon town. A part of the Kaziranga National Park is located within the Nagaon district. The district is bounded by the Brahmaputra River in the north (across the river is Sonitpur district, Karbi Anglong West and Hojai in the south, East Karbi Anglong and Golaghat district in the east. The district is a perfect example oxoman from where the word Assam originated, as it possesses rivers, river valleys, hills, jungles, and plains.

4.2 Soil & Rock pattern

- **Soil Type**

The alluvial soil is mostly loamy and consists of a mixture of clay and sand in varying proportions, ranging from pure sand on the banks of the Brahmaputra to sticky clay which is considered unfit for cultivation. Marshy soil is chiefly found in the low lying areas. These are black in colour. The red soil generally occupies the hill slopes and foot hills. Occasionally lateritic soil is also found near about Lumding.

The plain areas bordering Brahmaputra River are occupied by alluvial sediments belonging to Quaternary ages. Based on such criteria such as sedimentation, soil characteristics and geomorphic features, the Quaternary sediments can be grouped into two subdivisions, viz.

- Older Alluvium, and
- Younger alluvium.

The Older alluvium by virtue of its relative maturity is composed of somewhat oxidized sediments comprising yellow and the reddish brown colour sand, silt and clay in contrast to the light colour, less compact younger alluvium sediment. The Older alluvium always occupies the higher grounds than the adjacent younger alluvium but takes the proper stratigraphy position underlying the younger alluvium sediments in the plain areas.

The salient feature of district soils:

- **Red soils, red loam, and yellow earth**: These soils are found in the foothills and are made up of silica and aluminum. They are less fertile because they lack humus and nitrogenous substances. The surface soils are generally pale red to reddish brown or bright red in colour and have low water holding capacity (fairly well-drained) as well as poorer fertility.
- **Precambrian rocks:** The district is underlain by granites and gneisses from the

Precambrian age.

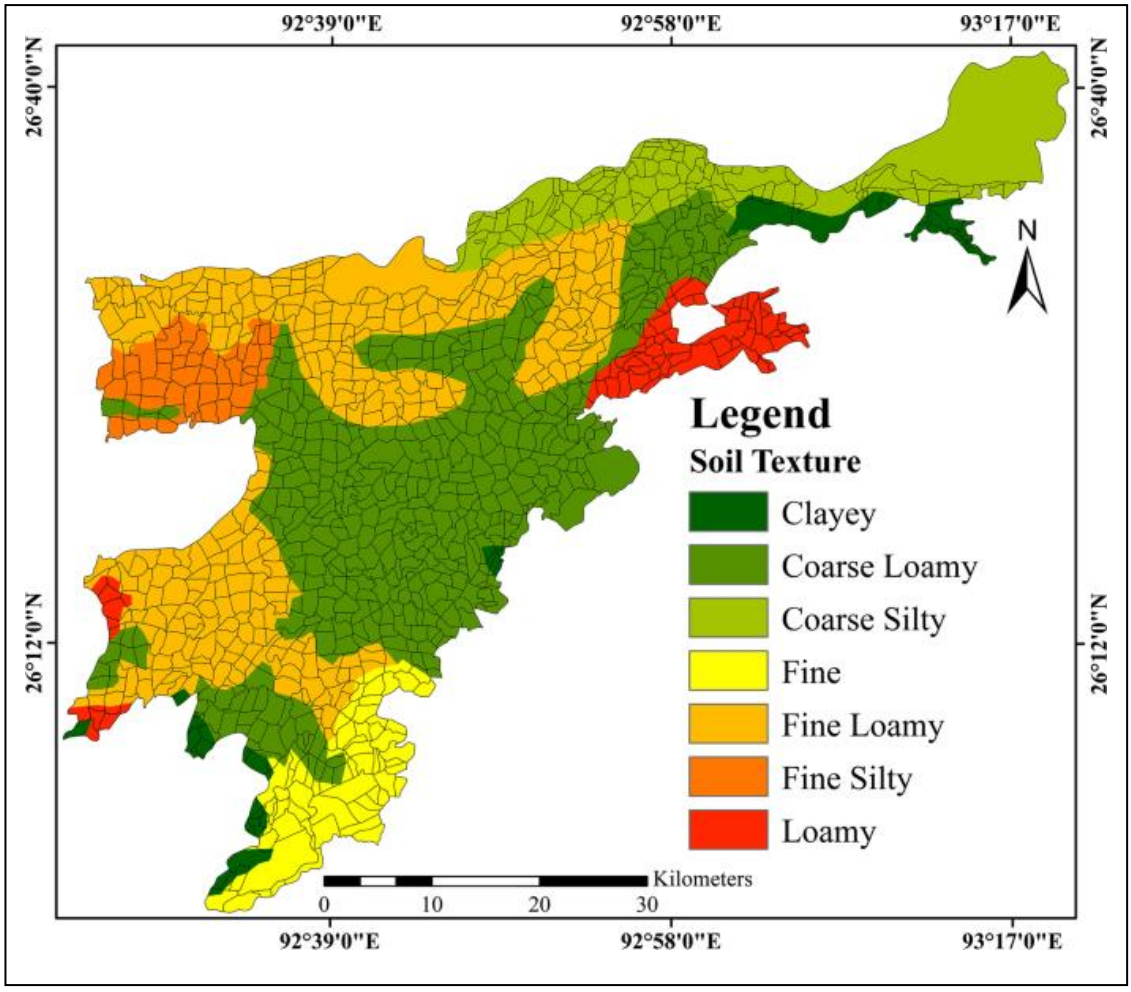
- **Tertiary and Quaternary alluvium:** The district also has rocks from the Barail and Surma series of the Tertiary age and Quaternary alluvium.

➢ **Rock type:**

Nagaon district belongs to Archean, Pre-Cambrian, Tertiary and Quaternary periods. The Archaean rocks comprise the metamorphic rock types of gneisses and schists which are introduced by younger acidic and basic intrusive.

- Precambrian age: Granites and gneisses are the main rock of this age.
- Tertiary age: Rocks of the Barail and Surma series are present in the district.
- Quaternary age: Alluvium is present in the district.
- Metamorphic rock: Gneisses and schists are the metamorphic rock types in the district.
- Sedimentary deposits: Shale, Sandstone, Limestone, and conglomerate are the sedimentary deposits in the district.

Figure 17: Soil Map of the Nagaon district



4.3 Different geomorphological units:

In general, geomorphology of a particular region includes physiographic features and drainage basins.

Physiographic Features

The major geomorphic units in the district are - i. Denudational hills, ii. Piedmont zone, iii. Flood plain deposits with Charland and Swampy areas**.**

i. **Denudational Hills:** It occupies eastern and southern part of the district comprising parts of Karbi angling hills and N.C.hills. They are NE-SW trending rugged topographic highs standing out due to differentiated erosion. The hilly terrain is covered by thick mantle of lateritic deposit and is densely forested.

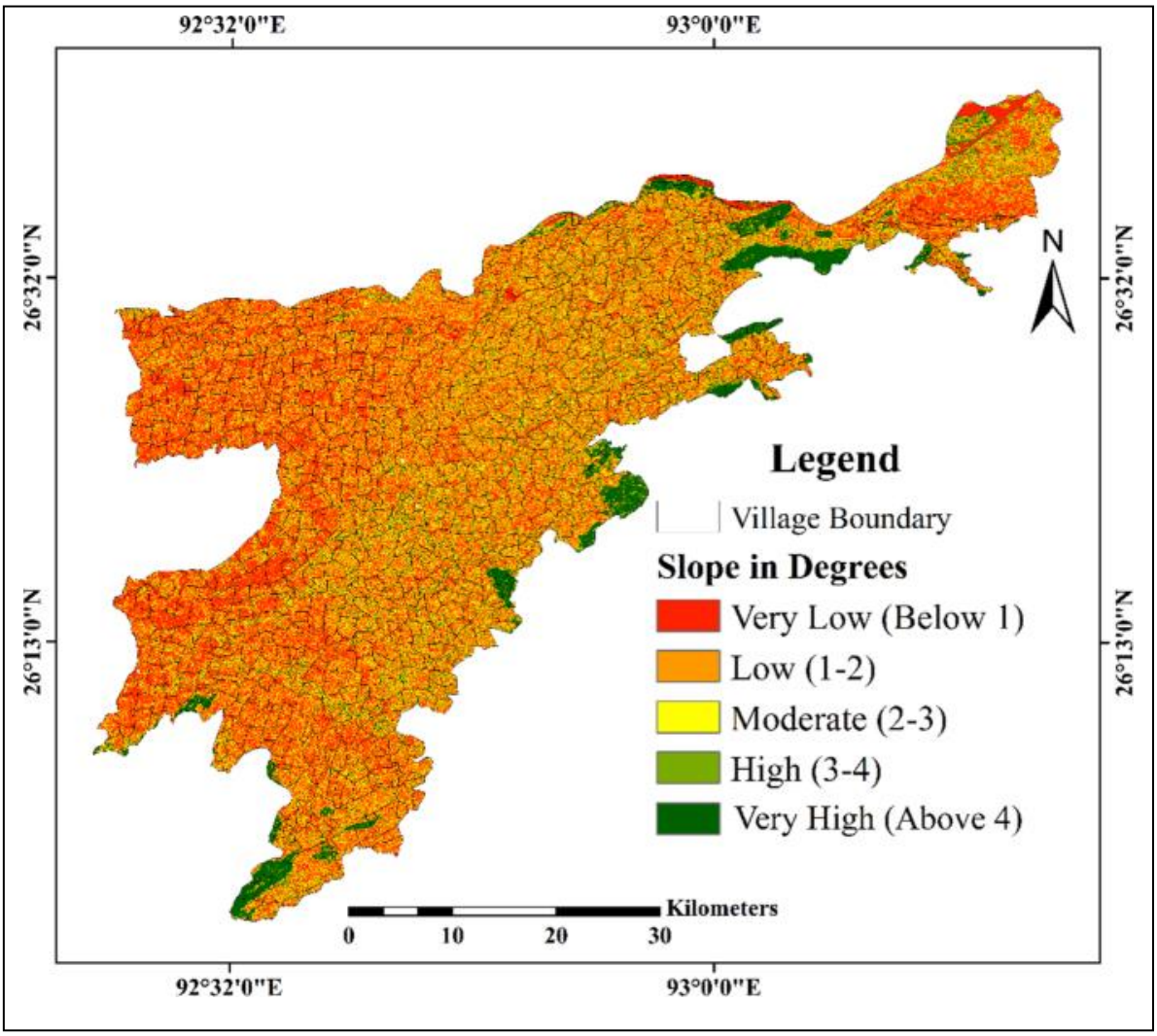
ii. **Piedmont Zone:** These zones occur at the contact of the denudational hills and plains. They are high land forms deposited adjacent to hill slopes by fluvial action. They consist of assorted admixture of cobbles, pebbles, sand and a matrix of clay.

iii. **Flood Pain deposits:** Flood Plain deposit occupy a major part of the district with huge thickness of unconsolidated alluvial sediment deposited by the mighty Brahmaputra and its tributaries. The Kopili River on the south and the Kalong River on the north-east have deposited the sediment during floods.

iv. **Charland:** Charland is relatively low lying area along the river Brahmaputra within the recent flood plain. The area is characterized by fertile land with sandy and silty loam. The Charland is formed due to oscillation of the river water which is either washed away by subsequent floods or strengthened by further deposition.

v. **Swampy areas:** Swampy areas are low lying areas or the natural depressions created due to change of river courses as abandoned channels or meander lakes. They are locally known as beels and are found abundantly in the district.

Figure 18: Elevation of river Map of the Nagaon district



CHAPTER 5: LAND USE PATTERN OF THE DISTRICT

The Brahmaputra valley of Assam is blessed with numerous waterbodies and swamps. The natural waterbodies are locally called as "Beel" while the swamps are known as "Jalah", "Doloni", Pitoni", "Duba" or "Hola". All these are as a whole termed as wetland. These wetlands are geomorphologically and ecologically very important features. These comprise a major component of hydrologic regime of the state. They act as storage basins during flood and thereby reducing the impacts of the flood. Wetlands are home of various aquatic flora and fauna and provide a good example of an aquatic ecosystem. Besides the socio-economic value of the wetlands are also significant. These beels are the traditionally used as the natural fisheries of Assam. Morikolong is one of the largest wetlandsof the Nagaon district situated almost nearby the township area. Infact, it is an ox bow lake formed due to the changing course of the Kolong River. It is almost 7 km long. The wetland and its numerous aquatic resources are utilised in various ways by the local people. Land use pattern of any place is ever changing. The gradual land use change in the surrounding region of wetland has also some impact on it. The recent decades experience a very high growth of population. With it, the land use pattern also changes drastically. Besides, the human impact on the wetland also increasing at an alarming rate. Major portion of the beel has been gradually disappearing due to the ever-increasing human encroachment. A large portion of the beel has been deposited by the garbage and converted to the human settlement and commercial areas. The bank vegetation cover is being destroyed and replaced by residential areas. At present, a small vegetation, grasses and only a small tract of the paddy field is available. This changing land use leads to change the original characteristics of the wetland and thereby reducing its quality as source of rich natural resources.

- ***Land cover:*** is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands or open water.

- ***Land use:*** shows how people use the landscape – whether for development, conservation, or mixed uses. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year.

- ***Forest & Plantation:*** The important forest types found in Nagaon District are: Moist semi-evergreen forests, Moist Mixed Deciduous forests, Rivera in Type Miscellaneous type with scattered pure or mixed patches of bamboos. The Nagaon Soil Conservation Division plants bamboo, medicinal plants, ginger, and broom in areas that are suitable for these crops. They also bring degraded wasteland and riverine non-agricultural land under plantation to provide permanent cover to the top soil. (http://assam.gov.in/).

- ***Cropland:*** Wet-Cultivation, shifting (Jhum) Cultivation/ terrace Cultivation are well-practiced in this district. The cropped area of Nagaon district has been decreasing, from 373,517 hectares in 2002–2003 to 339,496 hectares in 2018–2019.

- ***Built up land:*** a developed area, any land on which buildings and/or non-building structures are present, normally as part of a larger developed environment such as: developed land lot, rural area, urban area. Land covered by buildings and other man-

made structures.

- ***Shrub land:*** Land with woody vegetation less than 2 m in height and with greater than 10% shrub canopy cover. The shrub foliage can be either evergreen or deciduous. Shrub land, scrubland, scrub, brush, or bush is a plant community characterised by vegetation dominated by shrubs, often also including grasses, herbs, and geophytes. Shrub land may either occur naturally or be the result of human activity.

- ***Fallow land:*** Fallow Land is farmland that has no crops on it, usually for a year, to recover its fertility to grow crops. Land taken up for cultivation temporarily allowed remaining uncultivated for one or more seasons. The amount of fallow land in Nagaon district has been increasing.

- ***Wasteland:*** Sparsely vegetated land with signs of erosion and land deformation that could be attributed to lack of appropriate water and soil management, or natural causes. These are land identified as currently underutilized and could be reclaimed to productive uses with reasonable effort. Degraded forest (<10% tree cover) with signs of erosion is classified under wasteland.

- ***An empty area of land***: especially in or near a city, which is not used to grow crops or built on, or used in any way and/or a place, time or situation containing nothing positive or productive, or completely without a particular quality or activity.

- ***Water body:*** Areas with surface water, either impounded in the form of ponds, lakes, reservoirs or flowing as streams, rivers, etc. can be either fresh or salt-water bodies.

- ***Wetland:*** A wetland is a distinct ecosystem that is inundated by water, either permanently or seasonally. Wetland distribution at district level reveals that Nagaon district has number (379) of wetlands among all the districts of the state. The genesis and development of wetland are closely related to the geomorphic and tectonic history of the study area, hydrological behavior of the nearby river and prolonged human use of peripheral lands, depending upon their locational characteristics, wetlands is prone to various kinds of geo-environmental problems. Therefore, with growing need of wetland management it has become highly imperative to study genesis and development of wetlands and the present study is to focus on the wetlands of Nagaon district, Assam.

Table No 14: Area under LULC of Nagaon District, 1990-2020

Land Use/ Land Cover Categories	**Year 1990 (%)**	**Year 2000 (%)**	**Year 2010 (%)**	**Year 2020 (%)**
Built up	24.03	27.01	28.15	43.66
Agriculture	24.61	25.10	30.01	18.33
Forest	18.20	16.33	14.19	6.16
Water bodies	11.10	11.24	11.31	12.01
Sand bars	10.04	10.02	10.12	13.24

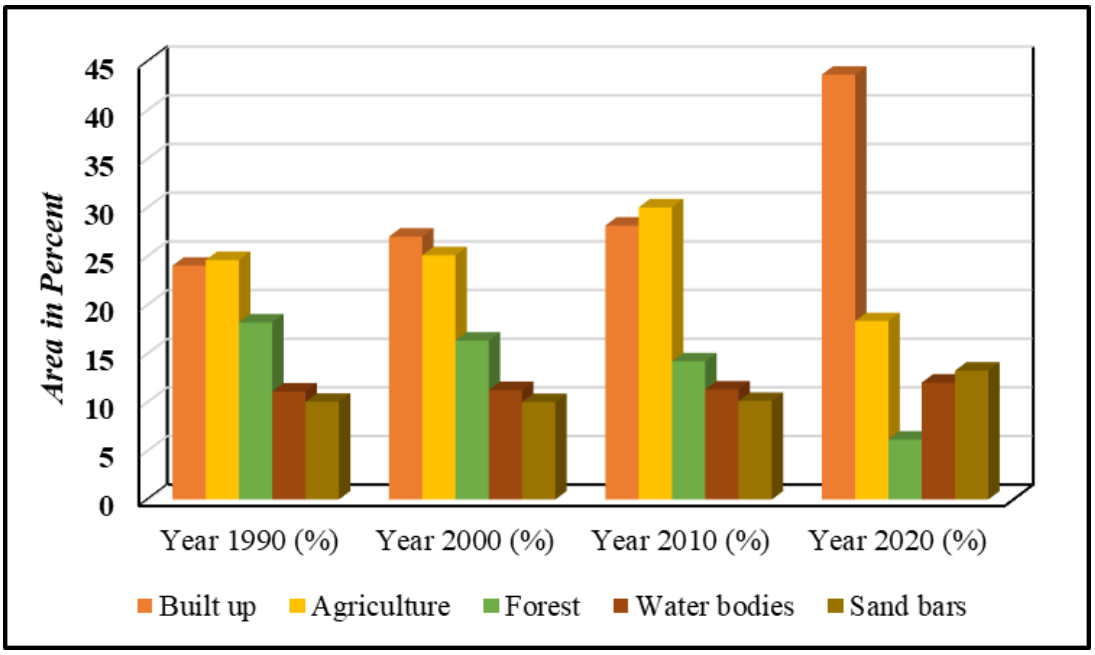
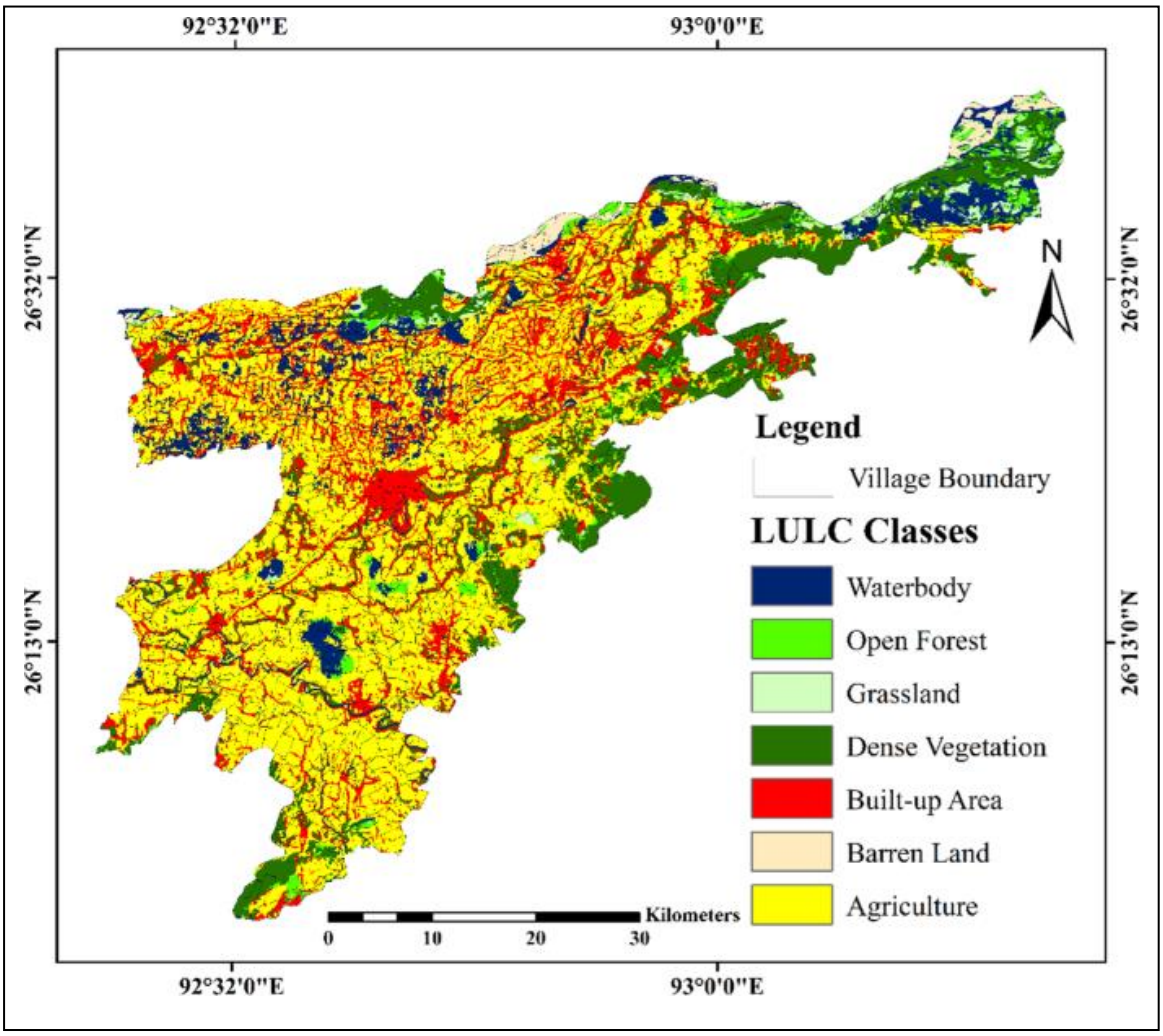


