Initial Environmental Examination

Project Number: 56283-001
July 2023

India: Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project in Assam

(Dibrugarh Subproject including Tinsukia District)

Prepared by the Flood and River Erosion Management Agency of Assam for the Asian Development Bank.

CURRENCY EQUIVALENTS

(As of 22 May 2023)
Currency unit - Indian rupee (₹)
1.00 = $0.012
$1.00 = 82.82

ABBREVIATIONS

AADB	-	Assam Agroforestry Development Board
ADB	-	Asian Development Bank
AIFRERMIP	-	Assam Integrated Flood and Riverbank Erosion Risks Management Investment Program
AIWTDS	-	Assam Inland Water Transport Development Society
ASDMA	-	Assam State Disaster Management Authority
CbFRM	-	Community-based flood/disaster risk management
DMO	-	Disaster Management Organization
EARF	-	Environmental Assessment and Review Framework
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
EMoP	-	Environmental Monitoring Plan
EMP	-	Environmental Management Plan
FREMAA	-	Flood and River Erosion Management Agency of Assam
FRERM	-	Flood and Riverbank Erosion Risk Management
IEE	-	Initial Environmental Examination
IUCN	-	International Union for Conservation of Nature IWAI
	-	Inland Water Transport Authority
MFF	-	Multitranche financing facility
MoEF&CC	-	Ministry of Environment Forest and Climate Change
NGO	-	Non-Government Organization
PISC	-	Project Implementation Support Consultant
PIU	-	Project Implementation Unit
PMU	-	Project Management Unit
PPTA	-	Project Preparatory Technical Assistance
PCB	-	Pollution Control Board
WRD	-	Water Resources Department

WEIGHTS AND MEASURES

dB	-	decibel
ha	-	hectare
km^2	-	square kilometer
km	-	kilometer
m	-	meter
mm	-	millimeter
m^3/s	-	cubic meter per second
l	-	liter

GLOSSARY

Porcupine	Tetrahedron-shaped concrete frames commonly made of six concrete members, each 3 meters long connected with bolts, which are placed in an arrayed manner in the riverbed to retard river water flow and induce sedimentation.
Revetment	A riverbank protection structure constructed on the bottom or banks of a river by placing a layer of material, such as rock, stones, concrete blocks, or mattresses including sand-filled geo-textile containers.
Spur	A river training structure built from the bank of a river in a direction transverse to the current, by placing a large quantity of rocks, stones, or concrete blocks (or earth armored with these heavy materials).

NOTES

(i) The fiscal year (FY) of the Government of India ends on 31 March. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2023 ends on 31 March 2023.

(ii) In this report, "$" refers to US dollars.

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EXECUTIVE SUMMARY

A. The proposed Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project (CRBIFRERMP) in Assam will build on the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP) to increase the reliability and effectiveness of flood and riverbank erosion risk management (FRERM) systems in flood-prone areas.[1] It will focus on the climate-resilient, holistic, integrated, systematic, and reach-wise approach to managing riverbank erosion and the attendant flood risk of the Brahmaputra River in the selected five selected project districts in Assam.

B. Climate impacts are projected to worsen the floods and riverbank erosion while Assam already suffers from recurrent flooding and continual riverbank erosion from the Brahmaputra River.[2] These are critical development inhibitors of the state as natural hazards and remoteness have led to long-term slower development than the national average, while population growth and density are similar. Therefore, Assam continues to face high poverty, and its socio-economic development has stalled.

C. To continue the outcome of AIFRERMIP, the project will focus on (i) applying and demonstrating a comprehensive integrated risk-informed approach to build climate and disaster resilience; (ii) transferring knowledge and advanced technologies and practices for holistic natural resources management, asset management, and co-benefits optimization; and (iii) enhancing women's climate and disaster resilience and empowerment. Also, the project will leverage benefits from and collaborate with a World Bank investment aiming at improving integrated water resources management along selected tributaries of the Brahmaputra River system in Assam.[3]

D. The project is aligned with the following impact: make Assam a disaster resilient state (encompassing substantial and inclusive disaster risk reduction; reduction in loss of lives and livelihoods; increased protection of property and assets; and enhanced capacity to cope with disasters).[4] The project will have the following outcome: climate resilient flood and riverbank erosion mitigation systems in the Brahmaputra River enhanced.

E. The project will combine structural and non-structural measures in four high-priority flood- and erosion prone areas to contribute to the broader stabilization of the river. The four high-priority subprojects characterized by a high risk of riverbank erosion, and valuable assets under threat, are: Dibrugarh (Dibrugarh and Tinsukia Districts), Morigaon, Palasbari-Gumi/Guwahati West (Kamrup rural District) or PGP, and Goalpara. The project CRBIFRERMP aims at delivering on following outputs:

(i) Output 1: Climate resilient flood and riverbank erosion risk mitigation measures implemented and maintained in subproject areas.

(ii) Output 2: Knowledge-based FRERM planning strengthened.

(iii) Output 3: Vulnerable people's livelihoods and resilience improved.

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[1] ADB. 2010. Report and Recommendation of the President to the Board of Directors: Multitranche Financing Facility - India: Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program. Manila.

[2] Since the Great Assam Earthquake in 1950, the river has widened from about 6 kilometers (km) to 9 km along its 650 km course in Assam eroding about 5.5% of Assam cultivable area destroying roads, homesteads, crops, and flood defenses. Since 1954, around 427,000 hectares (ha) of land (equivalent to about 7% of Assam area) have been eroded at an average annual erosion rate of 8,000 ha. Between 2000 and 2018, 93 locations eroded along the main stem of the Brahmaputra River in Assam causing damages to a total length of more than 400 km. Also, 40% of Assam area is prone to flooding by the Brahmaputra River and its tributaries, which is 9.4% of the national flood prone area.

[3] The World Bank-financed Assam Integrated River Basin Management Program (AIRBMP) ($108 million loan) approval is anticipated in early 2023. It is the first phase of a $500 million multiphase programmatic approach.

[4] Assam State Disaster Management Authority. 2022. Assam State Disaster Management Plan 2022 Vol. I. (p. 14).

F. Among the non-structural measures Nature-based solutions (NbS) e.g., bioengineering techniques such as the planting of reeds will be pilot tested to be applied to embankment slopes to reduce maintenance requirements from the risk of rain cuts and to provide local stakeholders with income generating activities opportunities through Assam Agroforestry Development Board (AADB). AADB will establish a PIU which will be responsible for implementing the nature-based solutions.

G. This proposed Dibrugarh subproject including Tinsukia District focuses on continuation of flood protection works along the Brahmaputra River. The subproject will involve erosion protection by construction of bank revetment and apron for a total length of 21.26 km is proposed out of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia. Adaptation works/emergency contingency works total of 4.65 km is proposed to be undertaken at 4 locations in Dibrugarh. Also, a total of 173 numbers of P.S.C porcupine over 3 layers are proposed to be launched in 5 locations in Dibrugarh and 2 locations in Tinsukia. For 5 locations in Dibrugarh, 72 number of porcupines, while a total of 101 number of porcupines are proposed to be launched at 2 locations in Tinsukia. Additionally, construction of 1.2 km (new) close gap in embankment at Maijan Beel in Dibrugarh is proposed. A reinforced concrete cement (RCC) triple shutter sluice gate in Maijan Beel embankment with regulator and fish pass is also proposed. Adaption works of 4.65 km at 3 locations of Dibrugarh with geo-bags is also proposed.

H. As per the Government of India (GOI) environmental impact assessment (EIA) Notification, 2006, this subproject does not require Prior Environmental Clearance (EC) from Ministry of Forest, Environment and Climate Change (MoEF&CC) or State Environmental Impact Assessment Authority (SEIAA). However, if new quarries (for sand and aggregates) will be opened, the subproject should obtain Prior EC and various government permissions including requirement from Pollution Control Board Assam (PCBA). In view of SPS 2009, the categorization of the project was determined using ADB rapid environmental assessment (REA) checklist. Through this checklist, the environmental categorization of CRBIFRERMP was determined by its most environmentally sensitive component that includes direct, indirect, cumulative, and induced impacts in the area of influence. The potential negative impacts were identified in relation to pre-construction, construction and operation phases through due diligence and compliance with environmental requirements of SPS 2009. Dibrugarh Subproject was assessed according to its components, location, scale, and sensitivity and the magnitude of its potential environmental impacts, and documented in this IEE.

I. Environmental assessment has been conducted for Dibrugarh Subproject based on detailed project report (DPR) made available by Flood and River Erosion Management Agency of Assam (FREMAA) and Water Resources Department (WRD) and the data provided by LEA Associates South Asian Pvt Ltd (LASA). LASA has been appointed by FREEMA for data collection, and their scope included (i) environmental quality monitoring for air, water, noise and soil; (ii) wildlife and habitat surveys; (iii) physical and socio-economic data including geographical information system (GIS) mapping for land use; (iv) environmental risks identification and analysis; and (v) public consultations. Based on the environmental assessments of the subproject (i.e. risk rating approach), the potential environmental impacts are not adverse, site-specific and few of them are irreversible. In most cases, mitigation measures are designed which are commonly used at construction sites and known to civil works contractors.

J. Dibrugarh subproject including Tinsukia is partly located in Dibrugarh District and Tinsukia District is classified as **Environmental Category B** as per the Safeguards Policy Statement (SPS) 2009 as no significant impacts are envisaged. Accordingly, this Initial Environmental Examination (IEE) assesses the environmental impacts and provides mitigation and monitoring measures to ensure that there are no significant impacts as a result of the project.

K. Negative impacts are not anticipated in protected areas (PA). There is 1 notified protected area (i.e., Dibru - Saikhowa National Park [NP]) within 1 km of the project intervention areas in Dibrugarh District, and 2 PAs in Tinsukia District (Dibru - Saikhowa NP and Bherjan-Borajan-Podumoni Wildlife Sanctuary [WLS]) within 1 km of the project intervention areas. The eco-sensitive

zone (ESZ) of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites are adjacent to or within the notified area of the ESZ of the Dibru - Saikhowa NP. The ESZ of Bherjan-Borajan-Podumoni WLS is notified as well, and subproject sites are outside the ESZ. On 14th July 2023, FREEMA obtained no objection letter from the Office of the Principal Chief Conservator of Forest (Wildlife) and Chief Wildlife Warden, Assam for construction activities within the ESZ of Dibru - Saikhowa NP. As part of condition, the project will ensure that (i) no porcupines will be installed and no adverse impact shall be caused to Ganges River Dolphin (*Platanista gangetica*) and other riparian wildlife including their habitat during project implementation. Ganges River Dolphins and other endangered species found in the Brahmaputra River and other nearby areas are not exclusive to the project site. Based on biodiversity report prepared by LEA Associates South Asian Pvt Ltd (LASA), Ganges River Dolphin has been reported from consultee within 100m - 1 km from the riverbanks, but primarily in the main channels of the Brahmaputra River

L. The area of analysis (i.e., 1 km) for critical habitat assessment has been taken up for all subprojects. In addition to the protected areas and IBA, considering International Finance Corporation (IFC) Performance Standard 6 thresholds, it is determined presence of Ganges River Dolphin (an IUCN endangered species) may trigger critical habitat. The primary surveys were carried out summer period (March – April 2023), and couldn't sight any Ganges River Dolphin in the subproject areas. The presence of this species was noted through secondary data sources (i.e. consultations with locals and fishermen). The secondary data doesn't conclusively establish the presence of ≥ 0.5% of the global population AND ≥ 5 reproductive units of the Dolphins in the subproject areas (Criteria 1a and 1c for critical habitat, IFC). The project is in a highly modified area, where anthropogenic activities are found around the riverbanks such as fishing, agriculture, tea gardens and settlements. There may be potential impact to Ganges River Dolphins due to transport of materials for the works through barges. However, construction works will be done during dry season when dolphins are in the deep channels and not nearby river banks. On the other hand, subproject is critical habitat due to fishing activities of local people - areas having biodiversity of significant social, economic, or cultural importance to local communities. The Dibrugarh subproject also triggers possible critical habitat due to proximity to Dibru-Saikhowa National park. ADB SPS, 2009 requires no net loss of biodiversity for a critical habitat area. The project will demonstrate measures on the lesser impacts to biodiversity through Nature-based solutions (NbS) such as bioengineering techniques of planting reeds along embankment slopes. A Biodiversity Action Plan (BAP) was prepared to provide actions in managing risks against wildlife in the area. It is also proposed that PISC shall be conducting a detailed biodiversity and ecology survey and assessment for the entire project area (encompassing the four subproject areas) during the project implementation period. The data collected from the surveys will further bolster the population census data of the Ganges River Dolphin. The PISC and PMU shall subsequently include the results and any revisions of the BAP to update IEE and submitted to ADB for necessary actions for disclosure.

M. However, no damage to the habitat of these species is anticipated at this stage. There are no other environmental sensitive resources found in the project area which are likely to be affected by the project. Efforts shall also be made by the contractors to ensure that construction waste does not end up in the water and channels are not obstructed. The geo-bags and other material used by the WRD as emergency flood protection measures needs to be properly disposed. All works along the river areas are minor and involve mostly earth works by local workers. Construction camps will be located outside of the villages and destruction of the existing vegetation will be minimum. Furthermore, care will be taken for construction not to obstruct the breeding period (April - August) in the fish breeding sites.

N. During the construction phase, a number of trees along the embankment are likely to be cut. If the compensatory afforestation at the rate of 1:10 (10 trees to be planted against each tree cut) are implemented effectively and survival rates are monitored, the result will be positive. The cost of compensatory afforestation is part of EMP. Project activities are likely to induce other environmental impacts during construction, but these will be temporary and reversible. Implementation of the prescribed mitigation measures in Chapter 6 (Anticipated Environmental Impacts and Mitigation

Measures) including the environmental management plan and monitoring plan will minimize temporary impacts.

O. The land acquisition and resettlement impact are likely triggered in both the anti-erosion works and flood protection works and the new embankment constructions involving both legal title holders and squatters. The Resettlement Plan (RP) being prepared parallelly for the subproject shall cover the details of the households likely to be affected and compensation to the affected persons as applicable per ADB SPS, national and state laws.

P. The stakeholders were involved in developing the IEE through discussions on-site and a public consultation workshop at village level, after which views expressed were incorporated into the IEE and in the planning and development of the project. Apart from on-site public consultations, secondary stakeholder5 meetings were held. The IEE will be made available at public locations and will be disclosed to a wider audience via the ADB and FREMAA websites. The consultation process will be continued and expanded during project implementation to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation. A grievance redress mechanism (GRM) is described within the IEE to ensure any public grievances are addressed quickly.

Q. The institutional arrangement for implementing EMP has been established. The Project Management Unit (PMU) will take an overall responsibility to implement the EMP and to address other environmental issues associated with the project, if any. The PMU is supported by an environment specialist to ensure compliance with environmental safeguards. The PMU will be assisted by WRD and AADB as project implementation units (PIUs). WRD's PIU will be supported by two Environment Officers for implementing the environmental safeguard requirements. The monitoring system has also been developed. The contractor will appoint an Environment, Health and Safety officer/focal person and will be required to submit a report on the implementation of the EMP on monthly basis while the PIU will also routinely carry out field monitoring. The PMU will be assisted also by the project implementation support consultant's team with an environmental specialist as member of the team. Annual reports on monitoring the implementation of the EMP and monitoring environmental quality will be submitted to ADB.

R. The proposed subproject will have net benefits in terms of soil erosion and preventing progression of land loss. It is estimated that benefited area will be about 26819 hectares (approximately) in Dibrugarh and 400000 hectares (approximately) in Tinsukia. The project is expected to benefit a population of 180000 in Dibrugarh and 300000 in Tinsukia. The project is likely to bring positive impact to wetlands, pond fisheries and agricultural productivity due to protection from flood and reduced sedimentation. The introduction of NbS (pilot) shall be beneficial in strengthening the flood protection works and embankment besides rejuvenating some wetlands along the Brahmaputra basis.

S. The project activities shall have an incremental impact on the local socio-economics by; (a) reducing impact of annual floods, (b) increase source of livelihood in agriculture, fisheries, etc. thus aiding poverty reduction, (c) creating employment opportunities in this project and else, (d) women involvement and empowerment, and (e) reducing the negative impacts of climate change. The project shall have overall positive impact on the life of the inhabitants in the subproject area.

T. Overall, there are no significant negative environmental and socio-economic impacts associated with the proposed project that cannot be mitigated to negligible or acceptable levels. There is full local community acceptance of the project. All required mitigation measures and monitoring are documented in the EMP. The observations and conclusions from the IEE, the project

[5] Including various departments of Guwahati University, community in general, forest and wildlife department, fisheries and agriculture department, PCBA, Agriculture and Fisheries departments, Brahmaputra Board, Assam Inland Waterways Transport Development Society (AIWTDS), Assam Rural Infrastructure and Agricultural Services (ARIAS) Society, Assam Agribusiness and Rural Transformation Project (APART), Assam Project on Forest and Biodiversity Conservation Society (APFBCS), various NGOs and CBOs, and the executing and implementing agencies (FREMAA, WRD, AADB,) etc.

appears to be acceptable for implementation, as designed according to GoI and ADB environmental and technical standards and policy requirements.

I. INTRODUCTION

A. Project Background

1. The livelihoods of people in the state of Assam are affected by water-related disasters including floods and riverbank erosion especially due to the vast flat floodplain of the Brahmaputra River - one of the world's largest rivers. Climate change impacts exacerbate these disasters and are projected to worsen the floods and riverbank erosion while Assam already suffers from recurrent flooding and continual riverbank erosion from the Brahmaputra River. These are critical development inhibitors of the state as natural hazards and remoteness have led to long-term slower development than the national average, while population growth and density are similar. Therefore, Assam continues to face high poverty, and its socioeconomic development has been hindered.

2. Riverbank erosion is one of the most prominent causes of disasters in Assam due to highly dynamic morphology of the Brahmaputra River and its tributaries. Since the Great Assam Earthquake in 1950, the river has widened from about 6 kilometers (km) to 9 km along its 650 km course in Assam eroding about 5.5% of Assam cultivable area destroying roads, homesteads, crops, and flood embankments. Since 1954, around 427,000 hectares (ha) of land (equivalent to about 7% of Assam area) have been eroded at an average annual erosion rate of 8,000 ha. Between 2000 and 2018, 93 locations eroded along the main stem of the Brahmaputra River in Assam causing damages to a total length of more than 400 km. Riverbank erosion disproportionately affects the poor, who face significant social hardships, such as loss of homesteads, lands, and crops, and are often displaced to fringe lands or urban slums. Disaster risks increase as the population grows, and the high population density of the state hinders people moving away from disaster-prone areas.

3. Erosion damage also extends to public infrastructure, including roads and flood embankments, and the high occurrence of riverbank erosion hinders construction and rehabilitation of flood embankments. About 40% of the state (ie: about 9.4% of the national flood prone area) is inundated on average annually during the monsoon by the Brahmaputra River and its tributaries, resulting in damages and loss of assets and crops. The threat of recurrent floods and riverbank erosion also discourages investment and leads to lower economic growth in the riparian areas. Effective flood and riverbank erosion risk management is therefore essential for economic growth, livelihood improvement, and poverty reduction in these locations. With a growing population as well as the expansion of settlements within the floodplain, future development will need to be carefully managed to protect the population from water-induced disasters. In addition, most of the length of the existing embankments system cannot be relied upon for protection from floods; during severe flood events, embankments are often overtopped or even breach which often leads to disaster. Furthermore, the growing population demands more reliable protection from riverbank erosion and flooding to safeguard their increasing assets and to sustain economic development.

4. Securing the livelihoods of the population living on floodplain needs to be addressed through public sector interventions aiming at: (i) mitigating the economic losses and social displacement caused by riverbank erosion, (ii) reducing the economic losses resulting from flooding, and (iii) providing a secure environment to facilitate an increase in agricultural and industrial production and to enhance related economic activities.

5. The multitranche financing facility (MFF) between the Government of India and the Asian Development Bank (ADB) for the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP) was approved by ADB in 2010. The facility increased the reliability and effectiveness of flood and riverbank erosion risk management systems in priority reaches along three subprojects of the Brahmaputra River through structural and nonstructural interventions, policy strengthening, and institutional and knowledge bases. The second and final tranche of the MFF was physically completed on 18 October 2020. Over the past 20 years, ADB

has supported development and innovation of a cost-effective systematic river stabilization approach introduced in Assam in 2010 via AIFRERMIP, providing a first opportunity to increase the state's disaster resilience and paving the way for replicability.

6. Under the AIFRERMIP, the currently named Flood and River Erosion Management Agency of Assam (FREMAA) was established by the state government as the project's executing agency to demonstrate holistic and sustainable FRERM in partnership with ADB. The investment has demonstrably strengthened FREMAA through capacity building.

7. Following the request of the State Government of Assam for a follow-on project, in early 2022, the Department of Economic Affairs (DEA) Government of India (GoI) posted to ADB a follow-on investment for external assistance of $400 million under which urban, suburban, and productive rural and other strategic sites have been prioritized for protection by improving key flood and riverbank erosion risk management (FRERM) infrastructure, such as flood embankments, riverbank protection, and flood management structures, and by enhancing or introducing a range of nonstructural protective measures to development capacity at state and local communities level. The title of this new investment is Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project (CRBIFRERMP) in Assam.

8. The CRBIFRERMP proposed to be financed by ADB will focus on the main stem of the Brahmaputra River in Assam and follow a climate resilient, holistic, integrated, systematic, and reach-wise approach to managing riverbank erosion and the attendant flood risk, while the World Bank-financed Assam Integrated River Basin Management Program (AIRBMP) focuses on river basins of selected tributaries of the Brahmaputra River in Assam.

9. The project will combine structural and nonstructural measures in four high-priority flood- and erosion prone areas to contribute to the broader stabilization of the river. The four high-priority subprojects characterized by a high risk of riverbank erosion, and valuable assets under threat, are: Dibrugarh, Palasbari-Gumi/Guwahati West, Morigaon, and Goalpara.

(i) **Output 1: Climate resilient flood and riverbank erosion risk mitigation measures implemented and maintained in subproject areas.** The project will combine structural and nonstructural measures in four subproject areas to stabilize their river reaches by applying an integrated river stabilization approach that was developed and refined under the earlier ADB-financed Jamuna–Meghna River Erosion Mitigation Project (JMREMP), AIFRERMIP, and the ongoing Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) in Bangladesh.[6] Specifically, this output will include: (i) constructing about 60 km of riverbank erosion protection and 14 km of adaptation/emergency works to stabilize the river and improve the river's navigability; (ii) placing about 32 km (194 screens) of pro-siltation measures such as porcupines to induce sediment deposition thereby reclaiming riverine land; and (iii) constructing/rehabilitating/widening about 4.0 km of climate resilient flood embankments including regulators, fish passes and drainage structures in critical areas to maintain river-floodplain interconnectivity to enhance biodiversity.[7] See Appendix 1 and 2 for details of the scope of works. As learned from prior investments, construction contracts will include provisions for five years of monitoring, adaptive maintenance, and emergency works from construction completion, to improve

[6] ADB. 2014. *Report and Recommendation of the President to the Board of Directors: Multitranche Financing Facility to Bangladesh: Flood and Riverbank Erosion Risk Management Investment Program.* Manila. Innovative features developed under JMREMP, AIFRERMIP, and FRERMIP, include sustainable low-cost sand-filled geotextile bag revetments placed underwater in combination with nature-based solutions will be expanded under the project.

[7] The new or rehabilitated embankments will be designed to accommodate: (i) multipurpose use, (ii) a 100-year flood return period water level, including sufficient base width and freeboard for climate impacts related increases in water levels.

sustainability. Nature-based solutions, such as reed plantations that promote sediment deposition and reduce rain cuts on slopes, will be pilot tested.

(ii) **Output 2: Knowledge-based FRERM planning strengthened.** This output will further develop key agencies' knowledge bases by improving various decision support tools initiated under AIFRERMIP and will strengthen the state's institutional capacity to deliver FRERM, thereby promoting disaster resilience of the state and affected communities. Specifically, Output 2 will: (i) strengthen flood forecasting and early warning systems in close collaboration with others; (ii) undertake flood mapping to identify people and infrastructure at risk of flooding and facilitate better land use planning and management on risk-sensitive land; (iii) improve erosion prediction and embankment breach models to prioritize maintenance; (iv) enhance asset management systems and conduct life-cycle reliability analyses to improve budget and maintenance decisions; (v) gather data through topographic and bathymetric surveys, flow and sediment measurements, and asset condition surveys; and (vii) strengthen existing guidelines for flood and riverbank protection design to address climate impacts and resilience, update river stabilization principles, and document the effectiveness of nature-based solutions. These outputs will also contribute to an update of the 2020 Flood and Erosion Management Plan.

(iii) **Output 3: Vulnerable people's livelihoods and resilience improved.** This output will directly improve the livelihoods and disaster resilience of poor and destitute people living on the flood embankments and *charlands* within the project areas and who are routinely severely affected by floods and riverbank erosion. It will specifically target women. Interventions will: (i) establish modern weaving centers, provide sewing machines, and train female headed households and female self-help groups to spin, weave, and market silk; (ii) increase vegetable production by providing climate resilient seeds, promoting improved agricultural practices, and extending marketing support; (iii) provide vocational training for unemployed youth; (iv) raise awareness on flood and riverbank erosion; and (v) strengthen disaster preparedness and emergency response (through also provision of equipment at district/regional level). Support for subsistence and small farmers will include: (i) assistance creating agriculture and fisheries businesses; (ii) identifying alternative income opportunities associated with the nature-based solutions in Output 1;[8] and (iii) improving rural markets. Further, the graduation approach will be piloted to complement the various state-led initiatives that strengthen beneficiaries' wellbeing by providing livelihood assistance through agriculture, livestock, fisheries, industries, and vocational training activities.[9] Beneficiaries will be producer collectives registered as Farmer Producer Companies (FPC) in the vicinity of the Brahmaputra River.

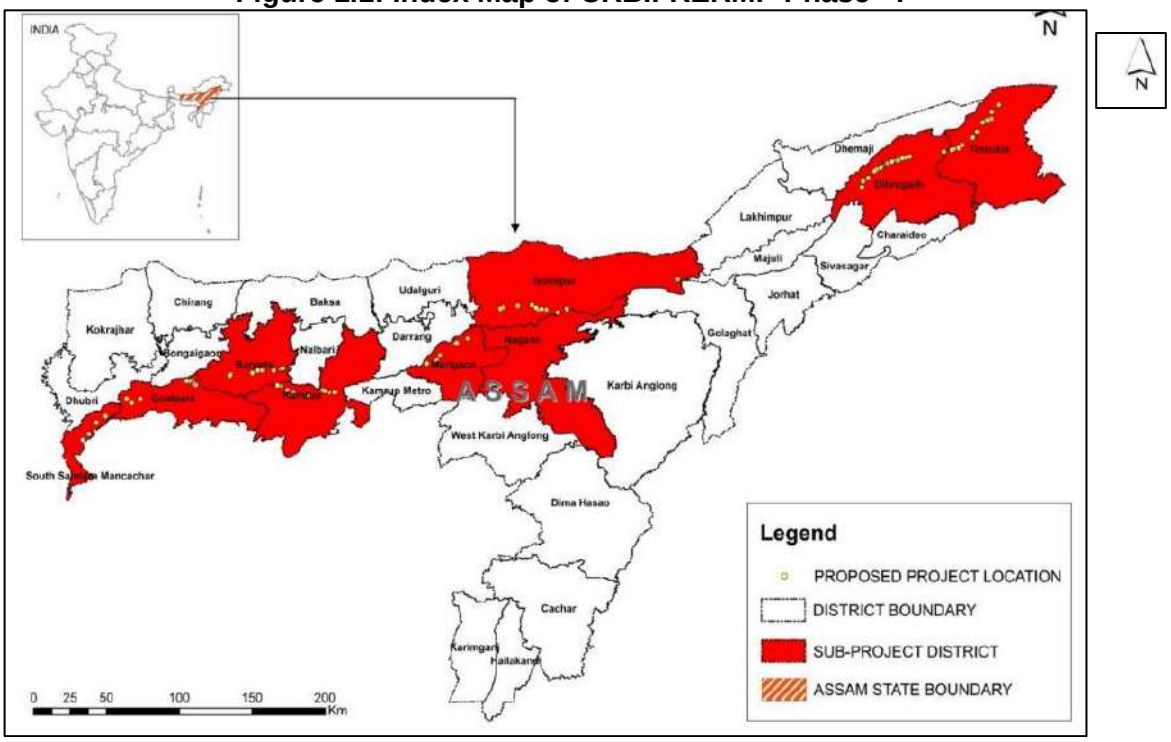
B. Subproject Locations and Components

10. Under CRBIFRERMP four high-priority subprojects characterized by a high risk of riverbank erosion, and valuable assets under threat have been selected. The location of the subproject locations are (i) Dibrugarh, (ii) Palasbari-Gumi/Guwahati West, (iii) Morigaon, and (iv) Goalpara are shown in Figure 1-1. This report covers the IEE of subproject in Dibrugarh -including Tinsukia District.

[8] New livelihood opportunities will arise from nature-based solutions along embankment slopes and reed plantations on charlands as well as from the revival of *beels* resulting in new fishing opportunities.

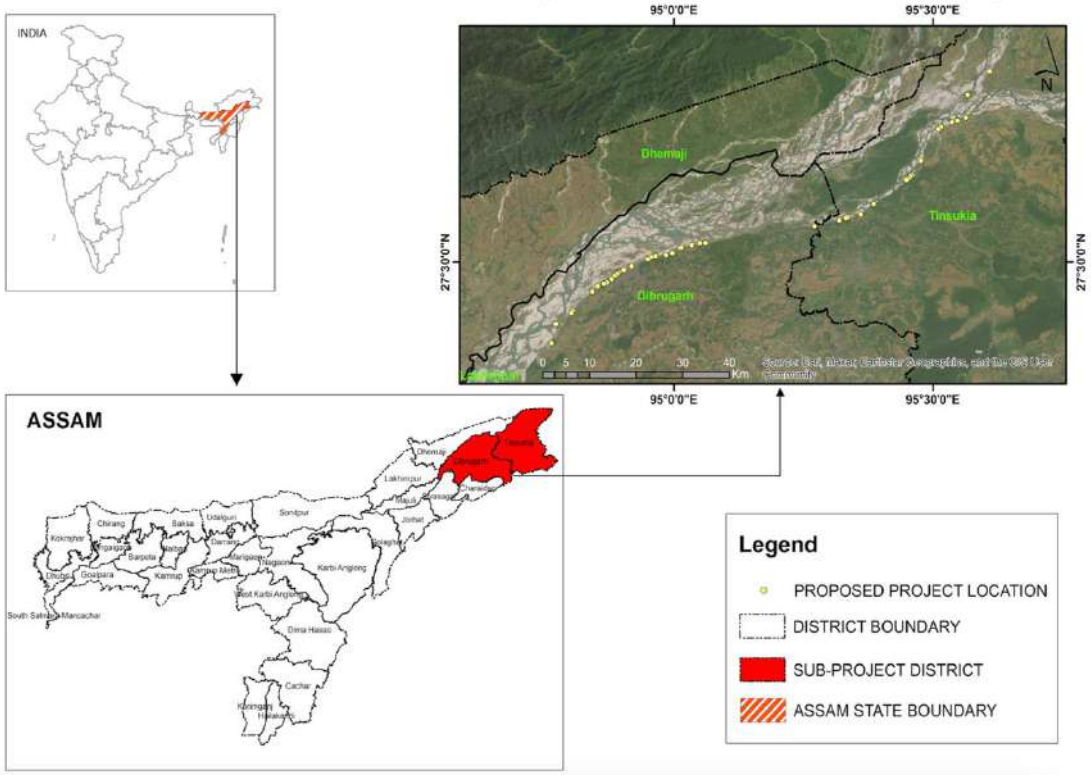
[9] The graduation approach combines cash transfers with an asset transfer, financial inclusion, tailored skills training, livelihood development, social inclusion, and life-skills coaching and psychosocial support. Cash transfers will be made to FPCs, not individuals.

Figure 1.1: Index Map of CRBIFRERMP Phase - I



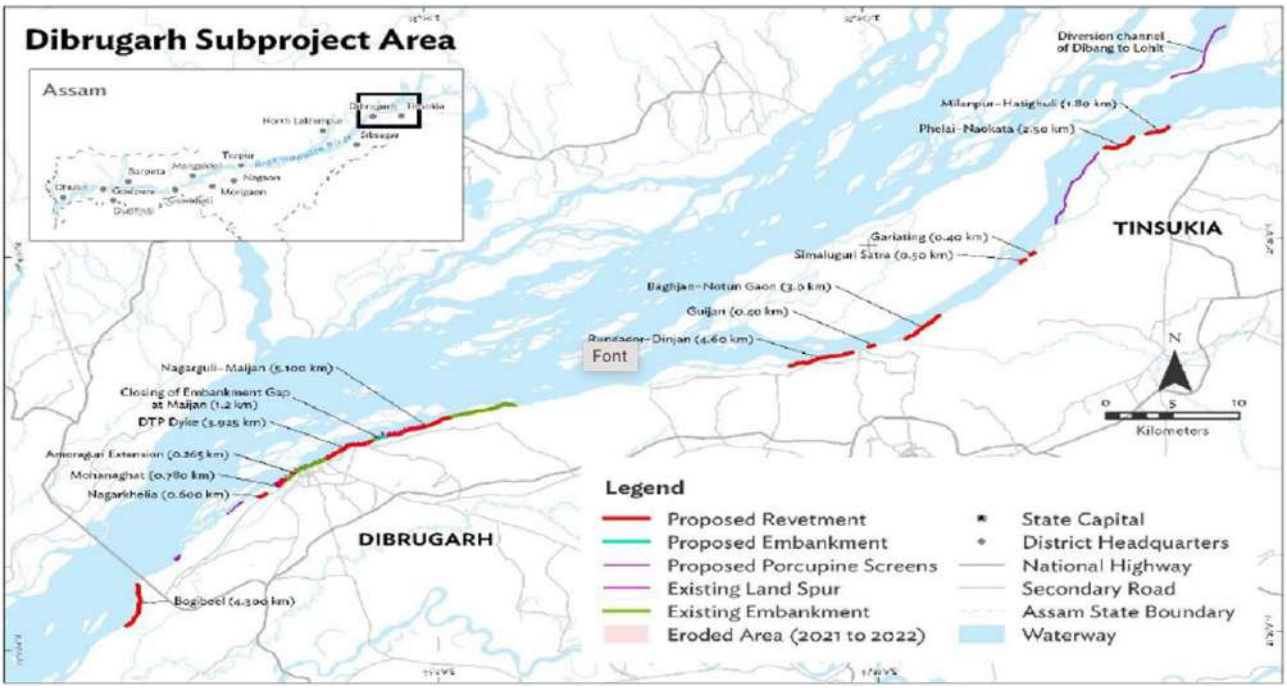
Source: FREMAA and WRD

Figure 1.2: Index Map of Dibrugarh including Tinsukia District Subproject)



Source: FREMAA and WRD

Figure 1.3: Location Map of Dibrugarh including Tinsukia District Subproject)



Source: ADB, WRD and FREMAA

11. The proposed Dibrugarh subproject is partly located in Dibrugarh District and partly in Tinsukia District. The subproject areas of Dibrugarh are located from Nagaghuli to Chaulkhowa on the south bank of Brahmaputra bounded by the geographical co-ordinates of 27°34'12.29"N 95°17'31.26"E to 27°24'29.73"N 94°48'7.66"E. The subproject covers Dibrugarh Town area and its adjoining areas up to Oakland at upstream to Bogibeel areas at downstream. The areas of Tinsukia proposed under this subproject are located in the district of Tinsukia on the south bank of Brahmaputra and is bounded by the geographical co-ordinates of longitude 95°-16'E to 95°-33'E and latitude 27°34 'N to 27°45°N. The project covers South Bank of Brahmaputra from Saikhowaghat - Milanpur area at upstream to Dinjan army camp areas at downstream. The subproject location and alignment are shown in Figures 1-2 and 1-3.

12. Project involves; (i) construction of bank revetment and apron works with geo-bag for a total length of 21.26 km of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia, (ii) adaption works for 4.65 km in Dibrugarh, (iii) pro-siltation measures by providing 173 numbers of P.S.C porcupine screen over 3 layers are proposed of which 72 screens at 5 locations in Dibrugarh and 101 screens at 2 locations in Tinsukia. Further, construction of a 1.2 km (new) close gap in embankment is proposed at Maijan Beel in Dibrugarh which includes a RCC triple shutter sluice gate with fish passes. The project also proposes revival of Maijan beel with nature-based solutions (NbS).

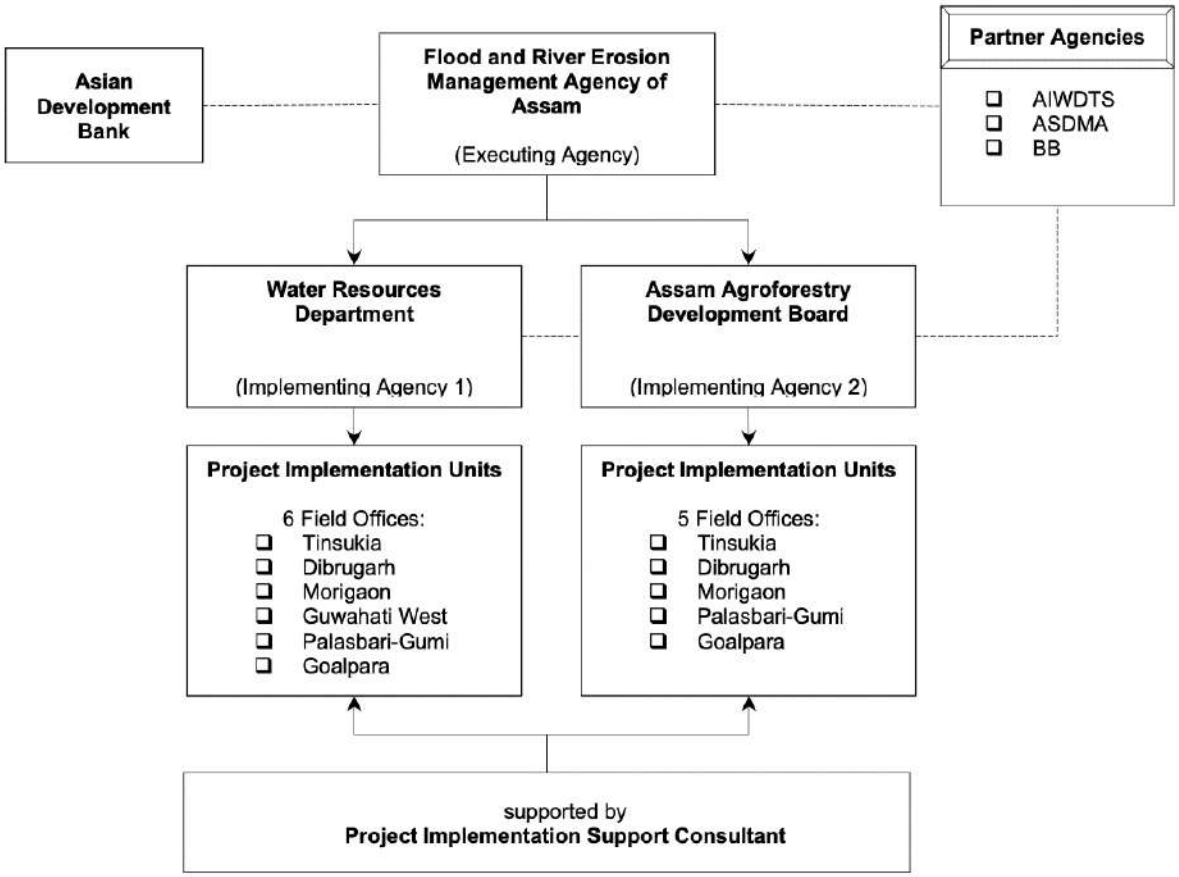
13. This IEE report is prepared to identify any potential impacts and outcome is preparation of an environmental management plan (EMP) to avoid and minimize the impacts.

C. Executing And Implementing Agencies.

14. The project CRBIFRERMP shall be executed by the State of Assam acting through FREMAA as executing agency and acting as PMU. FREMAA, the executing agency, will oversee, monitor progress, lead the land acquisition process, ensure full compliance with environmental and social safeguards, and report the progress. WRD - PIU will be the key implementing agency of the project

and will be responsible for the works (preparation of bidding documents, procurement, implementation, supervision). AADB will be an implementing agency of the project and will be responsible for the nature-based solutions with the support of FREMAA for the procurement. A PISC shall support and provide assistance to PMU/PIU in execution and implementation of the project. The organizational structure of FREMAA is indicated in the Figure 1-4.

Figure 1.4: Organizational Structure for CRBIFRERMP



Source: ADB

D. Purpose of this IEE Report

15. ADB requires the consideration of environmental issues in all aspects of the Bank's operations, and the requirements for environmental assessment are described in ADB's Safeguards Policy Statement (2009). Accordingly, this initial environmental examination (IEE) has been conducted to assess the environmental impacts and provide mitigation and monitoring measures to ensure that impacts will be addressed because of the subprojects.

16. The categorization of the project was determined by using ADB rapid environmental Assessment (REA) checklist (Appendix 3). Due diligence and environmental assessment of the subproject utilized different information such as: (a) environmental quality monitoring for air, water, noise and soil; (b) wildlife and habitat surveys; (c) physical and socio-economic data including geographical information system (GIS) mapping for land use; and (d) public consultations. The potential negative impacts were identified in relation to pre-construction, construction and operation of the infrastructures through environmental risks identification and analysis (see Appendix 13). Results of the assessment show that the subproject is unlikely to cause significant adverse impacts.

Thus, this IEE has been prepared in accordance with ADB SPS requirements for environment Category B.

17. This IEE is prepared for selected subproject area at Dibrugarh including Tinsuka District. The project will combine structural and nonstructural measures in four high-priority flood and erosion prone areas to contribute to the broader stabilization of the river. This IEE is based on the detailed project report prepared by the FREMAA and WRD. The IEE is based mainly on field reconnaissance surveys, field monitoring (environmental) survey and secondary sources of information. Stakeholder consultation is an integral part of the IEE.

18. The implementation of the subprojects will be governed by GoI and the state of Assam, and other applicable environmental acts, rules, regulations, and standards. Environmental safeguards requirements will be followed in accordance with the ADB SPS, 2009. During the design, construction, and operation, the project will apply pollution prevention and control technologies and practices consistent with ADB SPS, 2009 and international good practice, as reflected in internationally recognized standards.

19. FREMAA either directly or through its consultant's shall update the IEE report if there are changes in the designs, components, interventions or project area in the future to adequately reflect the changes.

E. Report Structure

20. The report has been structured in compliance with ADB SPS, 2009 and contains the following ten (10) sections including the executive summary at the beginning of the report:

Executive Summary

I. Introduction

II. Description of the Project

III. Analysis of Alternative

IV. Policy, Legal, and Administrative Framework

V. Description of the Environment

VI. Anticipated Environmental Impacts and Mitigation Measures

VII. Public Consultation and Information Disclosure

VIII. Grievance Redress Mechanism

IX. Environmental Management Plan

X. Conclusion and Recommendations

II. DESCRIPTION OF THE SUBPROJECT

A. Project Area

21. The subproject area Dibrugarh falls in Dibrugarh and Tinsukia Districts of Assam. The subproject sites of Dibrugarh are located from Nagaghuli to Chaulkhowa on the south bank of Brahmaputra bounded by the geographical co-ordinates of 27°34'12.29"N 95°17'31.26"E to 27°24'29.73"N 94°48'7.66"E. The subproject covers Dibrugarh Town area and its adjoining areas up to Oakland at upstream to Bogibeel areas at downstream. The sites of Tinsukia proposed under this subproject are located in the Tinsukia District on the south bank of Brahmaputra and is bounded by the geographical co-ordinates of longitude 95°-16'E to 95°-33'E and latitude 27° 34 'N to 27° 45°N. The project covers South Bank of Brahmaputra from Saikhowaghat - Milanpur area at upstream to Dinjan army camp areas at downstream. The subproject area is approachable by road and is at a distance of 440.9 km from Guwahati the capital city of Assam and is at an elevation of about 110 m from the mean sea level.

22. The subproject area covers very thickly populated villages from Nagaghuli to Chaulakhowa of Dibrugarh and Milanpur to Dinjan of Tinsukia. The benefited area will be about 26819 hectares (approximately) in Dibrugarh and 400000 hectares (approximately) in Tinsukia. The project is expected to benefit a population of 180000 in Dibrugarh and 300000 in Tinsukia. The location of the project area is given in Figure 1-2.

B. Existing situation

23. **Dibrugarh:** The flood-affected areas of Dibrugarh District due to the severe bank erosion of Brahmaputra River are Dinjan, Mulukgaon, Bogoritolia and Rohmoria, which located just downstream of the confluence of Dihang, Dibang, and Lohit rivers at the southern bank of Brahmaputra River. Before the great earthquake of 1950, these areas flourished with socio-economic activities and were naturally enriched with tea gardens, oil installations, coal mining, etc. However, during the Earthquake of 1950, the upper reach of Assam experienced drastic geological and morphological changes which resulted in extreme flood and erosion problems on the southern bank of the Brahmaputra River. Major parts of the important towns were washed away due to erosion, specifically after the earthquake, half of the Dibrugarh town was washed away. To tackle this flood and erosion problem, a series of flood protection structures like embankments and spurs were constructed which successfully and subsequently protected these severely flood and erosion-affected areas. Such activities are continuing as short-term and immediate measures adopted where and when required on a priority basis.

24. Since 1974, it is observed that the flood and erosion activity are gradually migrating upstream of Dibrugarh town and adjoining areas like Maijan, Nagaghuli, Oakland, and Rohmoria. Necessary measuress have been taken to tackle the situation.

25. In addition to this, from 1992 there is a significant change in river configuration of the Lohit River near the Hatighuli area, where due to the avulsion of Noa Dehing River after the breach of the embankment of Saikhowa Protection Bund PH-I on 30th March 1992, and whole discharge from Noa-Dehing river passes through Dholla, Dangori and Dibru river to join Brahmaputra River near Rohmoria. Moreover, the Ananta Nallah which was a small manmade channel subsequently developed to link the Lohit River to the Dangori river. Due to the fact described above, gradually the entire newly developed channel has become a major channel now called Anantanallah (Brahmaputra River) carrying a major portion of discharge and causing severe bank erosion as it flows along the southern bank of Dibru-Saikhowa reserve forest.

26. **Hydrological Report (Evaluation of Anantanallah)** The mighty Brahmaputra River consists of three main rivers all originating from different Himalayan regions and combining to form

one river, which carries the fifth-largest discharge in the world. They are Lohit, Dibang and Dehang. It comprises many hilly tributaries and becomes one river then combines with Dibang at the Eastern zone of Dholla in Assam and then combines with Deking in the lower reach to form the Brahmaputra River. One of the main tributaries of Lohit is the Noa-Dehing River which originates from Patkai Hills and combines with Lohit, upstream of the confluence of Lohit and Dibang.

27. The Lohit and Dibang Rivers followed a course along the northern side of the Dibru-Saikhowa National Park till the year 1992 and a small river called Dangori (combined Dholla and Dangori River) flows through the southern part of Dibru-Saikhowa National Park. This Dangori River joins river Dibru upstream of Guijanghat and finally outfalls at Brahmaputra River near Rohmoria. But the scenario has changed when the Dangori river had to carry an additional discharge of Noa-Dehing River when the embankment of Saikhowa Protection Bund PH-I breached on 30th March 1992 and the whole discharge from Noa-Dehing River passes through Dholla, Dangori and Dibru river to join Brahmaputra River near Rohmoria due to avulsion of the river Noa-Dehing at the downstream of breach point. This additional flow of river Noa-Dehing continued for one year till April 1993 when the breach was plugged and the original channel of Noa-Dehing was restored by dredging the bed of river Noa-Dehing for a length of about 3.5 km. This has caused a morphological change in the downstream stretches of the Dangori River, which has increased the discharge carrying capacity of the river Dangori as well as increased the river width. Gradually the mouth of Ananta Nallah (which was a manmade channel to connect between river Lohit and Dangori river) got widened to match the carrying capacity of the downstream reach and a major part of the combined flow of Lohit and Dibang Rivers started to flow along the southern fringe of the Dibru-Saikhowa National Park through Ananta Nallah with increasing magnitude from the year 1992. Subsequently, the river width of the Dangori River now called Brahmaputra River (Ananta Nallah) has increased from merely 50m to more than 2500m from 1992 to 2015. Now more than fifty percent of discharge of Lohit and Dibang is passing through Ananta Nallah.

28. As calculated from the satellite map, the land area lost due to bank erosion by Ananta Nallah (Brahmaputra River) is found to be 16265 Hec from 1976 to 2016.

29. The locations for the Dibrugarh District stretch from the geographical coordinates of 27°34'12.29"N 95°17'31.26"E to 27°24'29.73"N 94°48'7.66"E. All the project sites in Dibrugarh District are in this stretch. Important areas such as Nagaghuli, Kosuoni, Mohanghat, and the Bogibeel area are in this stretch. The Brahmaputra River on the southern bank is in the process of aggradation. As such, there is a drastic change in the morphology of the river system.

30. Moreover, due to the avulsion of Dibang River in the upper catchment, the flow in the Brahmaputra River has taken a new course and has given birth to new locations which are now critically prone to the erosion of the Brahmaputra River. More precisely, the Nagaghuli area faced severe damage in the flood wave of 2022. The Mohanaghat area is also vulnerable to erosion by the Brahmaputra River, and it is needless to highlight the severe damages that occurred in the Nagakhelia and Bogibeel area in the year 2022 which is now in a very critical condition.

31. After implementation of the AIFRERMIP Tranches I and II works at priority reaches from Oakland to the Dibrugarh Town area downstream, there is a gradual positive change in the river configuration and subsequent rising of the bed level along the bank. The porcupine works under AIFRERMIP Tranche I and II have given positive result and the main river course have been diverted away from the bank. However, in the final flood wave in the month of October 2022, severe damages to the protection works under Tranche-I and T-II were observed. The apron design in those works has been considered for adaptation in this proposed subproject under new ADB project CRBIFRERMP.

32. Pro-siltation measures taken up during subsequent years in the incoming sub-channel flow of the Brahmaputra River have been reduced to a considerable extent by the gradual deposition of induced silt by the porcupine screens.

33. However, it has been observed that the porcupine screens will have to be recouped and strengthened several times in subsequent years to achieve the desired result by inducing the silt along the bank and retaining it. It would be a continuous process to the time when we achieve a river regime where the siltation is induced to get a stable condition and level for reclamation of land. Therefore, it is observed that the construction of screens has been definitely helpful in making a conducive condition for minimizing erosion, but its performance is to be maximized by strengthening the existing porcupine screens and installing new screens in between. Additional porcupine screens are also required to be constructed along the newly developed channels for further choking up of the channel.

34. **Tinsukia:** Tinsukia District was not covered under AIFRERMIP Tranches I and II. The Dibang originates near Keya pass on the Indo-Chinese border in the Upper Dibang Valley District. The drainage basin of the river covers the districts of Upper Dibang Valley and Lower Dibang Valley. The Mishmi Hills lie in the upper course of the Dibang which enters the plains at Bomjir, Dambuk, etc. Originally, the Dibang river had two outer fringes at its outfall, one flowing south-eastward hitting at Milanpur area near Bandarkhal, and the other flowing towards southwest connecting river Siang at Jonai of Dhemaji. However, after the construction of a 4.5 km loft embankment by the Brahmaputra Board during the year 2018-19 right across its southeastern fringe, this channel of Dibang was completely shut off. Due to this abrupt termination of this fringe, the huge volume carried by this channel had an afflux effect on the upstream side at the Amarpur area of Sadiya Civil Sub-Division, causing severe damage to the cultivable and homestead land by erosion since then. But more serious and critical damage has materialized as per the prior apprehension about the detrimental effect of the Embankment across the Dibang by the Brahmaputra Board when the ultimate avulsion of Dibang river cutting right across the northeastern buffer zone of the Dibru Saikhowa National Park has taken place at 300 m downstream (d/s) of the end of the Brahmaputra board embankment. This avulsion has made its way through the Dibru Saikhowa Park traversing though huge land mass of 2.0 km width and 10.m height splitting up the National Park buffer zone by a width of 300 m on average.

35. The entire volume of the Dibang River now is flowing through this channel, drying up the erstwhile minor channel connecting Siang River. Now the brunt of the pressure of Dibang River is born by the Hatighuli and Phelai area causing serious threat to the Saikhowa Protection Bund Ph-III. The embankment namely Saikhowa bund Ph-III at Hatighuli campus has been badly damaged by the flood water of Brahmaputra River (Ananta Nallah) as a result the berm has been reduced from the toe of the embankment to the bank line day by day. The embankment system is providing flood protection to about 25 nos. of villages viz. Na-Bormura, Gohain Gaon, Hatighuli, Nao-Kota, Lao pati, Siring, Bormura, Dholla villages, etc. The Saikhowa Protection Bund Ph-III is protecting the entire area of Saikhowa, Dholla, Noa-Barmura, Kapatali, and Phelai Nao-kata area consisting of twenty villages which are thickly populated.

36. The active bank erosion situation became worse with receding water level during the first week of August 2021. The rate of erosion is escalating gravely threatening the Saikhowa Protection Bund Ph-III leaving an offset of only 30m from the current bank line to the toe line of the Brahmaputra Embankment. The Check Bund No.3 at Ch. 2600m at Phelai area has been washed away by a length of 30 m since July, 2021. All the temporary measures carried out at Hatighuli area have been completely washed away during the period from August 2021 to December 2021 besides washing away of 50 hectares of land mass in the last few years alone. The avulsion channel now causing severe devastation and erosion for stretch of 40.0 km bank line of Brahmaputra River starting from Hatighuli, Phelai via Baghjan-Dighaltarang-Darjijan up to Guijanghat area.

37. During the flood of 2019 and 2020, severe erosion has been observed at Fulbari Laopani, Naokota, Gariating, Simaluguri Satra, Tamuli and Laina area washing away several numbers of houses, tea gardens, roads, etc. Public protests are taking place regarding the erosion at these areas and local public has been demanding the execution of anti-erosion works in these areas.

38. This belt comprises over 10000 hectares of fertile and homestead lands including animal husbandry and fish farms with a population of about 50,000. This entire stretch from Milanpur to Naokota is undergoing devastating bank erosion since 2010 and the land loss has amounted to about 3000 hectares since then. See figure below.

Source: DPR WRD

39. **Erosion at Hatighuli and Phelai area**. Due to erosion at Baghjan area, several houses, tea gardens, roads etc. have been washed away. Agriculture is the core sector of economic development and backbone of all economic activities of these rural areas and if the precious agricultural land continues to be affected by the erosion of the Brahmaputra River, it will put tremendous pressure to the reducing agricultural land due to the increasing population. Already more than 7000 hectares of land have been eroded away by the Brahmaputra River since 1976 till 2016 from Hatighuli to Guijan area - the problem being very acute at Dighaltarang, Baghjan area where the extent of erosion is up to 700 hectares from 1996 to 2020 itself rendering hundreds of families homeless and converted productive land into unusable sand chor especially the Dighaltarang, Baghjan Tea Estate has lost greater chunk of its assets. Subsequently, this has put pressure on the existing cultivable land and district administration is facing rehabilitation problems for settlement of the erosion-affected families. See figure below.

Source: DPR WRD

40. The active riverbank damages of Brahmaputra River at No. 1 Kordoiguri, No. 3 Kordoiguri and Goriyating Gaon under Hapjan Mouza of Doomdooma Rev. Circle, whereas in Kordoiguri No. 1 area the situation is more acute as a vast cultivable land, tea garden, private and public properties have been washed away by the combined flow of newly avulsed river Dibang and the other major rivers namely Lohit, Noa-Dehing, Kundil, Balijan, Dholla and Dangorito form the main Brahmaputra (Ananta Nallah) channel. The old religious center "Simaluguri Satra" of "Moran community" is threatened up and the Satra is on the verge of complete wash out due to its serve bank damages. The Satra which was established in 1925 by Prabhu Sri Sri Chandrabhuj around 42.00km from Tinsukia Town has great historical and cultural value and considered as a valuable asset of Assamese native life.

41. The Rangagora Tea factory was established in the year 1839 with factory production capacity of 9 Lakh kg per year. Area of the Rangagora Tea Estate is 315.97 hectares. The factory has been a source of income for thousands of indiviuals. Total valuation of the building is about INR 9.00 Crore. During the flood of June-July 2020, and May 2021 the flood water directly hit the Rangagora Tea Factory area and washed away large land mass. The active bank erosion has become worse with receding water level during the first week of May 2021. The rate of erosion is increasing day by day. See figure below.

Source: DPR WRD

42. The spill channel of Ananta Nallah abruptly inflates the discharge of the Dholla River when the water level crosses 126.50 m on the gauge reading at Milanpur and the combined flow causes severe erosion and flood inundation problems at Fulbari Laopani, Tamuli and Laina area. If this spill channel of Ananta Nallah is closed down at its inception, then the discharge of Dholla river can be reduced significantly and the entire area of Laina, Fulbari Laopani, and Tamuli can be saved from this flood devastation. It is again reteriated that agriculture is the core sector of economic development and backbone of all economic activities of these rural areas and if the precious agricultural land continues to be affected by the erosion of the Brahmaputra River, it will put tremendous pressure to the reducing agricultural land due to the increasing population.

43. Substantial flood protection and anti-erosion (AE) works were undertaken in Dibrugarh District under the "Assam Integrated Flood and Riverbank Erosion Risk Management Investment Project (AIFRERMIP)". The AIFRERMIP was phased out as Tranches I and II on a priority basis to reduce the vulnerability against the flooding and riverbank erosion through short medium-term measures. The subsequent proposed implementation of the CRBIFRERMP under new ADB project is aimed to focus on priority reaches of Dibrugarh and include Tinsukia District under this subproject for Dibrugarh. The project is aimed towards an integrated comprehensive Flood and Erosion

Management Project to tackle the flood and erosion hazards of Brahmaputra River from Sadiya to Chaulkhowa (downstream of Bogibeel Bridge) and to maximize the result of the existing flood and erosion management works undertaken under ADB project AIFRERMIP Tranche I and II.

44. The proposed Dibrugarh subproject covering Dibrugarh and Tinsukia fits in with the overall structure of the master plan for flood control pertaining to the Brahmaputra River prepared by the Brahmaputra Boards. The flood and erosion protection measures taken up under AIFRERMIP Tranche I and II in Dibrugarh District, have so far given positive results and implementation of work, which have been proposed under CRBIFRERMP- proposed ADB project, after studying the efficacies of the Tranche I works would provide a comprehensive and integrated approach to the flood and erosion management works for the Tinsukia and Dibrugarh Town and its adjoining areas from the flood and erosion of the Brahmaputra River. Therefore, as the Tranche I and Tranche II works under AIFRERMIP have been completed, immediate implementation of the new proposal under CRBIFRERMP- proposed ADB project is required to derive maximum benefit from the overall works.

C. Proposed Project and its Rational

45. The proposed works in Dibrugarh subproject including Tinsukia shall be executed under proposed ADB financed CRBIFRERMP in Assam.

46. Although apart from Dibrugarh, the Tinsukia District is considered for the first time under ADB Loan, the priority works at Dibrugarh Tranche I were completed on January 2017 and subsequently, the Tranche II works were completed in December 2021. A detailed flood and erosion management study was done to evolve a comprehensive strategy for providing sustainable flood erosion management works. These works constituted mainly of the construction of protection works at priority zones with the strengthening of the existing embankment and new embankment construction including porcupine intervention wherever necessary.

47. The proposed sites of Dibrugarh District under CRBIFRERMP are located on the south bank of Brahmaputra and are bounded by the geographical coordinates of 27°34'12.29"N 95°17'31.26"E to 27°24'29.73"N 94°48'7.66"E. The project covers Dibrugarh Town area and its adjoining areas upto Oakland at upstream to Bogibeel areas at downstream. While as the proposed subproject sites in Tinsukia District are located on the south bank of Brahmaputra and are bounded by the geographical coordinates of Longitude 95°-16'E to 959-33'E and latitude 27° 34'N to 27° 45'N. The project covers South Bank of Brahmaputra from Saikhowaghat - Milanpur area at upstream to Dinjan army camp areas at downstream.

48. In the south bank of Tinsukia District, the protection works executed under different heads have been performing well and the ongoing work under NorthEast Special Infrastructure Development Scheme (NESIDS)[10] is providing good result in the reach of Guijan and its adjoining areas. However, there are some reaches that are not protected and these reaches are susceptible to erosion by oblique channel developed in the high stage of the flood of Brahmaputra River. In the Kordoiguri area the situation is more acute and a vast cultivable land, tea garden, and private and public properties have been eroded away by this course and now the old religious center "Simaluguri Satra" of "The Moran community" is threatened badly due to its serve erosion. The Satra was established in 1925 by Prabhu Sri Chandrabhuj around 42 km from Tinsukia Town. Already more than 7000 hectares of land has been eroded away by Brahmaputra River since 1976 till 2016 from Hatighuli to Guijan area, rendering hundreds of families homeless and converting productive land into unusable sand chor. During the flood of 2017 and 2018, severe erosion has been observed at

[10] https://mdoner.gov.in/activities/nesids-background#:~:text=Under%20the%20Scheme%20guidelines%20of,secondary%20sectors%20of%20education%20and

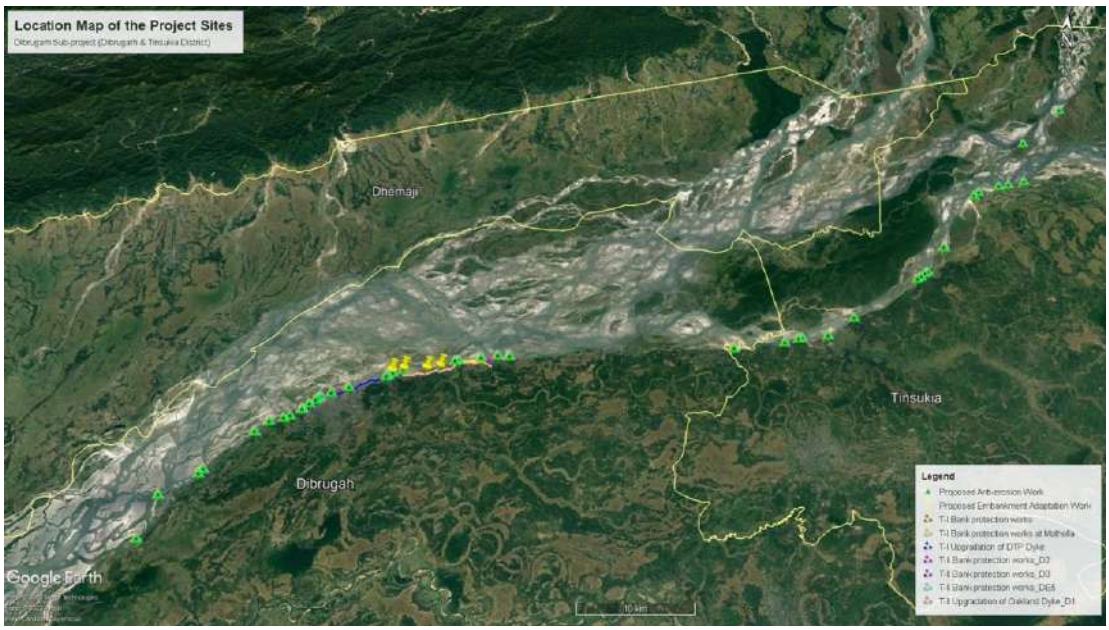
Dighaltarang, Baghjan area for a reach length of about 2400m. Several houses, tea gardens, Road, etc. have eroded away. Several numbers of Oil installations of Oil India Limited are in this area. There are huge public protests regarding the erosion in these areas and the local public has been demanding the execution of anti-erosion works by the OIL Authority. As no initiatives were taken by Oil India Limited, Duliajan, the local people resorted to obstructing the activities of the OIL, in these areas.

49. In Dibrugarh, the Brahmaputra flows along the town through the main channel. In places, this channel is silted up, but where it encounters anti-erosion work or clayey banks, flow gets more concentrated near the bank, sometimes in the direct vicinity of the embankment. The channel used to be separated from the northern mainstream of the river through a highly stable char. But in recent turn of events, the main channel is flowing along direct vicinity of the southern bank all along the Dibrugarh District with combined flow of Dibang, Lohit and Siang creating havoc in the district. The embankment system is however stable and adjacent to the town the embankment passes through densely populated area.

50. **Climate change and its impact:** There is a high degree of certainty that average air temperatures will increase in the future; however, the magnitude of this change is uncertain. Furthermore, the increase global temperatures impact specific features of the environment also is uncertain. However, anthropogenic warming of the earth is expected to have significant impacts on the riverine processes of the Brahmaputra. The changes are expected to increase the risk of flooding and riverbank erosion. The projected increased duration and/or intensity of monsoon rainfall will result in increased internal drainage requirements and higher peak flows of the Brahmaputra (Department of Environment and Forest Government of Assam, 2015. Assam State Action Plan on Climate Change (2015-2020). Higher peak flows will result in higher water levels, deeper scour, and higher flow velocities. Flood and erosion risk mitigation structure designs must account for these potential changes, to provide security to the people of Assam not just immediately, but throughout their entire design life.

51. The locations where the works were undertaken in previous ADB project AIFRERMIP in Dibrugarh District and the spots where the works are proposed to be carried out under this project in both Dibrugarh and Tinsukia Districts are indicated in the Figure 2-1.

Figure 2.1: Proposed works and works undertaken in previous AIFRERMIP T II



Source: WRD

D. Proposed Subproject Components

a. Structural Measures and Civil works

52. To protect the communities in Dibrugarh and Tinsukia Districts from land erosion riverbank revetment is necessary. Erosion protection by construction of bank revetment and apron with geo-bag size 1.03m x 0.70m (geo-bag type A) with toe key size 1.50m x 0.90m (geo-bag Type-C) for a total length of 21.26 km is proposed out of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia. Adaptation works/emergency contingency works total of 4.65 km is proposed to be undertaken at 4 locations in Dibrugarh. Also, a total of 173 numbers of P.S.C porcupine over 3 layers are proposed to be launched in 5 locations in Dibrugarh and 2 locations in Tinsukia. In 5 locations of Dibrugarh 72 number of Porcupines and 2 locations of Tinsukia a total of 101 number of Porcupines are proposed to be launched. For protection work, A-type geo-bags of size 1.03m x 0.70m are proposed to be used. 5 layers of C -Type geo-bags in Apron and 3 layers of A Type geo-bags are proposed to be used in both Dibrugarh and Tinsukia sites. Additionally, construction of 1.2 km (new) close gap in embankment at Maijan Beel in Dibrugarh is proposed. A RCC triple shutter sluice gate in Maijan Beel embankment with regulator and fish pass is also proposed. Adaption works of 4.65 km at 3 locations of Dibrugarh with geo-bags is also proposed.

53. Additionally, revival of Maijan beel with nature-based solutions is also proposed. Table 2-1 shows the details and locations of various components of the proposed work.

Table 2-1: Details and locations of various components of the subproject

Sl. No.	Infrastructure Component	Component details and location			
		Dibrugarh		**Tinsukia**	
1	Embankment	1.2 km (new) - close gap in embankment at Maijan Beel		None	
2	Sluice	RCC triple shutter sluice gate in Maijan Beel embankment with fish passes		None	
3	Revetment	Location	Length (km)	Location	Length (km)
		Nagarguli to Maijaan	0.9	Milanpur to Hatighuli	1.5
		Filungurito 7400ft spur	1.7	Pheliai to Naokota	2
		Dibrugarh Town Protection (DTP) Dyke (Dibrugarh Town area)	3.93	Gariating Gaon	0.4
		DTP Dyke Amoraguri	0.27	Simaluguri Satra	0.4
		Mohanaghat	0.78	Bahjan to Notun Gaon	2.1
		Nagarkhelia	0.6	Upstream Gujjan	0.3
		Chaulkhowa at D/S of Bogibeel bridge	3.69	Rungagorah to Dinjan	2.7
		Sub-total	11.86	Sub-total	9.4
		Total 11.87 + 9.4. = 21.26 km			
4	Adaption works	Location	Length (km)	None	
		Kasuoni	1		
		Mothola	2.4		
		DTP dyke	1		
		Emergency works	0.25		

Sl. No.	Infrastructure Component	Component details and location			
		Dibrugarh		Tinsukia	
		Total: 4.65 km			
5	Porcupine	Location	Nos	Location	Nos
		Kosunoni	9	Diversion channel of Dibang to Lohit	26
		Nagaghuli	25	Naokata area	75
		DTP Dyke	22		
		Mohpuwaliamora	9		
		Bogibeel	7		
		Sub-total	72	Sub-total	101
		Total 72+101 = 173			
6	Other works	Revive Maijan beel with NbS		None	

Source: FREMAA and WRD

54. The protection works include:

Dibrugarh

(i) Riverbank protected work with geo-bag apron and revetment in 7 reaches in 11.86 km

- Apron of size 43m Width x 1.00m Thickness (Type-C) for entire reach having Spurs and Bridge Effect and of size
- 33m width x 1.00m Thickness for normal reaches.
- Geo-bags at revetment at reach 1, 4, 5 and 6
- Mattresses for revetment at reach 2 and 3.
- Toe-key of polyvinyl chloride (PVC) coated wire netting cages of size 1.5mx1.5mx0.45m in two layers filled with silt filled geo-bags.

(ii) Pro-siltation measures by PSC porcupine screens from Kosuani to Wakhabi:

- Total No. of Reaches = 72 Nos.
- Layers = 3 Nos
- Rows in order of 4, 3 and 2, bottom to top.

(iii) Earthworks

- Reach length = 1200m (with 3 shutter RCC sluice)
- C/S Slope: 1: 3, R/S Slope: 1:2, Freeboard: 1.5 m above HFL

Tinsukia

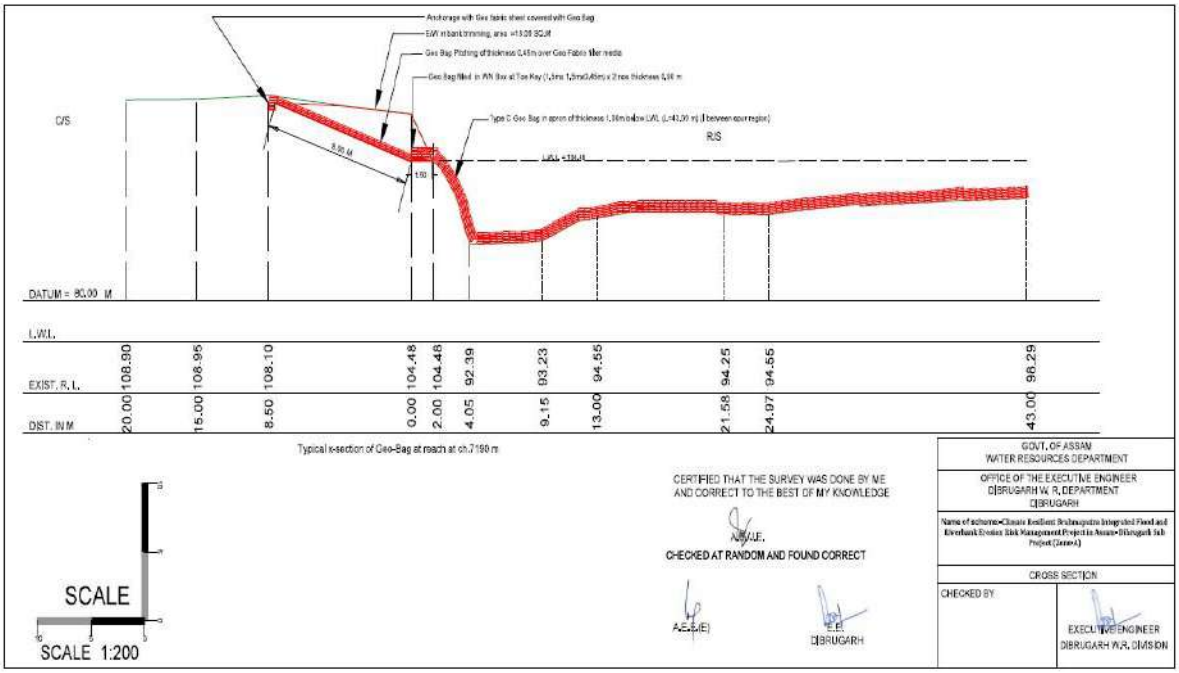
(i) Riverbank protected work with geo-bag apron and revetment in 7 reaches for 9.4 km

- Apron of size 33 m Width x 1.00m Thickness (Type C) for entire for normal reaches.
- Geo-bags at revetment for slope length of 15 m for 7 nos of reaches.
- Toe-key of PVC coated wire netting cages of size 1.5 mx1.5m×0.45m in two layers filled with silt-filled geo-bags.