Figure 19: Changes in LULC in Nagaon District in % in respect to total geographical area

Figure 20: Land Use and Land Cover Map of the Nagaon district



5.1) Forest:

The forest cover area of Nagaon district in Assam is 20.7% of the district's total geographical area or 793 sq.km. The district has one National Park (Kaziranga National Park) and one Wildlife Sanctuary (Lowkhowa Wildlife Sanctuary).

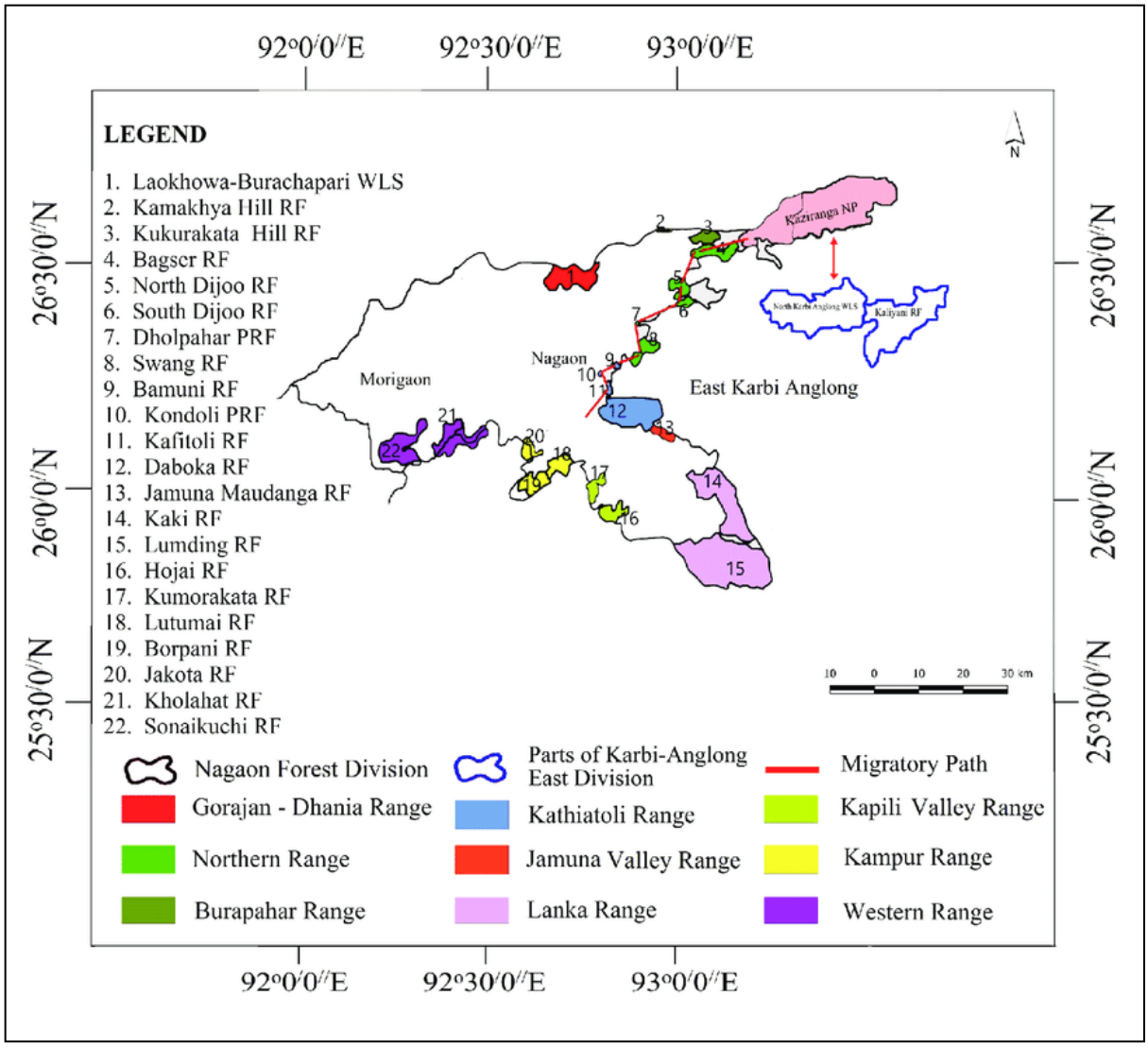
- ❖ Evergreen forests
- ❖ Dry Deciduous forests
- ❖ Tropical semievergreen forest
- ❖ Moist deciduous

Though a large part of Karbi Anglong District is covered with thick forest cover but the legal status of notified forest area is as under *(http://assam.gov.in/):*

Table No. 15: Forest distribution of Nagaon district

Geographical area	Very Dense Forest	Medium Dense Forest	Open Forest	Total area under forest cover	% of geographical area
3831 km²	40 km²	351 km²	402 km²	793 km²	20.7 %

Figure 21: Forest cover map of Nagaon district



5.2) Agriculture & Irrigation:

Nagaon district is primarily dependent on agriculture and forest products. Main source of income is paddy with surplus production. Rice, wheat, jute, maize, sugarcane are major crops of the district. The district has net and gross cropped areas of 2,17,805 hectares and 417218 hectares respectively, the net cropped area being 57 percent of the total geographical area. About 1,47,410 hectares (63.5%) out of the net cropped areas is put under multiple cropping with an average cropping intensity 192 percent as against 152.43 percent for the state. Besides rice, jute and sugarcane, mustard seed, vegetables etc. are other important agricultural products of the area. Dhing town is surrounded by a fertile area of land which produces jute, rice and mustard seeds abundantly.

Table No 16: Net irrigated area for the blocks of Nagaon

BLOCK	NET IRRIGATED (HA)
Bajiagaon	4054
Barhampur	2958
Batadraba	6569
Dulongghat	1207
Juria	6969
Kaliabor	5012
Kathiatoli	9680
Kathiatoli	4945
Khagarijan	2500
Laokhowa	4945
Pachim Kaliabor	3529
Raha	10786

5.3 Plantation & Horticulture:

The topography, agro-climatic conditions, prevalence of fertile soil and long tradition of growing plantation and horticulture crops have enabled commercial cultivation of several crop varieties. The major agricultural crops grown in the district are paddy, potato, mustard, jute, sugarcane, wheat and other vegetables. Besides these crops, the district produces various types of horticultural fruits like banana, papaya, litchi, pineapple, lemon etc. and other plantation crops such as coconut, areca nut etc. Tea cultivation is also done mostly in the organized sector. Sericulture is also an important activity practiced widely in the district. It is an important source of supplementary income and employment particularly to the rural womenfolk. The craft is mostly practiced in the tribal areas. Eri is most extensively raised in the district followed by Mulberry.

Horticulture could be one of the strongest features of the economy of Nagaon district because of its congenial agro-climatic and soil conditions. The district has definite advantages in producing potato, banana, chillies, areca nut, coconut etc. Bamboo, a large species of grass, grows abundantly in all parts of the district. It is an excellent substitute for timber in house building and for innumerable other purposes including handicraft industries. Presently a large quantity of bamboo grown in the district is consumed by

Hindustan Paper Corporation Limited as one of the major raw materials. Banana, pineapple, citrus are the major fruit crops grown in the district. In addition, other crops grown are guava,

mango, mandarin and oranges. Though most of these fruits are produced since time immemorial, the productivity levels are very low due to lack of scientific approach in their cultivation.

5.4 Mining:

Major minerals of the district are granite, quartz. Minor minerals as railway ballast, road metal, sand and brick clays are found in this district. The granites and gneisses near Jagiroad are being quarried for railway ballast and road metal. Granites and gneisses are also being quarried in many other parts of the district. The clay found extensively in the alluvial tract of the district is quite suitable for the manufacture of bricks and earthenware.

The main rocks that underlie the Nagaon district in Assam are granites and gneisses from the Precambrian age, and rocks from the Barail and Surma series of the Tertiary age**.** The district has quartz and silica sand. The Jiajuri deposit in Nagaon district has been explored for friable quartzite, which is glass and sand.

CHAPTER 6: GEOLOGY AND MINERAL WEALTH

6.0 GEOLOGY

Regional Geology:

The overall geological set up of India is divided into three parts i.e., Extra-peninsula, Peninsula and Indo-Gangetic Plain. The Assam states is partially covered by Himalayan Mountain System as the thick sequence of marine rocks followed by freshwater rocks was deposited in Cenozoic times. Another part of this state is partially occupied by Indo-Gangetic plains.

The different types of rocks from different ages are found in Assam state belonging to

a) Proterozoic Gneissic Complex;

b) Meso-Palaeo Proterozoic Shillong Group;

c) Neo-Proterozoic Lower Palaeozoic Granite Plutons;

d) Permo-carboniferous Lower Gondwana sedimentary rocks.

e) Alkali Complexes of Samchampi, Borpung and volcanic rocks represented by Sylhet Trap of Cretaceous age,

f) Lower Tertiary (Paleocene-Eocene) shelf sediments of the Jaintia Group extending along the southern and eastern flanks of Mikir Hills and geo-synclinal sediments of the Disang Group in parts of the North Cachar Hills;

g) Upper Tertiary (Oligocene to Pliocene) shelf and volcanic rocks represented by the Cretaceous Sylhet Trap and geo-synclinal sediments covering the southern flanks of Mikir Hills, the North Cachar Hills and the hills of the Cachar district in the Surma valley area exposed in the northern foothills of Naga-Patkai range covering the southern margin of Sibsagar, Jorhat and Dibrugarh districts. The northern part of Assam is comprised with southern foothills of Eastern Himalaya forming a narrow strip.

h) The Quaternary deposits consisting of Older and Newer Alluvium present in flood plains and terraces of the Brahmaputra valley, Surma valley and other river basins of Assam.

The district is situated in Brahmaputra Valley of Assam. There are different types of rocks are present ranging from Palaeoproterozoic to Meghalayan. Assam- Meghalaya Gneissic Complex (AMGC) of Palaleo-proterozoic to Neo-proterozoic in age, forming the basement of the district. It is composed of unclassified gneiss, biotite gneiss, gneisses and granites. This is overlain by Shillong Group of rocks which is characterized by Quartzite with phyllitic interbands and conglomerate along with rhyolite porphyry and meta-tuff. These rock types are generally Palaeo to Meso Proterozoic in age. The rocks both AMGC and Shillong Group have been intruded by the dykes of dolerite and epidiorite of Khasi Mafic-Felsic intrusive from Palaeo to Mesoproterozoic in age. Granite Plutons (Mikir Hills, Nongpoh and Kyrdem) are consist of Grey to pink porphyritic granite and Pyroxene Granitoid. These rocks are belonging to Neoproterozoic to Early Palaeozoic in age. Major parts of the district are covered by quaternary sediments. These quaternary sediments are

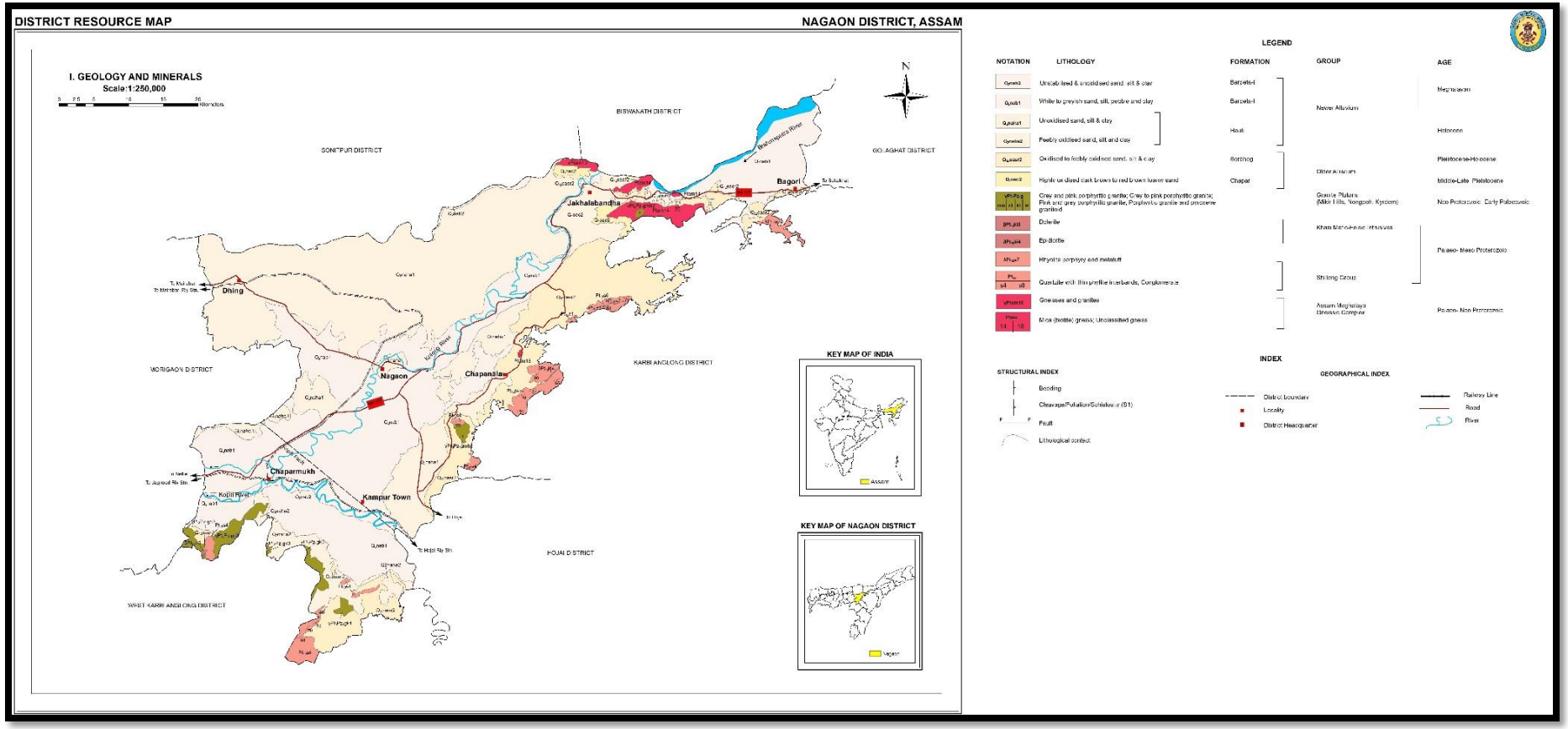
classified into two groups i.e., Older and Newer Alluvium. These Quaternary sediments are seperated from the rest of the Precambrian rocks by an unconformity. Older Alluvium is classified into two morpho-stratigraphic units i.e., Chapar and Sorbhog. Chapar Formation is composed of highly oxidized dark brown to red brown loamy sand. Sorbhog Formation is characterized by highly oxidized brownish grey to greyish sand, silty clay with occasional pebbles and cobbles. Newer Alluvium Group is classified into e.g., Haul (Nagaon), Barpete I and Barpete II. The oldest formation, Haul (Nagaon) forming the basement of quaternary sediments of Newer Alluvium. It is characterized by oxidized alternate sand and silt and also clay with carbonized wood and minor pebbles in flood plains. Barpeta-I comprises with white to greyish sand, silt, pebble and clay with carbonaceous matter. Barpeta- II contains with most recent sediments like unoxidized sand, silt, and clay with occasional pebbles along with carbonaceous matters.

Table 17: Stratigraphic succession of Nagaon District

AGE	GROUP	FORMATION	LITHOLOGY
Maghalayan	Newer Alluvium	Barpeta II (Sisimukh II)	Unoxidized & unstabilized sand, silt, clay with occasional pebbles and carbonaceous matters
Maghalayan		Barpeta I (Sisimukh I)	Unoxidized alternate well sorted fine to medium sand, silt and clay with carbonaceous matter
Holocene		Haul (Nagaon)	Oxidized alternate sand, silt, clay and clay with carbonized wood and minor pebbles
Pleistocene-Holocene	Older Alluvium	Sorbhog	Oxidized brownish grey to greyish sand, silty clay with occasional pebbles and cobbles
		Chapar	Highly oxidized dark brown to red brown loamy sand
-----Unconformity -----			
Neo Proterozoic-Early Palaeozoic	Granite Plutons (Mikir hills, Nongpoh, Kyrdem	--------	Grey to pink porphyritic granite and Pyroxene Granitoid.
Miocene-Pliocene	Khasi Mafic-felsic Intrusive	--------	Dolerite, Epidiorite
------Intrusive Contact------			
Palaeo-Meso Proterozoic	Shillong Group	--------	Quartzite with thin phyllite inter bands: conglomerate Rhyolite porphyry and meta tuff
------Unconformity------			
Palaeo-Neo Proterozoic	Assam Meghalaya Gneissic Complex	--------	Gneisses and granites; Mica (Biotite) gneiss, Unclassified gneiss

(Source: *GSI Miscellaneous Publication No. 30 Part IV Vol 2 (i) Assam. (2009)**)***

FIGURE 22: GEOLOGY AND MINERAL MAP OF THE DISTRICT



Local Geology (Based on Field Investigation):

The geology of Nagaon District encompasses the history of disposition of different types of litho-units in foreland facies condition of dispositional history. Geologically, the district comprises the Quaternary and Precambrian rocks. Precambrian rocks are mainly in Proterozoic Eon. The Precambrian rocks of Shillong Group are present. It includes amphibolite, phyllite, schist, grey white hard quartzite, feld spathic ferruginous quartzite, grey & white friable quartzite, with presence of conglomerates. The oldest rocks are Archean gneissic rocks which are forming the basement of the district. These rocks are pink to whitish granite gneiss and also granites. These igneous rocks occur as discordant bodies and forming boss like structure, intruding the central part of the gneissic rocks, creating inselberg. The quaternary sediments and recent deposit are layered again over these Precambrian rocks. This district is basically, from the point of view of geology, can be divided into three units:

- Denudation hills
- Pediment zones
- Valley areas

The relics of oldest Archaean landmass are representative of highly weathered condition having a rugged topography with vast pediment zones. Different structural features like foliation, gneissossity, cleavage, schistosity are also observed in these rocks. The drainage pattern of the studied area is the manifestation of the upper catchment of Kopili River, Kolong River. In the entire area, drainage pattern is dendritic to sub-parallel and totally is controlled by several of structural features and concealed lithology below the surface.

Following litho-units have been encountered from Nagaon District:

- Silt, Clay, Sand (Bimodal)
- Boulder, Cobble & Pebble intermingled with Silt & Clay
- Granite & Gneissic granite.

CHAPTER 7: MINERAL WEALTH

7.1 Overview of mineral resources:

Assam today is considered as "Mineral Paradise" having commercially exploitable major and minor minerals though there are reports of minerals and metals being used during early historic age, scientific mining and metallurgical industries in Assam started only after independence. During last 70 years, the mineral sector has grown here considerably. Rejecting all sorts of geological congregations and perturbations, it can be said that the economic progress of Assam is manifested in the form of retrogressive progress. In order to accelerate the economic growth exploitation of available mineral resources by developing mines with its full safety and establishment of target oriented and value added industries is an imperative. Development achieved, without jeopardizing the environment, in the mining and mineral beneficiation industries so far, availability of resources and existing trend would offer a glimpse of future, eradicating all types of schism in mineral economy, of mineral sector in the state of Assam.

Systematic investigation especially surface & subsurface mining in all the mineral & ore-bearing promising zones selectively will cater the light and then people will not be able to throw a volley of questions about the mineral wealth of Assam. A strong foundation in case of mining especially in Nagaon of Assam must give perspective and confidence. It is pertinent to say that the preparation of DSR of Nagaon is a laudable attempt. So, sustainable management of mineral resources is of immense importance & it is increasing at an exponential rate, therefore, sustainable management of mineral resources requires a long-term perspective so that these all last for the generations to come.

Sand, especially riverbed sand, is naturally occurring granular material composed of finely divided rock and mineral particles ranging between 0.0625 mm to 2 mm in diameter.

Basically, riverbed sands are produced due to weathering of rocks by mechanical forces. By a long-lasting process, the weathered rocks form gravel and further disintegrate to sand. Gravel occurs here as unconsolidated accumulations and consists of particles larger than sand (diameter >2 mm), that is granules, pebbles, cobbles, boulders or any other combinations of these.

7.2 Details of Resources:

MAJOR MINERALS

- **Limestone:** The deposit of limestone is generally occurred in northern portion of Cachar hills.
- **Sillimanite:** Recently, sillimanite containing schist in the Bamuni region of Nagaon district has been found to contain a significant concentration of sillimanite (10% to 15% of the mass).

MINOR MINERALS

The world scenario of reserve and production of river bed sand deposits indicate that although India stands among the top, from point of view, reserve, Assam is not also a solitary exception. The Nagaon district is amongst the last few in sand production. Sand production of Kopili, Borpani, Kolong and Jamuna rivers play a vital role.

- Riverbed sand and River bank sand deposits
- Ordinary earth and Brick earth material: Generally found in this district for manufacturing of the bricks.
- Granite & Quartzite: Pink granite, greyish white medium to coarse grained granite, ferruginous quartzite are also found in Nagaon. Muscovite, Mica flakes are also observed in this district. Quartzite is also observed in this district of smoky quartz and mica-infused quartz are also observed in this district.
- A friable quartzite (glass sand) deposit is located on an undulating plateau in the Jiajuri region of Nagaon District, Assam.

7.2.1 SAND AND OTHER RIVERBED MINERALS:

I. Drainage System

The drainage pattern of the studied area is the manifestation of the catchment of mainly Kopili River, Borpani River, Kolong, Jamuna, Brahmaputra. The drainage pattern is dendritic to sub-parallel and it is totally controlled by several of structural features and concealed lithology below the surface.

During the survey of the investigated area of Nagaon, it is noticed that a number of rivers and rivulets together with their streams of different orders drains the district. All the streams, rivulets and river courses vary depending on the topography and physiography of the area. The streams, rivulets and rivers follow the lowest elevation courses for which the drainage courses vary widely in the district. Generalised streams and river courses are in directions from W – SE in case of Kopili river. Kolong river is flowing NE- SW, forming the tributary of Brahmaputra River. Brahmaputra river is situated in the northern part of the district. The runoff water carries pebbles, cobbles and sand from upstreams and is deposited on river beds depending on the water flow rates. At places their banks are abrupt and broken into deep gullies.

Kopili River

Kopili is a south bank tributary of Brahmaputra which originates in the Borail Range Mountains in Meghalaya at an altitude of about 1600 m and has a total length of 290 km up to its confluence with Brahmaputra. Its basin is bound by the Jaintia Hills in the west and the South Cachar and Mikir Hills in the east. Kharkor, Myntriang, Dinar, Longsom, Amring, Umrong, Longku and Langkri are its major tributaries in its upper reaches. After entering Assam, the Kopili separates the Karbi Anglong district from the Dima Hasao North Cachar Hills district up to its confluence with Diyung River on its right at 135 km. After the confluence with Diyung, Kopili flows into the Nagaon district in a north-westerly direction. Coming down the hills it flows in a NW direction and meets the eastern tributary Jamuna at Jamunamukh further west of Nagaon district. It finally merges into Kalong near Jagiroad after a course of 262 Km (102 Km in Nagaon district). The Kopili basin comprises an area of about 1300 sq. Km and is rich in rice cultivation. Total length of this river in Nagaon District is about 88.6km.

Borpani River

Borpani River originates from Shillong hills of Meghalaya about 1300m in altitude and it enters into Karbi Anglong. It enters in Nagaon District from SE direction. Two power projects is situated on Borpani River in Assam i.e., 1. Karbi Langpi Hydro Electric Project (KLHEP) which is situated in Karbi Anglong District of Assam and 2. Karbi Langpi Middle-II Hydro-Power Project. It is situated in NagaonDistrict of 24MWw run-of river scheme. A Gravity and Masonary Dam is situated upon the Borpani river named Karbi Longpi Dam in Assam of about 197m in length and 35m in height. Total Length of Borpani River is about 34.6km in Nagaon District.

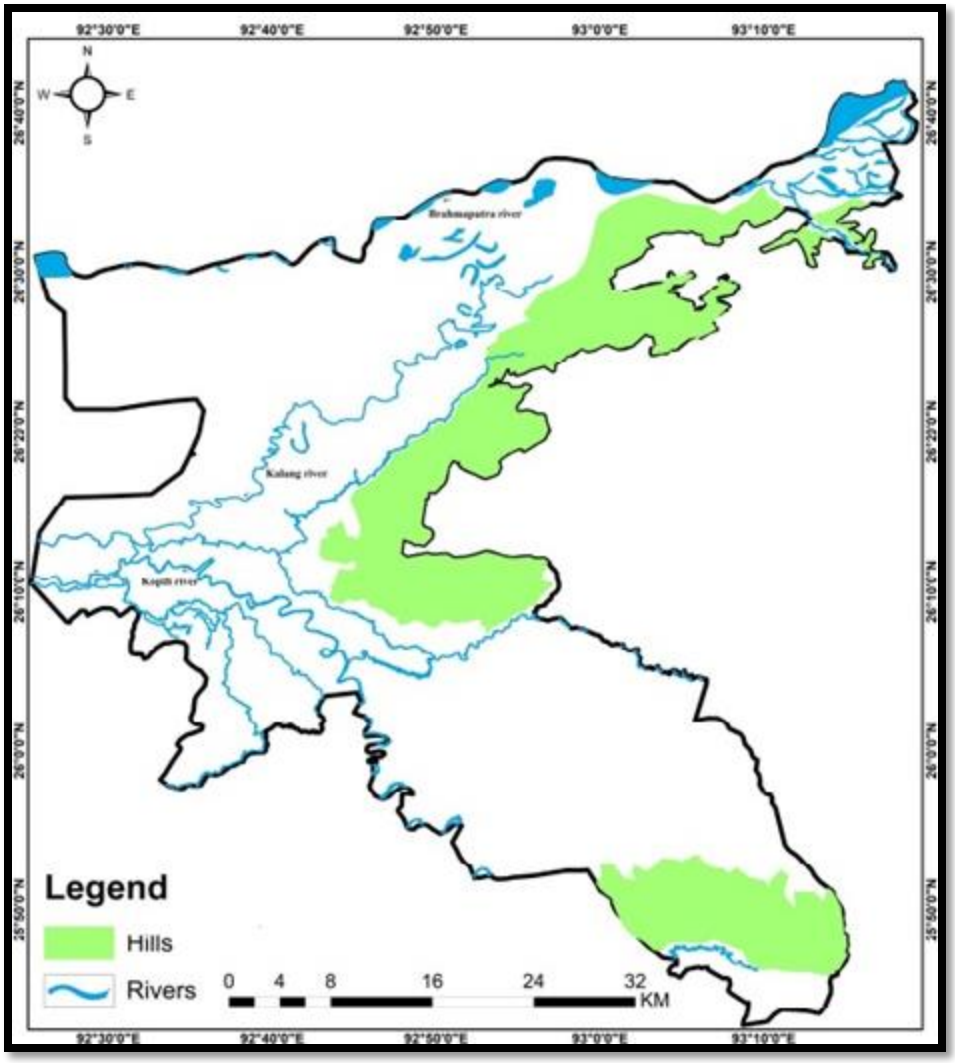
Kolong River

The river begins at Brahmaputra, around 13 km northeast of Silghat, and travels a meandering route across the district until returning to the parent river at Kajalimukh, roughly 24 km upstream of Guwahati. The Mikir Hills' northwest slopes are drained by the Diju and Missa Rivers, which join the Kalong in its upper levels.Many water coarses drain the area between Kalang and Brahmaputra, forming bils in the process. Kolong River is flowing. During a flood, the Kalong River plays a crucial role by providing water and completely burying the water courses. Total length of this river in this district is about 119km. The river meets streams like Diju, Missa and rivers like Killing, Kopili and Digaru along its course.

Jamuna River

The Jamuna is the main tributary of Kopili and originate from the Mikir hills. After flowing for about 120 Km from east to west, it falls in Kopili at Jamunamukh. This river runs in the eastern boundary of the district.

Figure 23: Drainage Map of Nagaon District



*(**Source:** Aquifer Mapping and Management of Ground Water Resources of Nagaon by CGWB)*

The common hydrological regime is defined by the tropical monsoon climate with alternating dry and wet seasons. Mid-June to mid-September is the rainy season in which 90 percent of the rainfall occurs. The spatiality of rain is also controlled by the orientation of the axis of monsoon trough. Naturally, the base flow is either little or almost lacking. The annual peak flow occurs during the highest monsoon downpour. So, the flood ability, transportability, competency and erosive power of the streams attain their maxima at that time. The network of channel is growing in a random fashion. All these aspects influence the rate of soil erosion in the district in a great way.

a) Drainage System with description of main rivers

Table 18: Drainage system with description of main rivers

Sl. No.	Name of the River	Area drained (sq.km.)	% area drained in the district
1.	Kopili	15	0.375
2.	Borpani	2.422	0.06
3.	Kolong	9.696	0.24

b) Salient Features of important rivers and streams

Table 19: Salient Features of important rivers and streams

Sl. No.	Name of the River/ Stream	Total length in the district (km)	Place of origin	Altitude at origin (m)
1.	Kopili	88.6	Borail Range Mountains in Meghalaya	1600m
2.	Borpani	34.6	Shillong plateau	1300m
3.	Kolong	121.2	Jakhalabandha, between the Kukurakata and Hatimura hills	90m

II. Annual deposition of riverbed minerals

Annual deposition of riverbed minerals is dependent on various factors which are explained below.

A) Geomorphological studies

Geomorphological characteristic of a river is foremost factor for annual deposition of sedimentary load. The study includes following parameter:

i) Place of Origin

Details of origin of rivers of Nagaon District are furnished in Table.

Table 20: Place of Origin of important rivers and streams

Sl. No.	Name of the River or Stream	Place of Origin
1	Kopili	Borail Range Mountains in Meghalaya
2	Borpani	Shillong plateau
3	Kolong	Jakhalabandha, between the Kukurakata and Hatimura hills

ii) Catchment Area

The Nagaon district of Assam is mainly drained by the Kopili River, Borpani River, Kolong River which are forming the main catchment area.

Table 21: Catchment areas of main rivers of Nagaon district, Assam

Sl. No.	Name of the River or Stream	Catchment Area (sq. km.)
1	Kopili	15
2	Borpani	2.422
3	Kolong	9.696

iii) General profile of river stream

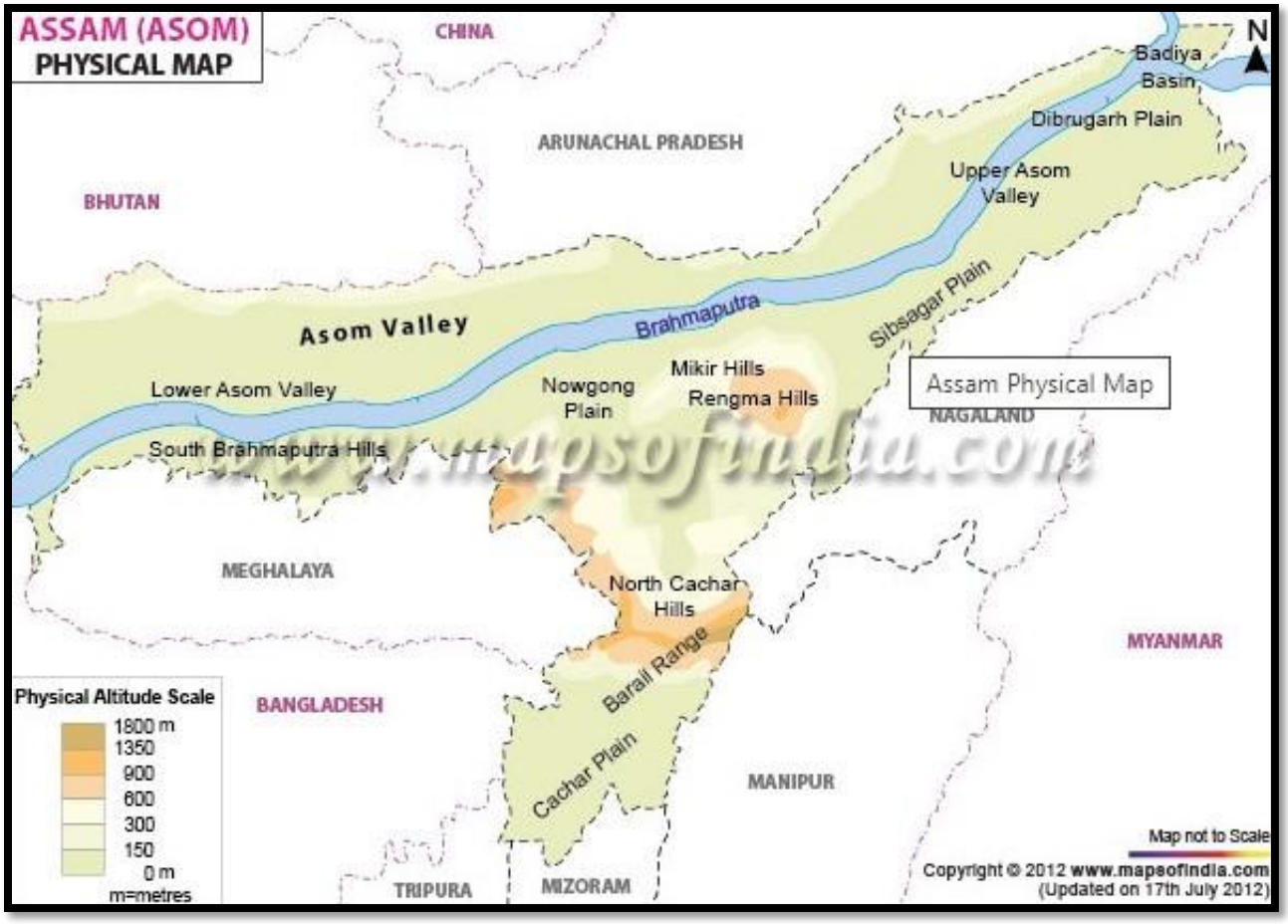
If rivers are always straight i.e., if rivers follow straight course the meaning of slope becomes value less, but if the river is curvy and follows a sinusoidal pattern (as is usually the case, at least to some extent), then we have to measure the horizontal distance along the sinuous projection of the course of the river on a horizontal plane. The slope can be measured in feet per mile or some metric units like meters per kilometers. Recalling some trigonometry, we might recognize the tangent of a slope angle although measuring the slope of a river is not an easy matter. The slope of the rivers of the district, in this case, has been measured following the method of Digital Elevation Model (DEM).

To reach the targeted approach, here contour lines are digitized from topographic map using a scale of 1:8000; from this map few contours are also digitized in flat areas. Spot heights are also digitized. From this height data, contour interpolation is completed in ArcGIS approach. This slope

map is exported to ERDAS for further processing. The slope map is classified to 0-15 degree or more than 15 degree.

The longitudinal profile and the cross-sectional profile of the streams or rivers is provided in **Annexure IX**.

Figure 24: Altitude Map of the Nagaon district, Assam



iv) Annual deposition Factor

Rivers are important geological agents for erosion, transportation and deposition. Deposition and erosion in river valleys can strongly modulate the downstream delivery of sediment (Fan and Cai, 2005; Malmon et al., 2005). A riverine sediment budget provides an effective conceptual framework within which to quantify sediment mobility, transport, deposition, and storage within a drain-age basin, as well as sediment output from the basin (Walling et al., 2002). It is therefore critical to understand this modulation effect (Walling and Horowitz, 2005). Annual deposition of riverbed materials depends on various factors which are as follows:

Geological erosion and soil erosion are the two basic terms used to describe erosion processes. Geological erosion refers to regular or natural erosion brought on by long-term geological processes that wear down mountains and produce floodplains, coastal plains, and other landforms to develop. Soil erosion happens gradually or at an alarming rate, but it is a continual process. It leads to various negative effects, including ongoing topsoil erosion, ecological harm, soil collapse, and many more.

The soil fragments are loosening or being washed away in the valleys, oceans, rivers, streams, or far-off regions throughout this process. Human activities like agriculture and deforestation have contributed to this situation getting worse.

Fluvial erosion is the direct removal of soil particles by moving water. The force of the flowing water and the resistance of the bank material to erosion both affect the pace of fluvial erosion.

1. Process of deposition

After erosion, the eroded materials get transported with running water. When the river losses its energy and velocity falls, the eroded material is deposited. A river can lose its energy when rainfall reduces, evaporation increases, friction close to river banks and when enters a shallow area (flood plain) or towards its mouth where it meets another body of water. Hjulström curve showing the relationship between particle size and the tendency to be eroded, transported or deposited at different current velocities.