(ii) Pro-siltation measures by PSC Porcupine screens:

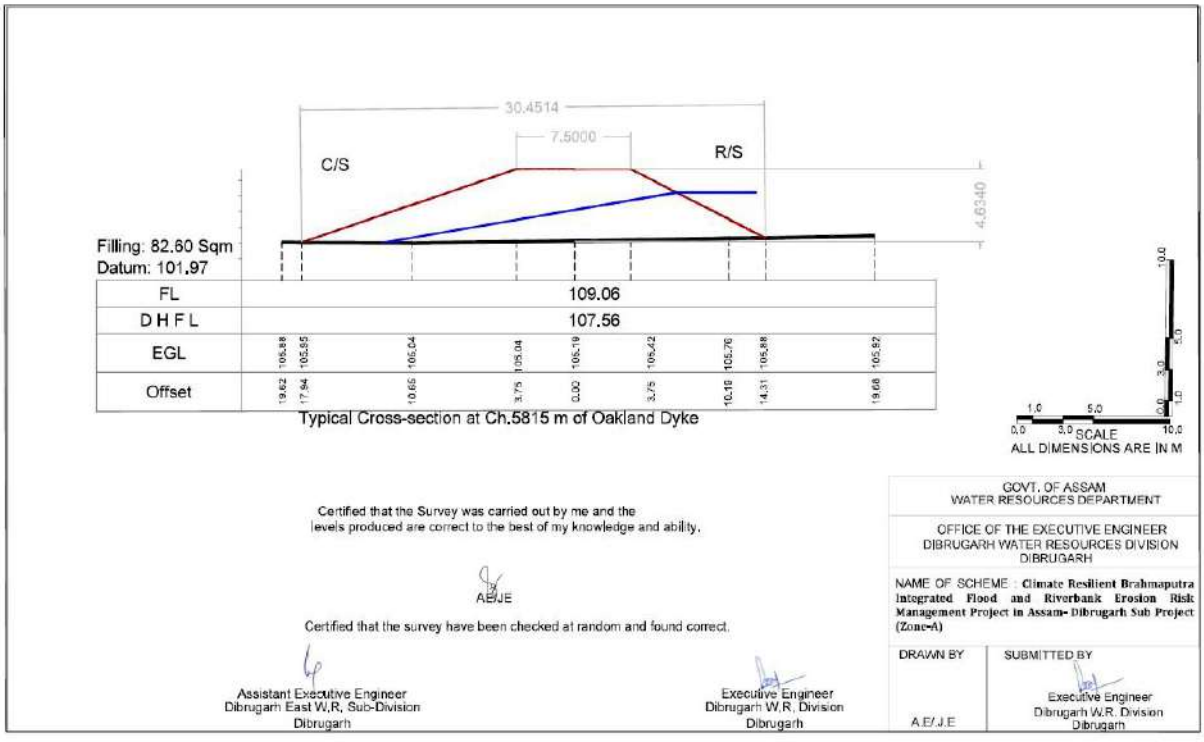
- Total No. of Reaches = 101 Nos.
- Layers = 3 Nos
- Rows in order of 5, 4 and 3, bottom to top.

Figure 2-2: Typical Cross Section (TCS) of anti-erosion (AE) works of Dibrugarh subproject



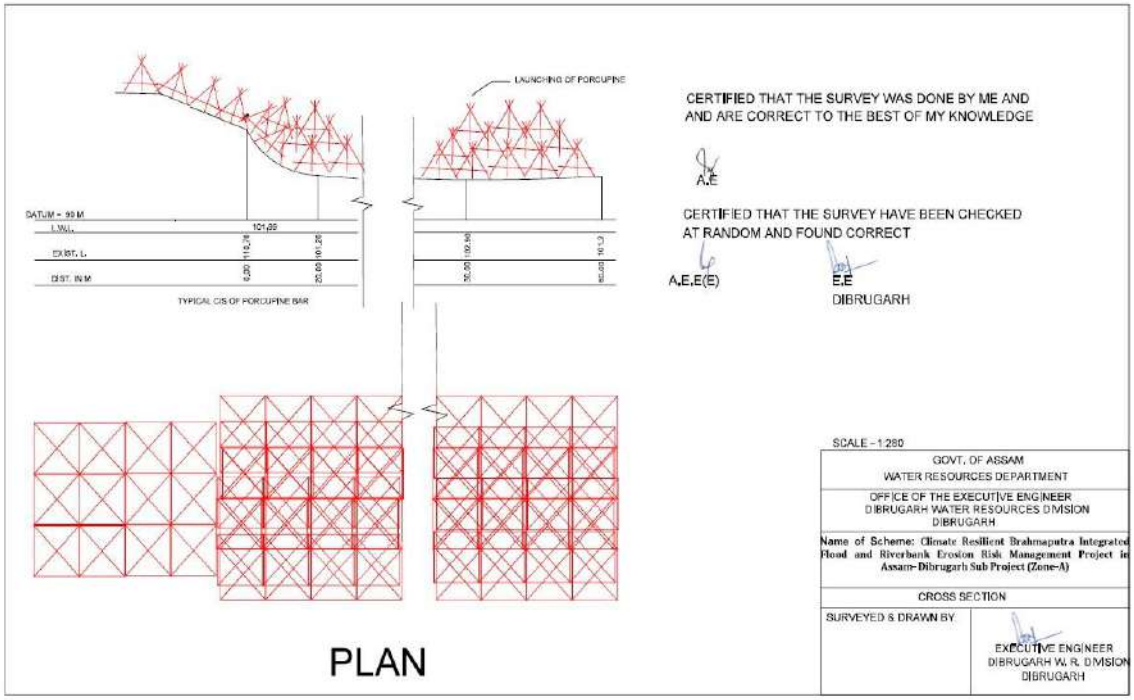
Source: WRD

Figure 2-3: TCS of AE works of Dibrugarh subproject



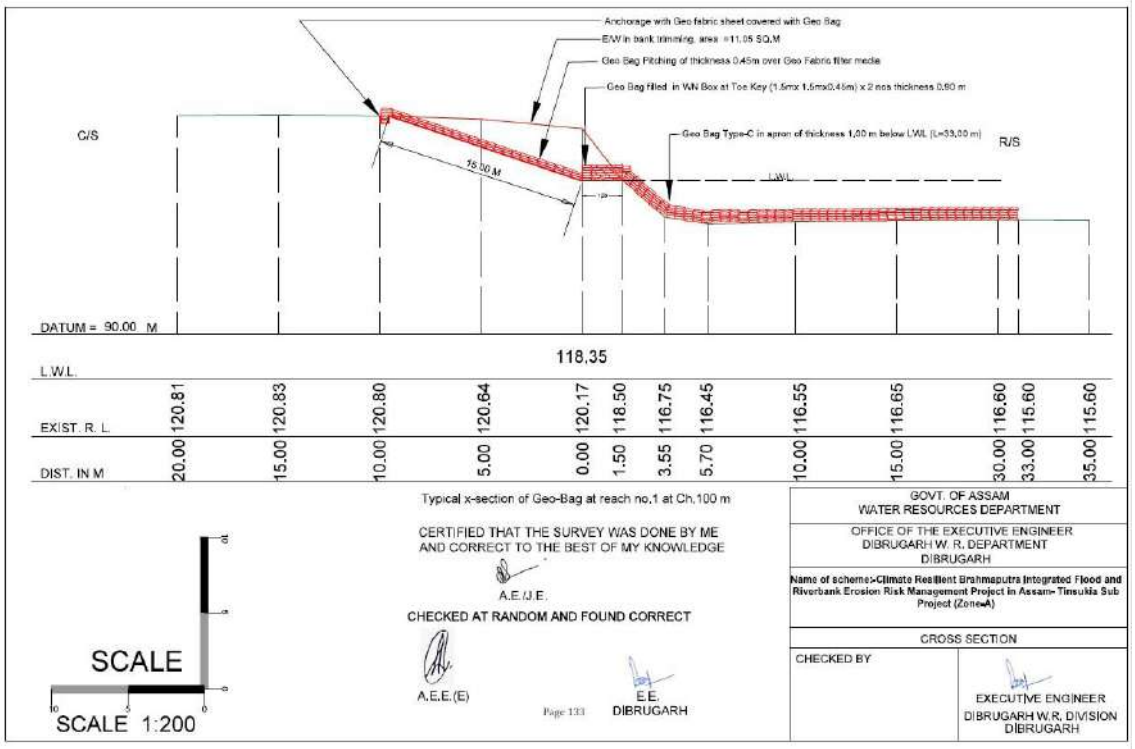
Source: WRD

Figure 2-4: TCS of AE works of Dibrugarh subproject



Source: WRD

Figure 2-5: TCS of AE works of Dibrugarh subproject



Source: WRD

Figure 2-6: Photographs of Project Area
Dibrugarh District


Proposed sites for AE and flood protection (FP) work at Nagarguli


Proposed site for construction of embankment and RCC triple shutter sluice gate at Maijan


Proposed site for AE and FP at DTP Dyke Dibrugarh


Proposed sites for AE and FP at DTP Dyke Amoraguri


Proposed sites for AE and FP work at Mohanaghat

Proposed site for AE and FP works at Nagarkhelia

Temporary AE and FP works by WRD and at proposed site Nagarkhelia

Proposed site for anti-erosion and flood protection at Chaulkhowa

Proposed site for anti-erosion and flood protection adjacent to a Resort Chaulkhowa

Proposed sites for AE and FP work at Milanpur Hatiguli

Proposed site for AE and FP works at Phelia Noakata

Temporary AE and FP works by WRD GoA at proposed site at Simalguri Satra

Satra a religious place likely to be affected by AE and FP works at Simalguri Satra

Proposed site for AE and FP works at Baghan Notungaon

Temporary AE and FP works by WRD GoA upstream of proposed site at Baghjan Notungaon

Proposed sites for AE and FP at Gujjan

Tea garden getting affected at proposed site for AE Gujjan

Proposed site for AE and FP work at Nagarkhelia

Temporary AE and FP work by WRD and at proposed site Nagarkhelia

Proposed site for AE and FP works at Rungagorah Tea Factory to Dinjan

Source: ADB TA Consultant

b. Non-Structural Measures

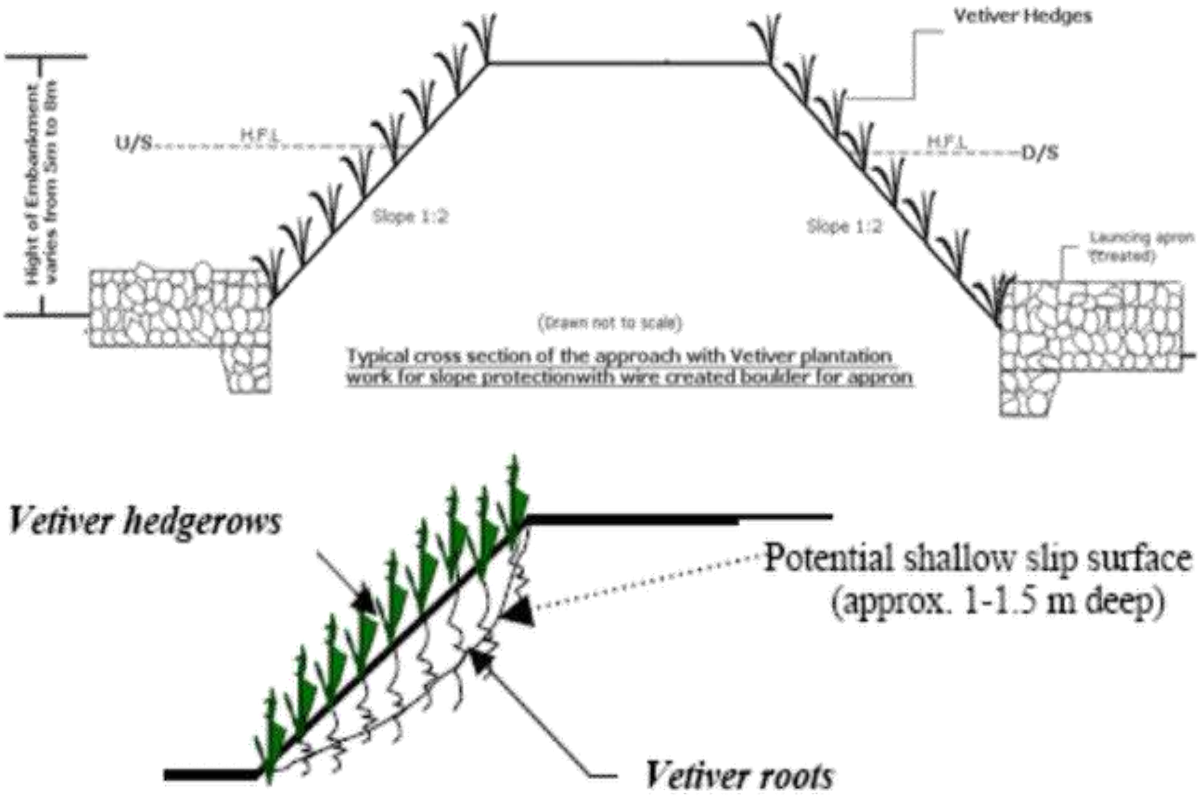
55. **Nature-based solutions:** Nature-based solutions (NbS) e.g., bioengineering techniques such as the planting of reeds will be pilot tested to be applied to embankment slopes to reduce maintenance requirements from the risk of rain cuts and to provide local stakeholders with income generating activities opportunities. Assam Agroforestry Development Board or AADB, has been created in June 2022 by the government of Assam as an unlisted public company classified as state government company under the Forest Department. It is mandated to increase the people's livelihood options through various agroforestry models and to support nature conservation. AADB will establish a PIU which will be responsible for implementing the nature-based solutions. AADB will develop, implement, improve, guide, and supervise pilot nature-based solutions including relevant research and dissemination of research results. The pilots will provide employment opportunities for riverine rural poor and as the pilots can be upscaled to broader implementation, more employment opportunities will be created in the next phases. The purposes of the AADB pilots are to prevent erosion of the slopes of embankments, to plan and promote wetland revival and biodiversity, and to promote siltation on possibly reclaimed land. Presently for the pilot project, AADB shall focus on providing NbS for embankments and riverbanks and Wetland conservation. The exact

locations of these pilot areas shall be identified based on surveys and studies, later on. FREMAA shall assist AADB for procurement of all goods and services.

56. For the NbS for embankments and riverbanks, the slopes shall be stabilized by using vetiver, khas and other deep-rooted grasses in different type of embankments. For this particular aspect AADB has tied up with Indian Institute of Technology (IIT) Indian School of Mines (ISM), Dhanbad (nominated Centre of Excellence by Govt. of India) shall provide the technical knowledge. AADB shall also plan and execute business models for sustainable harvesting of these grasses through local communities as part of livelihood improvements for people vulnerable to flooding and riverbank erosion. The grass species shall be supplied by 5 existing/rehabilitated forest nurseries (1 in each of the 5 districts covering the 4 subprojects) and managed by AADB. Locals (to be selected by AADB with criteria including such as DAGs, women, most severely affected by erosion and flooding, etc.) shall be employed through existing Forest Committees (legal entities) at local level) following the Joint Forest Management model for planting and maintaining the grasses.

57. AADB also plans to undertake wetland conservation (for watershed conservation and livelihood support). Identification of suitable vegetation for selected wetland conservation shall be done by AADB wherein multiple-use of wetlands shall be promoted, invasive species like water hyacinth (*Pontederia crassipes)* etc. shall be removed and the dried-up water hyacinth plant be used for preparation of papers etc. AADB shall provide the technological support including trainings to the local communities for preparation of paper besides help in planning and execute business models for the same. These rejuvenated wetlands shall be helpful in for flood water storage within dedicated land-use zones.

Figure 2-7: TCS of with Vetiver plantation for protection slope



Source: AADB

58. **Strengthening of Knowledge-based FRERM:** The project will strengthen the state's institutional capacity to deliver Flood and Riverbank Erosion Risk Management (FRERM), thereby promoting disaster resilience of the state and affected communities. This will: (i) strengthen flood forecasting and early warning systems in close collaboration with others; (ii) undertake flood mapping to identify people and infrastructure at risk of flooding and facilitate better land use planning and management on risk-sensitive land; (iii) improve erosion prediction and embankment breach models to prioritize maintenance; (iv) enhance asset management systems and conduct life-cycle reliability analyses to improve budget and maintenance decisions; (v) gather data through topographic and bathymetric surveys, flow and sediment measurements, and asset condition surveys; and (vii) strengthen existing guidelines for flood and riverbank protection design to address climate impacts and resilience, update river stabilization principles, and document the effectiveness of nature-based solutions.

59. **Improving vulnerable people's livelihoods and resilience:** The project will improve the livelihoods and disaster resilience of poor and destitute people living on the flood embankments and charlands within the project areas and who are vulnerable and affected by floods and riverbank erosion. The intervention will specifically target women. Interventions will: (i) establish modern weaving centers, provide sewing machines, and train female headed households and female self-help groups to spin, weave, and market silk; (ii) increase vegetable production by providing climate resilient seeds, promoting improved agricultural practices, and extending marketing support; (iii) provide vocational training for unemployed youth; (iv) raise awareness on flood and riverbank erosion; and (v) strengthen disaster preparedness and emergency response (through provision of equipment at district/regional level). Support for subsistence and small farmers will include: (i) assistance creating agriculture and fisheries businesses; (ii) identifying alternative income opportunities associated with the nature-based solutions in Output 111 and (iii) improving roadside markets. Further, the graduation approach will be piloted to complement the various state-led initiatives that strengthen beneficiaries' wellbeing by providing livelihood assistance through agriculture, livestock, fisheries, industries, and vocational training activities.12 Beneficiaries will be producer collectives registered as Farmer Producer Companies (FPC) in the vicinity of the Brahmaputra River.

E. Construction Material for Bank Protection

60. Flood management and river training works, in the form of embankment, bank revetment, spurs, RCC porcupines, sluices etc., will manage and control floodings, improve drainage system and check bank erosion. Construction of these works makes use of different kind of materials depending on the nature of problem and the structure provided. Different construction materials have their own uniqueness and are used according to the site conditions, availability, transportability, cost effectiveness, low maintenance cost etc.

61. Materials like boulders, timber are in use since ages, but due to their increased usage in other sectors leading to reduced supply and environment un- friendliness, their use now-a-days is decreasing. High wear and tear of timber structures in underwater and near water situation make it less suitable for its use in anti-erosion measures.

62. Now–a-day's use of new innovative materials like geo-textile in the form of bags, tubes, sand filled mattress, neo-web, submerged wanes and reinforced concrete (RCC) porcupines are being

[11] New livelihood opportunities will arise from nature-based solutions along embankment slopes and reed plantations on charlands as well as from the revival of *beels* resulting in new fishing opportunities.

[12] The graduation approach combines cash transfers with an asset transfer, financial inclusion, tailored skills training, livelihood development, social inclusion, and life-skills coaching and psychosocial support. Cash transfers will be made to FPCs, not individuals.

popular in construction of revetments, spurs, groynes, embankments, etc. These materials are used due to their unique characteristics like durability, resistance to chemical waste, environment-friendly nature and easiness in installation. Different construction materials to be used for structural measures of flood management under this project are described below.

63. **Geo-bags:** Geo-textile bags filled with sand shall be the preferred option. The sand should be coarse sand and free from organic material. Loamy and clayey type soil should be avoided. It is very stable material and used worldwide. The engineered bags life is much beyond 30 years, the economic life of the Project. Use of geotextile is considered beneficial even from aquatic fauna aspect.

64. Geo-textile bags are made of woven or nonwoven geo- textile fabrics which are specially designed for good soil tightness and high seam efficiency. Geo-textile bags range in volume from 0.05 m^3 to around 5 m^3, and are pillow shaped, box shaped or mattress shaped depending on the required application. Geo-textile bags have also been used as revetment and breakwaters to build structural erosion protection measures. The project proposes to use the geo-bag size 1.03m x 0.70m (geo-bag type A) with toe key size 3.00m x 0.90m and 1.50m x 1.00m (geo-bag Type C). A sample of use geo-textile bags in the field is shown in the Figure 2-8.

Figure 2-8: Use of Geo textile bags for Anti erosion works[13]

[13] Existing works by WRD in Dibrugarh subproject area and in Chunari to Jaleswar area of the Goalpara subproject

Source: ADB TA Consultant

65. **Reinforced cement concrete porcupine:** RCC is mainly used for construction of the PSC porcupine screens due to ease of construction, cast in-situ nature, longer durability and low cost. The use of RCC is replacing the timber in construction of porcupine screens.

66. River training is an art to protect the bank from erosion, changing the course, flood, and sediment control and navigation etc. Protection to the riverbanks is normally achieved by construction of stone revetments, impermeable spurs etc. The cost of these traditional methods is very high, due to which the bank protection is generally restricted to the important areas such as urban areas, important roads, railway lines, agricultural lands, etc. Construction of permeable structure is cheap and simple alternative method which can help not only to protect the bank but also to induce siltation along the bank and help to divert the river channel away.

67. Only a dampening action on the velocity of flow is achieved by a permeable structure, distinguished from the deflecting or repelling action of an impermeable structure. It is a well-known fact that the sediment transport capacity of a flow is highly sensitive to the flow velocity. Therefore, the dampening of velocity could result in deposition of courser particles in the downstream of the structure. So, the permeable structures can be called as sedimenting structure.

68. It is a structure made up of small units placed in suitable arrangements. These units are called as elements. Permeable structures are usually cheaper than the impermeable ones. The basic principle behind the permeable structure is to reduce the velocity by providing partial obstruction to the flow and thereby induce deposition of the sediment. The elements used in the PSC porcupine screens/spurs are as under:

a. **Members:** The porcupines are made of RCC members/elements. These members are casted in-situ at the site or location near the site. Generally, six members are used to construct one porcupine. The size of one member is kept as 3mx0.1mx0.1m or 2mx0.1mx0.1m. These members are joined with the help of Nails.
b. **Nails:** Standard commercially available nails of length 100 mm to 150 mm are used to join the porcupine members. Double nailing at critical joints may be provided.
c. **Galvanized iron (GI) Wire**: 4 to 5 strands of 4 mm GI wire should be used for inter-connecting the porcupines and may be anchored with the ground. Alternatively, 12 mm 3-4 strands wire ropes should be used for the interconnecting the porcupines.

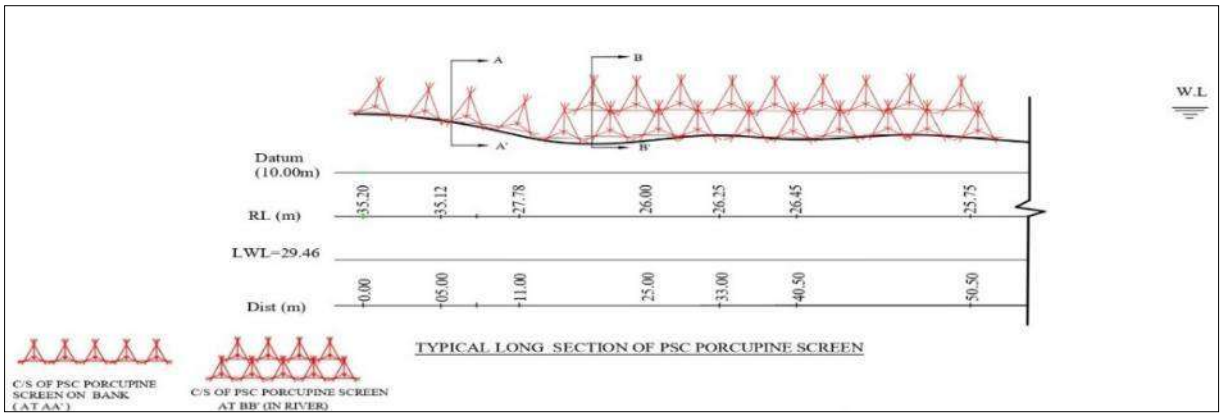
69. It is proposed that a total of 173 numbers of P.S.C Porcupines screens over 3 layers are to be launched in 5 locations in Dibrugarh and 2 locations in Tinsukia. In Dibrugarh a number of 72 Porcupines and Tinsukia 101 Porcupines will be launched for providing the riverbank protection. A

sample of a Porcupine is shown in the Figure 2-9 and Typical Long section and Cross section is depicted in Figure 2-10.

Figure 2-9: Presence of old Porcupine screens in Project Area[14]

Source: ADB TA Consultant

Figure 2-10: Typical Long section and Cross section of Porcupine Screens



Source: WRD

[14] Existing works by WRD in Dibrugarh subproject area (Tinsukia District) and in Baladmari char to Pahartali and Chunari to Jaleswar areas of Goalpara subproject area

70. **Concrete blocks:** Concrete is a composite material made from the combination of aggregate including sand, stones and a binder such as cement. Cement Concrete (CC) blocks are sometimes used in place of boulders for construction of bank revetment or slope protection of the embankment. The CC blocks may be cast in-situ and execution of works using the CC blocks is faster than the boulder works. In this project the CC Block is proposed to be provided only in apron of sluice in Dibrugarh. Figure 2-11 depicts the use of Cement Concrete blocks.

Figure 2-11: Use of Cement Concrete blocks

Source: ADB TA Consultant

71. **Adaptation and Emergency works:** Flood adaptation includes a set of actions to strengthen existing ecological or socioeconomic systems against the likely adverse effects. In order to ensure sustainability, revetments constructed under AIFRERMIP will be strengthened through adaptation works that include placement of additional geo-bags on the lowest slopes of the riverbank where the riverbed is substantially lower than anticipated in the original design.

72. The purpose is to increase the technical sustainability of riverbank protection works through the provision of adaptation works which will support riverbank protection to accommodate deeper scour depths following riverbed erosion, and emergency works (i.e: stockpiling of geo-bags and small contracts to fill and place these geo-bags during emergency events). Under this subproject adaptation/emergency contingency of 4.65 km at 3 locations of Dibrugarh with geo-bags is proposed.

73. **Sluice gate with Regulator and Fish passes**: "Sluice gate" refers to a movable gate allowing water to flow under it. When a sluice is lowered, water may spill over the top, in which case the gate operates as a weir. Usually, a mechanism drives the sluice up or down. One concern with the use of sluice gates is that fish often cannot navigate through them.

74. A RCC triple shutter sluice gate in Maijan Beel embankment in Dibrugarh with regulator and fish pass is proposed to be installed.

75. A triple shutter sluice gate with fish passes and a regulator is a hydraulic structure commonly used in water management systems to control the flow of water in rivers, canals, or other

watercourses. It is designed to facilitate water regulation while also providing fish passage to support aquatic ecosystems.

76. **Sluice Gate:** A sluice gate is a movable barrier that can be raised or lowered to control the flow of water. In a triple shutter sluice gate, there are three separate gates arranged horizontally, one above the other. These gates can be raised or lowered independently or together to adjust the flow rate.

77. **Fish Passes:** Fish passes are specialized structures incorporated into the sluice gate to enable the safe migration of fish. They consist of a series of pools or steps that create a gradual gradient for fish to swim against the water flow. Fish passes help fish bypass the barrier created by the sluice gate and allow them to migrate upstream or downstream.

78. **Regulator:** The regulator is a component that helps maintain a consistent water level upstream of the sluice gate. It consists of a series of openings or orifices that control the discharge of water. The size of the openings can be adjusted to regulate the water level and flow rate. The regulator ensures a controlled release of water downstream while preventing excessive flooding or drying up of the upstream area.

Figure 2-12: Sluice gate constructed at Palasbari under AFRIEMP

Source: FREMAA

79. **Other construction requirements:** The proposed project work aims at protecting the community from land erosion of Brahmaputra River by way of executing anti-erosion and flood protection works. The sites for bank revetment work align along with the riverbank and the selected reaches are actively erosion prone. It is necessarily to execute the apron work in the dry season. As such, a period of 6 years including the OandM period has been considered for the implementation which includes 2 years for construction and six months for pre-construction period.

80. The proposed construction activity under this project is simple involving anti-erosion works and flood protection works by way of construction of bank revetment and apron using geo-bags of different sizes. The geo-bags are required to be filled by sand which will be quarried by the contractor. Quarrying permits must be acquired by the contractors prior to start mining sands to fill the geo-bags. For both anti-erosion and flood protection works soil compaction and slope stabilization will involve earth work. Substantial quantity of the earth will be required for construction of 1:2 to 1:3 which is designed for 100-year flood return period. It is proposed that the demand for earth will be fulfilled by excavating borrow pits in the vicinity of the river embankment.

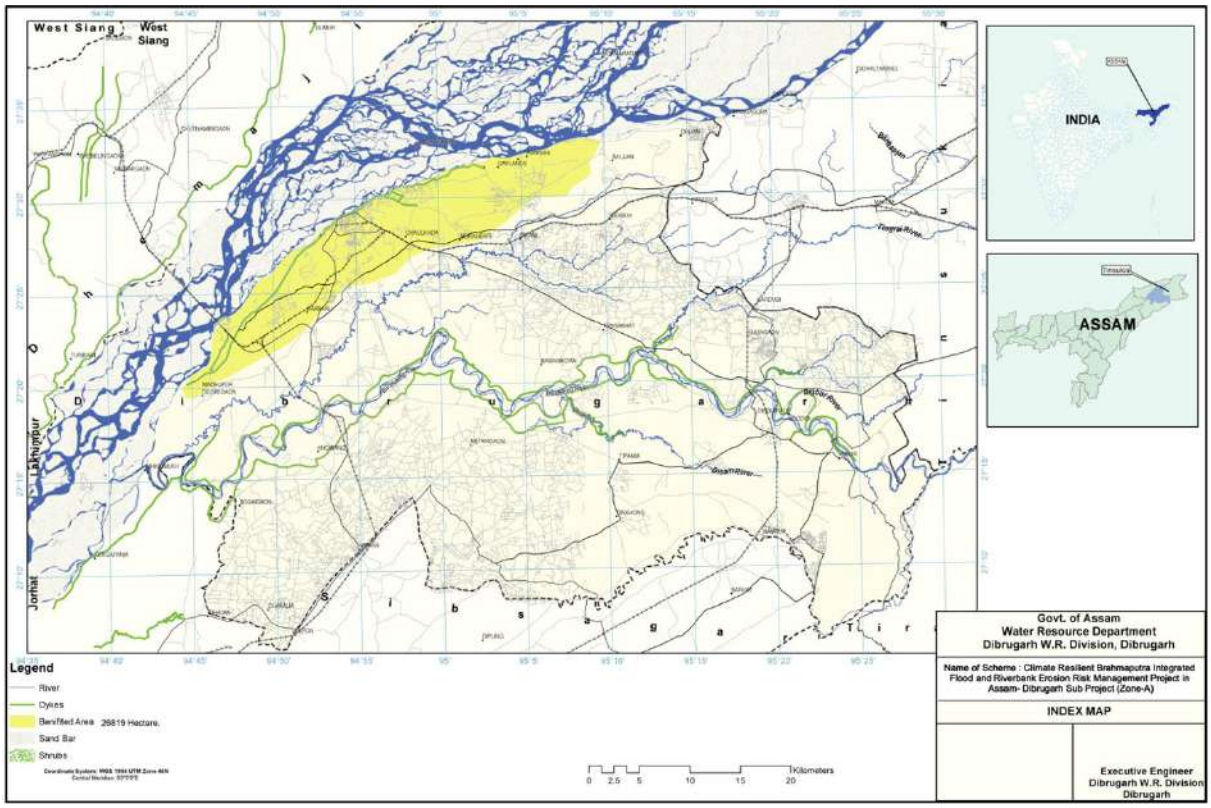
81. Since all the work sites are located along the Brahmaputra River, the construction material and equipment will be transported both through the road and river. The Contractor will employ barges for placing geo-bags under the water. The contractor is expected to transport the material by road up to a certain point from where the material will be transported by river.

F. Project Benefits

82. After implementation of the project, large area will be protected and will give benefit to the people for cultivation etc. Many school buildings, Government institutions, rural hospitals, public utility buildings, industrial setups will be safe from the grip of erosion of Brahmaputra River. Hence, it will be great help for maintaining socio-economic development of the people for a vast area. Furthermore, the most important communication to the local people will also be in future after implementation of the project.

83. The proposed project will not only protect a vast area comprising of thickly populated area in Dibrugarh between Nagaghuli to Chaulkhowa and Tinsukia between Milanpur to Dinjan. Approximately, 26819 hectares and 40000 hectares of valuable land in Dibrugarh and Tinsukia respectively will be benefited from this project. The project will benefit a population of 1800000 in Dibrugarh and 300000 in Tinsukia. The area has a rich cultural heritage and existing Industrial and upcoming industries with vast economic prospect in near future.

Figure 2-13: Dibrugarh subproject - Benefited area



Source: WRD

G. Implementation Schedule and Project Cost

84. The project is planned to be implemented over a period of six years (up to March 2030) including operation and maintenance (OandM). This implementation period includes 2 years as construction period and six months of pre-construction period. The total estimated cost of the subproject for structural works is estimated as USD 75.5 million.

III. ANALYSIS OF ALTERNATIVES

A. Introduction

85. The analysis of alternative is an effective tool to examine the number of options (locational and technological) and establishing most environmentally favorable alternative which cause minimum environmental loss to the natural and social environment. However, since the subproject is site specific, i.e., aims to sustain the functions of the existing flood embankment systems protecting a large number of people and landmass from frequent devastating flooding and riverbank erosion of the Brahmaputra River, the scope for assessing alternatives to the project is limited. To protect the community in Dibrugarh and Tinsukia Districts from land erosion of Brahmaputra riverbank revetment is necessary. Erosion protection by construction of bank revetment and apron with geo-bag size 1.03m x 0.70m (geo-bag type A) with toe key size 1.50m x 0.90m (geo-bag Type-C) for a total length of 21.26 km is proposed out of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia. Adaptation works/Emergency contingency works total of 4.65 km is proposed to be undertaken at 4 locations in Dibrugarh. Also, a total of 173 numbers of P.S.C porcupine over 3 layers are proposed to be launched in 5 locations in Dibrugarh and 2 locations in Tinsukia. In 5 locations of Dibrugarh 72 number of Porcupines and 2 locations of Tinsukia a total of 101 number of Porcupines are proposed to be launched. For protection work, A-type geo-bags of size 1.03m x 0.70m are proposed to be used. 5 layers of C-Type geo-bags in Apron and 3 layers of A Type geo-bags are proposed to be used in both Dibrugarh and Tinsukia sites. Additionally, construction of 1.2 km (new) close gap in embankment at Maijan Beel in Dibrugarh is proposed. A RCC triple shutter sluice gate in Maijan Beel embankment with regulator and fish pass is also proposed. Adaption works of 4.65 km at 3 locations of Dibrugarh with geo-bags is also proposed.

B. Without Project Option

86. **Physical Environment**. In the 'without project' scenario, loss of precious land will continue due to riverbank erosion. Average erosion 17 m/year. Siltation of land due to flood will result to reduced productivity or loss of single crop. No effect on ambient air and noise quality is anticipated. The sedimentation level in wetlands and riverbank may continue to increase due to erosion or flood.

87. **Biological Environment.** In the 'without project' scenario, the present species composition of the vegetation, fisheries and wildlife is expected to remain unchanged. In normal conditions (no flood scenario), no change is anticipated in fish productivity of wetlands, pond fisheries, or productivity of agricultural land. However, loss of vegetation or loss of agricultural productivity, loss of pond fisheries productivity would be high during floods.

88. **Socio-economic Environment.** Without the project, large number of populations will remain vulnerable to flood effect. Even the current rate of erosion to the tune of about 90.1 ha every year is a big loss of agricultural land and settlement areas. Flood also causes many linked socio-economic and health problems.

C. With Project Option

89. **Physical Environment.** In the 'with project' scenario, no change is expected in air, soil and water conditions. The air pollution and noise levels are likely to increase during construction phase but will be confined within the close vicinity of construction sites and will be temporary in nature. The bank protection measures will prevent erosion loss of the productive land and prevent increase of sedimentation load to river.

90. **Biological Environment.** In the 'with project' scenario, there is likelihood of improved fish productivity from wetland and pond fisheries. No significant impact is expected in terms of increase

in sedimentation level or fish productivity during construction stage. With the implementation of mitigation measures the overall impact of the project is likely to be nil or positive on the biological environment except in terms of loss of trees which will be minimized and regenerate over a period of time due to proposed tree plantation program as compensatory plantation. The project entails cutting of trees in in the subproject area due to construction of new embankment and some anti erosion works and other project activities. The number of trees to be felled is yet to be determined as of the time of preparation of the IEE. The number will be finalized at the pre-construction stage and disclose the actual number of trees in monitoring reports.

91. Needless to say, trees play an important role in the environment as oxygen purification, checking soil erosion, habitat of numerous different faunas etc. The bamboo and Simul trees are found in maximum quantity in all the subproject areas. The maturity period of bamboo is about 3 years and Simul is about 10 years, which means most of the trees are fast growing. The economic benefit has been worked out based on direct sale value of a matured tree. The average value of a Simul tree is INR 2,500/tree and that of bamboo is INR 4,000/bunch.

92. **Mitigation Cost:** With regards to mitigation measures, it is planned to plant ten times the tree cut. Since the number of trees to be impacted is yet to be finalized, the total trees to be planted shall be updated at the pre-construction period and shall be disclosed in monitoring reports. Trees shall be maintained for 5 years, and the cost of maintenance shall be part of the mitigation cost.

93. **Socio-economic Environment.** The 'with project' scenario is also likely to bring stability to the economy of the area. About 75% of Assam's farm families live in the Brahmaputra valley, where 90% of the net cropped area is at risk of flooding. Flooding causes agriculture losses and deposits sand on fertile fields. Reduced productivity disproportionately affects small farmers, especially female headed farms. Outmigration of men causes women additional burdens in household responsibilities, farm production, and financial obligations. Women have limited access to flood warnings, and little representation on decision-making bodies that would better help with flood response. With the implementation of the project, conservation of large area from erosion shall be done, which means increased agricultural produce. AADB shall also be running pilot nature-based solutions to prevent erosion of the slopes of embankments, to plan and promote wetland revival and biodiversity, and to promote siltation on possibly reclaimed land. It is expected that these pilots will provide employment opportunities for riverine rural poor and as the pilots can be upscaled to broader implementation, more employment opportunities will be created in the next phases.