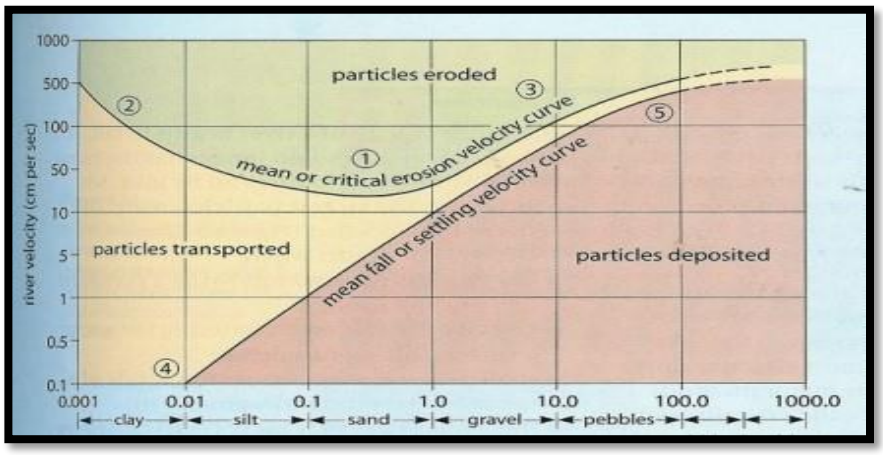


Figure 25: HJULSTRÖM CURVE

***(Source:** Sediment Petrology, Pettijohn)*

In this diagram, X-axis indicates the grain size in mm and Y-axis indicates the flow velocity of the river in cm. s^{-1}. The lower line of the diagram shows the relationship between flow velocity and particles in motion, with pebbles at 20-30 cm. s^{-1}, medium sand grains at 2-3 cm.s^{-1}, and clay particles at 0 cm s^{-1}. The grain size of particles can indicate the velocity at the time of sediment deposition. The upper line shows the flow velocity required to move a particle from rest, with smaller particles needing higher velocity to move them below coarse silt size due to the properties of clay minerals, which dominate the fine fraction in sediment. Clay minerals are cohesive and stick together, making it difficult to entrain them in a flow. The behavior of fine particles in a flow which has important consequences for deposition in natural depositional environments. Mud can accumulate in any setting where flow stops for long enough for clay particles to be deposited, and resumption of flow does not re-entrain the deposited clay unless the velocity is relatively high. Alterations of mud and sand deposition are seen in intermittent environments, such as tidal settings.

2. Mode of sediment transport in rivers

Sediment transport is the transportation of detrital particles via air, water, ice, or gravity. When transported by air and water (fluid transport), grains (which may be sand particles) travel as a bed load (by rolling, sliding, and saltation) or in suspension when the turbulence keeps the grains moving.

The amount and size of sediment moving through a river channel are determined by three fundamental controls: competence, capacity and sediment supply.

The sediment load of a river is transported in various ways although these distinctions are to some extent arbitrary and not always very practical in the sense that not all of the components can be separated in practice:

i. Dissolved load
ii. Suspended load
iii. Saltation load
iv. Wash load
v. Bed load

i. DISSOLVED LOAD: The amount of sediment carried in solution by a stream's total sediment load, particularly ions from chemical weathering, is known as the dissolved load. Along with suspended load and bed load, it makes up a significant portion of the overall number of debris removed from a river's drainage basin.

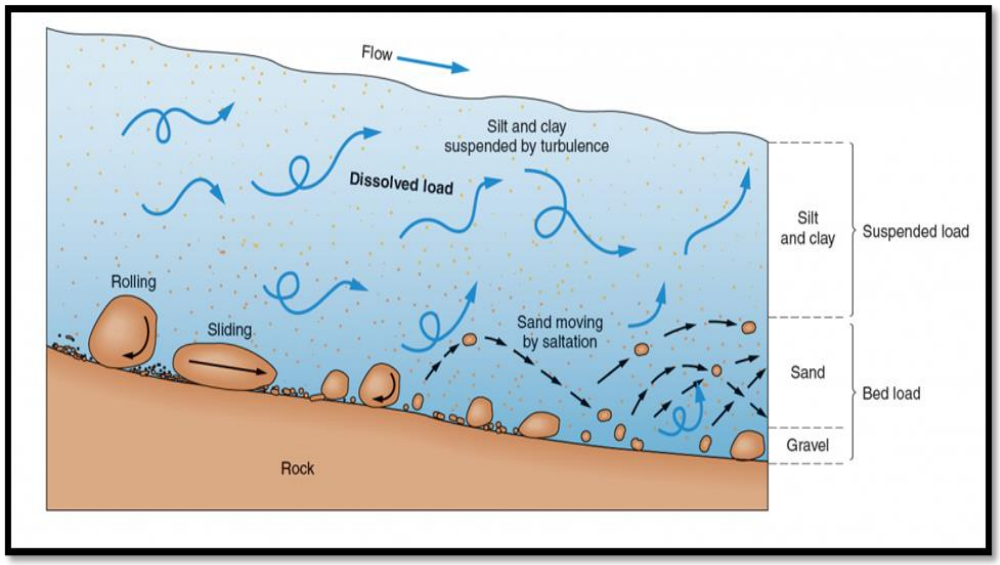
ii. SUSPENDED LOAD: The term "suspended load" describes the portion of the total sediment transport that is kept suspended by turbulence in the flowing water for extended periods of time without contact with the stream bottom. Sometimes the particles may float on the surface of the water and thus become the part of the fluid mass. The duration of a particle's suspension is determined by the intensity of turbulence and velocity of the river-flow. It is nearly moving at the same speed as the flowing water.

iii. SALTATION LOAD: The portion of the bed load that is moving, either directly or indirectly, as a result of the impact of bouncing, i.e., the intermittent jumping motion of the particles due to presence of eddies, along the stream bed. The smaller particles show higher lift and longer jump.

iv. WASH LOAD: Particle sizes smaller than those found in substantial amounts in the bed material make up that portion of the suspended load. It is conveyed through the stream without deposition since it is in almost permanent suspension. The discharge of the wash load through a reach is determined solely by the rate at which these particles become available in the catchment area, not by the flow's transport capacity.

v. BED LOAD: Particles that are too large to be carried as suspended load are bumped and pushed along the stream bed as bed load. The larger particles move close to the surface floor by rolling or sliding and occasional low leap. Bed load sediments do not move continuously. Streams with high velocity and steep gradients do a great deal of down cutting into the stream bed, which is primarily accomplished by movement of particles that make up the bed load.

Figure 26: Mode of Sediment Transport in Rivers



***(Source:**https://www.bgs.ac.uk/discovering-geology/geological-processes/deposition/#:~:text=Deposition%20is%20the%20laying%20down,sea%20shells)%20or%20by%20evaporation.(British Geological Survey))*

3. Sediment Transport Rate

The rate at which sediment is moved past a cross section of the flow is called either the sediment transport rate or the sediment discharge. It is related to the sediment load, but it‘s different, just because different fractions of the sediment load are transported at different rates. It can be measured in mass per unit time, or in weight per unit time, or in volume per unit time. The sediment transport rate is commonly denoted by Qs.

4. Estimation of Sedimentation

There are two approaches to obtaining values describing sediment loads in streams. One is based on direct measurement of the quantities of interest, and the other on relations developed between hydraulic parameters and sediment transport potential.

The total bed material load is equal to the sum of the bedload and the bed material part of the suspended load; in terms of volume transport per unit width, qt = qb + qs. Here wash load, i.e. that part of the suspended load that is too fine to be contained in measurable quantities in the river bed, is excluded from qs.

There are number of equations to compute the total sediment load. Most of these equations have some theoretical and empirical bases.

In 1973, Ackers and White developed a general theory for sediment transport which was calibrated against the flume-transport data then available. Their functions have been widely accepted as one of the best available procedures for estimating the total bed load over the full width of the flow section.

Dendy Bolton formula is often used to calculate the sedimentation yield. But use of these equations to predict sediment yield for a specific location would be unwise because of the wide variability

caused by local factors not considered in the equations development. However, they may provide a quick, rough approximation of mean sediment yields on a regional basis. Computed sediment yields normally would be low for highly erosive areas and high for well stabilized drainage basins with high plant density because the equations are derived from average values. The equations express the general relationships between sediment yield, runoff, and drainage area.

5. Sediment Yield

The water that reaches a stream and its tributaries carries sediment eroded from the entire area drained by it. The total amount of erosional debris exported from such a drainage basin is its sediment load or sediment discharge and the sediment yield is the sediment discharge divided by the total drainage area of the river upstream of the cross section at which the sediment discharge is measured or estimated. Sediment yield is generally expressed as a volume or weight per unit area of drainage basin—e.g., as tons per square kilometre. Further, sediment yield is usually measured during a period of years, and the results are thus expressed as an annual average.

v) Replenishment Study (As per EMGSM guidelines, 2020):

Replenishment defines rejuvenation of riverbed sand deposition phenomena. The word replenishment is the fulcrum of riverbed sedimentation under different depositional environmental conditions especially during rainy seasons. The rate of gross or absolute silt production (erosion) in the watershed and the ability of the stream system to transport the eroded material in a river have a direct relation with the quantity of sediment delivered into a river. The rate of gross erosion is dependent upon many physical factors like climatic conditions, nature of soil, and slope of the area, topography and land use. Hydro-physical conditions of the watershed govern the capability of transporting the eroded material. It has been observed that the average rate of sediment production decreases as the size of drainage area increases. And also, larger the watershed, the lesser is the variation between the rates. The larger watershed presents more opportunity for deposition of silt during its traverse from the point of production. The watershed with maximum land use class of forest, generate very low rate of production unless the forests are degraded or open forest. The cultivated watersheds with unscientific farming produce very high rate of silt production. The total amount of eroded material, which reaches a particular hydraulic control point, is termed as sediment yield. The rotational mining is being adopted to facilitate the replenishment of the excavated pits during rainy season. Thus, the mineable area is to be divided in two blocks i.e., the upstream block and the downstream block. The mining of these blocks is suggested on rotation basis in such a way that pit of previous year mining will act as depository for the monsoon season. Sand is extracted from the said lot during one year; more than the extracted quantity of the same are automatically replenished by rainfall in the monsoon by the river/nallah itself on account of its flow and velocity.

For sustainability of river sand mining, it is necessary that the mine pits formed as a result of sand excavation are refilled with sand by natural process of replenishment in a reasonable period of time so that the area is again available for mining. The rate of excavation should be decided in accordance with the rate of replenishment which is the rate at which sand/gravel is deposited on the river flood plain by the river during monsoon season. However, determination of site- specific rate of replenishment is quite difficult as it is dependent on several factors such as geology and topography of the catchment area of the river, breadth of the flood plain, rainfall in that particular year (which is quite variable and not very much predictable much in advance) etc. Dandy-Bolton formula is generally used to calculate the sediment yield. But it is to be kept in mind that to prepare the mining

plans of the mines, the factor of annual replenishment is to be taken into consideration while calculating the mineral reserves. It has also been observed that during flooding, all the pits replenish with sand. Hence, mined out areas in the pre- monsoon season will be completely replenished with sand during monsoon. Therefore, it has been assumed that the pits will be replenished after each monsoon.

Base Flow is influenced by incoming groundwater to aquifers and is closely related to watershed characteristics. Understanding baseflow characteristics is of great importance to river ecosystems and water management. Baseflow is the portion of stream flow that is delayed subsurface flow and generally maintained by groundwater discharge. Regardless of the specific climatic environment, its main features are tightly related to geological catchment properties. Understanding the baseflow process is important to deal with various water resource issues, such as water resources management strategies, low flow conditions assessment, hydrological modeling calibration, and water quality studies. However, no direct approach exists for continuously measuring the variability of streamflow recession under different conditions and the corresponding baseflow, because the baseflow is usually affected by diverse climatological and geological factors, with considerable variations in spatio-temporal watershed characteristics (e.g., geology, land use, soil type, etc.) and climatic conditions influence baseflow discharge to streams. Addressing such processes requires quantitative estimates of baseflow discharge across a gradient of watershed types. The development of quantitative methods for baseflow estimation is also necessary to understand water budgets (Stewart et al., 2007), estimate groundwater discharge (Arnold and Allen, 1999) and associated effects on stream temperature (Hill et al., 2013), and address questions of the vulnerability and response of the water cycle to natural and human-induced change in environmental conditions, such as stream vulnerability to legacy nutrients (Tesoriero et al., 2013). Given the importance of baseflow, many methods have been used to quantify the baseflow component of stream discharge beginning with Boussinesq (1877). Approaches for baseflow estimation can be grouped into two general categories: graphical hydrograph separation (GHS) methods, which rely on stream discharge data alone, and tracer mass balance (MB) methods, which rely on chemical constituents in the stream, stream discharge, and the streamflow end-member constituent concentrations (runoff and baseflow). Many different approaches for GHS exist, including recession curve methods and digital filter methods. Recession curve methods are generally considered more objective than digital filter methods because they provide an assumed integrated signal of basin hydrologic and geologic characteristics through identification of a linear recession constant based on the falling limb of the hydrograph (Barnes, 1939; Hall, 1968; Gardner et al., 2010).

However, in context of the rivers of district, the volume (weight) of the precipitated sand has been derived during Pre-monsoon and Post-monsoon period along with the thickness of the sand layers deposited in the respective periods. But, to erect hydrograph model which is essential for estimation of depth of base flow, data on daily discharge of water volume (weight) is required. Hence, it can be proposed that if these data are provided from the concerned authority of the state government (secondary data- already requested for providence), depth of base flow as well as the hydrograph model can be estimated. The quantitative estimation of the depth of base flow cannot be done due to absence of data. But a relative comparison between the mining depth and depth of baseflow has been done on the basis of collected data by making pit on the river bed.

Usually, replenishment or sediment deposition / depletion quantities can be estimated in the following ways:

- Direct measurement of the sand bar upliftment;
- Monitoring of the new sand bars created in the monsoons within the channel;
- Elimination of sand bars during the monsoon etc.;

With systematic data acquisition over a period of several years, regression equations can be developed for modeling of the sediment yield and annual replenishment with variable components.

Several theoretical and empirical formulae can be used for the calculation of catchment runoff and sedimentation loads as thumb rules. Sedimentation in riverbeds depends on catchment areas / characteristics, peak flood of the river. Some of the common empirical formulae used for rough estimation of the Catchment runoffs, Peak Discharge, Bed load transportation and sediment yields for replenishment studies are as under:

- **COMMON METHODS FOR REPLENISHMENT:**

❖ List of instruments: DGPS, GPS and Hammer.

❖ List of software: ARC GIS, Google Earth, Microsoft and Google Maps.

- **CATCHMENT YIELD CALCULATION**

The total quantity of surface water that can be expected in a given period from a stream at the outlet of its catchment is known as yield of the catchment in that period. The annual yield from a catchment is the end product of various processes such as precipitation, infiltration and evapotranspiration operating on the catchment. Catchment Yield can be estimated using following formula:

Catchment Yield (m3) =Catchment area (m2) * Runoff coefficient (%) *Rainfall (mts/annum)

The runoff generated from a watershed is estimated using Strange's Tables Method to get obtain approximate yield results. Runoff from a catchment is dependent upon annual rainfall as well as catchment area and characteristics such as soil types and the type of groundcover / land usage. Remote sensing is used for demarcation of catchment boundaries and computation of catchment area relevant to the drainage system. Strange's table is used to determine the Runoff coefficient of the catchment.

- **PEAK FLOOD DISCHARGE CALCULATION**

The term "peak discharge" stands for the highest concentration of runoff from the basin area. The accurate estimation of flood discharge remains one of the major challenges as it depends upon physical characteristics of the catchment area and the flood intensity, duration and distribution pattern. There have been many different approaches for determining the peak runoff from an area. As a result, many different models (equations) for peak discharge estimation have been developed. Formulae used for Peak Discharge calculation are as below:

i. As per Dicken's formula, Q = CA3/4

Where: **Q** is Maximum flood discharge (m3/sec); A is Area of catchment in Sq. Km and **C** is Constant whose value varies widely between 2.8 to 5.6 for catchments in plains and 14 to 28 for catchments in hills

ii. As per Jarvis formula, $Q = CA^{1/2}$

Where: **Q** is Maximum flood discharge (m3/sec); A is Area of catchment in Sq. Km and **C** is Constant whose value varies between 1.77 as minimum and 177 as maximum. Limiting or 100 percent chance floods are given by the value of C of 177.

iii. As per Rational formula, Q = CIA

Where: **Q** is Maximum flood discharge (m3/sec); A is Area of catchment in Sq. Km and **C** is the Runoff coefficient (ratio of runoff to total rainfall) which depends on the characteristics of the catchment area.

I is Intensity of rainfall (in m/sec).

- **BED LOAD TRANSPORT CALCULATION**

The most difficult problem in river engineering is to accurately predict bed load transport rates in torrential floods flowing from mountainous streams. Three modes of transport namely; rolling, sliding and saltation may occur simultaneously in bed load transport. The different modes of transportation are closely related, and it is difficult, if not impossible, to separate them completely. There are a number of equations to compute the total sediment load. Most of these equations have some theoretical and empirical bases.

i. Ackers and White Equation:

Ackers and White (1973) used dimensional analysis based on flow power concept and their proposed formula is as follows.

C**t =** C**s** G**s (d50/h) (**V**/U*)** n' **[(**Fgr**/A1) − 1]** m

The dimensionless particle dgr is calculated by:

Dgr = d50 (g(Gs-1)/v2)1/3

The particle mobility factor Fgr is calculated by:

Fgr = (U*n'/(Gs-1) g d50)1/2 * (V/ (5.66log (10h/ d50))1-n'

Where,

A1 = Critical particle mobility factor

Cs = Concentration coefficient in the sediment transport function

Ct = Total sediment concentration

d50= Median grain size

dgr= Dimensionless particle diameter

Fgr= Particle mobility parameter

g= Acceleration of gravity

Ds, Sg = Specific gravity

h= Water depth

m= Exponent in the sediment transport function

n'= Manning roughness coefficient

U= Shear velocity

V= Mean flow velocity

v= Kinematic viscosity

ii. Meyer – Peter's equation:

Meyer-Peter's equation is based on experimental work carried out at Federal Institute of Technology, Zurich. Mayer-Peter gave a dimensionless equation based, for the first time, on rational laws. Mayer- Peter equations giving an empirical correlation of bed load transport rates in flumes and natural rivers. The simplified Meyer-Peter's equation is given below:

gb = 0.417[τ0 (η'/ η)1.5 - τc]1.5

Where,

gb = Rate of bed load transport (by weight) in N per m width of channel per second. η'= Manning's coefficient pertaining to grain size on an unrippled bed and Strickler formula i.e., η'= (1/24) x d1/6 where d is the median size (d50) of the bed sediment in m.

η = the actual observed value of the rugosity coefficient on rippled channels. Its value is generally taken as 0.020 for discharges of more than 11cumecs, and 0.0225 for lower discharges.

τc = Critical shear stress required to move the grain in N/m2 and given by equation τc = 0.687da, where dais mean or average size of the sediment in mm. This arithmetic average size is usually found to vary between d50 and d60.

τ0= Unit tractive force produced by flowing water i.e., γwRS. Truly speaking, its value should be taken as the unit tractive force produced by the flowing water on bed = 0.97γwRS. R is the hydraulic mean depth of the channel (depth of flow for wider channel) and S is the bed slope.

- **SEDIMENT YEILD ESTIMATION**

Sedimentation occurs as the stream velocity decreases thus reducing its ability to carry sediment. Coarse sediments deposit first, which may then interfere with the channel conveyance and may cause rivers to meander and form distributaries. As the area of the flowing water increases, the depth decreases, the velocity is reduced, and eventually even fine sediments begin to get deposited.

As a result, deltas may be formed in the upper portion of reservoirs. The deposited material may later be moved to deeper portions of the reservoir by hydraulic processes within the water body.

There are many sediment transport equations which are suitable for use in the prediction of the rate of replenishment of rivers. Some of the common equations used to estimate sediment yields are:

- Dandy – Bolton Equation
- Modified Universal Soil Loss Equation (MUSLE) developed by Williams and Berndt (1977)

Dandy – Bolton Equation:

The formula uses catchment area and mean annual runoff as the key variables. It does not differentiate between the characteristics of basins and streams.

Dandy and Bolton equation estimates all types of sediment yield *i.e.*, through Sheet and rill Erosion, gully Erosion, Channel Bed and bank erosion and mass movement etc. Dandy- Bolton determined the combined influence of runoff and drainage area to compute the sediment yield. They developed two equations *i.e.*, for run off less than 2 inches and for run off more than 2 inches, which are given below:

For run off less than 2 inches:

(Q<2in) S=1289*(Q) 0.46*[1.43-0.26 Log (A)]

For run off more than 2 inches:

(Q > 2 in): S= 1958*(e -0.055*Q) *[1.43-0.26 Log (A)]

Where: S = Sediment yield (tons/sq miles/yr) Q = Mean Annual runoff (inch) A = Net drainage are in sq mile

Modified Universal Soil Loss Equation (MUSLE):

Modified universal soil loss equation (MUSLE) for estimation of sediment yield is also used widely. MUSLE is a modification of the Universal Soil Loss Equation (USLE). USLE is an estimate of sheet and rill soil movement down a uniform slope using rain- fall energy as the erosive force acting on the soil (Wischmeier and Smith 1978). Depending on soil characteristics (texture, structure, organic matter, and permeability), some soils erode easily while others are inherently more resistant to the erosive action of rain- fall.

MUSLE is similar to USLE except for the energy component. USLE depends strictly upon rainfall as the source of erosive energy. MUSLE uses storm-based runoff volumes (weight) and runoff peak flows to simulate erosion and sediment yield (Williams 1995). The use of runoff variables rather than rainfall erosivity as the driving force enables MUSLE to estimate sediment yields for individual storm events. The generalized formula of MUSLE is as below:

Y=11.8*(Q*qP).56 *K*Ls*C*P

Where,

Y = sediment yield of stream (t/yr/km2),

Q = average annual runoff (m3),

K = soil erodibility factor,

qP = Highest discharge recorded (m3/s),

Ls = gradient/slope length,

C = cover management factor,

P = erosion control practice.

A. REPLENISHMENT STUDY BASED ON SATELLITE IMAGERY

To delineate replenishment percentage in the river bed of the district, below mentioned steps have been followed.

- **Satellite imagery studies**

Satellite imagery study involves demarcation of sand/ RBM zones on riverbed of the district. Both pre and post monsoon images need to be analyzed to established potential sand/ RBM zones.

- **Field data collation**

Field data collation was carried out during May- June for all the sand/ RBM zones on continuous basis for pre monsoon period and November – December for all the sand/ RBM zones on continuous basis for post monsoon period. In both the cases, relative elevation levels were captured through GPS/DGPS/ Electronic Total Station. Thickness of the sand/ RBM zones was measured through sectional profiles. The field survey for collect post-monsoon data has been conducted November-December time period in 2023 while preparing the District Survey Report of Nagaon district.

- **Selection of study profiles**

Study profiles are selected based on the occurrence of the sand / RBM zones in the channel profiles. Aerial extents of each of the profiles are mapped from satellite imageries. Frequency distribution did while selection of the ground truthing of the zones.

- **Data compilation:**

Following data were compiled for generation of this annual replenishment report:

- Elevation levels of the different sand/ RBM zones as measured at site.
- Extents of the sand/ RBM zones are measured from the pre monsoon satellite imageries.

- Sand/ RBM zones production data of the district.

All these data were compiled while estimation of the replenished sand/ RBM zones in the district.

- **Assessment of sediment load in the river:**

Assessment of sediment load in a river is subjective to study of the whole catchment area, weathering index of the various rock types which acts as a source of sediments in the specific river bed, rainfall data over a period not less than 20 years, and finally the detail monitoring of the river bed upliftment with time axis. Again, the sediment load estimation is not a dependent variable of the imaginary district boundary, but it largely depends upon the aerial extents of the catchment areas, which crossed the district and state boundaries.

- **METHODOLOGY FOR CALCULATING THE TOTAL POTENTIAL OF MINOR MINERAL IN THE RIVER BED ANNUAL DEPOSITION**

For estimating the reserve of River Bed Material [Sand/Gravel (Minor Mineral)], the following parameters were considered:

a) The volumes of the reserves are calculated on the basis of the established width, thickness and length of the deposit as per actual field data.

b) The tonnage of the reserve quantity is obtained by multiplying the above volume with the bulk density of mineral to arrive at tonnes per cum (as per lab report).

c) The depth of the reserves has been estimated considering the available deposit thickness and the water level/red line.

The same procedure shall be followed for acquiring post monsoon data, its reserve estimation and then correlating between pre and post monsoon volumes as per table given below:

Table 22: Estimation of Sand/ RBM zones Reserves in Pre & Post Monsoon periods in sand/ RBM zones

Estimation of Sand Reserves in Pre & Post Monsoon periods in sand bars										
Sl. NO.	**Deposit zone code**	**Area in Sq. m.**	**Ave. Thickness (m)**	**Quantity (CUM)**	**Sl. NO.**	**Deposit zone code**	**Area in Sq. m.**	**Ave. Thickness (m)**	**Quantity (CUM)**	**Difference (cum) 'YY'**
PRE-MONSOON					**POST-MONSOON**					
1					1					
This table would be added after post-monsoon survey										
Source: *Field Survey and DGPS data*										

Table 23: Sediment Load Comparison Pre & Post monsoon period for different rivers of Nagaon District

River Name	Pre-monsoon No of Ghats	Post-monsoon No of Ghats	Pre-monsoon Sediment Load (CUM)	Post-monsoon Sediment Load (CUM)	Difference (CUM) 'YY'	Percentage Variance (%) (Postmosoon - Premosoon / Postmonsoon *100)
Kopili River						
Borpani River						
This table would be added after post-monsoon survey						
Source: *Field Survey and DGPS data*						

B. Geological studies

i) Lithology of the catchment area

- **Kopili River:** Unoxidized and unstabilized sand and silt
- **Borpani:** grey to pink Granite, sand, silt, clay

ii) Tectonics and structural behavior of rocks

The collision between the Indian and Eurasian Plates in the northern side and the subduction of Indian plate underneath the Burma arc plate forming a triple junction which provides a favourable tectonic framework for intense seismic activity (Hazarika et al. 2011). According to Nandy (1980), Kopili fault source zone in North-east India is stretched about 300km long and 50km wide which surrounding the Kopili Lineaments. Using remote sensing technique, Nandy and Dasgupta (1986) identified several buried faults and lineaments, including Kopili. Subsequently, Nandy (2001) verified the active fault status of the Kopili lineament based on its significant seismic activity. This lineament intersects three key tectonic regions in the area: (i) the eastern Himalayan mountain range, (ii) the Arakan Yoma subduction zone, and (iii) the lower Assam valley. The eastern Himalayan mountain range is marked by the deep extension of the northern part of the Kopili fault. This fault lies within the area that sharply rises from the Brahmaputra plains and extends to the Tibetan plateau in the north. Moving from south to north, the Himalayan range can be divided into the Sub, Lesser, and Higher Himalaya. Each of these divisions is separated by intra-continental thrusts, including the Frontal Foot Hill Thrust (FHT) between the Brahmaputra plains and Sub-Himalaya Siwalik, the Main Boundary Thrust (MBT) which separates Sub Himalaya from the Lesser Himalaya, and the Main Central Thrust (MCT) between the Lesser and Higher Himalaya. Extensive research has provided evidence to support the extension of the Kopili fault beyond the MBT and MCT, as documented (Nandy and Dasgupta in 1986, Nandy in 2001, and Kayal et al. in 2010). The NW-SE oriented Mishmi hills, located east of the Kopili fault, are considered to be the extension of the hills in Myanmar and form a significant part of the Himalayan Syntaxis. Within the tectonic block of the Mishmi hills, there are NW-SE trending thrust/reverse faults such as the Mishmi thrust and Lohit thrust (Thakur and Jain, 1975). The Kopili fault in the southern region is believed to intersect the Naga-Disang thrust of the Arakan Yoma Subduction Zone which includes the Indo-Myanmar ranges (Arakan Yoma, Chin Hills, and Naga Hills), the Myanmar basin (Central low lands), and the eastern highlands of Shan Plateau (Bender, 1983). The Shillong plateau, located to the west of the Kopili fault, is believed to have shifted 300 km to the east along the Dauki fault, as documented by Evans in 1964. This plateau is an elongated horst block oriented in an east-west direction, elevated between 600 m to 1800 m above the plains of Bangladesh, as noted by Bilham and England in 2001, and is marked by closely spaced lines. The smooth, light-colored surface of the Shillong plateau displays a distinctive grid-like arrangement of straight rivers and streams, reflecting the presence of prominent lineaments that signify surface manifestations of joints and faults. The Mikir Hills massif exhibits similar geologic features and stratigraphy and is regarded as an extension of the Shillong plateau towards the east. These two blocks, the Mikir Hills massif and the Shillong plateau, share similar geological characteristics but are divided by the Kopili fault, which is a seismically active tectonic belt trending in the NW-SE direction.

C. Climate Factors

i) Intensity of rainfall

Rainfall and humidity are closely allied in terms of climatology. The district has a climate which is characterised by a highly humid atmosphere, abundant rain and general coolness. Therefore, heavy summer rainfall and high humidity affect the weather of Nagaon district. The area enjoys a sub-tropical climate with abundance of monsoonal rain. The rainfall is not uniform throughout the district. The average rainfall is about 1541 mm.

ii) Climate zone

The Nagaon district has sub-tropical tropical/ Equatorial humid climate as Assam lies in the regime of monsoon climate of the sub-tropical belt. So, people of Nagaon enjoy heavy summer rainfall, abundance of monsoonal rain, experiences winter drought, high humidity and relatively pleasant temperature throughout a year.

iii) Temperature variation

Average temperature of the district is around 35 °C (Max) and minimum of 5 °C. In summer weather becomes hot and humid with temperature range 24 °C to 34°C. The temperature ranges from 11 °C - 25°C degree in winter which begins from October and continues till February. *(**Source**: Aquifer Mapping and Management Plan of Nagaon District, Assam by CGWB, 2022-2023)*

Annual Deposition:

Annual deposition of riverbed minerals has been calculated on post-monsoon sand volume. The pre-monsoon sand volume of the river is the depleted resources and is replenished by the monsoon rainfall.

- **TOTAL POTENTIAL OF MINOR MINERAL IN THE RIVER BED ANNUAL DEPOSITION**

According to Sustainable Sand Mining Guidelines, 2016 and Enforcement & Monitoring guidelines, for Sand Mining, 2020 mining depth of the mining zones are 1 meter for hilly area.

The annual deposition of riverbed minerals is shown in the Table given below.

Table 24: Annual deposition

River Name	Zone	Type of Material	Quantity in CUM (as per YY)	60% of quantity in CUM
Kopili River				
Borpani River				
This Table would be added after post-monsoon survey				

1. Riverbed minerals zone area recommended for mineral concession in the above table has been calculated as per the Enforcement & Monitoring Guidelines for Sand Mining (EMGSM) 2020.

2. As per guidelines, mining depth has been restricted to 3 meters depth and distance from the bank is ¼th of river width and not be less than 7.5 meters.

3. Also, mining is prohibited up to a distance of 1 kilometer (1 km) from major bridges and highways on both sides, or five times (5x) of the span (x) of a bridge/public civil structure (including water intake points) on up-stream side and ten times (10x) the span of such bridge on down-stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.

4. Riverbed minerals zone deposits acting as potential sites for sand mining along with other aspects as mentioned above are illustrated in Satellite images in **Annexure VIII.**

III. Riverbed Mineral Potential

Process of disposition etc.:

Sand: Huge quantities of quality sands are found to occur in part of rivers. Smaller patches are also available locally in the other smaller rivers as well.

Table 25: Resources of Potential Riverbed Mineral

Boulder (Mcum)	Pebbles/Gravel (Mcum)	Sand/White sand (Mcum)	Total Mineable, Mineral Potential (Mcum)

DETAILS OF POTENTIAL SOURCES / SITES OF RIVER BED MATERIAL

Potential sensitive sites for mining near forests, protected areas, habitation, bridges etc., shall be avoided. For this, a sub-divisional committee may be formed which after the site visit shall decide its suitability for mining. The list of mining leases as per the recommendation of the Committee needs to be defined in the following format given in as **Annexure –V.**

The Sub-Divisional Committee shall make recommendations regarding the suitability of all potential mining sites and also record the reason for approving the specific mining leases on the basis of its field inspections. The details regarding cluster and contiguous cluster formation will be provided as in **Annexure-VI.**

No mining Zone

Mining of river bed materials is prohibited is some places on the river channel due to presence of notable landmarks like, sanctuary or national parks, forests, bridge/public civil structure or highways.

A definition of a protected area was established by IUCN in 1994, which is described as

"*An area of land and /or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.*"

As per the Enforcement & Monitoring Guidelines for Sand Mining (EMGSM) 2020 the restricted zone for mining is a distance from the bank is ¼th of river width and not be less than 7.5 meters. Also, there is a no mining zone up to a distance of 1 kilometre (1 km) from major bridges and highways on both sides, or five times (5x) of the span (x) of a bridge/public civil structure (including water intake points) on upstream side and ten times (10x) the span of such bridge on down-stream side, subjected to a minimum of 250 meters on the upstream side and 500 meters on the downstream side.

No mining zone has been marked for an area up to a width of 100 meters from the active edge of embankments. Also, the concave side of the river is marked as no mining zone, as mining is this area will affect the course of river in future and will erode the river bank.

Mining has a range of environmental consequences for protected areas, whether operations are undertaken within them or nearby. The types of impact may be listed as follows:

- Direct land take and loss of vegetation cover in the mined area and other parts directly affected by associated activities such as deposition of tailings, or consequences such as subsidence;
- Pollution affects, especially on water supplies, aggravated by accidents (e.g., to tailing dams);
- Impacts due to access associated with mining (roads, railways, pipelines, power lines etc.), which permit illegal hunting, habitat fragmentation and alien invasions;
- Secondary effects of human immigration in association with real or perceived livelihood opportunities (e.g., on water supplies, illegal hunting, harvesting of vegetation, alien invasions,

illegal land settlements);

- Impacts on other protected area values from noise and visual intrusion, arising from both mining and secondary activities, including transportation.

The 2020 guidelines for sand mining stress on protecting rivers and habitats of species including turtles and calls for such sensitive areas to be declared as no-mining zones. It also called for using the latest technology for surveillance of illegal mining as well as estimating minable reserves.

A United Nations Environment report has said that, led by China and India, the world is mining sand at unsustainable levels exceeding the replenishment rate and that can have far-reaching social and environmental implications. Unsustainable sand mining practices are rampant in India. Despite a set of guidelines in 2016 to curb the practice, illegal and unsustainable sand mining has continued to be common, spurring the Indian government to take another step toward enforcing rules. The environment ministry has now come out with, Enforcement & Monitoring Guidelines for Sand Mining 2020‟ to regulate sand mining and check illegal mining.

This comes four years after the Government's Sustainable Sand Management Guidelines 2016, which was unsuccessful in putting an end to rampant illegal sand mining across the country. The latest guidelines suggest the use of technologies like drones with night vision for surveillance of sand mining sites, steps to identify sources of sand, procedures for replenishment of sand, post environmental clearance monitoring of sand mining sites, a procedure for environmental audit of such areas and steps to control the instances of illegal mining.

Among these, the focus on monitoring of sand mines after environment clearance is considerable given that so far it has been an area where the performance of authorities, central or state, is considered very poor.

The need for the latest version of the guidelines was felt after illegal and unsustainable sand mining continued despite the 2016 guidelines and many court cases. Since 2016, the National Green Tribunal, in many of the cases, stressed on the need of regulating sand mining and passed several orders. The court in some cases even expressed concern over the death of officials who tried to stop illegal mining and noted that on the ground level, illegal mining is still going on. The guidelines are thus a result of many such orders by the NGT wherein the tribunal passed directions to control it.

The new guidelines also laid special emphasis on the protection of rivers and species from sand mining as it called for surveys for identifying the stretches with freshwater turtles or turtle nesting zones. "Similarly, stretches shall be identified for other species of significant importance to the river ecosystem. Such stretches with adequate buffer distance shall be declared as no-mining zone and no mining shall be permitted," the guidelines said.

It also called for a survey report in every district for identifying the sand bearing area but also the "mining and no mining zones" considering various environmental and social factors like the distance of the mining area from the protected area, forest, bridges, important structures and habitation. According to the Sand Mining Framework 2018 of the central Government's Ministry of Mines, in India, there is a shortage of sand in the country, similar to the situation in other developed and developing countries. It estimated that the demand of sand in the country is around 700 million tons (in the financial year 2017) and it is increasing at the rate of 6-7 percent annually even as the quantity

of natural generation of sand is static.

Due to uncertainties and inadequateness in supply, the selling rate of the material varies significantly leading to black marketing and illegal mining of the mineral. It noted that illegal and uncontrolled extraction of sand has an adverse environmental impact.

Protect the rivers from illegal sand mining

The main sources of sand in India are considered to be rivers (riverbed and flood plain), lakes and reservoirs, agricultural fields, coastal/marine sand and manufactured sand.

The guidelines focus on identifying sand mining sources, its quantification and feasibility for mining considering various environmental factors like proximity of protected area, wetlands, creeks, forest etc. and presence of important structures, places of archaeological importance, habitation, prohibited area etc.

To protect the rivers from illegal sand mining, the guidelines said that abandoned stream channels on the floodplains should be preferred rather than active channels and their deltas and floodplains.

CHAPTER 8: OVERVIEW OF THE MINING ACTIVITY IN THE DISTRICT

8.1 GENERAL OVERVIEW

To prepare the DSR of Nagaon district of Assam, geological studies along with structural studies in the quest from knowing more and more pertaining to tectonic set up of this regime, suitability for river bed sand mining and time of deposition of different types of minerals are also important. The common hydrological regime plays a pivotal role for deposition of sand and other minor minerals mainly pebbles, cobbles, gravel and boulder. Assam, from climatological aspect gives a best fit result for economic sand deposits. Here, brown sand is noticeable in the riverbed of Kopili River, Borpani Kolong River etc. The spatiality of rain is controlled here by the orientation of the axis of monsoon trough. River bed sand mining or sand mining adjacent to a river or stream has a direct impact on the physical characteristics of the stream such as channel geometry, bed elevation, substratum composition and stability, in-stream roughness of the bed, pro velocity, discharge capacity, sediment transport capacity, turbidity, temperature etc. Alteration or modification of the said attributes may cause hazardous impact on ecological equilibrium of riverine regime.