94. Farmers thus will be able to plant three crops, instead of two crops in a year. Wetlands and pond fisheries productivity will improve due to reduce siltation load and improved fishery practices. The project will also provide better commuting opportunities to fishermen and people of the area through the paved road on the embankment, which means reduced commuting time to reach the markets. The flood protected environment may also promote agro-based industries in the area. The post-project scenario will enhance overall economy of the area. A major output of the project is to improve the livelihood of the vulnerable people and resilience. Various interventions including training and supports are proposed which shall improve the socio-economic environment of the project area. As per socioeconomic study, based on land use record of State Government of Assam, majority of the land in the subproject benefit area is agriculture which is about 62%.[15] The major crops grown are rice, maize, vegetables, mustard, tea and other Rabi and Kharif crops, with rice crop accounting for 66%. The crop farmers will considerably benefit post project implementation and these benefits can further improve with improved cropping pattern and use of climate resilient and

[15] ADB. India: Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program Project 2, Initial Environmental Examination Report (Palasbari Subproject - Palasbari and Gumi Reach, Kamrup District). May 2018. https://www.adb.org/projects/documents/ind-38412-033-iee-0

high yielding variety (HYV) seeds. With availability of land, even non-polluting industries as agro-based and cottage industries by female self-help groups shall also be promoted in the area.

D. 'Repeated *Embankment* Retirement' Option

95. **Physical Environment.** This option involves the retirement of flood embankments in response to the riverbank erosion process, with the acquisition of land and compensation to the affected people. In this scenario, loss of land will continue due to riverbank erosion. There is also a possibility of frequent flood inundation in the subproject area, unless the retired embankment can be constructed before the existing embankment is breached due to the riverbank erosion.

96. **Biological Environment.** In this option, the eroded land will turn into a river channel turning into an aquatic environment. The environment of floodplain and wetlands during the monsoon season will depend on the timing of constructing the retired embankment against the breach of existing embankment due to erosion. For other seasons, no change is anticipated in fish productivity of wetlands, or productivity of agricultural land in the flood plain.

97. **Socio-economic Environment.** Since this option involves continuous river erosion, there will also be displacement of people associated with eroded land lost due to river erosion, of which agriculture productivity will be lost. The similar economic benefits may be delivered in case of timely construction of retired embankment prior to the breach of existing embankment due to river erosion. However, there is a risk of failure given the lengthy procedures for land acquisition and opposition from the concerned population in the subproject areas (when compared with the 'with-project' option), in which case there will be repeated flood damages, affecting the confidence of local population on the reliability and effectiveness of FRERM systems leading to much less positive socio-economic impacts as compared with the 'with-project' option.

E. Conclusion.

98. “Without” subprojects would yield the project area to be continuously under-the threat of floods and effects of soil erosion that puts the socio-economic conditions and life of the general public at an increasing risk and could potentially worsen the living environment. This ‘no project’ scenario would impede further social and economic development of the project area and the defer commitments to improve the proportion of the population with better life.

99. The Repeated Embankment Retirement option involves loss of land due to erosion and needs substantial provisions for land acquisition. In this scenario, the threat of floods also continues to remain there. As such this “Repeated Embankment Retirement option” is also not feasible.

100. Given the large-scale benefits to the population and environment, ‘With Project’ alternative is thus considered appropriate.

IV. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

A. ADB's Environmental Safeguard Policy and Requirement

101. ADB SPS requires that during the design, construction and operation of the project necessary compliance to all applicable laws and international conventions/treaties along with pollution prevention and control technologies and practices consistent with international good practice, are ensured.

102. Screening and Categorization with that of ADB SPS 2009. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of the following four categories:

(i) **Category A.** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment (EIA) is required.

(ii) **Category B.** A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category A projects. An initial environmental examination (IEE) is required.

(iii) **Category C.** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

(iv) **Category FI**. A proposed project is classified as category FI if it involves investment of ADB funds to or through a FI.

103. The environmental impacts of the Dibrugarh subproject have been identified and assessed as part of the planning and design process. An environmental assessment using ADB's Rapid Environmental Assessment Checklists (Appendix 3) were conducted, and results of the assessments shows that the subproject is unlikely to cause significant adverse impacts. Thus, this IEE has been prepared in accordance with ADB SPS's requirements for environment Category B projects.

104. **Environmental Management Plan.** An EMP which addresses the potential impacts and risks identified by the environmental assessment shall be prepared. The level of detail and complexity of the EMP and the priority of the identified measures and actions will be commensurate with the Project's impact and risks. The EMP shall include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.

105. **Public Disclosure**. The IEE will be put in an accessible place (e.g., local government offices, libraries, community centers, etc.), and a summary translated into local language for the project affected people and other stakeholders. The following safeguard documents will be put up in ADB's website so that the affected people, other stakeholders, and the public can provide meaningful inputs into the project design and implementation:

(i) Final or updated IEE upon receipt; and

(ii) Environmental monitoring reports submitted by the Project Management Unit (PMU) during project implementation upon receipt.

106. **Consultation and Participation**. ADB SPS requires FREMAA to conduct meaningful consultation[16] with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. The consultation process and its results are to be documented and reflected in the environmental assessment report.

107. **Grievance Redress Mechanism**. ADB SPS requires FREMAA to establish a mechanism to receive and facilitate resolution of affected people's concerns, complaints, and grievances about the subproject's performance. The grievance mechanism shall be scaled to the risks and adverse impacts of the subproject.

108. **Monitoring and Reporting**. FREMAA shall monitor measure and document the implementation progress of the EMP. If necessary, the FREMAA shall identify the necessary corrective actions, and reflect them in a corrective action plan. FREMAA shall prepare and submit to ADB annual environmental monitoring reports that describe progress with implementation of the EMP and compliance issues and corrective actions, if any. For subprojects likely to have significant adverse environmental impacts during operation, reporting will continue at the minimum on an annual basis until ADB issues a project completion report.

109. **Unanticipated Environmental Impacts**. Where unanticipated environmental impacts become apparent during subproject implementation, ADB SPS requires the FREMAA to update the environmental assessment and EMP or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.

110. **Occupational Health and Safety.** ADB SPS requires the FREMAA, WRD and AADB to ensure that workers[17] are provided with a safe and healthy working environment, taking into account risks inherent to the sector and specific classes of hazards in the subproject work areas, including physical, chemical, biological, and radiological hazards. FREMAA shall take steps to prevent accidents, injury, and disease arising from, associated with, or occurring during the course of work, including: (i) identifying and minimizing, so far as reasonably practicable, the causes of potential hazards to workers; (ii) providing preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances; (iii) providing appropriate equipment to minimize risks and requiring and enforcing its use; (iv) training workers and providing them with appropriate incentives to use and comply with health and safety procedures and protective equipment; (v) documenting and reporting occupational accidents, diseases, and incidents; and (vi) having emergency prevention, preparedness, and response arrangements in place.

111. **Community Health and Safety**. ADB SPS requires identification and assessment of risks to, and potential impacts on, the safety of affected communities during the design, construction, operation, and decommissioning of the subproject, and shall establish preventive measures and plans to address them in a manner commensurate with the identified risks and impacts. The project management unit (PMU) and project implementation unit (PIU) shall ensure to apply preventive and protective measures for both occupational and community health and safety consistent with

[16] Per ADB SPS, 2009, meaningful consultation means a process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle; (ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues

[17] Including non-employee workers engaged by the borrower/client through contractors or other intermediaries to work on project sites or perform work directly related to the project's core functions.

international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines. PMU shall also adhere to necessary protocols in response to infectious diseases such as the corona virus disease (COVID-19) consistent with the guidelines of relevant government healthcare agencies and the World Health Organization.

112. PMU shall ensure to apply preventive and protective measures consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines.

113. **Physical Cultural Resources**. PMU and PIUs are responsible for siting and designing the subproject to avoid significant damage to physical cultural resources. ADB SPS requires that such resources likely to be affected by the subproject are identified, and qualified and experienced experts assess the subproject's potential impacts on these resources using field- based surveys as an integral part of the environmental assessment process. When the proposed location of a subproject component is in areas where physical cultural resources are expected to be found as determined during the environmental assessment process, chance finds procedures shall be included in the EMP.

114. **Pollution Prevention and Control Technologies**. During the design, construction, and operation of the project, PMU, shall apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines[18]. These standards contain performance levels and measures that are normally acceptable and applicable to the project infrastructures. When the government's regulations differ from these levels and measures, the project shall achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, PMU, will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

115. **Bidding and Contract Documents**. This IEE report, which contains the EMP, shall be included in bidding and contract documents and verified by PMU. The PMU shall also ensure that bidding and contract documents include specific provisions requiring contractors to (i) comply with all other conditions required by ADB, and including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; (iii) monitoring program as per EMP; and (iv) budget for EMP implementation, among others as may be required. A copy of the EMP will be kept on site during the construction period at all times. Non-compliance with, or any deviation from, the conditions set out in the EMP constitutes a failure in compliance and shall require corrective actions.

116. **Conditions for Award of Contract and Commencement of Work**. PMU shall not award any works contract under the subproject until (i) relevant provisions from the EMP are incorporated into the works contract; (ii) PMU has obtained ADB's clearance of final IEE report; and (iii) other necessary permits from relevant government agencies have been obtained.

B. Regulatory Requirements of the Government of India and Assam State

117. The implementation of the subprojects will be governed by Government of India and State Government of Assam and other applicable environmental acts, rules, regulations, and standards. These regulations impose restrictions on the activities to minimize or mitigate likely impacts on the environment. It is the responsibility of the project executing and implementing agencies to ensure

[18] World Bank Group. 2007. Environmental, Health, and Safety General Guidelines. Washington, D.C.; https://www.ifc.org-ehs-guidelines

subprojects are consistent with the legal framework, whether applicable international, national, state or municipal or local. Key standards include those related to drinking water quality, air quality, effluent discharge, and protected areas. Compliance is required in all stages of the subprojects including design, construction, and operation and maintenance.

118. **Environmental assessment**. The Government of India EIA Notification of 2006 (replacing the EIA Notification of 1994) sets out the requirement for Environmental Assessment in India. This states that Environmental Clearance (EC) is required for specified activities/projects, and this must be obtained before any construction work or land preparation (except land acquisition) may commence. Projects are categorized as A or B depending on the scale of the project and the nature of its impacts.

119. None of the components of this subproject falls under the ambit of the EIA Notification 2006, and therefore EIA Study or environmental clearance (EC) is not required for the subproject. However, mining of sand/river silt for use in filling geo-bags and aggregates for use in cement concrete structures are under the ambit of EIA notification and shall require prior EC from State Environmental Impact Assessment Authorities (SEIAA)

120. The Government of India has framed various laws and regulation for protection and conservation of natural environment. These legislations with applicability to this project are summarized below in Table 4-1.

121. The national and international environmental standards and guidelines are provided in Appendix 4.

122. As the project does not require forest land diversion and the project is not falling within any protected areas (National Parks, Tiger Reserve and Wildlife Sanctuaries), thus no clearance is required from Forest Department of Assam and from National Wildlife Board, MoEF&CC, Government of India.

123. The Eco-Sensitive Zone (ESZ) of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites located in Tinsukia District are adjacent to or within the notified area of the ESZ of the Dibru - Saikhowa NP. No objection Certificate (NoC) and permissions thus shall be required from Wildlife and Forest Department of Assam and State and National Wildlife Boards, Government of India.

Table 4-1: Key Environmental Legislations at a Glance

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
Environmental Protection Legislations					
National Environment Policy (NEP), 2006	NEP is a comprehensive guiding document in India for all environmental conservation programs and legislations by Central, State and Local Government. The dominant theme of this policy is to promote betterment of livelihoods without compromising or degrading the environmental resources. The policy also advocates collaboration method of different stakeholders to harness potential resources and strengthen environmental management.	Applicable for all the projects which have environmental impacts associated with its development and operation	No permit required. Permits are required as per various laws and rules framed under the act	MoEF&CC	-
The Environmental (Protection) Act, 1986 and The Environmental (Protection) Rules, 1987 and its amendments	All construction activities must comply with the legislation issued under this act and rules, the EIA process and implementation of the EMP will enable this. Construction activities must also comply with the environmental quality standards	• Umbrella act under which environmental rules, notifications, schedules and standards applicable to the proposed project are issued • Ecological Sensitive Zones are notified under the act	No specific permits but all environmental clearances, NOCs and permits are referred to the act	MoEF&CC, Assam Forest Dept, CPCB and Pollution control Board, Assam (PCBA)	-
EIA Notification 14th September 2006 and	Requires prior environmental clearance (EC) for new, modernization and	• Considered Not Applicable (EIA Notification 2006 does not classify for	• No prior EC required for embankment construction and	MoEF&CC/SEIAA	Contractor (obtaining for mining of sand/river silt)

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
amendment till date	expansion projects listed in schedule 1 of EIA Notification, 2006	embankment construction and anti erosion activities) • Applicable for mining of sand/river silt for use in filling geo-bags and aggregates for use in cement concrete structures	anti erosion activities • Prior EC required for mining of sand/river silt for use in filling geo-bags and aggregates for use in cement concrete structures		and FREMAA (monitoring)
Air (Prevention and Control of Pollution) Act, 1981, 1987 The Air (Prevention and Control of Pollution) Rules, 1982	Act to prevent and control Air pollution	Applicable. The applicability is due to emission from operation of construction equipment like batching plants, DG sets.	Consent to Establish (CTE) and Consent to Operate (CTO) to be obtained and maintained for setting up each facility, batching plant, DG set as prior to its establishment and operation from PCBA. Conditions to be complied	PCBA	Contractor (obtaining CTE and CTO) and FREMAA (monitoring)
Water Prevention and Control of Pollution) Act, 1974,1988 The Water (Prevention and Control of Pollution) Rules, 1975 The Water (Prevention and Control of Pollution) Cess Act, 1977 and amendment in 2003	Acts to prevent and control water pollution.	Applicable. It is applicable for the project's having potential to generate effluent during any stage of the project. Effluents are expected to be gaenerated during construction stage from construction camps.	CTE and CTO for disposal of sewage and construction of septic tank/soak pit prior to start of establishment and operation from PCBA. Conditions to be complied	PCBA	Contractor (obtaining CTE and CTO) and FREMAA (monitoring)

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
Noise Pollution (Regulation and Control Act) 2000 and 2010 as amended	Ambient Noise standards for different areas and zones	Applicable due to generation of noise during construction	No separate permits issued under this act. Permissions are covered for DG sets under CTE/CTO	PCBA	Contractor (obtaining CTE and CTO) and FREMAA (monitoring)
Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016	Protection to public against improper handling storage and disposal of hazardous waste. The rules prescribe the management requirement of hazardous wastes from its generation to final disposal.	Applicable. Project may generate hazardous wastes (like waste oil) during construction	Authorization for storage and handling of hazardous waste	PCBA	Contractor (obtaining permits from PCBA) and FREMAA (monitoring)
Manufacture, Storage, and Import of Hazardous Chemicals (MSIHC) Rules, 1989	Usage and storage of hazardous material	Applicable only for storage of highly inflammable liquids and gases like HSD/LPG. Compliance to the rules should be ensured	No specific permit is required, however Precautions defined under the material safety datasheets should be followed for use of hazardous substances listed under the schedules attached to this notification if any proposed to be used. Safety requirements should have to be complied if storage quantity exceeds the regulated threshold limit	Chief Controller of Explosives	Contractor (compliling with precautions and safety requirements) and FREMAA (monitoring)
Construction and Demolition Waste	To manage the construction and demolition waste	Applicable Applies to all those wastes resulting from Construction	Approval required from local authorities, if waste generation is	Local Authorities	Contractor (obtaining approvals) and

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
Management Rules, 2016		repair and demolition of any civil structure of individual or organization who generates construction and demolition waste such as building material, rubble, debris. Segregation, management and disposal of wastes to be as per rules.	>20 tons in a day or 300 tons per project in month		FREMAA (monitoring)
Plastic waste Management Rules, 2016	To manage the plastic waste generated	Applicable. Plastic waste is unlikely to be generated in small quantities. Wastes will be generated from packaging materials during construction. Wastes to be segregated and disposed as per Solid Waste Management Rules, 2016.	No authorization to be obtained. Waste management and minimization to be done. Fee to be paid to local bodies, if applicable	Local bodies	Contractor (obtaining) and FREMAA (monitoring)
The Batteries (Management and Handling) Rules, 2001	To regulate the disposal and recycling of lead acid batteries	Applicable Applicable for disposal of used lead acid battery if likely to be used in any equipment during construction stage.	No specific registration required. Compulsion to buy and sale through registered vendor only.	PCBA	Contractor (obtaining) and FREMAA (monitoring)
Forest Conservation and Wildlife Protection Legislation					
Indian Forest Act, 1927 The Forest (Conservation) Act, 1980 and amendments The Forest (conservation) Rules, 1981 and amendments	To protect forest by restricting conversion of forested areas into non-forested areas and deforestation	Not fully applicable. No forest land is being diverted. However large no. of tree cutting is envisaged for which NOC from forest department should be obtained prior to tree cutting as per applicable rules of the state. Compensatory plantation should be carried out as per state forest policy.	Forest Clearance/Permission for tree cutting.	Assam Forest Department and MoEF&CC	Contractor (obtaining) and FREMAA (monitoring)
Wildlife Protection Act, 1972, 1993 Biological Diversity	To protect wildlife through notifying National Parks (NP) and Wildlife	• No diversion of NP and WLS area. Wildlife	NOC for construction within notified ESZ/10	Chief Wildlife Warden, State Board of Wildlife and	FREMAA

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
Act, 2002	Sanctuaries (WLS) and notified ESZ or in its absence 10 km buffer areas around the Protected Areas (PAs)	clearance is thus not applicable • Proposed sites in Tinsukia District are adjacent to or within the notified area of the ESZ of the Dibru - Saikhowa NP. No objection Certificate (NoC) and permissions required	km in absence of notified ESZ	National Board of Wildlife	
Safety and Other Related Legislations					
Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Requirement of preparation of on-site and off-site Disaster Management Plans for accident-prone areas.	Not Applicable. The project does not involve handling of any hazardous chemical during both construction and operation, phase which may lead to continuous, intermittent or repeated exposure to death, or injury.	No permits issued under this act	Central, State and District Crisis Group (headed by the Deputy Commissioner)	Not Applicable
Public Liability and Insurance Act 1991	Protection from liability arising due to accidents from handling of hazardous chemicals.	Not Applicable. The project does not involve storage of any chemicals (i.e., HSD) beyond the threshold limit during construction and	No permits issued under this act. Owner of project should take out insurance policies providing for contracts of insurance so as he is insured against liability to give relief, before handling any such hazardous material	Labor Commissioner and Deputy Commissioner (DC)	Not applicable
Explosive Act 1884 and Explosive Rules, 2008	Safe transportation, storage and use of explosive material	Not Applicable No explosives (as described in act and rules) are proposed to be used in the construction and operation stage of the project.	Permission for storage and usage of explosive	Chief Controller of Explosives	Not applicable

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
The Petroleum Act, 1934 The Petroleum Rules 2002	Use and storage of Petroleum products	Applicable as storage of HSD/LPG or any other petroleum product may be required for the project purpose	License to store petroleum beyond prescribed quantity.	Chief Controller of Explosives/DC	Contractor (obtaining) and FREMAA (monitoring)
Central Motor Vehicle Act 1988 and amendments Central Motor Vehicle Rules, 1989 and amendments	To minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise pollution.	Applicable, for all the contractor's vehicles at site during construction and operation phase	Driving Licenses and Pollution under control certificates are issued under this Act	Motor Vehicle Department (Licensing authority, registration authority and State Transport Authorities)	Contractor (obtaining) and FREMAA (monitoring)
The Gas Cylinder Rules 2004	To regulate the storage of gas/ possession of gas cylinder more than the exempted quantity	Applicable if contractor store more than the exempted quantity of gas cylinder.	License to store gas cylinder more than the regulated quantity	Chief Controller of explosives	Contractor (obtaining) and FREMAA (monitoring)
Ancient Monuments Preservation Act 1904 Ancient Monuments and Archaeological Sites and Remains Act, 1958 and Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010. Heritage Conservation and Preservation Act, 2010	Areas within 100 meters (m) of the "protected monument/area" are designated as "prohibited area" and beyond that up to 200 m as "regulated area" respectively. No "construction" is permitted in the "prohibited area" and any construction activity in the "regulated area" requires prior permission of the Archaeological Survey of India (ASI).	Applicable only if any intervention is planned within 100 m of archaeological protected sites falling along the ROW. No archaeological sites are within the 100m of the project components	No objection certificate	Archaeological Survey of India, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH), Directorate of Archaeology, Assam	Not applicable

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
Ancient Monuments and Archaeological Sites and Remains (Framing of Heritage Bye laws and Other Functions of Competent Authority) Rules, 2011 National Monument Authority Rules, 2011					
Guidelines for evaluation of proposals/requests for groundwater abstraction for drinking and domestic purposes in Notified areas and Industry/ Infrastructure project proposals in non-notified areas, 2012	To regulate extraction of groundwater for drinking and domestic purpose	Applicable if groundwater is extracted for meeting drinking/ domestic water needs of contractor workers	No objection certificate	Central groundwater Authority/Board	Contractor (obtaining) and FREMAA (monitoring)
Other Regulations					
• Workmen's Compensation Act 1923 • Contract Labour (Regulation and Abolition) Act, 1970 • Minimum Wages Act, 1948 • Payment of Wages Act, 1936 • Equal Remuneration Act, 1979 • Child Labour (Prohibition and Regulation) Act, 1986 • Inter-State Migrant Workmen's (regulation of Employment and Conditions of Services) Act, 1979					

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority	Responsibility
• The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and the Cess Act of 1996 • The Factories Act, 1948 • Hazardous Wastes (Management and Handling) Rules, 1989 Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996					

Source: ADB TA Consultant

Table 4-2: International Conventions and Treaties

Law	Description	Requirement	Relevance to the project
Ramsar Convention, 1971	The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international co-operation for the conservation and wise use of wetlands and their resources. India is one of the signatories to the treaty. The Ramsar convention made it mandatory for the signatory countries to include wetland conservation in their national land use plans.	No Ramsar sites in project district. There is one Ramsar site (Deepor Beel) in Assam which is approx. 500 km from the one of the Dibrugargh District. Not applicable.	No
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	India is a signatory of this convention which aims to control international commercial trade in endangered species	Reported presence of IUCN Red listed species like River Dolphins and other species in the subproject area. Contractor to create awareness amongst workers to desist from illegal wildlife activities including poaching, hunting and fishing by workers	Yes
Montreal Protocol 1992	India is a signatory of this convention which aims to reduction in the consumption and production of ozone-depleting substances (ODS), while recognizing differences in a nation's responsibilities. Ozone depleting substances are divided in two groups Chlorofluorocarbons (CFCs) and Hydro chlorofluorocarbon carbons (HCFCs)	Not applicable in this project as no ODS are involved in construction works.	No
Basel Convention on Trans- boundary Movement of Hazardous Wastes, 1989	India is a signatory of this convention which aims to reduce trans-boundary movement and creation of hazardous wastes	Contractor to follow the provisions of Hazardous Waste Rules 2016 for storage, handling, transport and disposal of any hazardous waste emerged during construction works	Yes
Convention on Migratory Species of Wild	CMS, also known as Bonn convention, was adopted in 1979 and entered into force on 1 November 1983, which recognizes that states must be the protectors of migratory species that live within or pass	Reported presence of IUCN Red listed species like River Dolphins that migrate all along the Brahmaputra River and	Yes

Law	Description	Requirement	Relevance to the project
Animals (CMS), 1979 (Bonn convention)	through their national jurisdictions, and aims to conserve terrestrial, marine and avian migratory species throughout their ranges. Migratory species threatened with extinction are listed on Annexure 8 of the Convention. CMS Parties strive towards strictly protecting these species, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.	migratory avian species in the Central Asian Flyway in the subproject area. Contractor to create awareness amongst workers to desist from illegal wildlife activities including poaching, hunting and fishing by workers	
Convention on Biological Diversity (Rio De Janeiro, 1992)	The UN Convention on Biological Diversity which India ratified in 2019 deals with biodiversity conservation and sustainable usage, habitat preservation, and protection of indigenous people's rights, and intellectual property.	No direct relevance to the project though seeks to avoid or minimize the loss of any flora and fauna.	Yes

Source: ADB TA Consultant

V. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

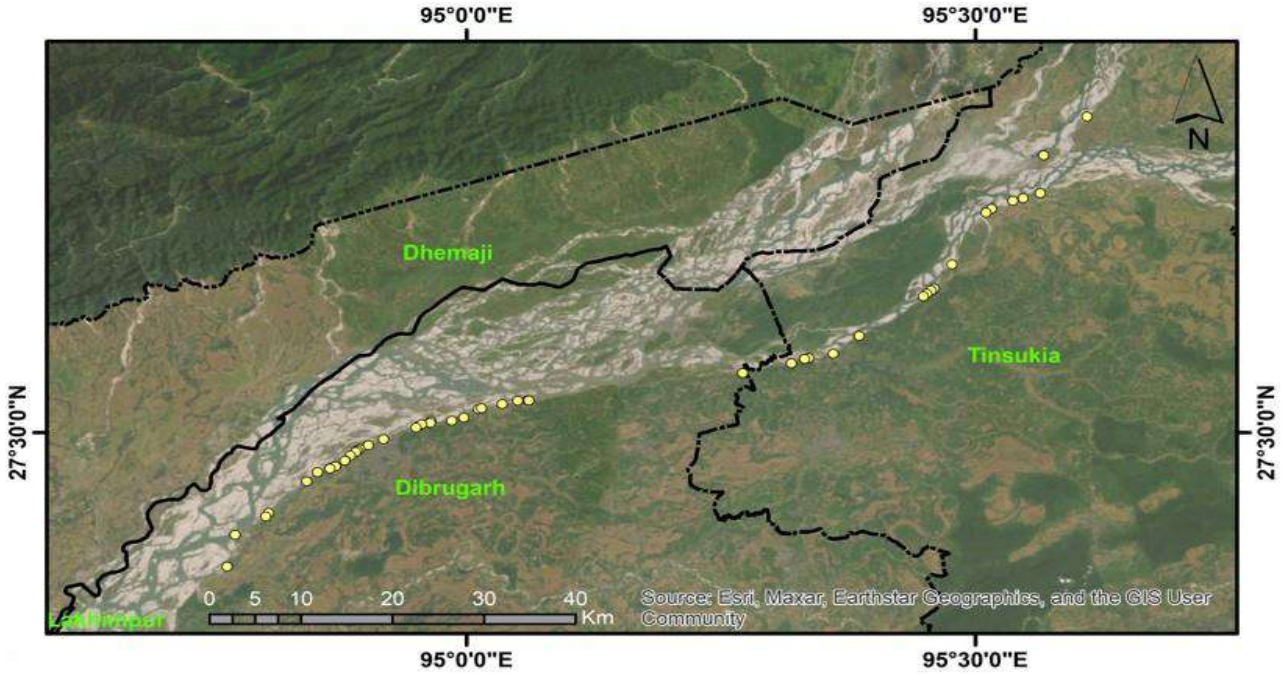
124. This section presents a brief description of the existing environment around the subproject area, including its physical resources, ecological resources, socioeconomic development and social and cultural resources. Broad aspects of various environmental parameters such as physical, biological, and socio-cultural and economic development parameters that are likely to be affected by the proposed subproject have also been discussed. For completing the baseline description, emphasis was given to data collection on the physical environment, biological environment, and socio-economic environment of the study area. These data are considered to be of prime importance considering the nature and location of the proposed subproject focused on the Dibrugarh and Tinsukia reaches in Dibrugarh and Tinsukia Districts of Assam.

B. Geographical location

125. The Dibrugarh subproject falls in Dibrugarh District and Tinsukia Districts of Assam. The part of subproject area fallng in Dibrugarh is located on the south bank of Brahmaputra and is bounded by the geographical co-ordinates of 27°34'12.29"N 95°17'31.26"E to 27°24'29.73"N 94°48'7.66"E. Dibrugarh part of the subproject covers Dibrugarh Town area and its adjoining areas up to Oakland at upstream to Bogibeel areas at downstream.

126. The other part of Dibrugarh subproject area for the project works is located in the Tinsukia District on the south bank of Brahmaputra and are bounded by the geographical coordinates of Longitude 95°-16'E to 95°-33'E and latitude 27° 34'N to 27° 45'N. The subproject covers south bank of Brahmaputra from Saikhowaghat - Milanpur area at upstream to Dinjan army camp areas at downstream.

Figure 5.1: Proposed work sites under Dibrugarh subproject in Dibrugarh and Tinsukia



Source: WRD

C. Project Area of Influence

127. For baseline establishment a project area of influence (PAI or study area) has been determined for the site; the subsequent sections provide an understanding of the PAI in relation to each environmental parameter and reasons for its selection.

- **Project Footprint/Direct Impact Area**: The project footprint is the area that may reasonably be expected to be directly physically disturbed by activities or infrastructure during construction. This area includes the area where project interventions are proposed.
- **Project Area of Influence or PAI**: The effects of physical activities or infrastructure during different phases on a particular environmental resource or sensitive receptor will have spatial and temporal dimensions. Some activities will impact resources or receptors in a larger radius than others whilst some resources or receptors will be more sensitive to impacts; this has been considered in defining the PAI in relation to each environmental parameter. The PAI has been divided into core and buffer zones:
  - **Core Zone**: the core zone is defined as the radius extending from the project footprint area (direct impact area) which will be subject to the most impacts or the greatest magnitude of change during construction and operation period; and
  - **Buffer Zone**: the buffer zone is the remaining part of the PAI which may be subject to impacts but fewer in number or of lesser magnitude than the core zone.

Table 5-1: Project Area of Influence (PAI)

Environment Parameter	Core	Buffer	Remarks
Biological	1 km	5 km (50km)	PAI of 5 km radius was considered for undertaking the biological data collection. Surveys provide an understanding of the project site, its immediate surroundings (core zone) and wider setting (buffer zone). For primary biological survey, both floral and faunal surveys were conducted through transects in the project footprint and within 1 km radius. For running an IBAT report a 50km buffer was used to pick up on any wide-ranging species and nearest protected/key biodiversity areas. The IBAT report is appended in Appendix 6.
Physical	500m	5 km	PAI of 5 km radius was considered for undertaking physical environment data collection. For most parameters, 500m radius was considered as core zone for mapping of sensitive receptors during the field surveys and for undertaking baseline monitoring.
Socio-economic	500 m	5 km	PAI of 5 km radius is considered for socio-economic context, with a core zone of 500m radius for mapping of individual sensitive receptors and consultations during field surveys.

IBAT = Integrated Biodiversity Assessment Tool, PAI = Project Area of nfluence

Source: ADB TA Consultant

D. Physical Environmental Setting

1. Land Use and Agricultral Practices

128. The land characteristic of both Dibrugarh District and Tinsukia District is mostly flat plain except a few forested hills with elevation between 40 to 50 meters. The two districts also include a large number of riverine tracts and sandy river island in the Brahmaputra River. Agriculture is the main occupation of the people of both the district. The area of the govt. waste land is very large but with the inflow of Immigrants a large area of the virgin soil has been upturned. A large area of waste land such as char area has been taken up for habitation and also for agriculture.

129. The following Table 5-2 indicates the pattern of land use under various classification of land in Dibrugarh District and Tinsukia District

Table 5-2: Land use Pattern in Dibrugarh District and Tinsukia

Dibrugarh District	
Land Put to Different Uses	**Area in Hectares**
Total Geographical Area	338,100
Forest area	21,794
Land not available for cultivation	125,001
Land put to non-agriculture uses	101,837
Barren and un-cultural land	23,164
Other uncultivated land excluding fallow land	29,153
Permanent pastures and other grazing land	5,069
Land under misc., trees, groves etc. not included in net area	13,020
Cultivable waste land	11,064
Fallow other than current fallow	4,654
Current fallow	6,828
Net area sown	150,670
Area sown more than once	14,111
Tinsukia District	
Land Put to Different Uses	**Area in Hectares**
Total Geographical Area	379,000
Forest area	126,468
Land not available for cultivation	85,153
Land put to non-agriculture uses	33,759
Barren and un-cultural land	51,394
Other uncultivated land excluding fallow land	23,432
Permanent pastures and other grazing land	5,637
Land under misc., trees, groves etc. not included in net area	14,118
Cultivable waste land	3,677
Fallow other than current fallow	8,990
Current fallow	4,252
Net area sown	130,705
Area sown more than once	14,361

Source: Statistical Handbook 2022. Directorate of Economics and Statistics, Government of Assam

130. Lea Associates South Asia Pvt. Ltd. (LASA) has been appointed by FREEMA for data collection for environmental assessment and their scope included (a) environmental quality monitoring for air, water, noise, soil, (b) wildlife and habitat survey, (c) physical and socio-economic data including GIS mapping for land use, (d) environmental risks identification and analysis and (e) public consultations. Lea Associates has done the LULC study in April 2023 by utilizing recent (January, February, April 2023) satellite images, the project area's present land use pattern is examined at two different scales while taking the nature and potential impact of the project aspects into consideration. On a larger scale, a 5 km buffer was selected surrounding the project locations, and the land use pattern within the zone is identified using GIS and satellite images. Land use pattern within 1 km buffer from the project locations also studied.

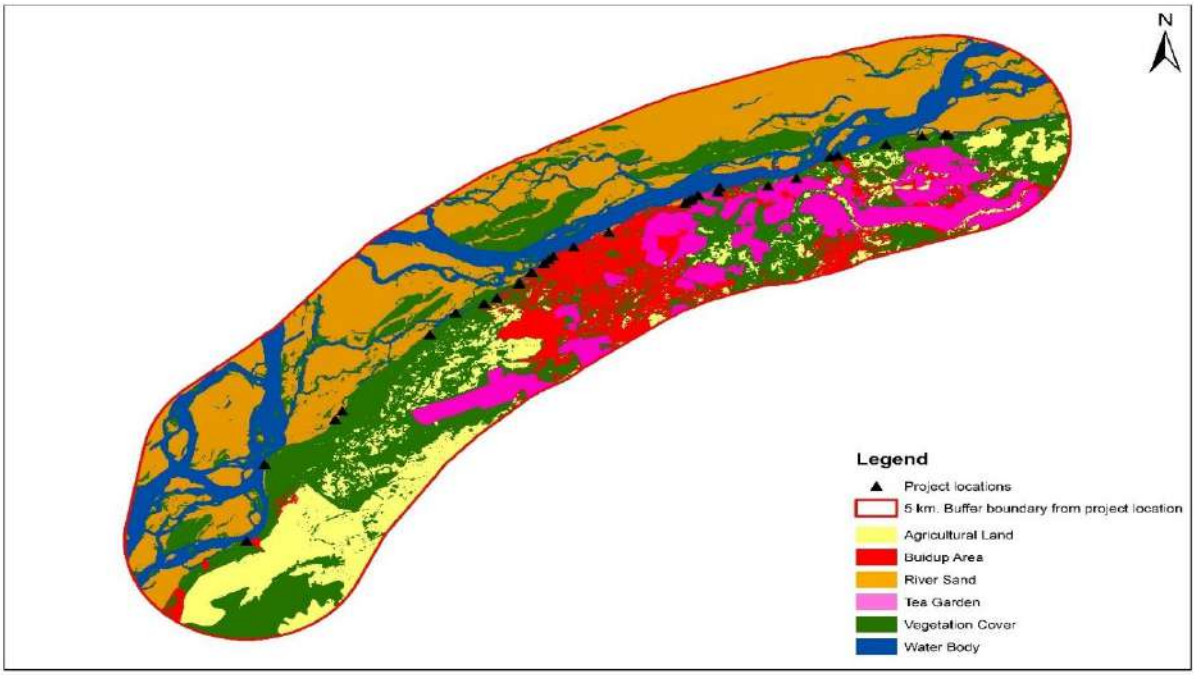
131. The land use pattern of the project locations of Dibrugarh District and Tinsukia District within the 5km and 1km buffer from the project location are presented in Figure 5.2 to 5.5 and the area covered by different land use within 5 km and 1 km buffer from project locations is presented in Tables 5.3 to 5.6.

Table 5-3: Land use area within 5 km Buffer Zone on either side of the Project locations of Dibrugarh District.