8.2 LIST OF THE EXISTING MINING LEASES OF THE DISTRICT (LOCATION, AREA, PERIOD FOR EACH MINOR MINERAL):

The existing Sand Mahals and stone quarries of the respective ranges in Nagaon District are attached in **ANNEXURE II.**

8.3 DETAILS OF PRODUCTION OF SAND AND OTHER MINERALS DURING LAST THREE YEARS:

- **Total Mineral production of Sand in the district of 2020-2023:**

Table 26: Production of the District for the year 2020-2021

Sl. No.	Name of the Mineral	Production (In CuM)
1	Sand	40832.28

Table 27: Production of the District for the year 2021-2022

Sl. No.	Name of the Mineral	Production (In CuM)
1	Sand	46473.3

Table 28: Production of the District for the year 2022-2023

Sl. No.	Name of the Mineral	Production (In CuM)
1	Sand	43785.71

- **Total Mineral production of In-situ Minerals (Minerals other than sand) in the district of 2020-2023:**

Table 29: Production of the District for the year 2020-2021

Sl. No.	Name of the Mineral	Production (In CuM)
1	Stone	25000

Table 30: Production of the District for the year 2021-2022

Sl. No.	Name of the Mineral	Production (In CuM)
1	Stone	20000

Table 31: Production of the District for the year 2022-23

Sl. No.	Name of the Mineral	Production (In CuM)
1	Stone	25000

CHAPTER 9: DETAILS OF REVENUE GENERATED FROM MINERAL SECTOR DURING LAST THREE YEARS

9.1 REVENUE GENERATION FROM MINERAL SECTOR:

- **Royalty generated in the district for Sand of 2020-2023:**

Table 32: Revenue Generated in the District for year 2020-2021

Sl. No.	Name of theMineral	Royalty (Rs.)
1	Sand	10410163

Table 33: Revenue Generated in the District for year 2021-2022

Sl. No.	Name of theMineral	Royalty (Rs.)
1	Sand	12966646

Table 34: Revenue Generated in the District for year 2022-2023

Sl. No.	Name of theMineral	Royalty (Rs.)
1	Sand	11315686

- **Royalty generated in the district for In-situ Mineral (Mineral other than Sand) during last three years:**

Table 35: Revenue Generated in the district for year 2020-2021

Sl. No.	Name of the Mineral	Royalty (Rs.)
1	Stone	14137020

Table 36: Revenue Generated in the district for year 2021-2022

Sl. No.	Name of the Mineral	Royalty (In Rs.)
1	Stone	13966626

Table 37: Revenue Generated in the district for year 2022-2023

Sl. No.	Name of the Mineral	Royalty (In Rs.)
1	**Stone**	19425813

- **Total Royalty & Revenue Received from 2020-2024 in Nagaon district:**

Table 38: Total Royalty & Revenue Received from 2020-2024 in Nagaon district

Financial Year	Royalty (Rs.)	Cess (Rs.)	Total Revenue
2020-2021	24547183	6675740	31222923
2021-2022	26933272	7387861	34321133
2022-2023	30741499	8417332	39158831
2023-2024	13301420	3665629	16967049

CHAPTER 10: TRANSPORT

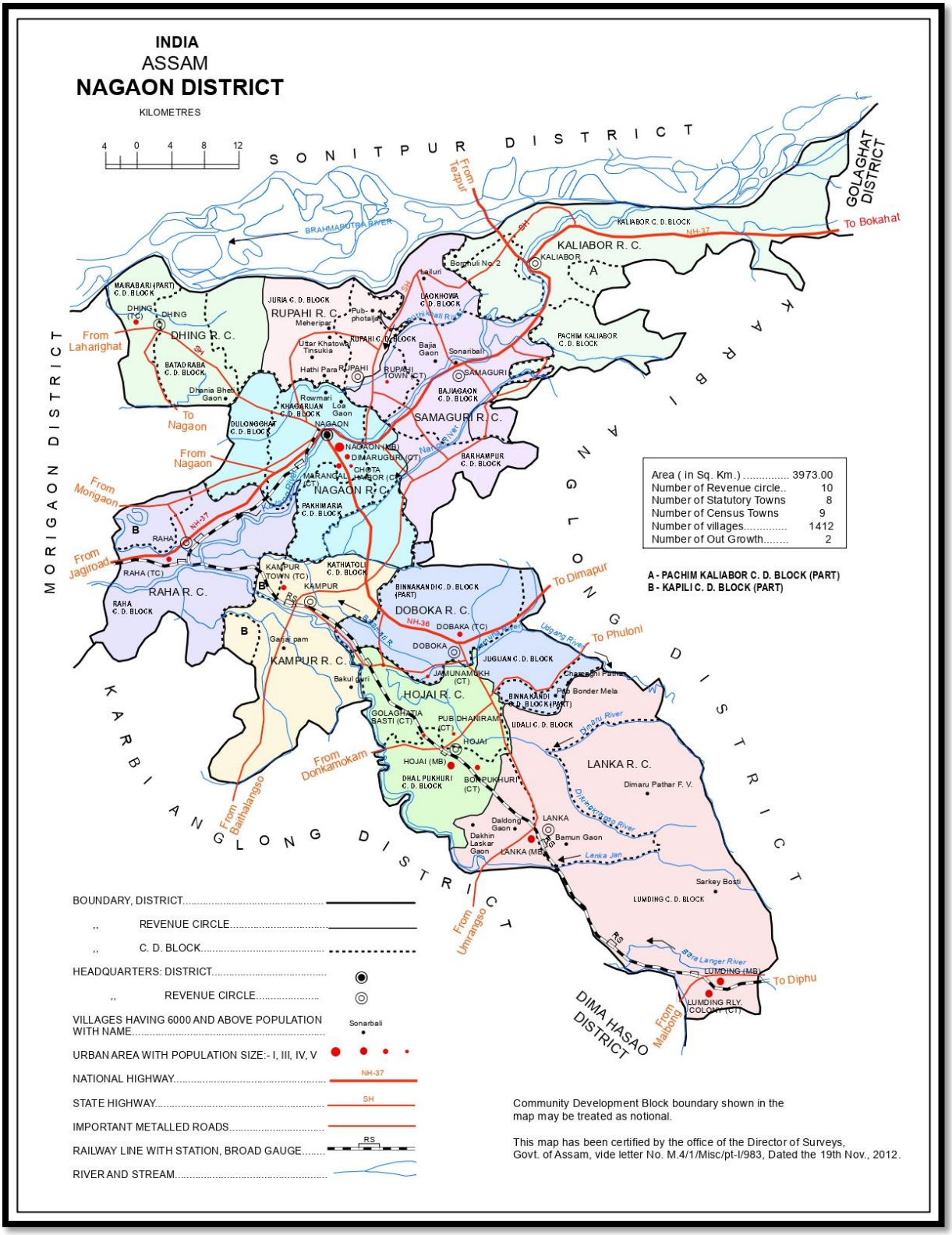
A major road like the National Highway No. 36 runs in south- eastern part of the district (Figure). National Highway-36 runs through the district connecting Badarpur with Central Part of Nagaon District. NH-37 passes through the central part of the district, connecting to the Bokahat from Tejpur and also joins with Jagirroad. State highway are also joined different parts of the district and nearby district town such as Laharighat, Phuloni, Donkamukan, Umrangso etc. Morigaon district is also attached with Nagaon District through State Highway. Road networks are passing through the center of the district from Maibong to Diphu, from Umrangso to Phuloni. This district is also well connects with day and night bus service with other places such as Guahat, Dibrugarh, Jorhat, North Lakhimpur, Tinsukia, Sibsagar, Duliajan, Dhemaji Haflong, Moran etc. Guwahati from the district head quarter is about 120 km.

The Northeast Frontier Railway (NFR) passes through the middle of the district. There are 10 railway station present in this District. Chaparmukh is the major railway junction present about 30km from Nagaon, near Raha. The district headquarter has two railway has two railway station at Nagaon and Haibargaon.

Nagaon district does not have any airport. The nearest airport is Salonibari Airport which is situated in Tezpur in Sonitpur District, It is located at a distance of about8okm from Nagaon District. Lokapriya Gopinath Bordoloi International Airport, Guwahati is located about 130km has a good flight connectivity with all the major destination throughout the country.

Existing sand mining area of the district are connected with the state highways by blacktop or village/link roads. However, there is a scope for development of infrastructural structure. Mining of riverbed sand in the potential areas can generate considerable revenue and can be utilized for development of road network and infrastructure of the district.

Figure 27: Transport Map of Nagaon District



***(Source:** Census report of Nagaon District)*

CHAPTER 11: IN-SITU MINERALS

11.1 MINERAL RESERVE

The sediments of Tertiary Age formed a treasury of few economic mineral deposits in Assam State. Nagaon District is no exception of these. Limestone is a sedimentary rock with economic values generally found in North Cachar Hills of the district. This limestone is generally cementing grade, favorable for Cement industry. Quartzite of Shillong Group also present in this district, generally used in building materials. Granites is also present in this district. Granites is generally pinkish in colour as orthoclase is present in this rock in significant amount, medium to coarse grained in nature, showing porphyritic texture. These granites are usually used for building material. Clay is present in this district for producing the bricks. *(**Source**: Miscellaneous Publication of GSI)*

Mineral resources of the district are explained below.

- **Limestone:** The deposit of limestone is generally occurred in northern portion of Cachar hills. The limestone of this area is generally cement grade in nature with significant amount of CaO% and less amount of MgO% is present in this area, favourable for the cement plant.

- **Sillimanite:** Sillimanite is present in this district. It is used for producing of refractories in manufacturing ally of metals. Significant concentration (10% to 15% of the bulk) of sillimanite has recently been reported from sillimanite bearing schist of Bamuni area of Nagaon district.

11.2 MINERAL POTENTIAL

Potential minor mineral occurrences have been demarcated in this district survey report. This DSR encompasses the presence of different types of in-situ minor minerals such as Quartzite, feldspar, granite, glass sand etc.

Quartzite is a white to greyish in colour, hard, compact, medium to coarse grained, almost mono-minerallic metamorphic rock showing non-foliated texture. It is generally formed from quartz arenite sandstone by experiencing extreme heating and pressure related to orogenic belts. Quartzite is present umjakini range, Ouguri range, central range in this district. This rock type is usually used in roofing, tiles and flooring for decorating purposed in building.

Porphyritic granites and pink granites of granitic pluton are also found in this district. Granites are generally found in central range of this district, generally used in decorative stone in the building. Mica Schist is also present in this district. Granite or granite gneisses are present in around Kaliabor area, used for building stones and road metals.

Mica-infused quartz is also present in this district where natural mica is exposed.

The Jiajuri area of Nagaon District, Assam, has a friable quartzite (glass sand) deposit situated on an undulating plateau. The region's soil thickness ranges from 0.25 m to 2.00 m. Mica and quartz are the most common minerals, however the minerals orthoclase, kaolinite, and iron oxide (hematite & goethite) are found as tiny minerals. As accessories, sphene, zircon, tourmaline, and corundum minerals. Sub-angular to sub-rounded quartz grains are seen in nature. The texture of quartzite is clastic and granular. The range of grain sizes is 0.05 mm to 0.125 in. Where the size of quartz is large, quartzite displays granoblastic texture. Grains have a range of 0.05 to 0.30 mm.

12. REMEDIAL MEASURE TO MITIGATE THE IMPACT OF MINING

12.1 Environment Sensitivity

Nagaon District represent a unique geo-environmental setup. 23.02% area of total geographical area of the district falls under forest area. Laokhowa Wildlife Sanctuary is a designated buffer of the Kazairanga Tiger Reserve and an essential component of the Laokhowa- Burachapori eco-system. As human population increases, forests are being depleted for the extension of agricultural lands, introduction of new settlements, roadways etc. the Government of Assam has complied several legal frameworks to protect the reserve forests and other eco-sensitive zones from all sorts of forest degradation including encroachment, illegal felling, lopping, grazing, illegal collection of NTFP, illegal clearance of forests for coal mining, illegal removal of minor minerals etc.

Due to unprecedented growth of population during the last few decades, nature has started reacting sharply to the accumulated human guilt. Soil erosion and its conservation play an important role. The land use practices play the most important role in determining the stability factors in respect of landslide hazards.

12.2 Sand and Stone mining Impact

Another serious environmental problem around the globe in recent years is of sand and gravel mining. Sand mining is a process of extraction of sand from an open pit, river bed, sea beaches, ocean floor, river banks, deltas and island dunes. The extracted sand could be utilized for various types of manufacturing, such as concrete used in the construction of building and other structures. The sand can also be used as an abrasive. The demand for sand will increase with population growth and urbanization. The high demand of sand has led to unsustainable sand mining process resulting in illegal mining.

Although most jurisdictions have legal limit on the location and volume of sand that can be mined, illegal sand extraction is taking place in many parts of the country due to rapid urbanization and industrialization.

Removal or extraction of too much sand from rivers leads to erosion of river banks. Deltas can recede due to sand mining. These destructive effects of sand mining ultimately result in loss of fertile land and property. It also destabilizes the ground and causes failure of engineering structures.

In-stream mining directly alters the channel geometry and bed elevation. Removing sediment from the channel disrupts the pre-existing balance between sediment supply and transporting capacity, typically inducing incision upstream and downstream of the extraction site. The resultant incision alters the frequency of floodplain inundation along the river courses, lowers valley floor water table and frequently leads to destruction of bridges and channelization structures.

In Nagaon district while mining, all stone mahals and sand mahals should be geotagged. Sand, stone or any minor minerals mining operation would be done under strict supervision of forest officer following all rules and regulations stipulated in Assam Minor Mineral Concession Rules to avoid any environmental and ecosystem degradation.

12.3 Remedial measure

12.3.1. Sustainable Mining Practices:

- The depth mining in riverbed shall not exceed 3 meter or base flow level whichever is less, provided that where the Joint Inspection Committee certifies about excessive deposit or over accumulation of mineral in certain reaches requiring channelization, it can go above 3 meters.

- Mining shall be done in layers of 1 meter depth to avoid ponding effect and after first layer is excavated, the process will be repeated for the next layers.

- No stream should be diverted for the purpose of sand mining. No natural water course and/ or water resources are obstructed due to mining operations.

- No blasting shall be resorted to in river mining and without permission at any other place.

12.3.2 Monitoring the Mining of Mineral and its Transportation:

- For each mining lease site, the access should be controlled in a way that vehicles carrying mineral from that area are tracked and accounted for.

- There should be regular monitoring of the mining activities in the State to ensure effective compliance of stipulated EC conditions and of the provisions under the Minor Mineral Concessions Rules framed by the State Government.

12.3.3 Noise Management:

- Noise arising out of mining and processing shall be abated and controlled at source to keep within permissible limit.

- Restricted sand mining operation has to be carried out between 6 am and 7 pm.

12.3.4 Air Pollution and Dust Management:

- The pollution due to transportation load on the environment will be effectively controlled and water sprinkling will also be done regularly.

- Air pollution due to dust, exhaust emission or fumes during mining and processing phase should be controlled and kept in permissible limits specified under environmental laws.

- The mineral transportation shall be carried out through covered trucks only and the vehicles carrying the mineral shall not be overloaded. Wheel washing facility should be installed and used.

12.3.5 Bio-Diversity Protection:

- Restoration of flora affected by mining should be done immediately. Five times the number of trees destroyed by mining to be planted preferably of indigenous species. Each EC holder shall have to undertake plantation of trees over at least 20% of the total area of lease in the same plot or plots utilised for such working.

- No mining lease shall be granted in the forest area without forest clearance in accordance with the provisions of the Forest Conservation Act, 1980 and the rules made there under.
- Protection of natural home of any wild animal shall have to be ensured.
- No felling of tree near quarry is allowed. For mining lease within 10km of the National Park / Sanctuary or in Eco-Sensitive Zone of the Protected Area, recommendation of Standing Committee of National Board of Wild Life (NBWL) has to be obtained as per the Hon'ble Supreme Court order in I.A. No. 460 of 2004.
- Spring sources should not be affected due to mining activities. Necessary protection measures are to be incorporated.

12.3.6. Management of Instability and Erosion:

- Removal, stacking and utilization of top soil should be ensured during mining. Where top soil cannot be used concurrently, it shall be stored separately for future use keeping in view that the bacterial organism should not die and should be spread nearby area.
- The EC should stipulate conditions for adequate steps to check soil erosion and control debris flow etc. by constructing engineering structures.
- Use of oversize material to control erosion and movement of sediments.
- No overhangs shall be allowed to be formed due to mining and mining shall not be allowed in area where subsidence of rocks is likely to occur due to steep angle of slope.
- No extraction of stone / boulder / sand in landslide prone areas.
- Controlled clearance of riparian vegetation to be undertaken.

12.3.7. Waste Management:

- Site clearance and tidiness is very much needed to have less visual impact of mining**.**
- Dumping of waste shall be done in earmarked places as approved in Mining Plan.
- Rubbish burial shall not be done in the rivers.

12.3.8. Pollution Prevention:

- Take all possible precautions for the protection of environment and control of pollution.
- Effluent discharge should be kept to the minimum and it should meet the standards prescribed.

12.3.9. Protection of Infrastructure:

- Mining activities shall not be done for mine lease where mining can cause danger to site of flood protection works, places of cultural, religious, historical, and archaeological importance.

- For carrying out mining in proximity to any bridge or embankment, appropriate safety zone should be worked out on case-to-case basis, taking into account the structural parameters, location aspects and flow rate, and no mining should be carried out in the safety zone so worked out.

Mining shall not be undertaken in a mining lease located in 300-500 meter of bridge, 300 meter upstream and downstream of water supply / irrigation scheme, 100 meters from the edge of National Highway and railway line, 50 meters from a reservoir, canal or building, 25 meter from the edge of State Highway and 10 meters from the edge of other roads except on special exemption by the Sub-Divisional level Joint Inspection Committee.

CHAPTER 13: SUGGESTED RECLAMATION PLAN FOR ALREADY MINED OUT AREAS

As per statute all mines/quarries are to be properly reclaimed before final closure of the mine. Reclamation plans should include:

1. Baseline survey of river cross section. The study of cross section is basis for delineating channel form. Cross-sections must be surveyed between two monumented endpoints set on the river banks, and elevations should be referenced based on benchmark set in the area;

2. The proposed mining cross-section data should be plotted over the baseline data to illustrate the vertical extent of the proposed excavation;

3. The cross-section of the replenished bar should be the same as the baseline data. This illustrates that the bar elevation after the bar is replenished will be the same as the bar before extraction;

4. A planimetric map showing the aerial extent of the excavation and extent of the riparian buffers;

5. Planting plan developed by a plant ecologist familiar with the flora of the river for any areas such as roads that need to be restored;

6. Each EC holder shall have to undertake plantation of trees over at least 20% of the total area of the plot or plots of land as subject to such working in accordance with a plan approved by the concerned Divisional Forest Officer holding jurisdiction, provided further the competent authority i.e., The Divisional Forest Officer may fix up norms for plantation of trees in a particular area regarding choice of species, spacing, nos of trees and maintenance etc.

7. A monitoring plan has to establish.

CHAPTER 14: RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

Risk analysis is the systematic study of risks encountered during various stages of mining operation. Risk analysis seek to identify the risks involved in mining operations, to understand how and when they arise, and estimate the impact (financial or otherwise) of adverse outcomes. The sand mining operation in the district is mainly done manually.

14.1. Identification of risk due to river sand mining

There is no land degradation due to mining activities as mining is done only on river bed dry surface. There will be no OB or waste generation as the sand is exposed in the river bed and is completely saleable. There will be neither any stacking of soil nor creation of OB dumps. The mining activity will be carried out up to a maximum depth of 3m below the surface level. So, there is no chance of slope failure, bench failure in the mines. However, there are some identified risks in the mining activity which are as follows:

1. Accident during sand loading and transportation
2. Inundation/ Flooding
3. Quick Sand Condition

14.2. Mitigation measures

14.2.1. Measures to prevent accidents during loading and transportation:

- During the loading, trucks should be brought to a lower level so that the loading operation suits the ergonomic condition of the workers.
- The workers will be provided with gloves and safety shoes during loading.
- Opening of the side covers of the truck should be done carefully and with warning to prevent injury to the loaders.
- Mining operations will be done during daylight only.
- The truck will be covered with tarpaulin and maintained to prevent any spillage.
- To avoid danger while reversing the trackless vehicles especially at the embankment and tipping points, all areas for reversing of lorries should be made man free as far as possible.
- All transportation within the main working will be carried out directly under the supervision and control of the management.
- Overloading should not be permitted and the maximum permissible speed limit should be ensured.