Land use	Area in Hectare	%
Water body	6438.21	13.77
River sand	13694.65	29.30
Agriculture land	5436.16	11.63
Buildup area	3871.72	8.28
Vegetation cover	13225.92	28.30
Tea garden	4065.50	8.69
Total	**46732.18**	**100**

Source: LASA, April 2023

Figure 5.2: Land use map of the 5 km Buffer Zone on either side of the Project locations of Dibrugarh District. (Febuary, 2023)



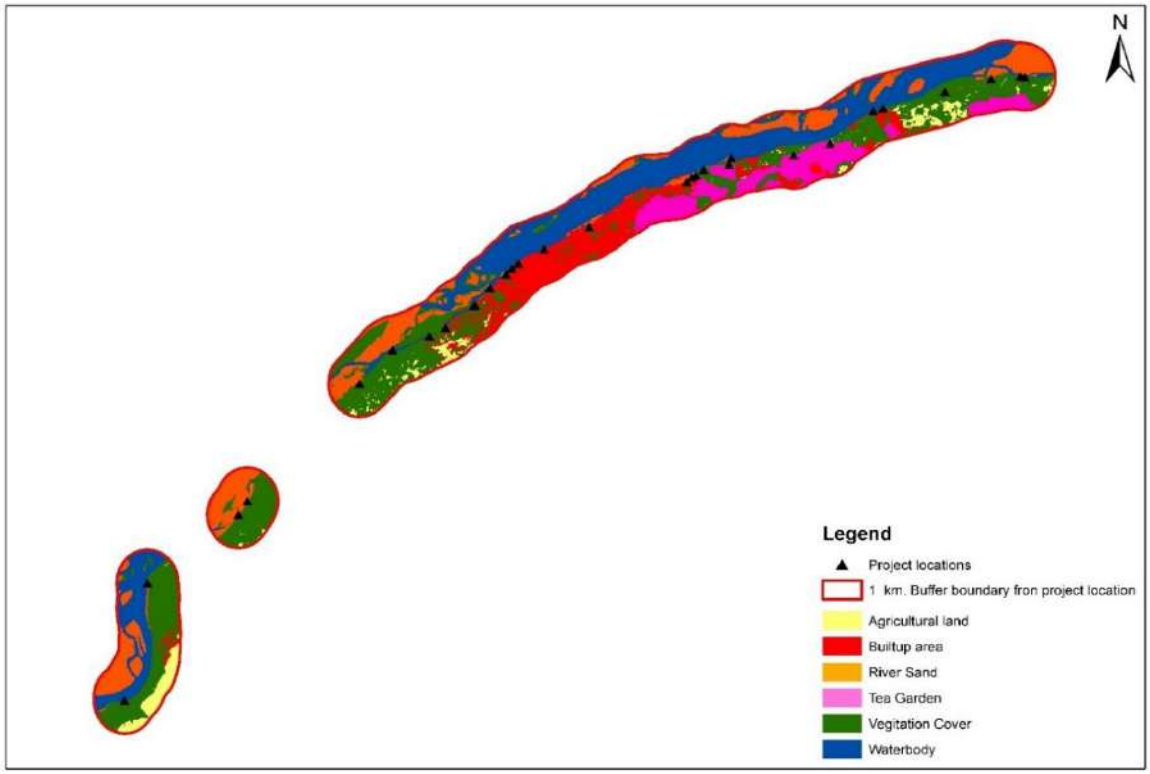
Source: LASA, April 2023

Table 5-4: Land use area within 1 km Buffer Zone on either side of the Project locations of Dibrugarh District

Land use	Area in Hectare	%
Water body	2121.66	28.76
River sand	1142.97	15.49
Agriculture land	326.30	4.42
Buildup area	853.70	11.57
Vegetation cover	2290.47	31.05
Tea garden	641.58	8.69
Total	**7376.71**	**100**

Source: Lea Associates South Asia Pvt. Ltd. (LASA), 2023

Figure 5-3: Land use map of the 1 km Buffer Zone on either side of the Project locations of Dibrugarh District. (Febuary, 2023)



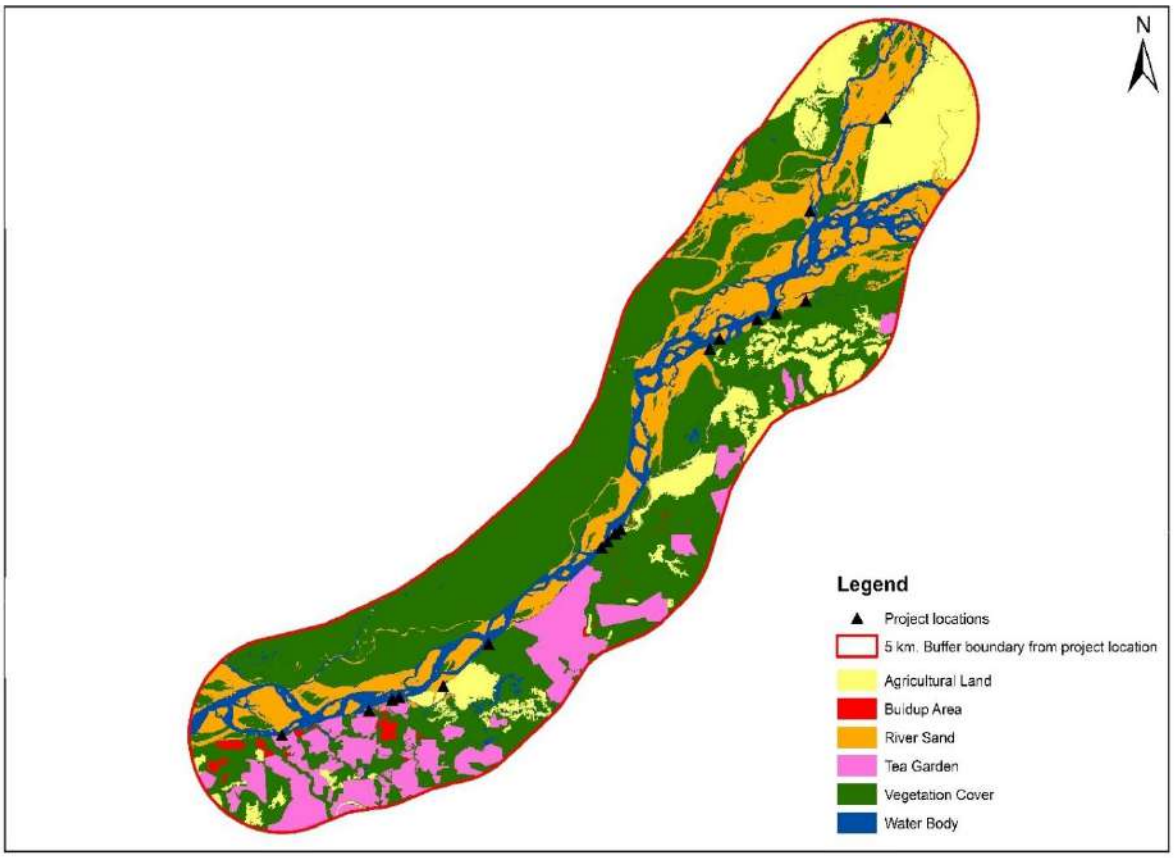
Source: LASA, April 2023

Table 5-5: Land use area within 5 km Buffer Zone on either side of the Project locations of Tinsukia District.

Land use	Area in Hectare	%
Water body	4987.43	8.82
River sand	9995.74	17.69
Agriculture land	7955.91	14.08
Buildup area	326.50	0.57
Vegetation cover	27439.14	48.57
Tea garden	5781.71	10.23
Total	**56486.46**	**100**

Source: Lea Associates South Asia Pvt. Ltd. (LASA), 2023

Figure 5-4: Land use map of the 5 km Buffer Zone on either side of the Project locations of Tinsukia District. (Febuary, 2023)



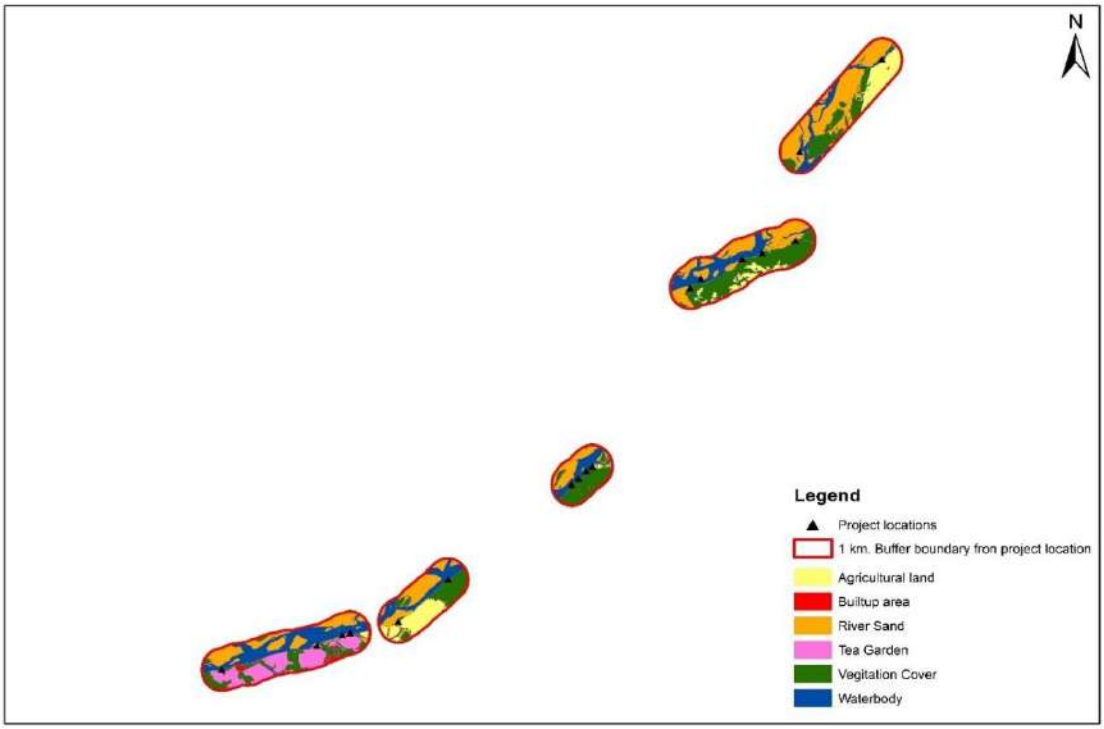
Source: LASA, April 2023

Table 5-6: Land use area within 1 km Buffer Zone on either side of the Project locations of Tinsukia District

Land use	Area in Hectare	%
Water body	1439.71	21.10
River sand	2248.58	32.95
Agriculture land	760.60	11.14
Buildup area	59.54	0.87
Vegetation cover	1802.46	26.42
Tea garden	511.31	7.49
Total	**6822.23**	**100**

Source: Lea Associates South Asia Pvt. Ltd. (LASA), 2023

Figure 5-5: Land use map of the 1 km Buffer Zone on either side of the Project locations of Tinsukia District. (Febuary, 2023)



Source: LASA, April 2023

132. Vegetative cover land-use is dominant within 1 km of the study area in Dibrugarh District. The total study area is 7376.71 ha, out of which vegetation cover 2290.49 ha (31.05 %), Water body 2121.66 ha (28.76%), River sand 1142.97 ha (15.49%), Buildup area 853.70 ha (11.57 %), Tea Garden 641.58 ha (8.69%) and Agriculture land 326.30 ha (4.42%).

133. While as river sand dominates within 1 km of the study area in Tinsukia District. The total study area cover is 6822.23 ha, out of which 2248.58 ha (32.95%) is under river sand. This is followed by 1802.46 (26.42%) Vegetation cover, 1439.71 ha (21.1) Water body, 760.60 (11.14%) Agriculture land, 511.31 ha (1.49%) tea garden and 59.54 ha (0.87%) Buildup area.

2. Physiography, Drainage, Topography, and Soils

134. **Dibrugarh:** The district is occupied with two different landforms namely- (a) Flood plain of Brahmaputra River and (b) the terrace deposits and denudational hills in the southern part. Maximum part of the district occupying the alluvial flood plains and is almost flat, except gentle undulations at places. Land elevation of the land ranges between 86.88 m and 152 m above msl. General slope is towards west and southwest. The terrace deposits and denudational hills present in the southeastern part of the district, range in elevation from 115 to 350 m amsl and rise upto 500m amsl in Tikak Parbat area. The regional trend of the hills is NorthEast to SouthWest. Soils of the area are sandy to clayey loam type and grayish is color. Based on pedogenic and pedological characters, soils of this area may be classified into following classes a) Recent riverine alluvial soils (Antisol) b) Old riverine alluvial soils (Inceptisol) c) Old Mountain valley alluvial soils (Alfisol)

135. The district is a part of Brahmaputra River basin. The area is drained by Brahmaputra River and its tributaries. Important tributaries of Brahmaputra River are Burhi Dihing, Disang, Dibru, Sessa and Lekhijan. All these tributaries are pereminal and are highly meandering. The lower order streams present a dendritic pattern but higher older streams show a subparallel pattern.

136. The immediate hinterland of the Dibrugarh reach consists largely middle plain zone and is characterized by beels, wetlands and poor drainage. The Maijan Beel to the immediate west of

Oaklands Tea Garden is part of a residual flood runner of the Dibru River. Various anabranches, distributaries and flood runners of the Burhi-Dihing River crisscross the area behind and to the southwest of Dibrugarh Town. One of these channels, the Buridehingmukh River, enters the Brahmaputra just to the west of the western end of the DTP dyke.

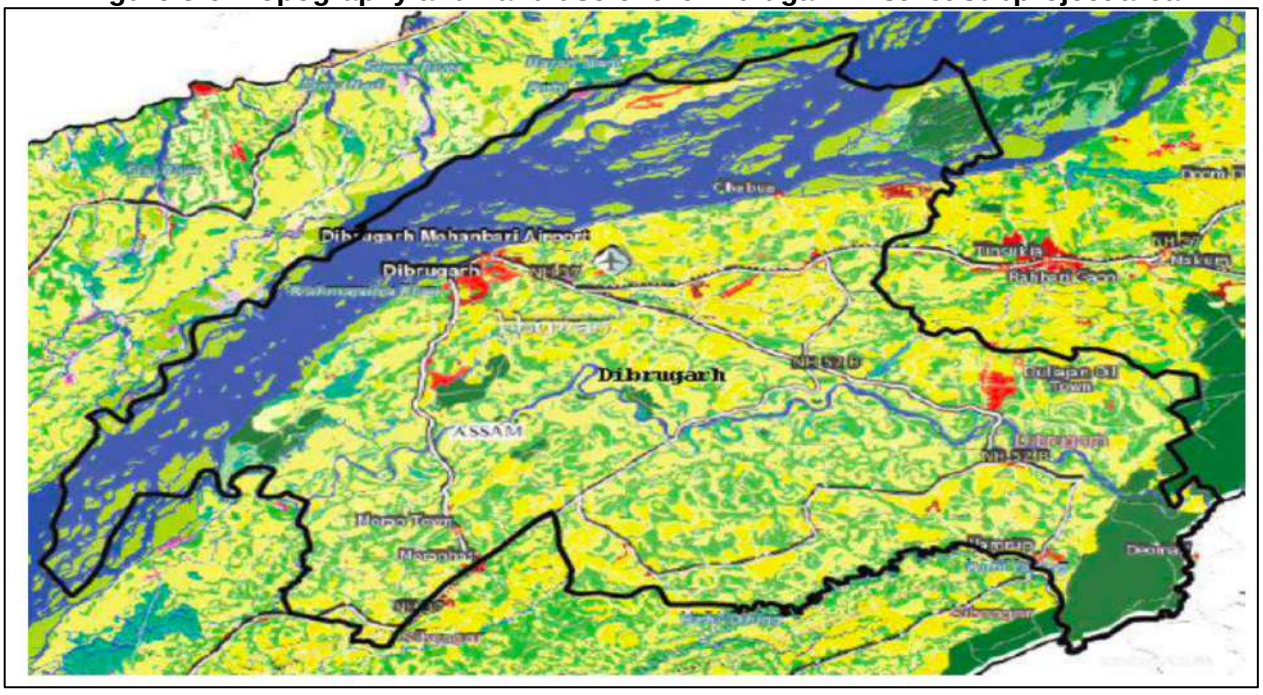
137. **Tinsukia:** Physiographically the district is characterised by Brahmaputra plains and hills in the southern part, with gentle slope towards northwest. The distinguishable geomorphic units are as follows: (a) flood plain (b) younger and older alluvium plain (c) structural hill. The soil in the area may be grouped into three broad categories depending upon the origin and occurrence. These are: (i) Newer alluvial Soil: Flood plain areas of Brahmaputra River and the tributaries in the northern part are characterised by light grey clay with sand and silt. (ii) Older alluvial Soil: It occurs mainly in the central part with limonite yellow to reddish yellow clay. (iii) Soil cover in forest and hilly areas: It is deep reddish in colour and occurs over the older geological formation in the southern most part of the district.

138. The district is drained by mighty Brahmaputra River flowing Northeast to Southwest direction and its tributaries Dibru and Burhi-Dihing flowing from Naga-Patkai Hill range in the south. All the rivers are ephemeral in nature and carry huge quantities of water and sediment during rainy season and cause submergence of low-lying areas.

Topography

139. **Dibrugarh:** Topographically, the Dibrugarh District slopes gently from east to west, from an elevation of around 200 m in south-eastern corner of the district to some 99 m at the mouth of the Burhi-Dihing River. The Dibrugarh Reach, which consists of a mix of active floodplain and middle plain zones, follows this topography, with elevations falling from about 115 m across the Oaklands Tea Estate to about 100 m around the Bogibeel Bridge site Figure 5-6.

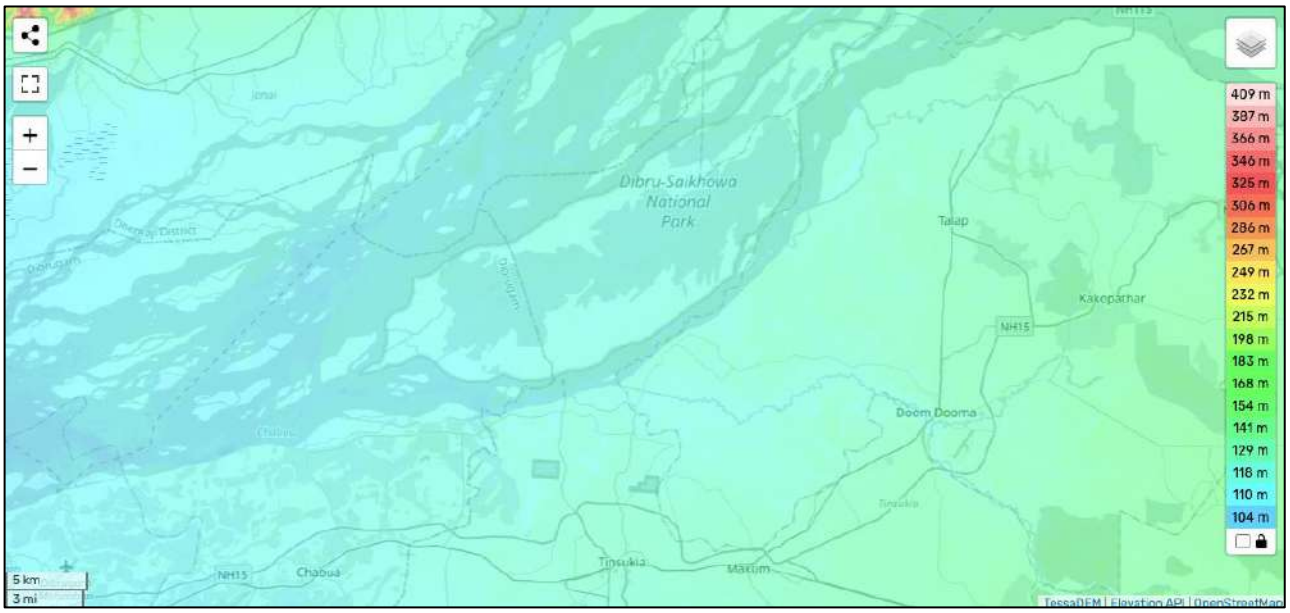
Figure 5-6: Topography and Land use of the Dibrugarh District subproject area



Source: ADB. India: AIFRERMIP Project 2, IEE Report (Dibrugarh Subproject). May 2018 https://www.adb.org/sites/default/files/project-documents/38412/38412-033-iee-en.pdf

140. **Tinsukia** Topographically Tinsukia District is isolated from the main plateau by the embayments of the Kepili River, the upland there displays a rugged topography. It generally has a northerly slope, with average elevations ranging from about 1,500 feet (450 metres) to about 3,300 feet (1,000 metres).

Figure 5-7: Topography and Land use of the Tinsukia District-subproject area



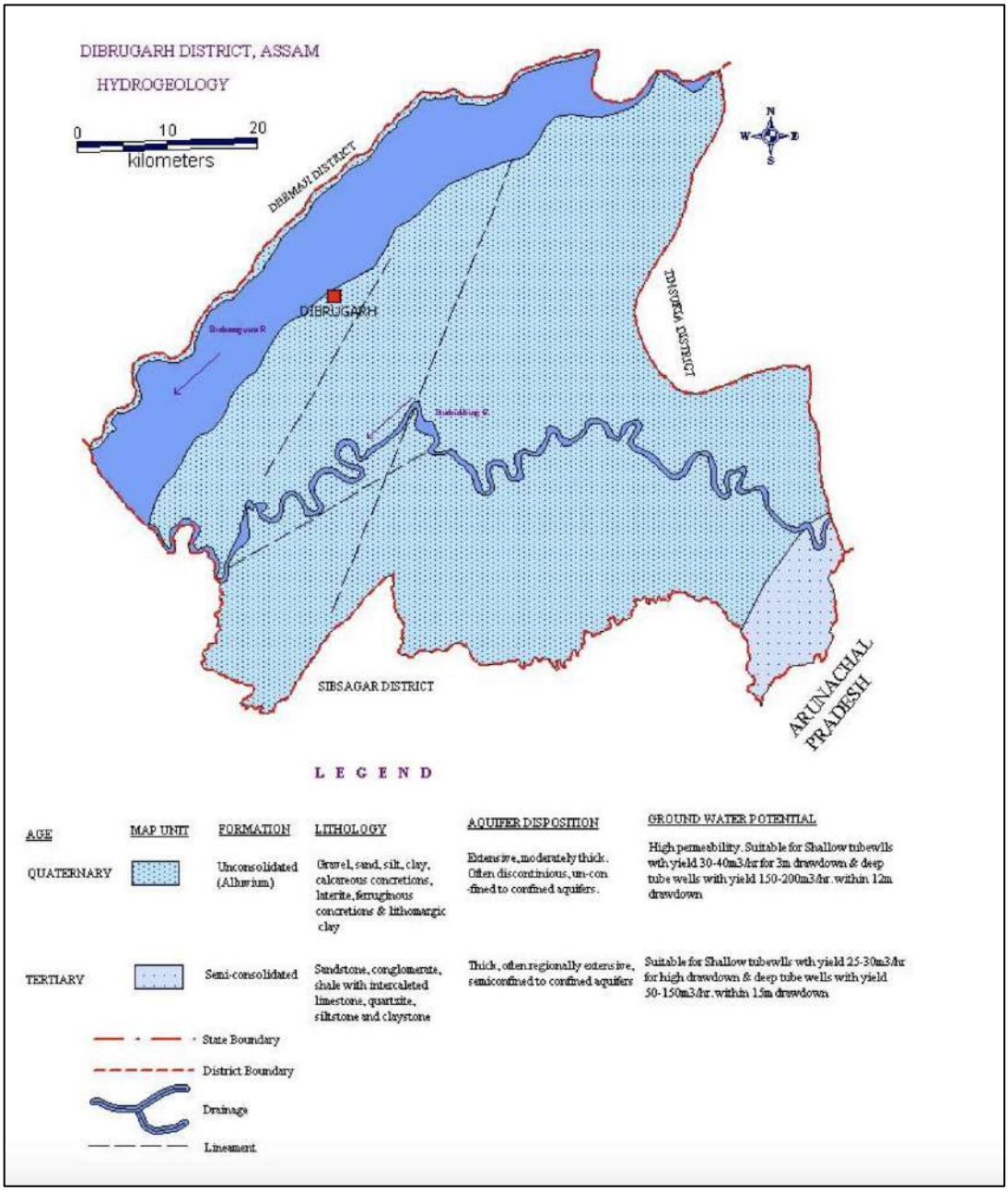
Source: https://en-gb.topographic-map.com/map-ljkf4s/Tinsukia/?center=27.26195%2C95.4245&zoom=9

Hydrogeology

141. **Dibrugarh** Unconsolidated alluvial deposits of quaternary age cover major part of the district. Only about 4 % area of the district is underlain by semi consolidated formation of tertiary age belongs to Disang and Barail Groups of rock. A single system of aquifer (granular zone) below a thin clay cover on top is present mainly in the southern part of the district. In the northern part, this single aquifer system is separated into a multiple aquifer system by thick clay partings. Thickness of aquifer increases from east to west. Groundwater in the shallow aquifer group exists in unconfined to semi confined condition. In general depth of tube wells varies from 35 to 45 m. The tube wells constructed down to a depth of 50 m yields 27 to 45 m^3/hour. Hydrogeology of the district is depicted in Figure 5-8. Pre-monsoon depth to water level ranges from 0.16 to 4.23 m below ground level (bgl). It is observed that Pre-monsoon depth to water level ranges from 2 to 4 m bgl in the southern part of the district i.e., Khowang, Joypur area and in a limited area in the northern part of the district i.e., parts of Lahoal, Borboruah and Tengakhat. But, in parts of Lahol and Panitola blocks, depth to water level goes upto 4 m bgl. Post-monsoon depth to water level ranges in this district from 0.14 to 5.693 m bgl.

142. The study of longterm water level trend shows no significant change in rise/fall in water level in the last 10 years.

Figure 5-8: Hydrogeology of the Dibrugarh District

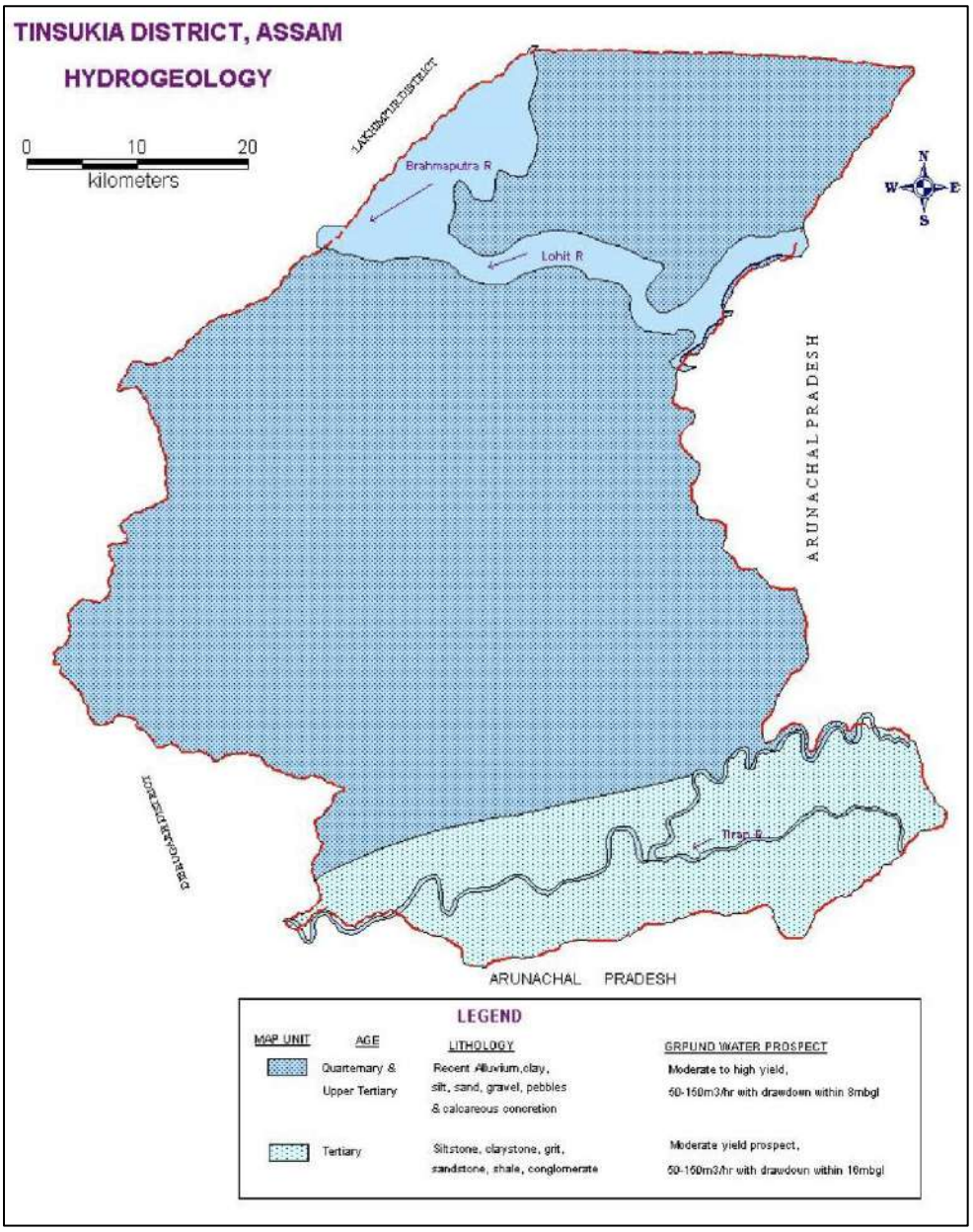


Source: Groundwater Information Booklet Dibrugarh District, Assam Central Groundwater Board, Ministry of Water Resources. 2013 https://cgwb.gov.in/District_Profile/Assam/DIBRUGARH.pdf

143. **Hydrogeology of Tinsukia** The district can be sub-divided into two broad hydrogeological Units (i) Tertiary Group of Semi-consolidated rocks (ii) Quaternary alluvium of Unconsolidated sediments. Tertiary group of sedimentary rocks are confined to the southern most part of the area where groundwater occurs in the shallow weathered zone and this may be developed through large diameter open wells. Groundwater occurs in deeper aquifer consisting of Tipam sandstone and in boulders and gravel beds of Dihing group which are suitable for development through deep tube wells. Alluvial plain covers major part of the district. Groundwater occurs in regionally extensive aquifers down to explored depth of 250 m with a very good yield prospect. The aquifers are consisting of sands of various grades and are suitable for both shallow and deep tube wells. Groundwater rests at shallow depth and in major part of the district, depth to water level varies from

2 to 5 m bgl during pre-monsoon period and from 1.68 to 4.5 m bgl during post monsoon period. The long tern water level trend study shows no significant change of water level in the last 10 years.

Figure 5-9: Hydrogeology of the Tinsukia District



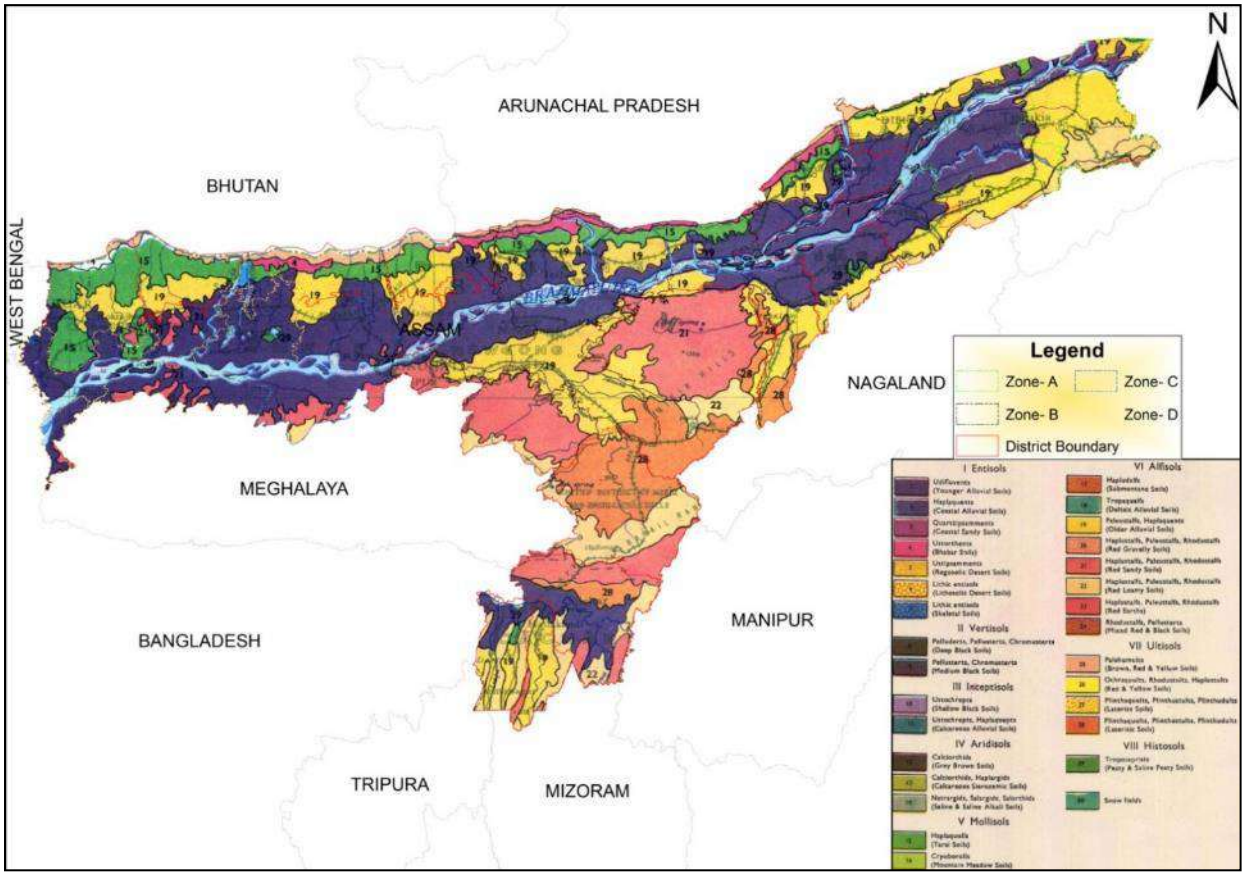
Source: Groundwater Information Booklet Tinsukia District, Assam Central Groundwater Board, Ministry of Water Resources. 2013 https://cgwb.gov.in/District_Profile/Assam/Tinsukia.pdf

144. **Soil Type:** Different types of soil have formed in the state as a result of the state's diverse geological conditions, topographical features, climatic conditions, and vegetation types. The four major groups of soils in Assam are alluvial soils, piedmont soils, hill soils, and lateritic soils.

145. The fertile alluvial soils have a wide distribution across the Brahmaputra plain. The alluvial soils can further be divided into two main sub types-young alluvial and old alluvial soils. Modern alluvium deposits define the young alluvial soil. These soils are typically grey to moulted grey in color. On the other hand, some areas of the districts of Kokrajhar, Barpeta, Nalbari, Kamrup, Darrang, Sonitpur, Lakhimpuir, and Dhemaji have historic alluvial soils. The old alluvial soils often have very deep, fine- to coarse-textured loams.

146. The northern, constrained region along the piedmont zone of the Himalayan foothills is where the piedmont soils are found. The soils are very deep and fine to coarse loamy in texture. The southern hill portions of the state are often where generally the hill soils are found. These soils have a fine to coarse loamy texture and a deep, dark greyish-brown color. In the NC Hills (Dima Hasao) district and in some areas of the southern Karbi Plateau, lateritic soils are widely distributed. These soils have heavy loams and a fine, dark texture.