- There will be regular maintenance of the trucks and the drivers will have valid driving license

14.2.2. Measures to prevent incidents during Inundation/ Flooding:

- To minimize the risk of flooding/ inundation following measures should be under taken:
- Mining will be completely closed during the monsoon months.
- Proper weather information, particularly on rain should be kept during the operational period of mines so that precautionary measures will be undertaken.

14.2.3. Measures for mitigation to quick sand condition:

- Quicksand zone and deep-water zone will be clearly demarcated and all the mine workers will be made aware of the location.
- Mining will be done strictly as per the approved mining plan.

14.3. Disaster Management Plan

As the depth of mining will be maximum of 3m below the surface level considering local condition, the risk related to mining activity is much less. The mining operation will be carried out under the supervision of experienced and qualified Mines Manager having Certificate of Competency to manage the mines granted by DGMS. All the provisions of Mines Act 1952, MMR 1961 and Mines Rules 1955 and other law applicable to mine will strictly be complied. During heavy rainfall and during the monsoon season the mining activities will be closed. Proper coordination with Irrigation Department should be maintained so that at the time of releasing water, if any, from the dam suitable warning/information is given in advance. Special attention and requisite precautions shall be taken while working in areas of geological weakness like existence of slip, fault etc. The mining site will be supplied with first aid facilities and the entire mines worker will have access to that.

CHAPTER 15: CONCLUSION & RECOMMENDATIONS

15.1 CONCLUSION

Sand mining or River Bed Minerals mining (used here as a generic term that includes mining of any riverine aggregates regardless of particle size) is a global activity that is receiving increasing media attention due to perceived negative environmental and social impacts. As calls grow for stronger regulation of mining, there is a need to understand the scientific evidence to support effective management. This paper summarizes the results of a structured literature review addressing the question, the review found that most investigations have focused on temperate rivers where sand or river bed mineral mining occurred historically but has now ceased. Channel incision was the most common physical impact identified; other physical responses, including habitat disturbance, alteration of riparian zones, and changes to downstream sediment transport, were highly variable and dependent on river characteristics. Ecosystem attributes affected included macro invertebrate drift, fish movements, species abundance and community structures, and food web dynamics. Studies often inferred impacts on populations, but supporting data were scarce. Limited evidence suggests that rivers can sustain extraction if volumes (weight) are within the natural sediment load variability. Significantly, the countries and rivers for which there is science-based evidence related to sand or river bed mineral mining are not those where extensive sand mining or gravel, pebbles, boulder extraction is currently reported. The lack of scientific and systematic studies of mining in these countries prevents accurate quantification of mined volumes (weight) or the type, extent, and magnitude of any impacts. Additional research into how river bed mining is affecting ecosystem services, impacting biodiversity and particularly threatened species, and how mining impacts interact with other activities or threats is urgently required.

The rapid rise in urbanization and construction of large-scale infrastructure projects are driving increasing demands for construction materials globally. United Nations Environment Programme (UNEP; 2014) estimated that between 32 and 50 billion tonnes of sand and gravel are extracted globally each year with demand increasing, especially in developing countries (Schandl et al., 2016). Rivers are a major source of sand and gravel for numerous reasons: cities tend to be located near rivers so transport costs are low; river energy grinds rocks into gravels and sands, thus eliminating the cost of mining, grinding, and sorting rocks; and the material produced by rivers tends to consist of resilient minerals of angular shape that are preferred for construction (whereas wind-blown deposits in deserts are rounder and less suitable. Sand mining or river bed minerals mining activities are one of many recognized pressures affecting riverine ecosystems, where biodiversity is already in rapid decline (World Wildlife Fund, 2018). Increasingly, there are media reports about the negative environmental and social impacts of river bed mining, and as calls grow for stronger regulation of mining (Schandl et al., 2016), there is a need to understand the scientific evidence of mining impacts to underpin management.

Impacts of sand mining or river bed mineral mining on rivers may be two types such as direct or indirect. Direct impacts are those in which the extraction of material is directly responsible for the ecosystem impact, such as due to the removal of flood plains habitat. Indirect impacts are related to ecosystem changes that are propagated through the system due to physical changes in the river system resulting from sand extraction. For example, the removal of material from a river can alter the channel, river hydraulics, or sediment budget which in turn can alter the distribution of habitats and ecosystem functioning. These types of impacts can be difficult to attribute to river bed mining, as they may require long time frames to emerge, and other interventions can result in similar changes. The situation is further complicated by the

existence of geomorphic thresholds in river systems (Schumm, 1979). Alterations linked to removal of sand, gravel, pebbles, boulder from rivers may not be gradual and/or linear, and only limited changes may be observed for an extended period, but once a threshold is reached, change may become rapid and irreversible. Whether the impacts of sand or river bed mineral mining are positive, neutral, or negative depends on the situation and perceptions of different stakeholders.

During the preparation of the present report prominent rivers/ streams has been studied in detail. These mineral concessions shall also reduce demand load and will be helpful to minimize illegal extraction of minerals, failure of which may result in to illegal mining at odd hours and shall be haphazard and more detrimental to the local ecology. Irrespective of it following geo-scientific considerations are also suggested to be taken into account during the river bed mining in a particular area:

1. Abandoned stream channels or terrace and inactive floodplains may be preferred rather than active channels and their deltas and floodplains.

2. Stream should not be diverted to form inactive channel.

3. Mining below subterranean water level should be avoided as a safeguard against environmental contamination and over exploitation of resources.

4. Mining area should be demarcated on the ground with Pucca pillars so as to avoid illegal unscientific mining.

15.2 Recommendation:

1. The mining lease distribution for the district must be carried out by involving a district level committee constituted with inter-disciplinary members of various departments including irrigation and waterways, DL&LRO, forest, biodiversity, wetland management, SWID or any other relevant department which the district authority may find suitable to include.

2. While recommending for Mining Leases, the District Level Committee should ensure the protection of Biodiversity Zones as recorded by relevant Government Agenesis from time to time.

3. It is recommended to have a periodical review along with primary data collection during pre- and post-monsoon periods to record the seasonal variance of the sedimentation rate on annual basis and update replenishment rate of the district.

4. Efforts should be given to restrict distribution of mining leases along the confluence zone of the rivers where rich aquatic habitats are reported.

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ANNEXURE – I

- **Details of Sand / M – Sand Source**

  a) Rivers,

  b) De-siltation location: (Lakes/Ponds/Dams etc.)

  c) Patta Lands/khatedari Land

  d) M-Sand Plants

a) Rivers:

Sl No	River Name / M-Sand plant	Total stretch of River (in Km)	Type Of River
1	Kopili River	88.6	Perennial
2	Borpani Rivr	34.6	Perennial

b) List of De-siltation location (Lake, Pond, Dams, River)

Name	Maintain/Controlled by Sate Govt./PSU etc.	Location	District	Lake/Pond/ Dams/River/ Canal	Tehsil	Village	Size (Ha)	Existing /Proposed
NA								

c) List of Patta Lands / Khatedari land

Owner	Area Kanal / Nala / Tilla	GPS Coordinates	Material / Forest Produce/ Mineral	District	Tehsil	Village	Agricultural Land (Yes / No)
NA							

d) M-Sand plants with location:

Sl. No.	Plant Name	Owner	District	Tehsil	Village	Geolocation		Quantity (Tonnes /Annum)
						Latitude	Longitude	
NA								

ANNEXURE – II

➢ List of Potential Mining Leases (existing)

- **Rivers**
- **Patta Lands/Khatedari Land: (existing)**
- **De-Siltation Location: (Lakes/Ponds/Dams etc.) (existing)**
- **M-Sand Plants: (existing)**

- **List of existing mining zones of the district with location, area, period for each minor mineral (River Bed)**

Sl. No.	River Details	Name of the mines or Desilting sites	Lease Details	Area (Ha)	Geolocation		Distance in (km) from PA/BR/ WC	Distance from Forest Area (in km)	Mining Leases within 500 meters (if yes cluster area)	Production as per EC (M3)	Mineral to be mined (Sand/Bajri/RBM etc)	Existing /Proposed
					Latitude	Longitude						
1	Kopili River	Jamunamukh-Kopili Nodi Sand Permit Area Part- 1 (B) of 2018-20	2 Year	4.2	26°07.136'N 26°07.156'N 26°07.166'N 26°07.079'N 26°06.970'N 26°06.890'N 26°06.882'N 26°06.950'N 26°07.018'N 26°07.069'N 26°07.102'N 26°07.122'N 26°07.136'N	91° 43.658'E 92° 43.657'E 92° 43.663'E 92° 43.825'E 92° 43.915'E 92° 43.936'E 92° 43.896'E 92° 43.878'E 92° 43.833'E 92° 43.778'E 92° 43.734'E 92° 43.685'E 92° 43.658'E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	55036	Sand	Existing
2	Kopili River	Jamunamukh-Kopili Nodi Sand Permit Area Part- 1 (C) of 2018-20	2 Year	4.91	26° 9'15.50"N 26° 9'15.65"N 26° 9'32.49"N 26° 9'31.21"N 26° 8'48.04"N 26° 8'44.71"N 26° 8'44.83"N 26° 8'48.13"N 26° 8'24.21"N 26° 8'23.97"N 26° 8'29.69"N 26° 8'29.89"N	92°41'0.10"E 92°41'2.07"E 92°40'52.72"E 92°41'51.31"E 92°41'41.58"E 92°41'42.11"E 92°41'47.03"E 92°41'46.43"E 92°42'22.17"E 92°42'24.22"E 92°42'23.45"E 92°42'24.79"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	6000	Sand	Existing

3	Borpani River	Borpani Sand Permit Area No.1 (A) of 2020-22	2 Year	4.95	26° 3'14.09"N 26° 3'14.59"N 26° 3'8.29"N 26° 3'8.75"N 26° 3'8.68"N 26° 3'8.08"N 26° 3'5.32"N 26° 3'5.63"N 26° 3'2.44"N 26° 3'3.30"N 26° 3'2.72"N 26° 2'59.61"N 26° 2'59.53" N 26° 2'55.02"N 26° 2'55.39"N 26° 2'53.01"N 26° 2'53.53"N 26° 2'50.34"N 26° 2'50.29"N 26° 2'48.86"N 26° 2'49.69"N	92°37'43.01"E 92°37'43.94"E 92°37'47.36"E 92°37'53.37"E 92°37'48.16"E 92°37'52.24"E 92°37'56.34"E 92°37'57.56"E 92°37'59.74"E 92°38'0.51"E 92°38'3.56"E 92°38'4.78"E 92°38'6.22"E 92°38'9.84"E 92°38'10.49"E 92°38'15.91"E 92°38'17.97"E 92°38'20.83"E 92°38'21.68"E 92°38'25.28"E 92°38'26.75"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	30000	Sand	Existing

4	Borpani River	Borpani Sand Permit Area Part- 1 (B) of 2020-27	7 Year	4.5	26° 9.362'N 26° 9.296'N 26° 9.299'N 26° 9.334'N 26° 9.362'N 26° 8.864'N 26° 8.829'N 26° 8.715'N 26° 8.737'N 26° 8.864'N 26° 10.292'N 26° 10.276'N 26° 10.191'N 26° 10.278'N 26° 10.292'N 26° 10.981'N 26° 10.895'N 26° 10.888'N 26° 10.980'N 26° 10.981'N	92° 34.225'E 92° 34.169'E 92° 34.230'E 92° 34.254'E 92° 34.225'E 92° 31.876'E 92° 31.864'E 92° 32.170'E 92° 32.156'E 92° 31.874'E 92° 31.156'E 92° 31.152'E 92° 31.181'E 92° 31.175'E 92° 31.156'E 92° 30.605'E 92° 30.593'E 92° 30.614'E 92° 30.630'E 92° 30.605'E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	53000	Sand	Existing
5	Borpani River	Borpani Sand Permit Area (Govt. Permit)	2 Year	4.95	25°58'14.70"N 25°58'12.20"N 26° 4'7.10"N 26° 4'1.30"N	92°35'30.20"E 92°35'36.10"E 92°37'11.00"E 92°37'5.40"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	-	Sand	Existing
6	Borpani River	Borpani Sand Permit Area Part-1(B) Down Site (Govt. Permit)	2 Year	2.02	26°10'25.20"N 26°10'16.29"N 26°10'17.08"N 26°10'22.60"N 26°10'26.13"N 26°10'25.87"N 26°10'25.20"N 26°10'22.40"N	92°31'15.40"E 92°31'9.01"E 92°31'10.06"E 92°31'4.75"E 92°31'6.95"E 92°31'13.85"E 92°31'7.20"E 92°31'6.20"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	-	Sand	Existing

7	Kopili River	Chaparmukh-Kopili Nodi Sand Permit Area Part- 1 (A)	2 Year	4.91	26°11'37.29"N 26°11'34.71"N 26°11'34.99"N 26°11'32.45"N 26°11'27.70"N 26°11'25.71"N 26°11'25.33"N 26°11'23.25"N 26°11'26.66"N 26°10'19.40"N 26°10'20.50"N 26°10'23.84"N 26°10'24.49"N 26°10'26.75"N 26°10'26.47"N 26°10'27.92"N 26° 9'40.69"N 26° 9'40.39"N 26° 9'39.84"N 26° 9'39.38"N 26° 9'39.38"N 26° 9'39.10"N 26° 9'38.76"N 26° 9'40.07"N 26° 9'40.03"N 26° 9'38.40"N 26° 9'38.54"N 26° 9'38.36"N 26° 9'40.09" N 26° 9'39.97"N	92°35'55.29"E 92°35'52.68"E 92°35'57.77"E 92°35'55.29"E 92°35'44.40"E 92°35'47.46"E 92°35'41.77"E 92°35'44.96"E 92°35'43.26"E 92°37'17.19"E 92°37'18.19"E 92°37'13.00"E 92°37'14.73"E 92°37'12.82"E 92°37'10.32"E 92°37'11.69"E 92°37'41.64"E 92°37'43.18"E 92°37'41.63"E 92°37'46.16"E 92°37'46.16"E 92°37'44.69"E 92°37'46.79"E 92°37'46.39"E 92°37'48.47"E 92°37'50.50"E 92°37'48.95"E 92°37'52.01"E 92°37'52.58"E 92°37'50.83"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	-	Sand	Existing
8	Kopili River	Chaparmukh-Kopili Nodi Sand Permit Area Part- 1	2 Year	4.6	26°11'53.50"N 26°11'50.86"N 26°11'50.80"N 26°11'48.35"N	92°33'41.00"E 92°33'43.23"E 92°33'37.90"E 92°33'39.75"E	No PA/BR/ WC available	No forest availabl e in	No	22000	Sand	Existing

		(B)			26°11'50.03"N 26°11'49.12"N 26°11'51.24"N 26°11'52.80"N 26°12'11.07"N 26°12'7.60"N 26°12'10.31"N 26°12'7.70"N 26°12'8.74"N 26°12'10.68"N 26°12'10.23"N 26°12'9.81"N 26°12'8.31"N 26°11'35.14"N 26°11'32.60"N 26°11'31.61"N 26°11'36.20"N 26°11'34.86"N 26°11'34.29"N 26°11'33.17"N 26°11'34.23"N 26°11'33.52" N 26°11'32.44"N 26°11'23.30"N 26°11'21.04"N 26°11'20.44"N 26°11'18.30"N 26°11'20.16"N 26°11'19.51"N 26°11'18.88"N 26°11'18.55"N 26°11'20.99"N 26°11'22.92"N	92°33'38.71"E 92°33'39.19"E 92°33'42.76"E 92°33'42.08"E 92°32'27.27"E 92°32'28.54"E 92°32'22.62"E 92°32'23.80"E 92°32'23.52"E 92°32'27.56"E 92°32'27.61"E 92°32'28.03"E 92°32'28.69"E 92°33'25.65"E 92°33'20.83"E 92°33'24.13"E 92°33'22.30"E 92°33'21.67"E 92°33'21.67"E 92°33'20.80"E 92°33'25.10"E 92°33'25.21"E 92°33'24.76"E 92°33'13.30"E 92°33'15.50"E 92°33'9.76"E 92°33'11.93"E 92°33'14.13"E 92°33'14.01"E 92°33'13.59"E 92°33'12.30"E 92°33'10.56"E 92°33'13.20"E 92°33'12.83"E	in 500m	500m				

					26°11'22.79"N 26°11'22.42"N 26°11'21.85"N	92°33'12.60"E 92°33'11.72"E						
9	Kopili River	Chaparmukh Kapili Nodi Sand Permit Area 1 (C)	2 Year	2.5	26°11'47.80"N 26°11'45.97"N 26°11'46.71"N 26°11'44.16"N	92°31'7.00"E 92°31'8.42"E 92°30'56.94"E 92°30'56.37"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	4000	Sand	Existing
10	Kopili River	Chaparmukh Kapili Nodi Bamunijan Silbheta Sand Permit Area	2 Year	2	26°10'32.51"N 26°10'32.22"N 26°10'26.24"N 26°10'23.43"N	92°28'45.89"E 92°28'48.01"E 92°28'43.00"E 92°28'45.10"E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	-	Sand	Existing
11	Kopili River	Jamunamukh-Kopili Nodi Sand Permit Area Part- 1 (A)	7 Year	23.5	26° 6.329'N 26° 6.289'N 26° 6.218'N 26° 6.174'N 26° 6.115'N 26° 6.055'N 26° 6.016'N 26° 5.970'N 26° 5.960'N 26° 5.934'N 26° 5.929'N 26° 5.943'N 26° 5.947'N 26° 5.968'N 26° 5.990'N 26° 6.029'N 26° 6.062'N 26° 6.078'N 26° 6.052'N 26° 6.032'N 26° 6.008'N	92° 43.061'E 92° 43.151'E 92° 43.089'E 92° 43.060'E 92° 43.051'E 92° 43.053'E 92° 43.074'E 92° 43.106'E 92° 43.141'E 92° 43.197'E 92° 43.245'E 92° 43.313'E 92° 43.359'E 92° 43.407'E 92° 43.452'E 92° 43.517'E 92° 43.572'E 92° 43.595'E 92° 43.608'E 92° 43.605'E 92° 43.576'E	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	210000	Sand	Existing

					26° 5.961'N 26° 5.917'N 26° 5.888'N 26° 5.863'N 26° 5.839'N 26° 5.890'N 26° 5.928'N 26° 5.960'N 26° 6.015'N 26° 6.101'N 26° 6.135'N 26° 6.184'N 26° 6.213'N 26° 6.262'N 26° 6.297'N 26° 6.329'N	92° 43.522'E 92° 43.448'E 92° 43.389'E 92° 43.330'E 92° 43.217'E 92° 43.094'E 92° 43.054'E 92° 43.026'E 92° 42.979'E 92° 42.952'E 92° 42.954'E 92° 42.967'E 92° 42.983'E 92° 42.006'E 92° 43.043'E 92° 43.061'E						

➢ List of existing mining zones of the district with location, area, period for each minor mineral (In-Situ)

Sl.No.	Name of the Project Proponent	Block No.	Geolocation		Area in Hectares	Production as per EC (M3)	Registration Date	Validity of the Lease
			Latitude	Longitude				
1	Sri Biswajit Banik	Dholpahar Stone Mahal No. 1 of 2018-23	$26^0$22'44.116"N $26^0$22'46.993"N $26^0$22'47.362"N $26^0$22'44.485"N	$92^0$52'58.684"E $92^0$52'58.096"E $92^0$53'02.085"E $92^0$53'02.673"E	1	50000	19-04-2018	5 Year
2	Sri Jayanta Kr. Laskar	Tapatjuri Stone Mahal No. 1 of 2018-23	$26^0$16'52.900"N $26^0$16'51.542"N $26^0$16'48.721"N $26^0$16'50.079"N	$92^0$47'01.600"E $92^0$47'04.876"E $92^0$47'03.084"E $92^0$46'59.808"E	1	50000	25-02-2019	5 Year
3	Sri Jayanta Kr. Laskar	Kafitoli Stone Mahal No. 1 of 2018-23	$26^0$13'34.065"N $26^0$13'34.237"N $26^0$13'31.539"N $26^0$13'31.368"N	$92^0$48'13.345"E $92^0$48'17.665"E $92^0$48'17.939"E $92^0$48'13.618"E	1	50000	20-06-2019	5 Year

b) List of Patta Lands / Khatedari land

Owner	Area Kanal / Nala/Tilla	GPS Coordinates	Material/Forest Produce/Mineral	Total Mineral to be Mined (in m3)	District	Tehsil	Village	Agricultural Land (Yes / No)
NA								

c) List of De-siltation location (Lake, Pond, Dams, River)