Figure 5-10: Soil region map of Assam



Source: National Atlas of India

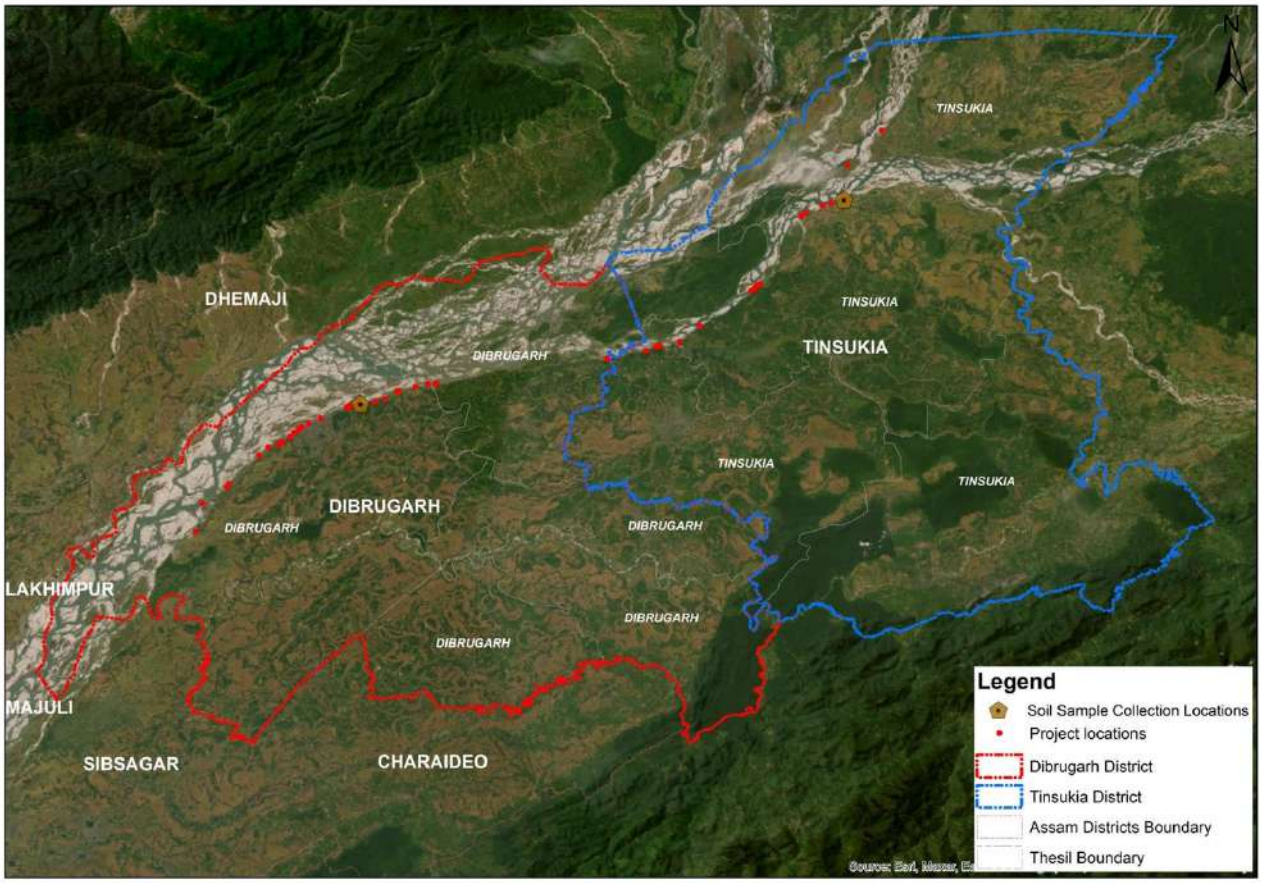
147. **Dibrugarh:** The district's soils are greyish in colour and range in texture from sandy to clayey loam. They are acidic in reaction with pH ranges from 4.6 to 5.9. Additionally, they have low to moderate phosphate and medium to high potash contents. The following classes of soils may be categorised into this region's soils based on pedogenic and pedological characteristics. Old mountain valley alluvial soils (Alfisol), recent riverine alluvial soils (Antisol), and old riverine alluvial soils (Inceptisol) are the three types. The predominantly soil of the district is clay loam which is covering an area of 255062 ha that is 76.59% of the total geographical area followed by clay soil with 8.78%, sandy soil by 7.60% and sandy loam soil-7.03%.

148. **Tinsukia:** Depending on the origin and occurrence, the soil in the district can be divided into three general groups. These areas: (a) Newer alluvial soil: In the northern portion of the Brahmaputra River's flood plains and its tributaries, light grey clay with sand and silt dominates. (b) Older alluvial soil, which is primarily found in the centre and contains limonite yellow to reddish yellow clay. (c) The soil cover in forest and hilly regions: It is deep reddish in colour and covers the older geological formation in the southernmost section of the district.

149. The soil quality of the project area was sampled and analyzed at village Mothila 1st part 27°30'36.85"N. 94°58'3.28"E in Dibrugarh District and 1 no. Gohaingaon 27°45'42.98"N

95°33'47.33"E in Tinsukia Dstrict. The sampling location is shown in Figure 5-11 and the soil quality results at selected location are given in Table 5-7.

Figure 5-11: Soil Sampling Locations within Subproject area



Source: LASA, 2023

Table 5-7: Soil Test Report within Subproject

S. No.	Parameters	Units	Indian Standard	EU Standard 2002	Monitoring Result	
					Mothila 1st part Dibrugarh	1 no. Gohaingaon Tinsukia
A	**Physical Characteristics**					
1.	Colour				Greyish Brown	Greyish Brown
2.	Textural class				Sandy Loam	Sandy Loam
3.	Bulk Density	gm/cm^3			1.16	1.27
4.	Water Holding Capacity	%			27.3	29.1
Particle Size Distribution						
7.	Sand	%			66.2	56.3
8.	Silt	%			15.4	17.3
9.	Clay	%			18.2	26.4
B	**Chemical Characteristics**					

S. No.	Parameters	Units	Indian Standard	EU Standard 2002	Monitoring Result	
					Mothila 1st part Dibrugarh	1 no. Gohaingaon Tinsukia
10.	pH (1:2 Suspension)	-			6.10	6.25
11.	Electrical Conductivity	µmhos/cm			248.2	316.4
12.	Organic Matter	%W/W			2.34	2.62
13.	Exchangeable Calcium	mg/kg			1711.4	1862.4
14.	Exchangeable Magnesium	mg/kg			648.2	782.6
15	Copper	mg/kg	135-270	140	10.2	9.1
16	Nickel	mg/kg	75- 150	75	7.1	8.3
17	Chromium	mg/kg		150	9.3	10.6
18	Iron	mg/kg		300	147.1	156.2
19	Lead	mg/kg			1.1	1.2
20.	Sulphate	mg/kg			7.2	11.2
C	**Available Nutrients**					
21	Nitrogen (as N)	kg/ha			314.2	368.4
22	Phosphorous	kg/ha			154.6	162.8
23	Exchangeable Potassium	kg/ha			78.2	92.7

150. **Source:** LASA, 2023

151. To generate baseline for soil, sampling was carried out at Dibrugarh subproject area. The sample is collected from the agricultural area adjacent to riverbanks. Based on result and comparison with Indian Standard and EU 2002, it can be concluded that soil is deficient in micro-nutrient (i.e., heavy metals). The monitoring reports and the sampling pictures are placed at Appendix 8

152. **Soil Erosion:** Riverbank erosion in the valley during times of major flooding is a regular annual feature. Due to the variable depth of coarse sand that has been deposited on the surface as a result of over bank flooding caused by embankment breaches, the fertile cultivable land is no longer suitable for crop production. Records from the Assam Government Revenue Dept. show that in 1994, soil erosion in the Upper Brahmaputra Valley and North Bank Plain zone affected 6116 hectares of land.

153. Assam's highly productive and fertile soils are currently facing with the major issue of soil erosion. The most frequent sort of soil erosion in the entire state occurs when there is heavy precipitation and a humid climate. During the flood season, topsoil erosion is a serious issue in the plain. Nearly 3.2 million hectares of land in the state's plain districts are thought to be susceptible to topsoil erosion of varying intensity. Another form of soil degradation, known as terrain deformation by mass movement, is mostly confined to the Karbi Anglong and N.C. hill areas.

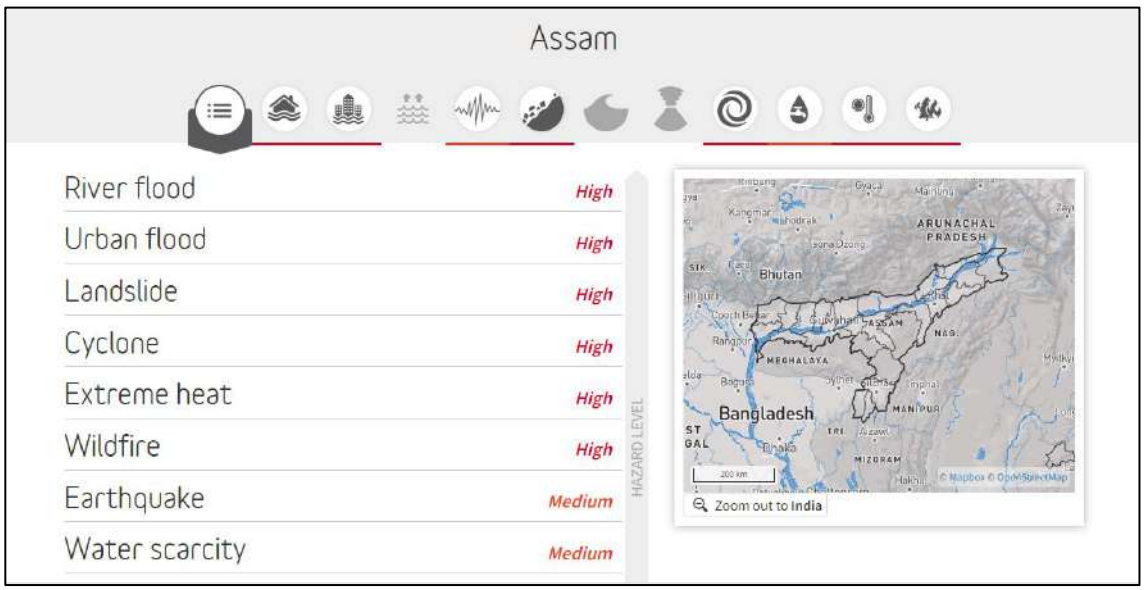
154. A total of around 1.53 million hectares are covered with hills. The state's rivers' bank erosion is a significant sort of soil erosion that has recently taken on alarming proportions. It has been observed that in some locations, rivers are eroding a few km of bank alongside villages, productive agricultural regions, and roadways. The world's largest river island, Majuli, is presently severely eroding and practically in danger being lost. Depending on how severe the state's floods are, the

amount of damage caused by bank erosion fluctuates from year to year.

155. The Dibrugarh subproject area both Dibrugarh District and Tinsukia District are facing a severe threart of soil erosion as described in the preceding Chapter II Description of Subproject.

156. **Hazard Profile** As per data generated from Think Hazard [19] the likelihood of different natural hazards in the state of Assam is depicted in the figure 5.12. The likelihood of natural hazards in the state of Assam is high for floods, cyclones, extreme heat and landslides.

Figure 5-12: Likelihood of Different Natural Hazards in Assam



Source: Think Hazard

157. In recent past there has been an increase in the number of natural disasters. The growing incidents of natural disasters are highly correlated to the increasing vulnerability of households and communities in developing countries. Floods and earthquakes are the two major hazards which pose a serious threat to the state of Assam and subproject districts. Both Dibrugarh and Tinsukia Districts have also been ravaged by catastrophic events in the past and has worst experience in terms of loss of life and property.

158. **Floods and Flooding Behavior** Assam possesses a high risk of flooding due to a number of factors, including its location in an area with heavy rainfall and its proximity to the Himalayas, which makes it vulnerable to flash floods, landslides, and other floods in addition to river overflows. Deforestation in river catchments and subsequent soil erosion may also cause sedimentation in rivers, reducing the ability of the land to absorb rainwater and causing additional runoff and flooding. The risk of flooding in Assam is increasing due to climate change, which is one of the factors causing more extreme weather events, including as flooding and periods of excessive rainfall.

159. Assam is prone to floods due to rise in river water levels in Brahmaputra River and its tributaries. It appears that, the Assam state is vulnerable to flood during the monsoon season more than twice every year. The monsoon season, which normally lasts from June to September, is when rain falls most frequently. During this time, the state frequently experiences floods. The list of recent flood events from 1998 and the duration of floods which were mapped by National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO), Department of Space, and Government of India using satellite data is listed in Table 5-8.

[19] Think Hazard. 2020. https://thinkhazard.org/en/report/1487-india-assam/EQ

Table 5-8: Major Flood Events in Assam state

Sl. No	Year	Description of the flood event	Districts Affected
1	1998	Floods occurred in Assam during June	6
2	2003	Floods have affected in two spells during 16th and 23rd June	21
3	2004	Floods occurred in 4 spells during 20-21st April, 28th Jun- 6th Jul, 10th Jul-5th Aug, 10-13th Oct	9
4	2005	Floods occurred in during 20-21st April, 28th Jun- 6th Jul, 10th Jul-5th August, 10-13th Oct	20
5	2006	Floods occurred in 3 spells during 2nd-16th Jun, 26th June, 26th - 28th July	24
6	2007	Floods occurred in 2 spells during 21-26th Jun, 14th Jul- 4th Oct	21
7	2008	Floods occurred in 2 spells during 9-23rd Jul, 2nd Aug -14th Sep	21
8	2009	Floods occurred during 1st Jul - 28th Aug. In addition, Matmora embankment breach in Lakhimpur district	21
9	2010	Floods occurred during on 19th Jun - 31st Jul, 17th Aug - 23rd Sep	24
10	2011	Floods occurred during on 29th Jun - 18th August	16
11	2012	Floods occurred during on 6th Jun - 7th Oct	28
12	2013	Floods occurred during 1-10th Jul, 9-14th Aug, 9-12th Sep	27
13	2014	Floods occurred during 16th - 29th Aug, 22nd - 29th Sep	27
14	2016	Floods occurred during 24-26th April, 5-29th July	20
15	2017	Floods occurred during 3rd Jun - 22nd Jul	36
16	2018	Floods occurred during 8th Jun - 13th Sep	37
17	2019	Floods occurred during 10th Jul - 2nd Aug	34
18	2021	Floods occurred during 7th Jun - 6th Sep 2021	33
19	2022	Floods occurred during 18th May - 26th May and 16th June - 17th July 2022	35

Source: Flood Affected Area Atlas of India (1998-2022) - Satellite based Study, NRSC and ISRO in association with NDMA, GoI, March 2023 [20]

160. The cumulative flood impacted region map of Assam State has been generated using multi-date satellite derived spatial flood inundation maps between 1998 and 2002 by National Remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO), Department of Space, Government of India, in Association with National Disaster Management Authority Ministry of Home Affairs, Government of India. Cumulative flood affected area is estimated as 24.64 lakh ha affecting 35 districts of the State. Figure 5-13 depict a map of the flood affected areas of Assam and the Table 5-9 provides the details of the flood affected areas in the 5 subproject districts.

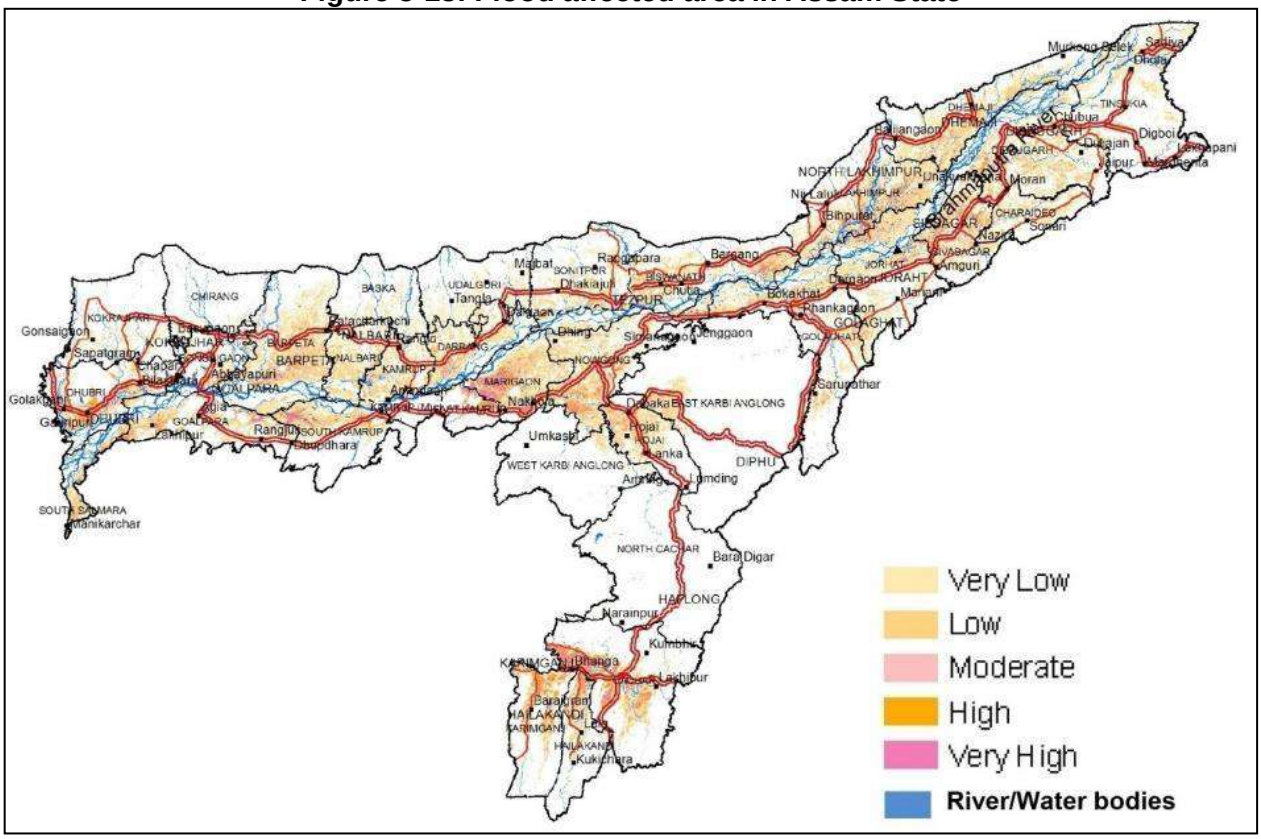
Table 5-9: Project Districts Wise Flood Affected Areas of Assam

Sl. No.	District	Flood Affected Area (Ha)
1	Kamrup Rural	132885
2	Dibrugarh	132438
3	Morigaon	104622
4	Goalpara	76700
5	Tinsukia	74530
Total in 5 subproject districts		**521175**
Total in Assam		**2,464,958**

Source: Flood Hazard Zonation Atlas for Assam State (1998-2015) – A Geospatial Approach, September 2016.

[20] https://ndem.nrsc.gov.in/documents/downloads/Flood%20Affected%20Area%20%20Atlas%20of%20India%20-Satellite%20based%20study.pdf

Figure 5-13: Flood affected area in Assam State



Source: Flood Hazard Zonation Atlas for Assam State (1998-2015) – A Geospatial Approach, September 2016.

161. **Flood hazards zones during 1998-2015** A geospatial approach to study the Flood hazard of the state of Assam was conducted by National Remote Sensing Centre, Indian Space Research Organization and Dept of Space, Govt. of India in association with Assam State Disaster Management Authority of Assam to categories the frequently flood affected areas in the state. In this approach, 18 years (1998-2015) of satellite data from Indian and foreign satellites was used in identifying the flood hazard zones and the flood hazard is categorized into 5 classes, i.e., very high, high, moderate, low and very low based on the frequency of inundation. Further, a flood hazard ranking index, which represents the worst flood affected districts in Assam, is calculated based on the hazard severity, percentage of flood inundation area and intra-annual flood wave index. The atlas is ground verified by the Government of Assam. It is observed that out of 34 districts in Assam, 17 districts are worst flood affected and about 2.2 million hectares in Assam is affected by floods at least once during last 18 years. The flood hazard statistics of Dibrugarh ad Tinsukia Districts (subproject area) is presented in the Table 5-10 below:

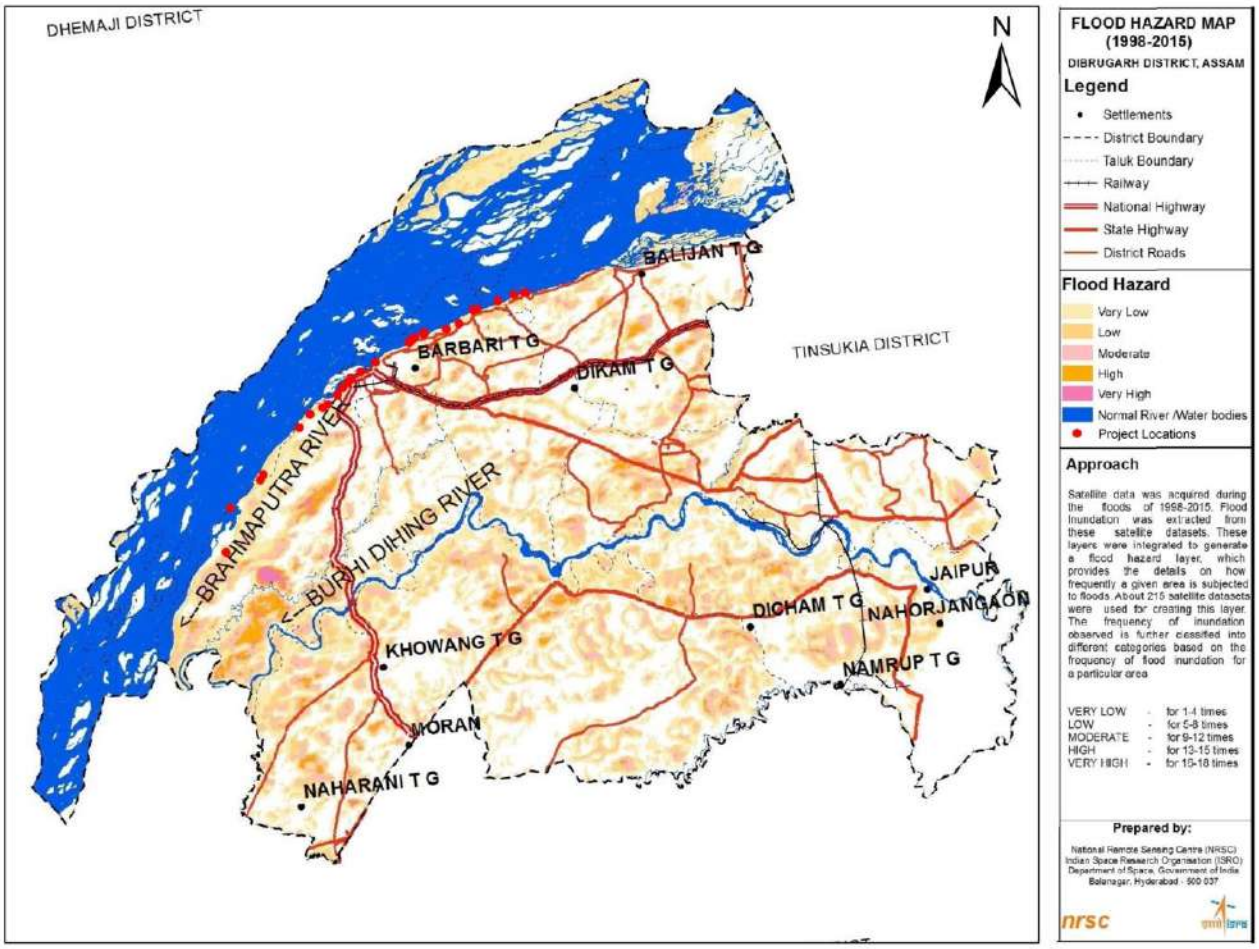
Table 5-10: Flood Hazards Statistics Dibrugarh and Tinsukia

Hazard Code Severity	Flood Hazard	Area (hectares)
Dibrugarh		
1	Very Low	74004
2	Low	31481
3	Moderate	16632
4	High	4280
5	Very High	557

Hazard Code Severity	Flood Hazard	Area (hectares)
Tinsukia		
1	Very Low	56602
2	Low	13184
3	Moderate	2403
4	High	157
5	Very High	0

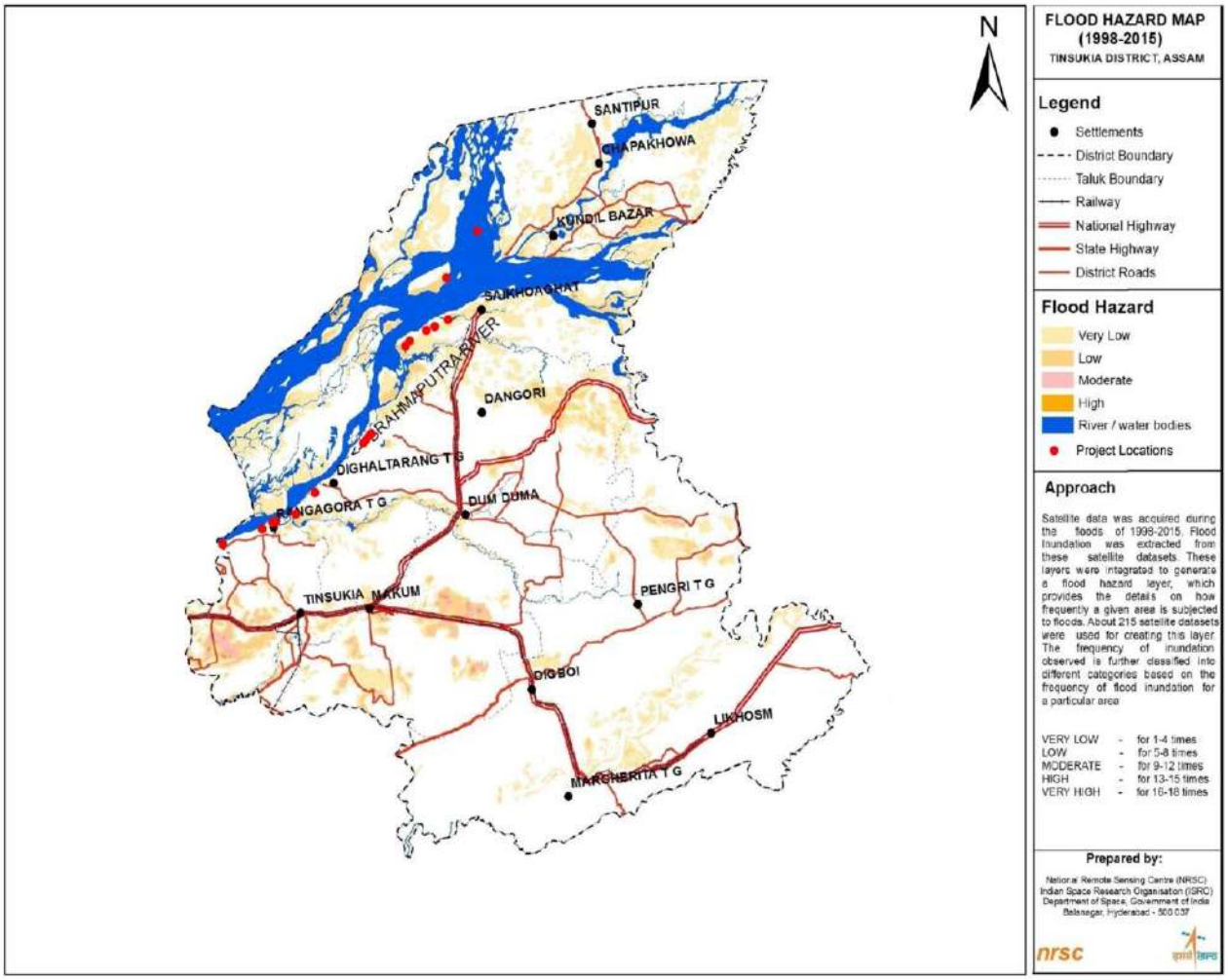
Source: Flood Hazard Zonation Atlas for Assam State (1998-2015) – A Geospatial Approach, September 2016.

Figure 5-14: Flood Hazard Map (1998-2015) Dibrugarh District



Source: Flood Hazard Zonation Atlas for Assam State (1998-2015) – A Geospatial Approach, September 2016.

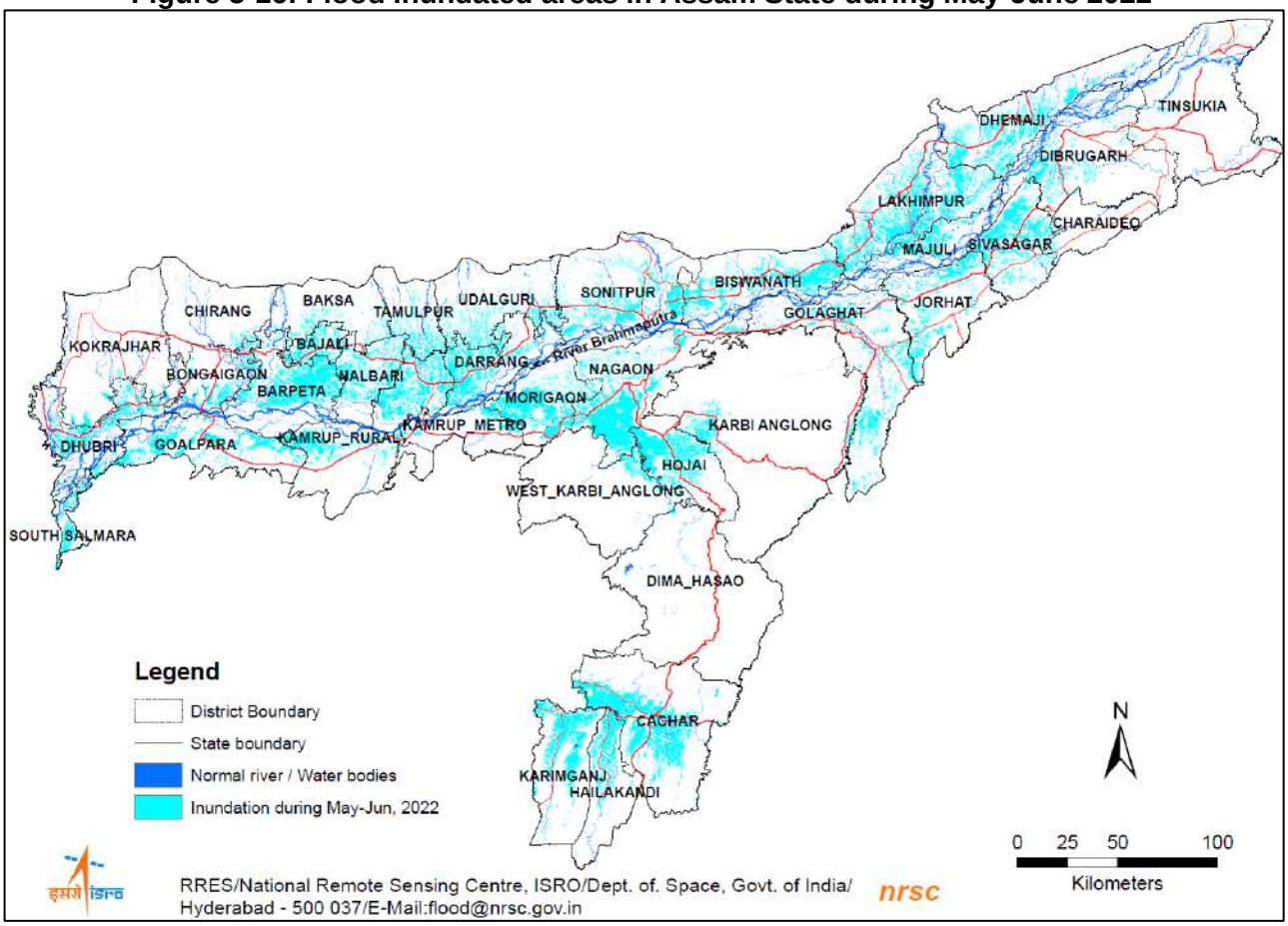
Figure 5-15: Flood Hazard Map (1998-2015) Tinsukia District



Source: Flood Hazard Zonation Atlas for Assam State (1998-2015) – A Geospatial Approach, September 2016.

162. **Flood inundation areas of Assam 2022** Satellite based analysis has been carried out continuously by NRSC during May-June 2022 and flood inundation occurring in larger areas were mapped and monitored across Assam state. It is observed that the total area under flood inundation is observed to be ~ 10.37 Lakh Ha. District wise area Inundated area during first wave of floods pre-monsoon in 3rd week of May 2022 and the second wave of floods started during 16-28th June 2022 which has affected 34 districts in Assam state presented in below in Table 5-11 spread over 35 districts as shown Figure 5-16.

Figure 5-16: Flood Inundated areas in Assam State during May-June 2022



Source: Satellite based Analysis - Flood Mapping and Monitoring in Assam State, Disaster Management Support Group, National remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO), Dept. of Space, Govt. of India Balanagar, Hyderabad-37 Telangana State, India, August 2022

Table 5-11: Area of Project Districts Affected During the Flood Inundation in May-June 2022

Sl. No.	District	Area Inundated (ha)
1	Kamrup rural	61074
2	Morigaon	48224
3	Goalpara	35742
4	Dibrugarh	17866
5	Tinsukia	1218
Total in Assam		**10,37,985**

Source: Satellite based Analysis - Flood Mapping and Monitoring in Assam State, Disaster Management Support Group, National remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO), Dept. of Space, Govt. of India Balanagar, Hyderabad-37 Telangana State, India, August 2022

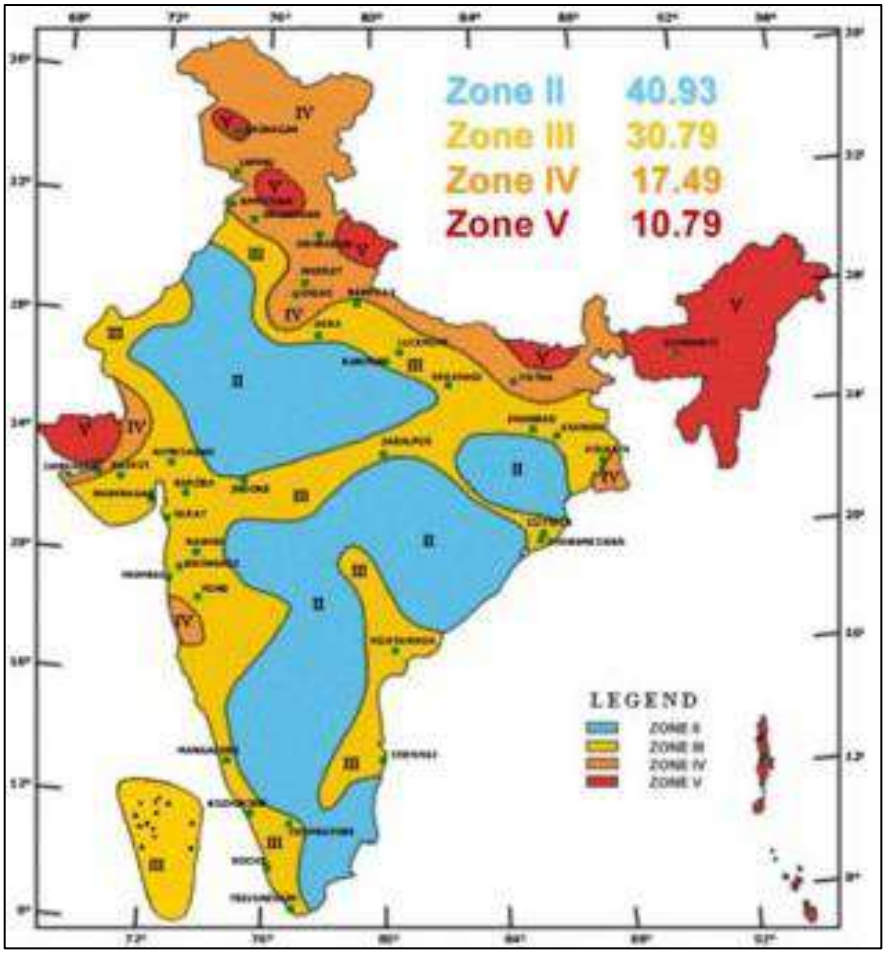
163. **Seismic Hazard:** High seismic activity is a feature of northeast India and the areas surrounding it. The eastern Himalayas, the Indo-Myanmar arc, the Mishmi Massif, the Shillong Plateau and surrounding areas, the Tripura folded belt, the Assam intermountain depression, and the northern part of the Bengal basin are all included in this region, which spans the northern portion of the Assam-Arakan geological province.

164. Even though the majority of northeast India is susceptible to earthquakes, their magnitudes typically range from 5 to 8 or higher. Low-magnitude earthquakes with a Richter scale value of less

than 5 are widely distributed in the area. However, the majority of earthquakes with a magnitude of greater than 5 have been recorded in West Tripura, Central Manipur, and the lower Brahmaputra Valley. Earthquakes measuring between 5 and 6 on the Richter scale have primarily been felt in Assam's northern, western, southern, and eastern rims. The Brahmaputra Valley, northern Manipur, eastern Nagaland, and east-central Mizoram saw the majority of the earthquakes, which typically had Richter scale magnitudes between 6 and 7, on a regular basis. The areas with the highest densities of powerful earthquakes, with magnitudes ranging from 7 to 8, have been found to be south-eastern Manipur, and central and lower Brahmaputra Valley. Only the easternmost region, has had earthquakes with a maximum magnitude of above 8.0.

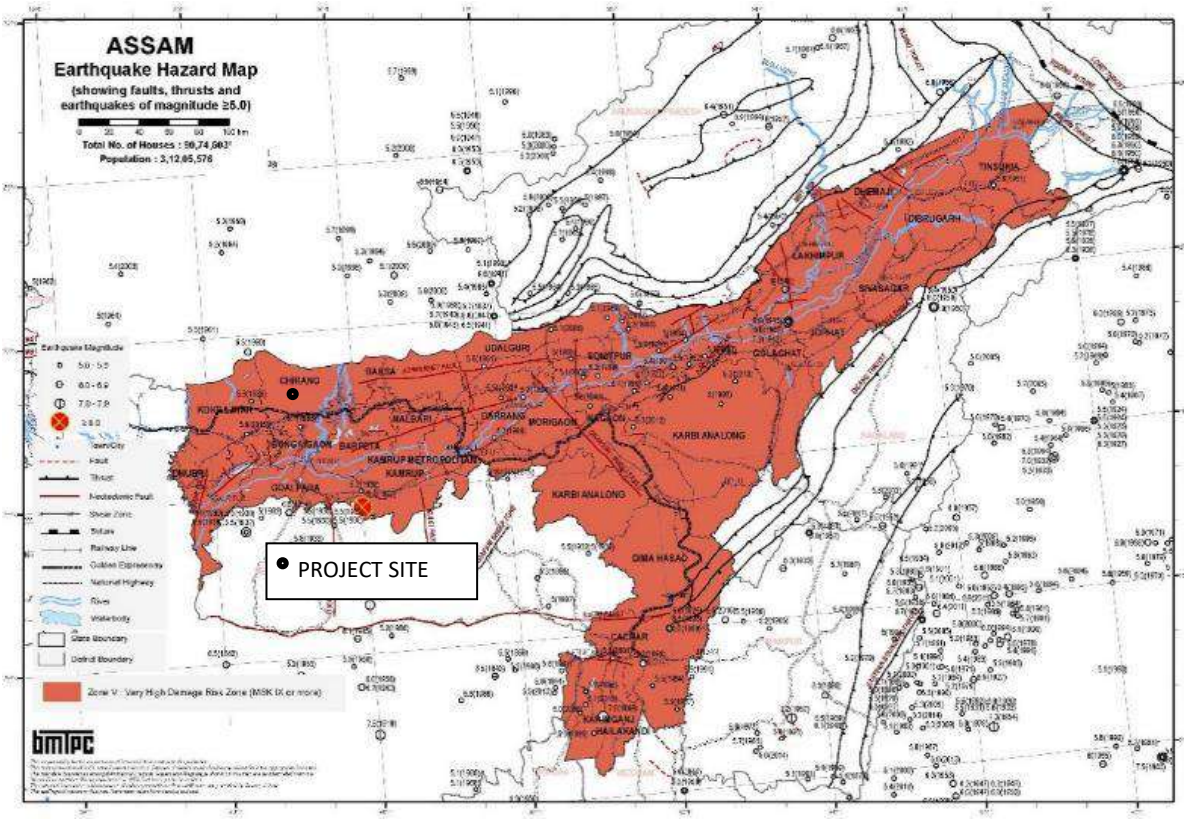
165. According to Figure 5-17 seismic hazard zonation map of India, the entire northeast of the country is located in zone V, the most vulnerable area in the nation. Recent research has shown that adjacent locations are affected differently by earthquake shaking. The conditions at the site are closely related to the shaking's intensity. 5-18 represents the seismo-tectonic setup of Assam and indicates the location of historical earthquakes within the region.

Figure 5-17: Seismic Zonation Map of India - 2002



Source: National Institute of Disaster Management (NIDM). https://nidm.gov.in/safety_earthquake.asp

Figure 5-18: Earthquake Hazard Map of Assam



Source: https://www.bmtpc.org/DataFiles/CMS/file/VAI2019/eq-assam.html

166. According to Global Seismic Hazard Assessment Program (GSHAP) data, the state of Assam falls in a region of moderate to high seismic hazard. As per the 2002 Bureau of Indian Standards (BIS) map, Assam also falls in Zones II, III and 5 (Zone I is low Risk and Zone V is high Risk). Historically, parts of this state have experienced seismic act5ity in the M6, which means Strong as per US Geological Survey.

167. As per the data from Think hazard, the earthquake hazard in both Dibrugarh and Tinsukia Districts is classified as medium according to the information that is currently available. This means that there is a 10% chance of potentially-damaging earthquake in Assam in the next 50 years.

168. Even though the majority of northeast India is susceptible to earthquakes, their magnitudes typically range from 5 to 8 or higher. Low-magnitude earthquakes with a Richter scale value of less than 5 are widely distributed in the area. However, the majority of earthquakes with a magnitude of greater than 5 have been recorded in the lower Brahmaputra Valley. Earthquakes measuring between 5 and 6 on the Richter scale have primarily been felt in Assam's northern, western, southern, and eastern rims. The Brahmaputra Valley saw the majority of the earthquakes, which typically had Richter scale magnitudes between 6 and 7, on a regular basis. The areas with the highest densities of powerful earthquakes, with magnitudes ranging from 7 to 8, have been found to be central and lower Brahmaputra Valley.

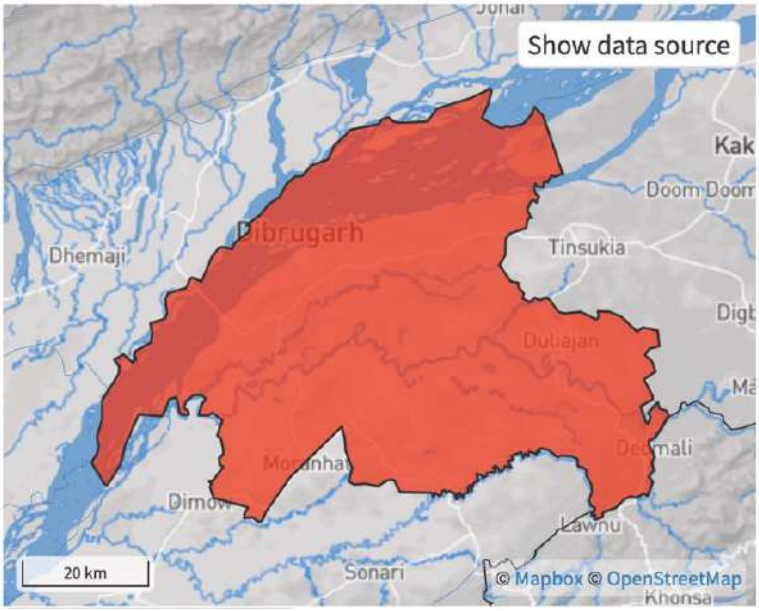
Table 5-12: Major Earthquakes in Assam

Place	Year	Magnitude
Cachar,	Assam January 10,1869	Mw > 7.0
Shillong plateau	June 12,1897	Mw 8.1 - 8.7
Sibsagar	August 31,1906	Ms 7.0
Srimangal	July 08, 1918	Ms 7.6

Place	Year	Magnitude
SW Assam	September 9,1923	Ms 7.1
Dhubri	July 2,1930	Ms 7.1
Assam	January 27,1931	Ms 7.6
N-E Assam	October 23,1943	Ms 7.2
Upper Assam	July 29,1949	Ms 7.6
Upper Assam	August 15,1950	Mw 8.6-8.7

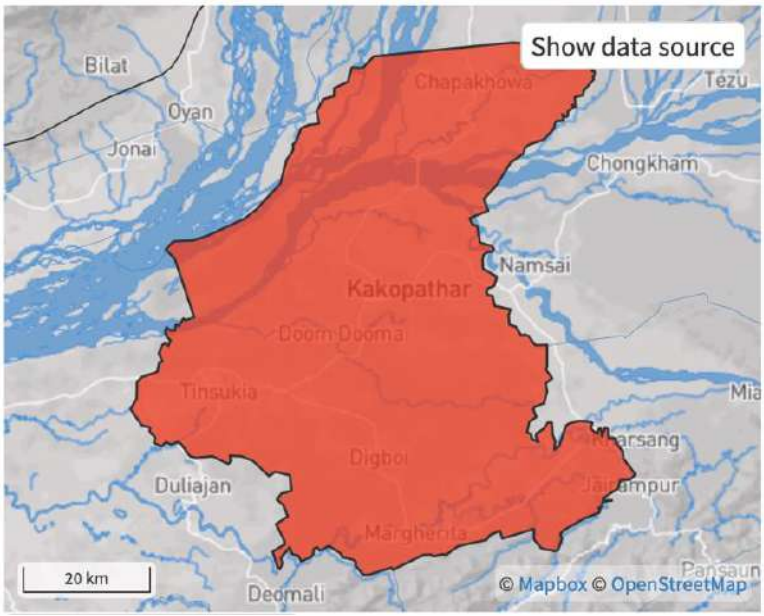
Source: Seismic Microzonation Atlas of Guwahati Region, Department of Science and Technology Government of India, 2007 https://asdma.assam.gov.in/sites/default/files/Seismic_Microzonation.pdf

Figure 5-19: Seismic Hazard in Subproject Area Dibrugarh



Source: *ThinkHazard! https://thinkhazard.org/en/*

Figure 5-20: Seismic Hazard in Subproject Area Tinsukia



Source: *ThinkHazard!* https://thinkhazard.org/en/

3. Climate

169. The climate of the region is sub-tropical with a hot, humid summer season dominated by the southwest monsoons from early-June to mid-September and a cool, dry winter from late October to the end of February. The pre-monsoon season starts in the early part of March until May marked by occasional thunderstorms and rising temperatures during the day. The post (retreating) monsoon season from last part of September to mid-October generally represents fair weather conditions with declining rainfall as well as temperature.

170. The Brahmaputra Valley in Assam forms an integral part of the subtropical monsoon regime of Eastern Asia receiving a mean annual rainfall of 230 centimeter (cm) with a variability of 15–20%. Distribution of rainfall over river basins in Assam shows marked spatial variations, e.g., from as low as 175 cm in the Kopili Basin located in the central part of the valley to as much as 410 cm in Jiadhol Basin close to the Matmora reach in upper Assam.

Table 5-13: Summary of Long-Term Meteorological Data 1991 – 2021 Dibrugarh

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temp °C	17.6 °C	18.9 °C	21.4 °C	23.3 °C	25.8 °C	27.4 °C	27.6 °C	28 °C	27.4 °C	25.4°C	21.7 °C	18.3 °C
Min. Temp °C	12.3 °C	14.4 °C	17 °C	19.8 °C	22.7 °C	25 °C	25.4°C	25.5 °C	24.8 °C	22.°C	17.6 °C	13.8 °C
Max. Temp °C	22.1°C	23.7 °C	25.8°C	26.9 °C	29.1 °C	30.4 °C	30.4 °C	30.9 °C	30.5 °C	28.9 °C	26.1 °C	23.2 °C
Precipitation/Rainfall mm (in)	38 (1)	85 (3)	214 (8)	401 (15)	427 (16)	464 (18)	484 (19)	412 (16)	347 (13)	130 (5)	18 (0)	14 (0)
Humidity (%)	75%	72%	71%	79%	81%	84%	86%	85%	84%	81%	76%	76%
Rainy days	4	7	11	14	17	20	20	20	17	9	2	2

Source: https://en.climate-data.org/asia/india/assam/dibrugarh-3672/

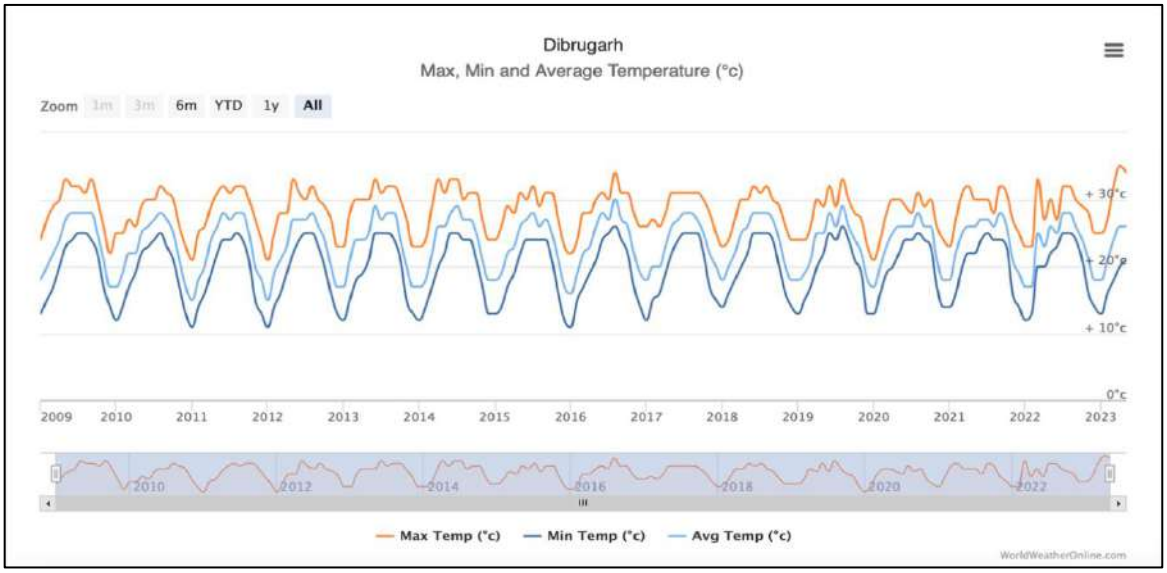
Table 5-14: Summary of Long-Term Meteorological Data 1991 – 2021 Tinsukia

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temp °C	17.5 °C	19.4 °C	21.9 °C	23.6 °C	26.1 °C	27.4 °C	27.6 °C	27.7 °C	27.9 °C	27.3 °C	21.8 °C	18.6 °C
Min. Temp °C	12.8 °C	14.7 °C	17.3 °C	19.9 °C	22.7 °C	24.9 °C	25.3°C	25.2 °C	24.5 °C	21.8 °C	17.5 °C	14 °C
Max. Temp °C	22.3°C	24.2 °C	26.5 °C	27.6 °C	29.7 °C	30.7 °C	30.6 °C	31 °C	30.6 °C	28.9 °C	26.1 °C	23.3 °C
Precipitation/Rainfall mm (in)	38 (1)	88 (3)	200 (7)	348 (13)	342 (13)	404 (15)	438 (17)	391 (15)	314 (12)	115 (4)	16 (0)	14 (0)
Humidity (%)	71%	67%	66%	75%	78%	82%	85%	84%	83%	80%	74%	73%
Rainy days	4	7	11	14	17	20	20	20	17	9	2	2

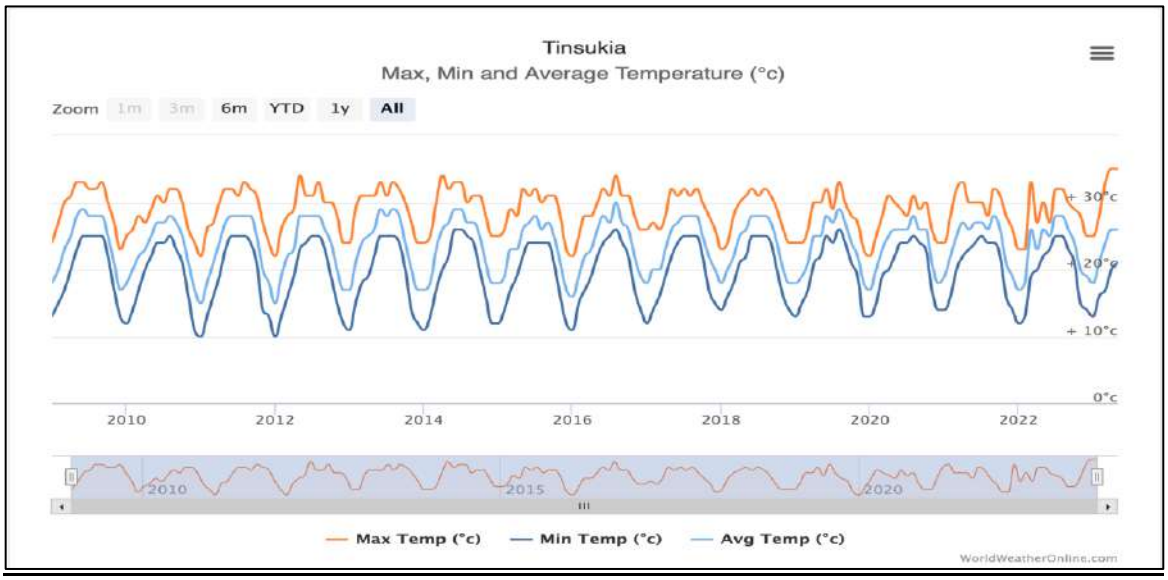
Source: https://en.climate-data.org/asia/india/assam/tinsukia-24719/

171. **Temperature** The average annual temperature in Dibrugarh is 23.5 °C. Highest temperature is generally observed in the months of July/August (35˚C) and lowest is in the months of December/January (7-8˚C). The district experiences 2300 to 3000 mm. rainfall per year. Average annual rainfall of the district is 2819 mm. while normal rainfall (1901-1950) is 2796.4 mm. On an average 64 to 68% of annual rainfall is received during the monsoon period (June to September) and 22-26%of annual rainfall during pre-monsoon period (March-May). Humidity is the morning hour's ranges from 90-95% and 50-70% in the afternoon hours. Wind speed ranges generally from 30- 60km/hour. Sunshine hours range from 3 to 7. The climate of the region is sub-tropical wet and is characterized by hot and humid summer and dry cool winter.

172. Tinsukia District experiences sub-tropical humid climate where winter temperature goes up to 37°C. Humidity of the district exceeds 90 percent during rainy season. In the region, the wet season is hot, oppressive, and mostly cloudy and the dry season is warm and mostly clear. The district is endowed with high rainfall throughout the year. The South West monsoon sets in the month of June and lasts up to September. Out of 2323 mm normal annual rainfall, about 65 percent rain is received from monsoon. The mean daily maximum temperature during winter is about 24°C and minimum is 17.5°C. The mean daily maximum temperature during summer is 31°C and the minimum is 24° C.



Source: https://www.worldweatheronline.com/dibrugarh-weather-averages/assam/in.aspx



Source: https://www.worldweatheronline.com/tinsukia-weather-averages/assam/in.aspx

173. **Rainfall** In Dibrugarh, the wet season is hot, oppressive, and partly cloudy and the dry season is warm and mostly clear. The average annual temperature in Dibrugarh is 23.5 °C. Highest temperature is generally observed in the months of July/August (35˚C) and lowest is in the months of December/January (7-8˚C). The district experiences 2300 to 3000 mm. rainfall per year. Average annual rainfall of the district is 2819 mm. while normal rainfall (1901-1950) is 2796.4 mm. On an average 64 to 68% of annual rainfall is received during the monsoon period (June to September)

and 22-26%of annual rainfall during pre-monsoon period (March-May). Humidity is the morning hour's ranges from 90-95% and 50-70% in the afternoon hours. Wind speed ranges generally from 30- 60km/hour. Sunshine hours range from 3 to 7. The climate of the region is sub-tropical wet and is characterized by hot and humid summer and dry cool winter.

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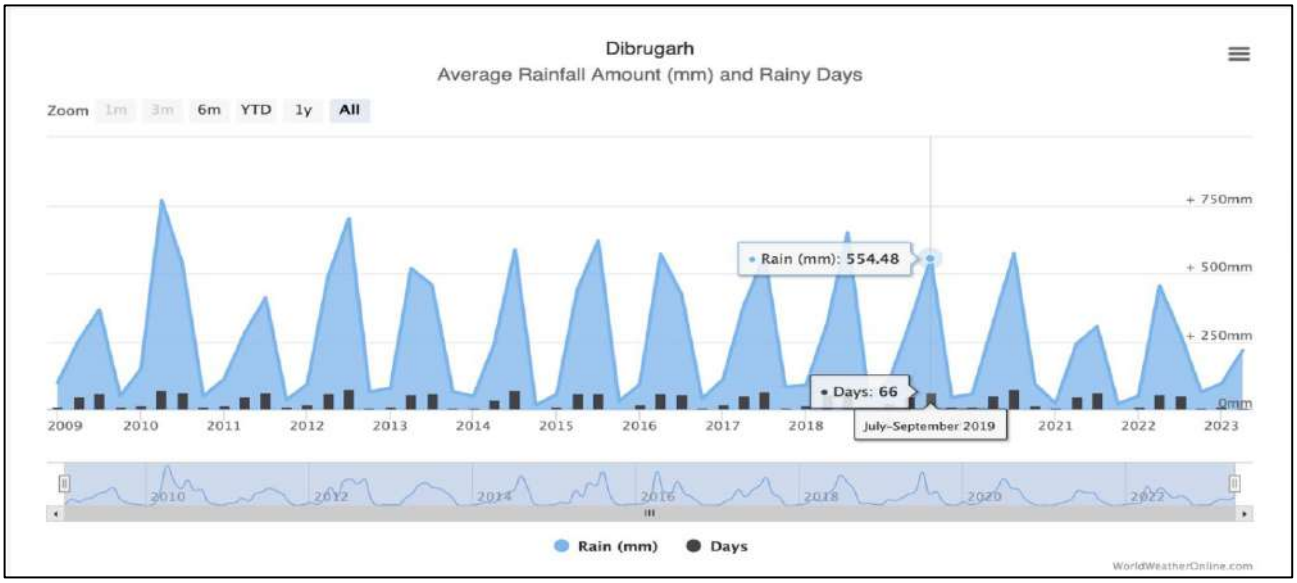
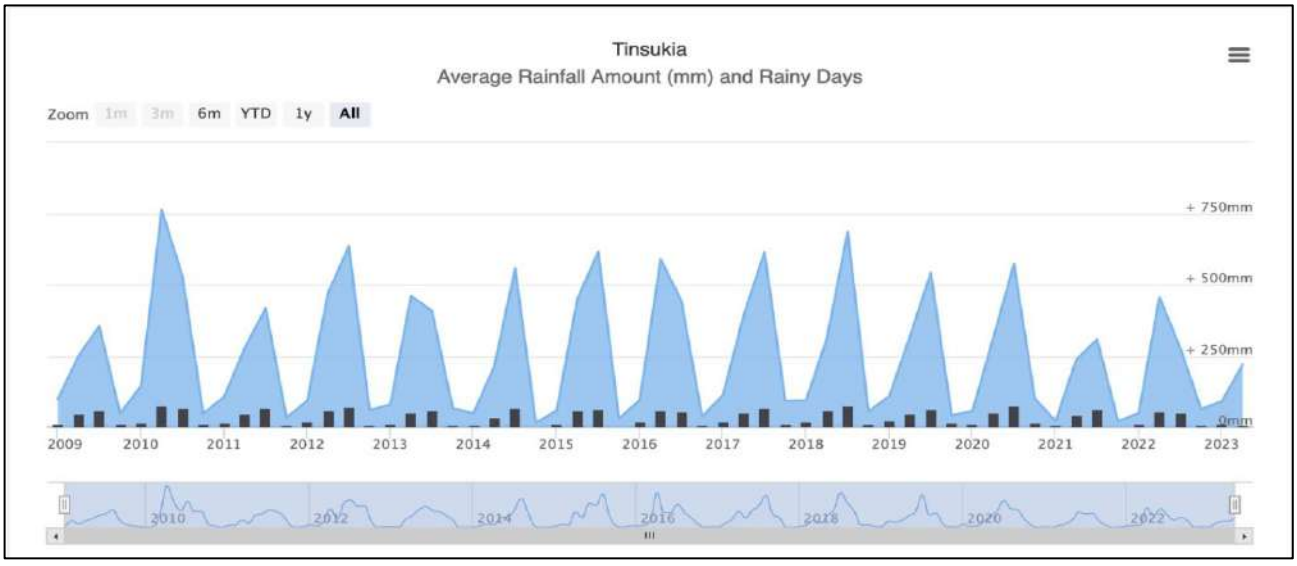


Source: https://www.worldweatheronline.com/dibrugarh-weather-averages/assam/in.aspx



Source: https://www.worldweatheronline.com/tinsukia-weather-averages/assam/in.aspx

4. Water Environment

175. The State of Assam in general and the Brahmaputra Valley in particular, is endowed with vast water resources potential. The Brahmaputra River and the 33 major tributaries joining it in Assam including the main trans-Himalayan tributaries of Subansiri, Jia Bharali, and Manas carry about 30% of the country's total water resources potential. Surface water bodies covering about 8,251 km2 account for 10.5% of the total geographical area of the State. Of these, the river systems including waterlogged areas occupy 6,503 km2. The annual surface water availability is over 53 million ha m. Besides, there are 3,513 wetlands in the Brahmaputra valley covering 1012.3 km areas in Assam. Groundwater is also plentifully available at shallow depth in the valley and the utilizable groundwater resources estimated at over 2 million ha m.

176. **Surface water** The Dibrugarh District is a part of Brahmaputra River basin. The area is drained by Brahmaputra River and its tributaries. Important tributaries of Brahmaputra River are Burhi Dihing, Disang, Dibru, Sessa and Lekhijan. All these tributaries are pereminal and are highly meandering. The lower order streams present a dendritic pattern but higher older streams show a subparallel pattern.

177. In Dibrugarh reach, till the great earthquake of 1950, the northeastern corner of the reach was drained by the Dibru River, a tributary of the Brahmaputra with its confluence about 18 km east of the Dibrugarh City. However, due to the raising of the riverbed through aggradations as a result of the earthquake, the Dibru River got merged with the Brahmaputra River. At present Maijan channel, a tributary of the former Dibru River, meets the Brahmaputra through a small opening and is a great cause of concern. The Burhi Dihing is a major tributary of the Brahmaputra that joins this stretch at its extreme western end about 16 km. downstream from the Bogibeel Bridge. The course of the river shows intense meandering in the valley. It carries an average annual discharge of 141,539 cubic meters /second, and a sediment yield of 1,129 tons/km^2/year.

178. The Tinsukia District is drained by mighty Brahmaputra River flowing Northeast to Southwest direction and its tributaries Dibru and Burhi-Dihing flowing from Naga-Patkai hill range in the south. All the rivers are ephemeral in nature and carry huge quantities of water and sediment during rainy season and cause submergence of low-lying areas.

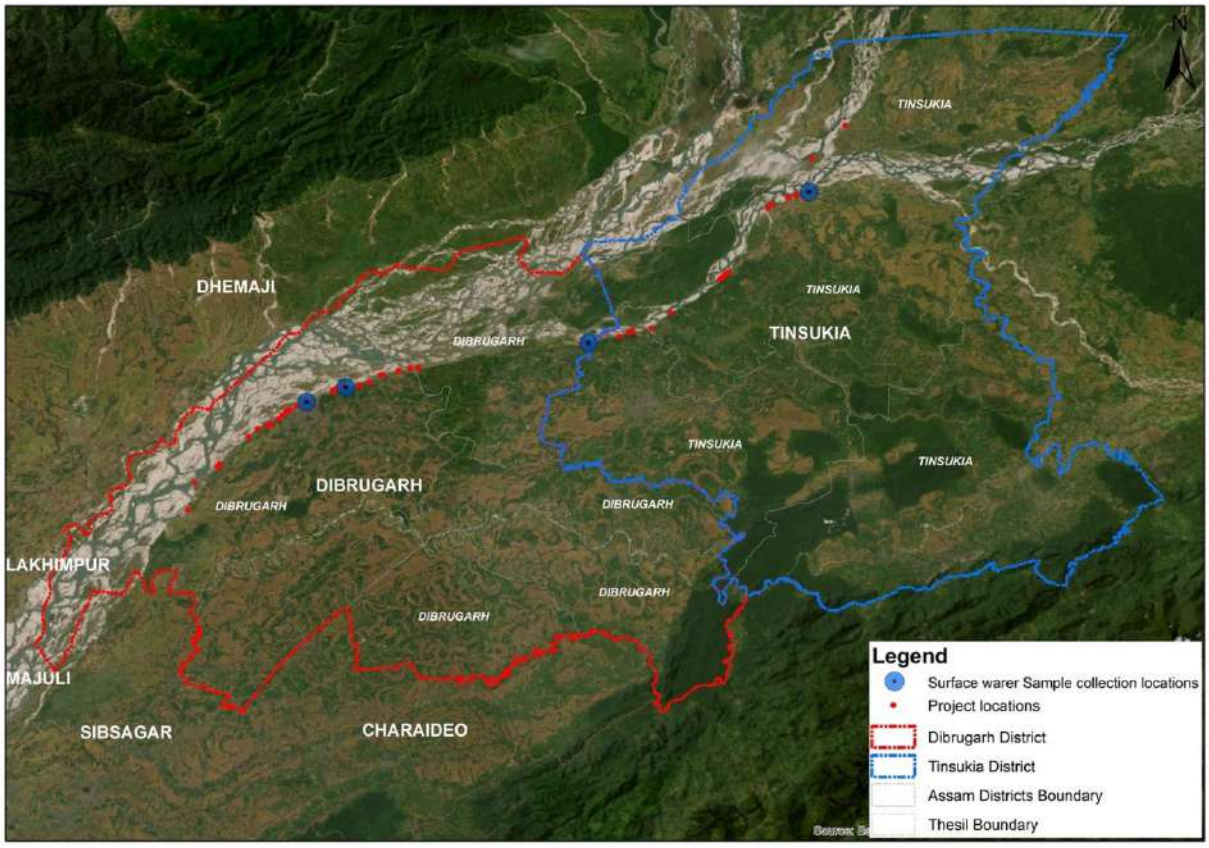
179. Tinsukia is dotted with several small streams and rivulets that contribute to the surface water resources of the area. These smaller water bodies often serve as local water sources for nearby communities.

180. Water quality monitoring and analysis in regard to physico-chemical as well as biological parameters was carried out on samples collected from four locations in the project area as per Table 5-15. The locations of the sampling points are shown in Figure 5-21. The results of analysis are presented in Table 5-16, which are compared with the water quality criteria of designated best use given by Central Pollution Control Board (CPCB) and World Health Organizations (WHO) standards.

Table 5-15: Surface Water Sampling Locations

Sl. No	Name of Division	LAC	Village Name	Date of Monitoring	Geographical Coordinate	Subproject
1.	Dibrugarh	Lahowal	Mothola 1st part	04-04-23	27°30'36.85"N; 94°58'3.28"E	Riverbank Protection
2.	Dibrugarh	Dibrugarh	Maijan Bora Saika Gaon	03-04-23	27°29'29.06"N; 94°55'0.61"E	Riverbank Protection
3.	Tinsukia	Doomdooma	1 no Gohaingaon	06-04-23	27°45'42.98"N; 95°33'47.33"E	Riverbank Protection
4.	Tinsukia	Chauba	Khamti Gwalii (Koilapothat Gaon)	06-04-23	27°34'2.84"N; 95°16'46.16"E	Riverbank Protection

Figure 5-21: Surface Water Quality Monitoring Location within Subproject area



Source: LASA Primary Survey Report, 2023

Table 5-16: Surface Water Quality Result – Subproject area

Sl. No	Parameters	Unit	IS: 2296 - 1992(Class C) – CPCB	WHO Standard	Test Report Dibrugarh subproject			
			Tolerance Limit		Mothola 1st part, Dibrugarh	1 no. Gohaingaon, Tinsukia	Khamti Gwali (Koilapothar Gaon)	Maijan Bora, Dibrugarh
1	pH	-	6.5 -8.5	6-9	7.05	7.20	7.35	7.30
2	Temperature	°C	-		27.5	27.4	27.8	27.8
3	D.O	mg/l	Minimum -4		7.90	8.20	8.10	8.10
4	BOD	mg/l	30	30	3.60	3.10	2.80	2.80
5	Color	Hazen	300		5	5	5	5
6	Odour	-	-		Agreeable	Agreeable	Agreeable	Agreeable
7	TDS	mg/l	1500		312.2	324.6	336.2	284.8
8	TSS	mg/l	-	50	24.0	22.0	26.0	16.0
9	TKN	mg/l			2.6	3.4	3.7	3.2
10	Ammonical Nitrogen	mg/l			0.36	0.41	0.53	0.43
11	Nitrate (as NO3)	mg/l	50		2.21	2.3	2.6	2.5
12	Free Ammonia	mg/l			<0.1	<0.1	<0.1	<0.1
13	Chlorides (as Cl)	mg/l	600		14.7	18.1	14.6	16.3

Sl. No	Parameters	Unit	IS: 2296 - 1992(Class C) – CPCB	WHO Standard	Test Report Dibrugarh subproject			
			Tolerance Limit		Mothola 1st part, Dibrugarh	1 no. Gohaingaon, Tinsukia	Khamti Gwali (Koilapothar Gaon)	Maijan Bora, Dibrugarh
14	Sulphates (as SO4)	mg/l	400		15.1	13.2	11.3	16.4
15	Fluoride (as F)	mg/l	1.5		0.39	0.41	0.38	0.47
16	Oil and Grease	mg/l	0.1		<0.1	<0.1	<0.1	<0.1
17	Phenolic Compound (as C6H5OH)	mg/l	0.005		<0.001	<0.001	<0.001	<0.001
18	Arsenic	mg/l	0.2		<0.1	<0.1	<0.1	<0.1
19	Mercury (as Hg)	mg/l	-		<0.001	<0.001	<0.001	<0.001
20	Lead (as Pb)	mg/l	0.1		0.03	0.03	0.03	0.05
21	Cadmium (as Cd)	mg/l	0.01		0.004	0.004	0.006	0.006
22	Chromium (as Cr+6)	mg/l	0.05		0.02	0.02	0.03	0.03
23	Copper (as Cu)	mg/l	1.5		0.23	0.12	0.27	
24	Zinc (as Zn)	mg/l	15		0.51	0.41	0.68	0.61
25	Selenium (as Se)	mg/l	-		<0.1	<0.1	<0.1	<0.1
26	Anionic detergents (as MBAS)	mg/l	1.0		<0.1	<0.1	<0.1	<0.1
27	Iron (as Fe)	mg/l	50		0.76	0.71	<0.1	0.64
28	Sulphide(as H2S)	mg/l	-		0.54	0.57	0.62	0.43
29	Phosphate (as PO4)	mg/l	-		7.60	8.20	0.46	6.80
30	Cyanide (as CN)	mg/l	0.05		<0.1	<0.1	7.80	<0.1
31	Manganese (as Mn)	mg/l			0.05	0.03	<0.1	0.04
32	COD	mg/l	-	125	18.2	21.3	0.05	17.6
33	Total Coli form	MPN/ 100ml	500		840	460	780	845

Source: Lea Associates South Asia Pvt. Ltd. (LASA), 2023

181. Based on the test report it can be concluded that all the 34 parameters against which surface water is analyzed, only one parameter exceed the CPCB limits (i.e., Total Coliform). This increase in Total Coliform number in Brahmaputra River is mainly due to discharge of untreated sewerage water through network of drains, streams, nala, etc. from towns and cities. The monitoring reports and the sampling pictures are placed at Appendix 8.

182. **Groundwater.** The entire Brahmaputra Valley especially its floodplain zone underlain by unconsolidated alluvial materials is a vast reservoir of groundwater. The dynamic resource of groundwater in the Brahmaputra valley is estimated to be of the order of 2.79 million ha m. In the floodplain zone the depth of water is shallow, normally within 5 m below ground level. During the post monsoon period, in almost the entire flood plain area of the Brahmaputra Valley, the water table lies within 2 m below the ground surface, caused mainly by the impact of monsoon rains and recharge to the groundwater aquifers. This situation leads to water logging in large areas of the floodplain.

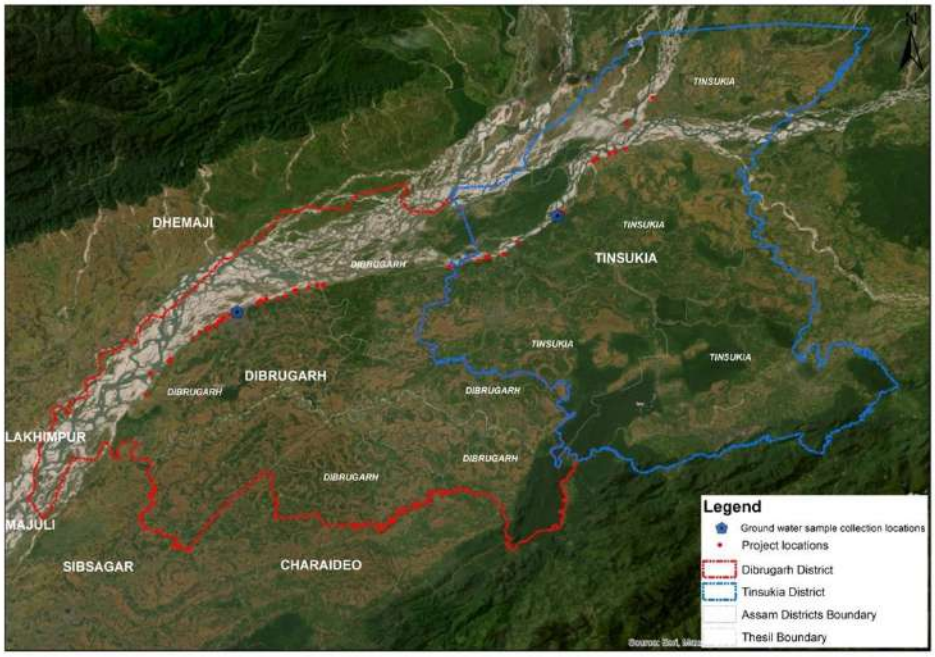
183. **Dibrugarh** Study by Central Ground Water Board the dynamic groundwater resources are estimated based on the methodology adopted as per GEC 1997 following water level fluctuation and rainfall infiltration factor method. The net groundwater availability estimated in the year 2009 is 1794.65 mcm. The existing gross groundwater draft 266.76 mcm and the stages of development

are 15% only. Future provision for domestic and Industrial use is 31.08 mcm and for Irrigation use is 1519.49 mcm. Assessment unit can be categorized into 4 categories as safe, semi-critical, critical, and over-exploited. In Dibrugarh district stage of groundwater development is 12%, which shows under the safe category. As long-term water level trend does not show any major change so the whole district may be considered as safe.