Name	Maintain/Controlled by Sate Govt./PSU etc.	Location	District	Lake/Pond/Dams/River/Canal	Tehsil	Village	Size (Ha)	Existing /Proposed
NA								

d) M-Sand plants with location

Sl. No.	Plant Name	Owner	District	Tehsil	Village	Geolocation		Quantity (Tonnes /Annum)
						Latitude	Longitude	
NA								

ANNEXURE – III

- **list of Cluster and Contiguous Clusters**
  - **Clusters:**
  - **Contiguous Clusters:**

- **Cluster details**

River Name	Cluster No.	Lease No.	Location (Riverbed/Patta Land)	Village	Area (in Ha)	Total Excavation (Ton)	Total Mineral Excavation (Ton)
NA							

- **Contiguous Cluster details**

River Name	Contiguous Cluster No.	Cluster No.	Number of leases in the cluster	Location (Riverbed/Patta Land)	Distance between clusters	Village	Area of Cluster (Ha)	Total Mineral Excavation (Ton)
NA								

ANNEXURE – IV

- **Transportation Routes for Individual leases and leases in Cluster**

➢ Transportation Routes for individual leases details:

Lease No.	Transportation Route No.	Number of tippers /days of lease	Number of tippers /days of all the lease on route	Length of the Route in Km	Type of Road (black Topped/ unpaved)	Recommendation for road (Black Topped/ unpaved)	The road will be constructed by Govt. / Lease Owner	Route Map & Location
NA								

➢ Transportation Routes for leases in Cluster details:

Cluster No.	Transportation Route No.	Number of tippers / days of cluster	Number of tippers / days of all the clusters on route	Length of Route in km	Type of Road (Black Topped / unpaved)	Recommendation for road (Black Topped / unpaved)	The road will be Constructed by Govt. / Lease Owner	Route Map & Location
NA								

ANNEXURE – V

- **Final list of Potential Mining Zones : (Proposed)**
- **Final list of Patta land: (Proposed)**
- **De-siltation Location: (Lakes/Ponds/Dams etc.)(Proposed)**
- **Final list of Sand/M – Sand Source: (Proposed)**

➢ Final List of potential Mining zones: (River Bed)

Sl. No.	Lease Details (Zone Code)	River Details	Area (In Ha)	Latitude	Longitude	Depth	Distance (In Km) From PA/BR/ WC	Distance From Forest Area (In Km)	Mining Leases Within 500 meters (if Yes cluster area In Ha)	Total Excavation in (CUM/Yr) (Mine Depth max as 3m)	Mineable Reserve (cum)	Mineral to be mined (Sand/ Bajri/ RBM etc.)	Existing / Proposed
1	NGN_PRO_01	Kopili River	51.1	26°6'12.71"N 26°6'10.40"N 26°6'14.60"N 26°6'16.82"N	92°43'47.74"E 92°43'51.21"E 92°43'26.15"E 92°43'26.10"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	1533000	919800	Sand	Proposed
2	NGN_PRO_02	Kopili River	10.7	26°6'41.82"N 26°6'42.59"N 26°7'10.91"N 26°7'8.89"N	92°43'53.06"E 92°43'56.97"E 92°43'36.86"E 92°43'35.86"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	321000	192600	Sand	Proposed
3	NGN_PRO_03	Kopili River	81.6	26°9'35.03"N 26°9'37.15"N 26°8'16.11"N 26°8'11.97"N	92°40'44.10"E 92°40'46.01"E 92°42'17.97"E 92°42'9.97"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	2448000	146880	Sand	Proposed
4	NGN_PRO_03A	Kopili River	7.89	26° 9'14.67"N 26°9'12.07"N 26°9'27.11"N 26°9'26.63"N	92°39'30.34"E 92°39'32.20"E 92°40'2.88"E 92°39'59.70"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	236700	142020	Sand	Proposed
5	NGN_PRO_04	Kopili River	90.3	26°11'46.61"N 26°11'43.50"N	92°36'6.31"E 92°36'8.91"E	3	No PA/BR/	No forest	No	2709000	162540	Sand	Proposed

				26°9'48.27"N 26°9'45.07"N	92°38'33.38"E 92°38'33.79"E		WC available in 500m	available in 500m					
6	NGN_PRO_04A	Kopili River	31	26°11'20.91"N 26°11'19.10"N 26°11'33.68"N 26°11'36.48"N	92°33'11.01"E 92°33'13.38"E 92°34'35.90"E 92°34'35.88"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	930000	558000	Sand	Proposed
7	NGN_PRO_05	Kopili River	28.2	26°12'1.83"N 26°12'0.02"N 26°11'21.10"N 26°11'22.58"N	92°31'57.87"E 92°32'0.07"E 92°32'51.73"E 92°32'54.37"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	846000	507600	Sand	Proposed
8	NGN_PRO_06	Kopili River	6.27	26°11'58.91"N 26°11'59.21"N 26°11'47.80"N 26°11'45.90"N	92°30'53.28"E 92°30'57.28"E 92°31'7.00"E 92°31'8.40"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	188100	112860	Sand	Proposed
9	NGN_PRO_06A	Kopili River	3.66	26°11'34.39"N 26°11'30.58"N 26°11'17.80"N 26°11'18.31"N	92°30'38.46"E 92°30'40.08"E 92°30'27.50"E 92°30'27.44"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	109800	65880	Sand	Proposed
10	NGN_PRO_07	Kopili River	5.32	26°10'22.29"N 26°10'24.74"N 26°10'40.17"N 26°10'40.37"N	92°28'34.28"E 92°28'33.96"E 92°28'44.94"E 92°28'47.17"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	159600	95760	Sand	Proposed
11	NGN_PRO_08	Borpani River	3.38	26°10'31.06"N 26°10'31.87"N 26°10'17.05"N 26°10'16.37"N	92°31'11.60"E 92°31'12.75"E 92°31'9.99"E 92°31'9.01"E	3	No PA/BR/ WC available in 500m	No forest available in 500m	No	101400	60840	Sand	Proposed

12	NGN_PRO_09	Borpani River	18.4	26°10'8.39"N 26°10'8.83"N 26°8'49.06"N 26°8'48.05"N	92°31'12.44"E 92°31'13.37"E 92°31'55.45"E 92°31'54.58"E	3	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	552000	331200	Sand	Propo sed
13	NGN_PRO_10	Borpani River	16.4	26° 8'44.76"N 26°8'44.07"N 26°8'54.96"N 26°8'55.83"N	92°32'12.07"E 92°32'12.57"E 92°33'47.25"E 92°33'46.64"E	3	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	492000	295200	Sand	Propo sed
14	NGN_PRO_11	Borpani River	6.69	26°3'14.00"N 26°3'14.54"N 26°2'44.16"N 26°2'43.06"N	92°37'42.95"E 92°37'43.94"E 92°38'29.00"E 92°38'28.39"E	3	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	200700	120420	Sand	Propo sed
15	NGN_PRO_12	Borpani River	8.44	25°58'40.05"N 25°58'38.03"N 25°58'18.62"N 25°58'19.29"N	92°35'57.45"E 92°35'56.84"E 92°35'37.01"E 92°35'34.60"E	3	No PA/BR/ WC available in 500m	No forest availabl e in 500m	No	253200	151920	Sand	Propo sed
Total			**369.35**							**11080500**	**6648300**		

➢ Final List of potential Mining zones: (Earth Mining)

SL. No.	Zone Code	Name of the Mineral	Area of Mineralization (Ha)	Depth of Mineralization (in Meter)	Geological Reserve (cum)	Mineable Reserve (cum)	Latitude	Longitude
1	NGN_PRO_IS_01	ORDINARY EARTH	79.7	3	2391000	1434600	26°33'35.18"N 26°33'56.02"N 26°33'41.01"N 26°33'19.29"N	93° 0'42.05"E 93° 1'17.13"E 93° 1'33.02"E 93° 0'54.75"E
2	NGN_PRO_IS_02	ORDINARY EARTH	19.5	3	585000	351000	26°27'51.92"N 26°27'38.30"N 26°27'45.80"N 26°27'56.60"N	92°44'47.51"E 92°44'59.36"E 92°45'11.82"E 92°44'56.24"E
3	NGN_PRO_IS_03	ORDINARY EARTH	75.9	3	2277000	1366200	26°28'24.01"N 26°28'15.39"N 26°28'1.12"N 26°28'5.40"N 26°28'13.73"N	92°36'21.28"E 92°36'22.72"E 92°35'35.07"E 92°35'25.53"E 92°35'30.00"E
4	NGN_PRO_IS_04	ORDINARY EARTH	27.7	3	831000	498600	26°27'49.26"N 26°27'38.77"N 26°27'37.54"N 26°27'47.41"N 26°27'51.76"N	92°30'18.84"E 92°30'20.66"E 92°30'47.59"E 92°30'45.45"E 92°30'39.03"E
5	NGN_PRO_IS_05	ORDINARY EARTH	70.3	3	2109000	1265400	26°26'48.79"N 26°26'27.69"N 26°26'30.25"N 26°26'48.79"N 26°26'53.85"N	92°27'35.72"E 92°27'40.43"E 92°28'9.36"E 92°28'16.07"E 92°27'57.09"E

6	NGN_PRO_IS_06	ORDINARY EARTH	56.9	3	1707000	1024200	26°23'2.83"N 26°23'9.23"N 26°22'48.20"N 26°22'43.60"N	92°46'37.69"E 92°47'15.17"E 92°47'7.72"E 92°46'55.06"E
7	NGN_PRO_IS_07	ORDINARY EARTH	30.6	3	918000	550800	26°22'45.77"N 26°22'56.82"N 26°22'48.92"N 26°22'41.56"N	92°52'50.94"E 92°53'5.00"E 92°53'20.50"E 92°53'17.05"E
8	NGN_PRO_IS_08	ORDINARY EARTH	63.4	3	1902000	1141200	26°19'57.21"N 26°19'30.98"N 26°19'26.00"N 26°19'29.24"N 26°19'59.45"N	92°52'11.23"E 92°52'10.87"E 92°52'37.10"E 92°52'42.08"E 92°52'22.03"E
9	NGN_PRO_IS_09	ORDINARY EARTH	107	3	3210000	1926000	26°16'40.89"N 26°16'58.23"N 26°16'45.63"N 26°16'29.57"N 26°16'33.12"N	92°46'48.61"E 92°47'5.25"E 92°47'37.02"E 92°47'36.06"E 92°46'50.04"E
10	NGN_PRO_IS_10	STONE	72.5	3	2175000	1305000	26°13'33.17"N 26°13'40.66"N 26°13'32.49"N 26°13'21.72"N 26°13'12.42"N	92°47'47.97"E 92°47'58.25"E 92°48'28.20"E 92°48'33.28"E 92°48'25.04"E
11	NGN_PRO_IS_11	ORDINARY EARTH	84.9	3	2547000	1528200	26° 8'11.76"N 26° 8'25.96"N 26° 8'0.03"N 26° 7'54.88"N 26° 8'5.41"N	92°39'20.10"E 92°39'32.16"E 92°40'12.72"E 92°39'53.73"E 92°39'22.98"E
12	NGN_PRO_IS_12	ORDINARY EARTH	40.6	3	1218000	730800	26°17'6.45"N 26°17'3.31"N 26°16'42.41"N	92°40'9.05"E 92°40'33.69"E 92°40'17.28"E

							26°16'45.69"N	92°40'3.89"E
13	NGN_PRO_IS_13	ORDINARY EARTH	196	3	5880000	3528000	26°17'6.17"N 26°16'15.44"N 26°16'9.07"N 26°16'36.93"N 26°16'45.67"N	92°34'6.16"E 92°33'48.24"E 92°34'14.03"E 92°34'34.04"E 92°34'53.16"E
14	NGN_PRO_IS_14	ORDINARY EARTH	76.5	3	2295000	1377000	26°15'0.60"N 26°15'10.42"N 26°14'47.02"N 26°14'39.06"N 26°14'37.75"N	92°26'30.39"E 92°26'50.08"E 92°27'12.24"E 92°27'6.27"E 92°26'51.22"E
15	NGN_PRO_IS_15	ORDINARY EARTH	51.7	3	1551000	930600	26°10'17.49"N 26°10'21.47"N 26°10'16.43"N 26° 9'58.57"N 26° 9'58.35"N	92°35'38.42"E 92°36'4.25"E 92°36'11.29"E 92°35'55.86"E 92°35'43.74"E
16	NGN_PRO_IS_16	ORDINARY EARTH	18.6	3	558000	334800	26° 8'17.46"N 26° 8'9.94"N 26° 8'19.20"N 26° 8'26.69"N 26° 8'25.75"N	92°34'1.01"E 92°34'17.31"E 92°34'23.26"E 92°34'8.13"E 92°34'4.19"E
17	NGN_PRO_IS_17	ORDINARY EARTH	48.5	3	1455000	873000	26° 3'20.76"N 26° 3'26.86"N 26° 3'13.88"N 26° 2'57.24"N 26° 3'2.21"N	92°35'12.78"E 92°35'25.13"E 92°35'42.33"E 92°35'17.75"E 92°35'10.98"E
18	NGN_PRO_IS_18	ORDINARY EARTH	33.9	3	1017000	610200	26° 1'46.68"N 26° 1'41.86"N 26° 2'8.96"N	92°35'12.55"E 92°35'31.63"E 92°35'54.78"E

19	NGN_PRO_IS_19	ORDINARY EARTH	53.7	3	1611000	966600	25°59'47.09"N 25°59'32.66"N 25°59'16.93"N 25°59'23.14"N	92°33'58.57"E 92°33'39.50"E 92°34'13.45"E 92°34'24.56"E
20	NGN_PRO_IS_20	ORDINARY EARTH	30.3	3	909000	545400	25°59'49.00"N 25°59'39.96"N 25°59'46.71"N 25°59'52.81"N	92°37'8.29"E 92°37'10.00"E 92°37'41.91"E 92°37'40.75"E
21	NGN_PRO_IS_21	STONE	82	3	2460000	1476000	26°32'39.02"N 26°32'51.20"N 26°33'3.37"N 26°32'52.42"N 26°32'35.13"N 26°32'31.51"N	93° 0'41.19"E 93° 0'48.55"E 93° 1'21.99"E 93° 1'30.41"E 93° 1'19.16"E 93° 0'55.78"E
22	NGN_PRO_IS_22	ORDINARY EARTH	55.5	3	1665000	999000	26°32'2.65"N 26°31'41.25"N 26°31'43.51"N 26°31'58.46"N 26°32'7.63"N	92°57'44.50"E 92°57'44.57"E 92°58'5.89"E 92°58'19.59"E 92°58'5.88"E
23	NGN_PRO_IS_23	STONE	92.7	3	2781000	1668600	26°18'26.68"N 26°18'49.04"N 26°18'14.42"N 26°18'5.39"N	92°52'25.70"E 92°52'50.31"E 92°53'12.00"E 92°52'38.39"E
24	NGN_PRO_IS_24	ORDINARY EARTH	132	3	3960000	2376000	26°17'22.52"N 26°17'43.07"N 26°17'31.24"N 26°17'7.02"N	92°47'53.54"E 92°48'42.44"E 92°48'55.97"E 92°48'57.76"E
25	NGN_PRO_IS_25	ORDINARY EARTH	86.9	3	2607000	1564200	26°14'58.45"N 26°14'51.16"N 26°14'30.06"N 26°14'22.58"N	92°45'34.11"E 92°46'1.68"E 92°45'57.38"E 92°45'39.86"E

							26°14'32.83"N	92°45'18.26"E
26	NGN_PRO_IS_26	STONE	101	3	3030000	1818000	26°33'19.76"N 26°33'2.98"N 26°32'52.87"N 26°33'10.29"N	93° 2'8.45"E 93° 1'58.51"E 93° 3'0.76"E 93° 3'13.04"E
27	NGN_PRO_IS_27	STONE	121	3	3630000	2178000	26°19'17.51"N 26°18'55.34"N 26°18'38.69"N 26°18'59.00"N	92°53'17.48"E 92°53'12.81"E 92°53'57.54"E 92°54'17.76"E
28	NGN_PRO_IS_28	ORDINARY EARTH	169	3	5070000	3042000	26°16'27.89"N 26°16'24.65"N 26°15'27.43"N 26°15'33.18"N	92°47'45.35"E 92°48'20.57"E 92°47'59.61"E 92°47'38.06"E
29	NGN_PRO_IS_29	STONE	97.1	3	2913000	1747800	26°13'47.18"N 26°14'4.08"N 26°13'43.16"N 26°13'31.93"N 26°13'25.40"N	92°48'28.58"E 92°48'42.53"E 92°49'24.89"E 92°49'26.00"E 92°49'10.97"E
TOTAL			**2175.4**		**65262000**	**39157200**		

- **Final List of proposed Patta Lands/Khatedari land**

Owner	Sl. No.	Area (hectare)	Latitude	Longitude	District	Tehsil	Village	Khasra No	Type of Material	Total Reserve (CUM)	Total Mineral to be mined (CUM)	Existing/ Proposed
NA												

- **Final List of Proposed De-siltation location (Lake, Pond, Dams, River):**

Name	Maintain/Controlled by Sate Govt./PSU etc.	Location	Khasra No.	District	Tehsil	Village	Size (Ha)	Quantity (CUM/Year)	Existing / Proposed
NA									

- **Final List of Proposed M-Sand Plants:**

Sl. No.	Plant Name	Owner	District	Tehsil	Village	Geolocation		Quantity / Capacity (Tonnes/Annum)	Existing / proposed
						Latitude	Longitude		
NA									

ANNEXURE – VI

- **Final list of Cluster and Contiguous Clusters**

- **Cluster details (Riverbed)**

River Name	Cluster No.	Lease No.	Location (Riverbed/Patta Land)	Tehsil	Area (in Ha)	Total Excavation (CUM)	Total Mineable Mineral Excavation (CUM)
NA							

- **Contiguous Cluster details**

River Name	Contiguous Cluster No.	Cluster No.	Number of leases in the cluster	Location (Riverbed /Patta Land)	Distance between clusters	Tehsil	Area of Cluster (Ha)	Total Mineral Excavation (Ton)
NA								

- **Note: The final Cluster details shall be as per the approved mine plan and as per the environment clearance granted by the competent authority.**

ANNEXURE – VII

- **Final Transportation Routes for individual Zones and Zones in Cluster(s): (Proposed)**

➢ Transportation Routes for individual leases details (Riverbed)

Lease No.	Transportation Route No.	Number of tippers /days of lease	Number of tippers /days of all the lease on route	Length of the Route in Km	Type of Road (black Topped/ unpaved)	Recommendation for road (Black Topped/ unpaved)	The road will be constructed by Govt. / Lease Owner	Route Map & Location
NA								

➢ Transportation Routes for leases in Cluster details (Riverbed)

Cluster No.	Transportation Route No.	Number of tippers / days of cluster	Number of tippers / days of all the clusters on route	Length of Route in km	Type of Road (Black Topped / unpaved)	Recommendation for road (Black Topped / unpaved)	The road will be Constructed by Govt. / Lease Owner	Route Map & Location
NA								

- **Note: The final transportation routes shall be as per the approved mine plan and as per the environment clearance granted by the competent authority.**