184. **Tinsukia** Study by Central Ground Water Board using the dynamic groundwater resources are estimated based on the methodology adopted as per GEC 1997 following water level fluctuation and rainfall infiltration factor methods. The annual dynamic groundwater resources are estimated to be 159036 ha m, while the net annual groundwater draft is 16697 ha m. The stage of groundwater development is only 12% and the district is still under “safe” category. The demand of groundwater for domestic and industrial use projected till 2025 is estimated to be about 4257 ham and 125230 ham water is still available for future irrigation development.

185. Groundwater quality of sample taken from handpump located at village Maijan Bora Saikia Gaon 27°29'29.06"N 94°55'0.61"E and village 1 no. Kardoiguri 27°39'5.99"N 95°27'3.15"E of Dibrugarh District and Tinsukia Districts on 03.04.2023 and 05.04.2023 respectively. Both the selected sites are near the settlement area. The sample location is indicated in the Figure 5-22 Based on the groundwater test report and its comparison with the WHO and IS:10500 (2012) standards, it can be concluded all monitored parameters are within the permissible limits. The groundwater is fit of drinking. The results of the groundwater quality is presented in Table 5-17

Figure 5-22: Groundwater Quality Monitoring Locations within Subproject Area



Source: LASA Primary Survey Report, 2023

Table 5-17: Groundwater Quality Result – subproject area

Sl. No	Parameters	Unit	Limit (IS-10500:2012)		WHO Drinking Water Standard	Test Result	
			Desirable Limit	Permissible Limit		Maijan Bora Saikia Gaon Dibrugarh	1 no. Kardoiguri Tinsukia
1	Color	Hazen	5	15	5	<5	<5
2	Odour	-	Agreeable	Agreeable	Un Objectionable	Agreeable	Agreeable

Sl. No	Parameters	Unit	Limit (IS-10500:2012)		WHO Drinking Water Standard	Test Result	
			Desirable Limit	Permissible Limit		Maijan Bora Saikia Gaon Dibrugarh	1 no. Kardoiguri Tinsukia
3	Taste	-	Agreeable	Agreeable		Agreeable	Agreeable
4	Turbidity	NTU	1	5	1.5	<1	<1
5	pH	-	6.5-8.5	No Relaxation	8.2-8.8	7.30	7.10
6	Total Hardness (as CaCO3)	mg/l	200	600		126.3	118.8
7	Iron (as Fe)	mg/l	1.0	No Relaxation		0.53	0.51
8	Chlorides (as Cl)	mg/l	250	1000		31.3	28.2
9	Fluoride (as F)	mg/l	1	1.5	0.5	0.45	0.41
10	TDS	mg/l	500	2000		308.4	316.2
11	Calcium(as a2+)	mg/l	75	200		34.2	28.4
12	Magnesium (as Mg2+)	mg/l	30	100		12.6	11.5
13	Sulphate (as SO_4)	mg/l	200	400	0 Max	16.8	14.6
14	Nitrate(as NO3)	mg/l	45	No Relaxation	3	14.2	11.8
15	Total Chromium (as Cr)	mg/l	0.05	No Relaxation	0.05	<0.01	<0.01
16	Alkalinity as CaCO3	mg/l	200	600		138.2	126.2
17	Aluminum (as Al)	mg/l	0.03	0.2		<0.01	<0.01
18	Total Arsenic(as As)	mg/l	0.01	No Relaxation	0.01	<0.01	<0.01
19	Copper (as Cu)	mg/l	0.05	1.5	2	<0.05	<0.05
20	Manganese (as Mn)	mg/l	0.1	0.3	0.4	<0.01	<0.01
21	Zinc (as Zn)	mg/l	5	15		0.18	0.14
22	Ammonia (as NH3-N)	mg/l	0.5	No Relaxation		<0.1	<0.1
23	Anionic Detergents (as MBAS)	mg/l	0.2	1		<0.1	<0.1
24	Boron(as B)	mg/l	0.5	1	0.5	<0.5(BDL)	<0.5(BDL)
25	Mineral Oil	mg/l	0.5	No Relaxation		<0.1	<0.1
26	Phenolic Compound (as C6H5OH)	mg/l	0.001	0.002		<0.001	<0.001
27	Cadmium (as Cd)	mg/l	0.003	No Relaxation	0.003	<0.002	<0.002
28	Cyanide(as CN)	mg/l	0.05	No Relaxation		<0.1	<0.1
29	Lead	mg/l	0.01	No Relaxation	0.01	<0.01	<0.01
30	Mercury(as Hg)	mg/l	0.001	No Relaxation	0.006	<0.001	<0.001

Sl. No	Parameters	Unit	Limit (IS-10500:2012)		WHO Drinking Water Standard	Test Result	
			Desirable Limit	Permissible Limit		Maijan Bora Saikia Gaon Dibrugarh	1 no. Kardoiguri Tinsukia
31	Nickel (as Ni)	mg/l	0.02	No Relaxation	0.07	<0.02	<0.02
32	Residual Free Chlorine	mg/l	0.2	1.0	0.5-1.5	<0.2	<0.2
33	Molybdenum (Mo)	mg/l	<0.05	0.07		No Relaxation	No Relaxation
34	Polynuclear Aromatic Hydrocarbons	mg/l	<0.0001	0.0001		No Relaxation	No Relaxation
35	Poly chlorinated biphenyl	mg/l	<0.0001	0.0005		No Relaxation	No Relaxation
36	Total Coli form	MPN/100ml	Shall not be detectable in any 100 ml of sample		Absent	<1	<1
37	*E. Coli*	*E. coli*/100 ml	Shall not be detectable in any 100 ml of sample		Absent	Absent	Absent

Source: LASA Primary Survey Report, 2023

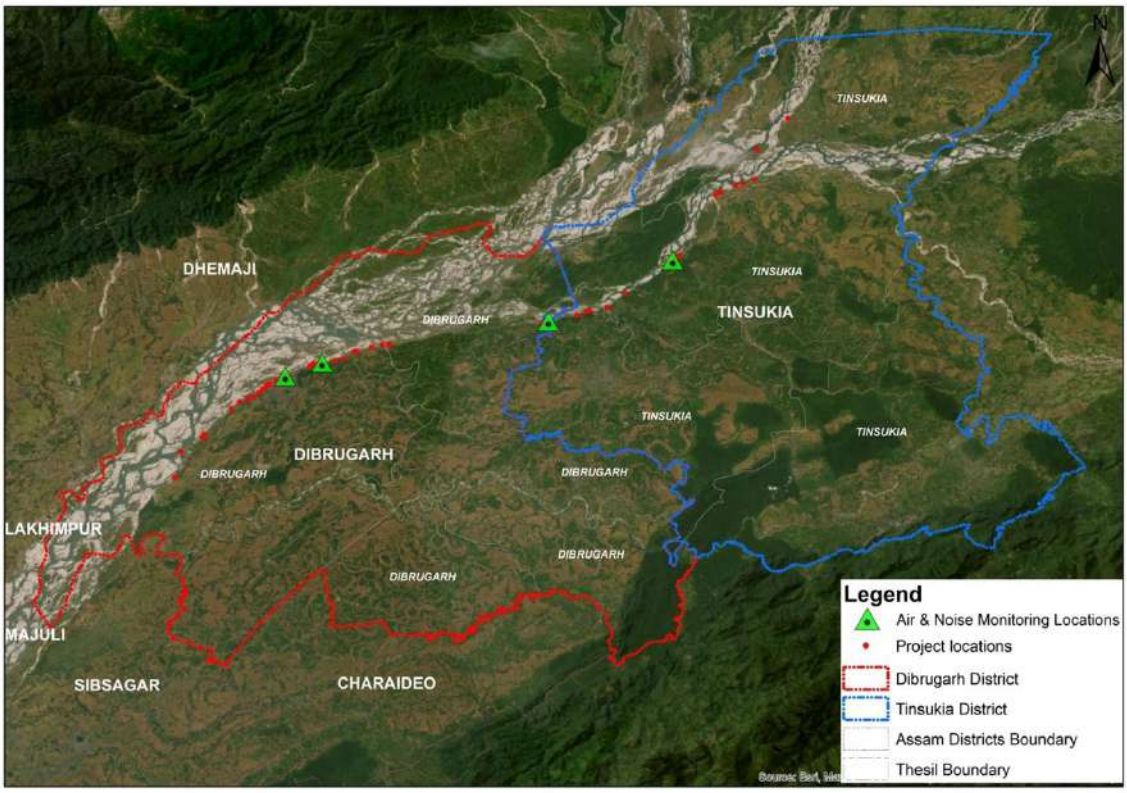
186. Based on the groundwater test report and its comparison with the WHO and IS:10500(2012) standards, it can be concluded all monitored parameters are within the permissible limits. The groundwater is fit for drinking. The monitoring reports and the sampling pictures are placed at Appendix 8

5. Air Quality

187. Except for the stretch falling withi the Dibrugarh town area and presence of industrial area in a part of subproject area in Tinsukia, the subproject area comes under rural setting or tea plantations. With the limited economic development and infrastructure, the ambient air environment is relatively undisturbed. However, in order to scientifically establish the baseline air quality status as required in this assessment and in view of its future relevance, ambient air quality was monitored at four locations in the field as indicated in Figure 5-23. The monitoring locations were finalized based on available sensitive receptors, land-use patterns and competitive users. To carry out measurement of ambient air pollution, CPCB Guidelines – Guideline for the Measurement of Ambient Air Pollutants were referred. The monitoring locations were finalized based on Guidelines for Ambient Air Quality Monitoring issued by CPCB.

188. The results of ambient air quality monitoring in the reach are presented in Table 5-18. The ambient air quality results have also been compared with the National Ambient Air Quality Standards (NAAQS) and WHO Ambient Air Quality Guidelines for Residential and Rural Areas in India. The average time for monitoring for PM_{10}, $PM_{2.5}$, NO_2, SO_2 is 24 hours and for CO is 1 hour.

Figure 5-23: Ambient Air and Noise Level Monitoring Locations within Subproject Area



Source: LASA Primary Survey Report, 2023

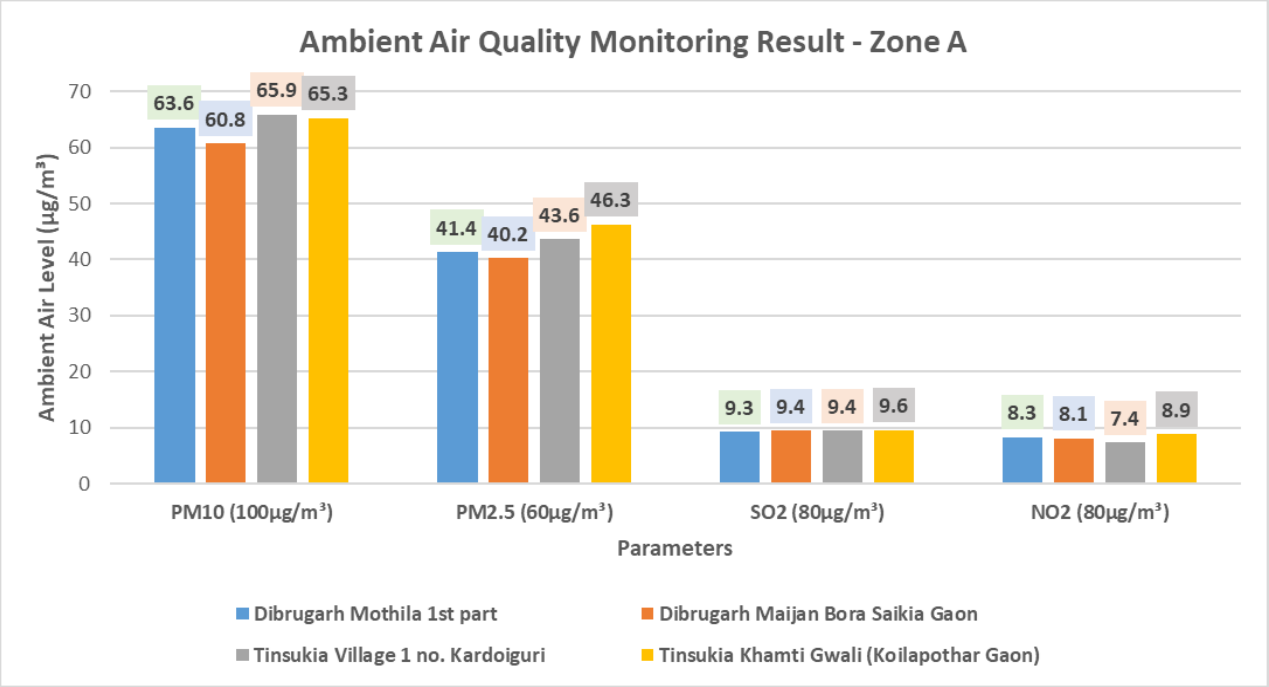
Table 5-18: Ambient Air Quality Monitoring Locations and Result

Date of Monitoring	Village Name	Geographical Coordinate	Sensitive Receptors	Ambient Air Quality Monitoring Parameters				
				PM_{10}	$PM_{2.5}$	SO_2	CO	NO_2
24-03-23	Mothila 1st part Dibrugarh	27°30'36.85"N 94°58'3.28"E	Settlement Area/ Teagarden	63.6	41.4	9.3	1.19	8.3
23-03-23	Maijan Bora Saikia Gaon Dibrugarh	27°29'29.06"N 94°55'0.61"E	Settlement area	60.8	40.2	9.4	1.16	7.4
28-03-23	Village 1 no. Kardoiguri of Tinsukia	27°39'5.99"N 95°27'3.15"E	Settlement Area/Simalu-guri Satra	65.9	43.6	9.4	1.16	7.4
29-03-23	Khamti Gwali (Koilapothar Gaon) Tinsukia	27°34'2.84"N 95°16'46.16"E	Settlement Area	65.3	46.3	9.6	1.17	8.9
National Ambient Air Quality Standard for Industrial, Residential, Rural and other Areas				**100**	**60**	**80**	**4 (1 hourly)**	**80**
WHO Ambient Air Quality Guidelines (interim target-1)				150	**75**	**125**	**-**	**200 Guideline**

Source: LASA Primary Survey Report, 2023

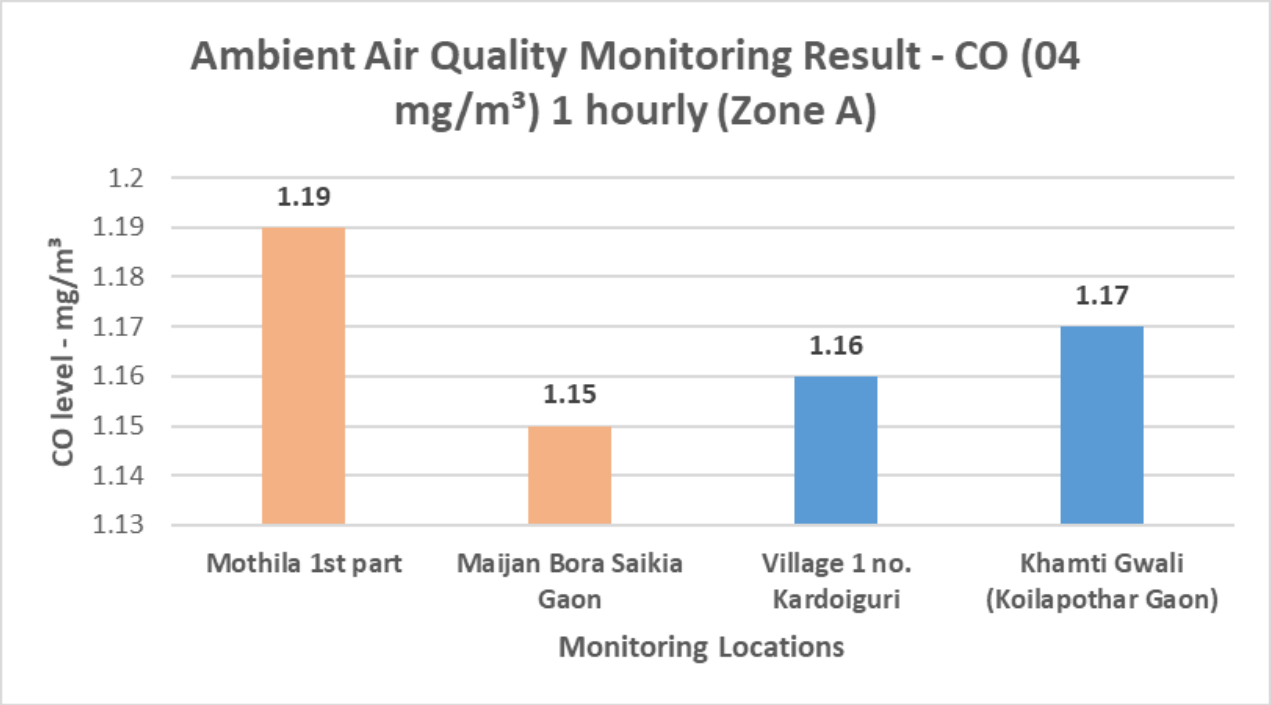
189. Based on monitored data reflected in the table above the monitoring result for all the parameters are within the National Ambient Air Quality Standard. The monitoring reports and the sampling pictures are placed at Appendix 8.

Figure 5-24: Ambient Air Quality Monitoring Results Dibrugarh



Source: LASA Primary Survey Report, 2023

Figure 5-25: Ambient Air Quality Monitoring Results Tinsukia



Source: LASA Primary Survey Report, 2023

6. Noise Environment

190. Ambient noise levels along the subproject area have been monitored at Mothila 1st part Dibrugarh, Maijan Bora Saikia Gaon Dibrugarh, 1 no. Kardoiguri, Tinsukia, and Khamti Guwali (Koilapothar Gaon) Tinsukia during day and nighttime as per the directives issued by CPCB-Protocol for Ambient Level Noise Monitoring. Monitoring was carried out continuously for 24h hrs. Day time monitoring duration is from 6:00 A.M to 10 :00 P.M. Nightiime noise monitoring duration start from 10:00 P.M to 6:00 A.M.

191. In the absence of any major source of noise pollution in the immediate vicinity of the impact corridor, the noise levels observed were well within the standards for residential areas. The sampling location for noise level monitoring is indicated in the Figure 5-26. The ambient noise levels during day and nighttime are presented in Table 5-19.

Table 5-19: Ambient Noise Monitoring Location and Result

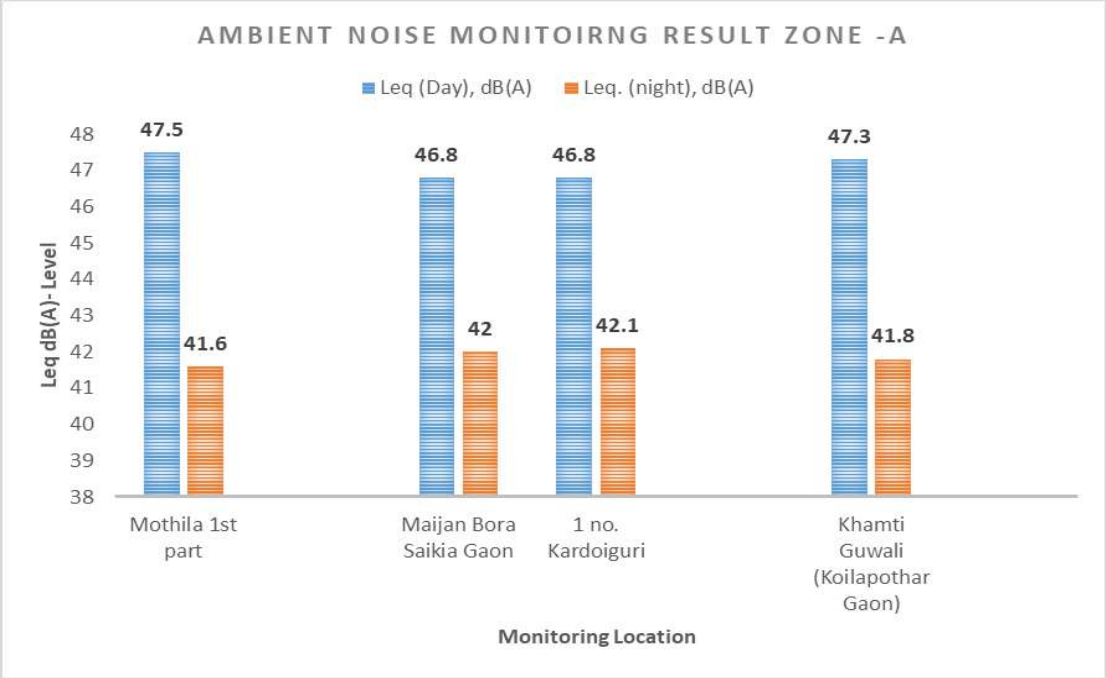
Date of Monitoring	Location/Village Name	Geographical Coordinate	Sensitive Receptors	Noise Monitoring Result	
				Leq (Day), dB(A)	Leq. (night), dB(A)
04-04-23	Mothila 1st part Dibrugarh	27°30'36.85"N 94°58'3.28"E	Settlement Area/ Teagarden	47.5	41.6
03-04-23	Maijan Bora Saikia Gaon Dibrugarh	27°29'29.06"N 94°55'0.61"E	Settlement area	46.8	42.0
07-04-23	1 no. Kardoiguri Tinsukia	27°39'5.99"N 95°27'3.15"E	Settlement Area/ Simaluguri Satra	46.8	42.1
06-04-23	Khamti Guwali (Koilapothar Gaon) Tinsukia	27°34'2.84"N 95°16'46.16"E	Settlement Area	47.3	41.8
National Standards (CPCB) [21]			Silent Area	55	45
			Residential Area	65	45
			Commercial area	75	70
			Industrial Area		
World Bank - Noise Level Guidelines [22] (Day time (07:00 – 22:00); Nighttime (22:00 – 07:00)			Residential institutional educational	55	45
			Industrial commercial	70	70

Source: LASA Primary Survey Report, 2023

[21] Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2000 vide S.O. 1046(E), dated 22.11.2000 and by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2002 vide S.O. 1088(E), dated 11.10.2002, under the Environment (Protection) Act, 1986.

[22] Environmental, Health, and Safety (EHS) Guidelines GENERAL EHS GUIDELINES: ENVIRONMENTAL NOISE MANAGEMENT – World Bank Group

Figure 5-26: Ambient Noise Monitoring Result



Max Leq.dB (A) – 47.2; Min Leq. dB(A) – 40.5

Source: LASA Primary Survey Report, 2023

192. Based on the Figure above, it is clear that the background ambient noise level fall in the range residential area Category of CPCB and from the results it can be concluded that background noise level within respective category of CPCB is within the permissible limit for Day and Nighttime. The monitoring reports and the sampling pictures are placed at Appendix 8.

7. Key Physical Aspects

193. Summary of the key physical aspects in the PAI are given in Table 5-20.

Table 5-20: Summary of Key Physical Environmental setting in PAI

Particulars	Key Features in PAI
Elevation and Topography	• The general elevation of the project sites is around 115 m above mean sea level (AMSL). The project area is characterized by undulating plain.
Land Use and Land Cover – Study Area	• Physiography is characterized primarily by plains • LU is predominantly agrarian
Microclimatic condition	• The climate in the districts is moderate during the winter and in summer, it is hot. • The maximum temperature is 40 degree Celsius during July and August, a minimum temperature falls up to 12 degrees Celsius in the month of January. • Monsoon rain normally begins from the early part of the month of June and heavy rain occurs in the district till the month of September. annual normal rainfall of the district is 2819 mm
Geological and Climatic Risks	• Seismic hazards: Zone-V and Very High Damage Risk Zone • Surface Water Flooding – High Medium Risk

Particulars	Key Features in PAI
	• Landslides – Low Risk area • Storms and cyclones–High Risk area
General environmental conditions – soils, air quality, noise, water	• Parameters are within CPCB standards in general

Source: ADB TA Consultant

E. Biological Setting

1. Protected Areas (PA)

194. The State of Assam is a constituent unit of the Eastern Himalayan Biodiversity Region; one of the two biodiversity "Hot Spots" in the country. The climatic condition and wide variety in physical features witnessed in Assam have resulted in a diversity of ecological habitats such as forests, grasslands, wetlands, which harbor and sustain wide ranging floral and faunal species placing.

195. The State of Assam has 5 National Parks (NP), 17 Wildlife Sanctuaries (WLS) and 1 Ramsar wetland site which is also a WLS. There is 21 Key Biodiversity Areas (KBA) and Important Bird Areas (IBA) in the state[23, 24.] The details are as follows:

Table 5-21: Summary of Protected Areas in Assam

Sl. No.	Name	National Status [25, 26]	IUCN Protected Area Level/ Ramsar Criteria	IBA Criteria [27, 28]	KBA	Critical Habitat as a PA
1	Dibru-Saikhowa NP	NP	Not categorized yet but considered as Category II as per IUCN criteria	A1, A2	Yes	Supports CR/EN species
2	Kaziranga NP	NP	Category II (NP) and X (World Heritage Site) as per IUCN criteria 29	A1, A2, A4i, A4iii	Yes	Fulfils IUCN category II PA criterion

[23] Key Biodiversity Areas (KBA) are sites contributing significantly to the global persistence of biodiversity in terrestrial, freshwater and marine ecosystems. Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into five categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and, irreplaceability. KBAs comprise an "umbrella" set of internationally recognized priority sites for biodiversity that includes Important Bird Areas (IBAs) and Alliance for Zero Extinction (AZE) sites. IBAs are priority sites for bird conservation because they regularly hold significant populations of one or more globally or regionally threatened, endemic or congregatory bird species, or highly representative bird assemblages.

[24] WII ENVIS, Govt. of India. 2017. http://wiienvis.nic.in/Database/Key_Biodiversity_Areas_8647.aspx

[25] WII ENVIS, Govt. of India. 2023. http://wiienvis.nic.in/Database/wls_8230.aspx

[26] Assam State Biodiversity Board, Govt. of Assam. https://asbb.assam.gov.in/information-services/protected-area-network

[27] BirdLife International (2022) Country profile: India (http://datazone.birdlife.org/country/india)

[28] Rahmani, A.R., Islam, M.Z. and Kasambe, R.M. (2016) Important Bird and Biodiversity Areas in India: Priority Sites for Conservation (Revised and updated). Bombay Natural History Society, Indian Bird Conservation Network, Royal Society for the Protection of Birds and BirdLife International (U.K.). Pp. 1992 + xii

[29] IUCN. 1990. IUCN Directory of South Asian Protected Areas. IUCN, Gland, Switzerland and Cambridge, U.K. xxiv + 294 pp. https://wedocs.unep.org/bitstream/handle/20.500.11822/8084/IUCN_directory_South_Asian_Protected_Areas.pdf?sequence=3&isAllowed=y

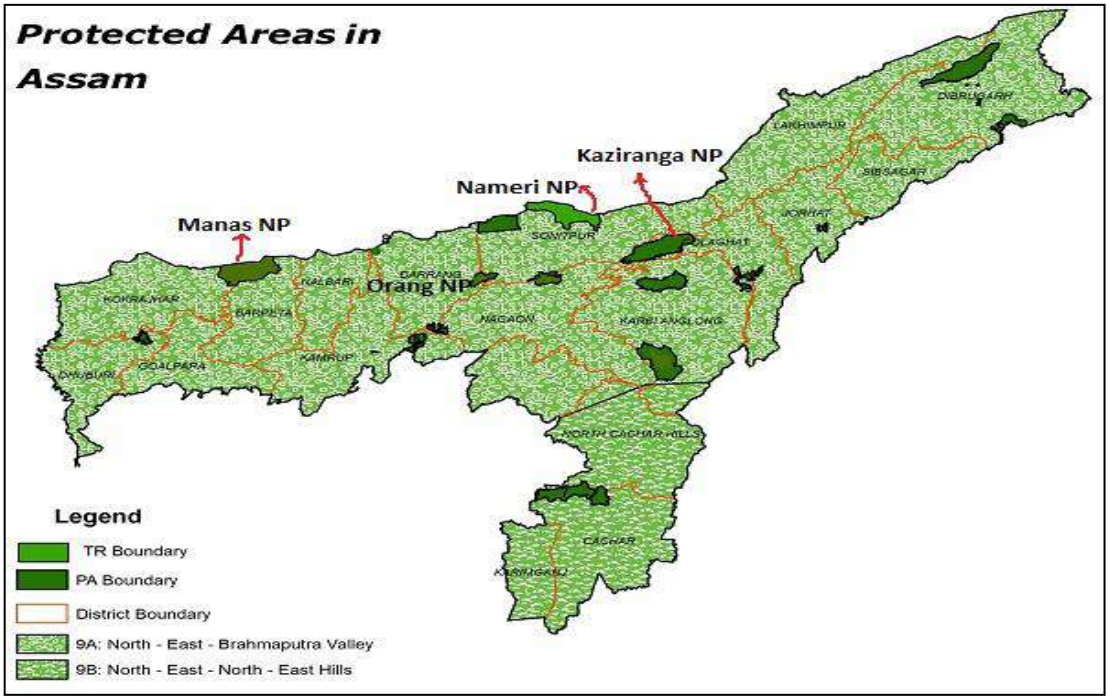
Sl. No.	Name	National Status [25, 26]	IUCN Protected Area Level/ Ramsar Criteria	IBA Criteria [27, 28]	KBA	Critical Habitat as a PA
3	Manas NP	NP	Category IV (habitat or species management area) as per IUCN	A1, A2	Yes	Supports CR/EN species
4	Nameri NP	NP	Category IV as per IUCN	A1, A2	Yes	Supports CR/EN and endemic species
5	Orang NP	NP	Category IV as per IUCN	A1, A4ii	Yes	Supports CR/EN and migratory species
6	Amchang WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1	Yes	Supports CR/EN species
7	Barail WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1, A2, A3	Yes, as part of Barail Range	Supports CR/EN and endemic species
8	Barnadi WLS	WLS	Category IV as per IUCN	A1	Yes	-
9	Bherjan-Borajan-Podumoni WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1	Yes	-
10	Burachapori WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1, A2	Yes	-
11	Chakrashila WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1, A4i, A4iii	Yes	-
12	Deepor Beel	Ramsar Site	Ramsar Site per criterion 1, 2, 4, 7 and 8. Category IV as per IUCN	A1, A4iii	Yes	Ramsar site it is a wetland that provides key ecosystem services/ fish breeding ground
13	East Karbi Anglong WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1	Yes	-
14	Garampani WLS	WLS	Category IV as per IUCN	A1	Yes	-
15	Hollongapar-Gibbon WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1	Yes	Supports CR/EN and endemic species
16	Laokhowa WLS	WLS	Category IV as per IUCN	A1, A2	Yes	Supports CR/EN and endemic species
17	Marat Longri WLS	WLS	Not categorized yet but considered as	A1	Yes	-

Sl. No.	Name	National Status [25, 26]	IUCN Protected Area Level/ Ramsar Criteria	IBA Criteria [27, 28]	KBA	Critical Habitat as a PA
			Category IV as per IUCN			
18	Nambor Doigrung WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1	Yes	-
19	Nambor WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1	Yes	-
20	Pabitora WLS	WLS	Category IV as per IUCN	A1, A2, A4iii	Yes	Supports CR/EN and migratory species
21	Pani-Dihing WLS	WLS	Not categorized yet but considered as Category IV as per IUCN	A1, A4iii	Yes	-
22	Sonai-Rupai WLS	WLS	Category IV as per IUCN	A1	Yes	Supports CR/EN species

CR = Critically Endangered, EN = Endangered, IBA = important bird area, KBA = Key Biodiversity Areas, IUCN = International Union for Conservation of Nature

Source: ADB TA Consultant

Figure 5-27: Map Showing Protected Areas in Assam



Source: Wildlife Institute of India.
http://wiienvis.nic.in/WriteReadData/UserFiles/image/PAs_Map_Database/images/assam_envis1.jpg

2. Areas of Eco-sensitivity/Protected Area/Restricted Area

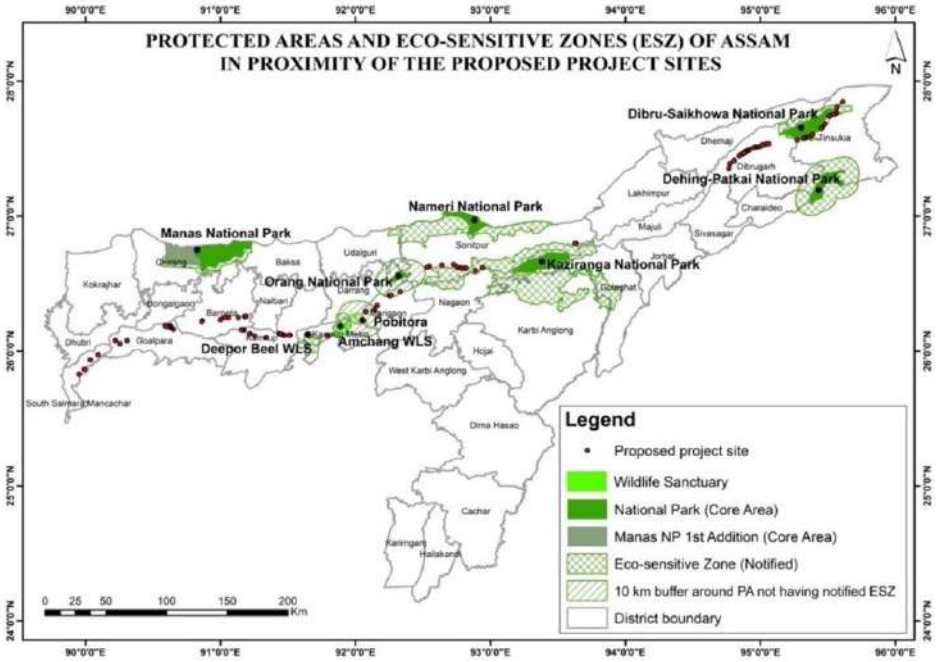
196. There is 1 notified protected area (Dibru - Saikhowa NP) within 1 km of the project intervention areas in Dibrugarh District, and 2 PAs in Tinsukia District (Dibru - Saikhowa NP and Bherjan-Borajan-Podumoni WLS) within 1 km and 5km of the project intervention areas as provided in Table 5-22. The Assam Plains is reported to be an Endemic Bird Area (EBA) 30 as per Birdlife International. The subproject area falls under the EBA.

Table 5-22: Protected Areas and KBAs within 10km of the Project Area

Subproject District	PA (Name and Distance - within)			KBA (Name and Distance - within)		
	1-5 km	5-10 km	>10 km	1-5 km	5-10 km	>10 km
Dibrugarh	Dibru - Saikhowa NP	-	-	Dibru - Saikhowa NP	Jamjing and Sengajan	-
Tinsukia	1. Bherjan-Borajan-Podumoni WLS 2. Dibru - Saikhowa NP	-	D'Ering Memorial WLS	1. Dibru - Saikhowa NP 2. Bherjan-Borajan-Podumoni WLS 3. Maguri and Motapung Beels	Dibang Reserve Forest and adjacent areas	1. D'Ering Memorial WLS Sanctuary 2. Dum Duma, Dangori and Kumsong Reserve Forests

Source: IBAT Proximity Report. Generated under license 5840-42026 and 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org and Assam WL department

Figure 5-28: Map Showing Protected Areas and ESZs in Proximity to Project Sites



Source: Chief Wildlife Warden Assam through WRD

[30] BirdLife International (2023) Endemic Bird Areas factsheet: Assam plains. Downloaded from http://datazone.birdlife.org/eba/search on 24/05/2023. BirdLife Data Zone

The Eco-Sensitive Zone (ESZ) of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites are adjacent to or within the notified area of the ESZ of the. Dibru - Saikhowa NP. The details are given in the Table 5-23. The ESZ of Bherjan-Borajan-Podumoni WLS is notified as well, and Dibrugarh Subproject sites are outside its boundaries.[31] On 14th July 2023, FREEMA obtained no objection letter from the Office of the Principal Chief Conservator of Forest (Wildlife) and Chief Wildlife Warden, Assam for construction activities within the ESZ of Dibru - Saikhowa NP. As part of condition, the project will ensure that (i) no porcupines will be installed and no adverse impact shall be caused to Ganges River Dolphin and other riparian wildlife including their habitat during project implementation.

Table 5-23: Details of Project with respect to Wildlife Boundary and ESA Area

Name of the subproject	Name of the project site	Distance from Wildlife Boundary in meters	Distance from Eco-Sensitive Zone in meters	Remarks
Dibrugarh subproject	Milanpur to Hatighuli	363 m	Within	NoC/permissions from CWLW/SBWL/NBWL required
	Phelai to Naokota	937 m	Within	
	Gariating Gaon	-	760 m outside	-
	Simaluguri Satra	-	Outside	NoC/permissions from CWLW/SBWL/NBWL required
	Baghjan to. Notun Gaon	331 m	Within	
	Guijan	1286 m	Within	
	Rungagorah to Dinjan	466 m	Within	

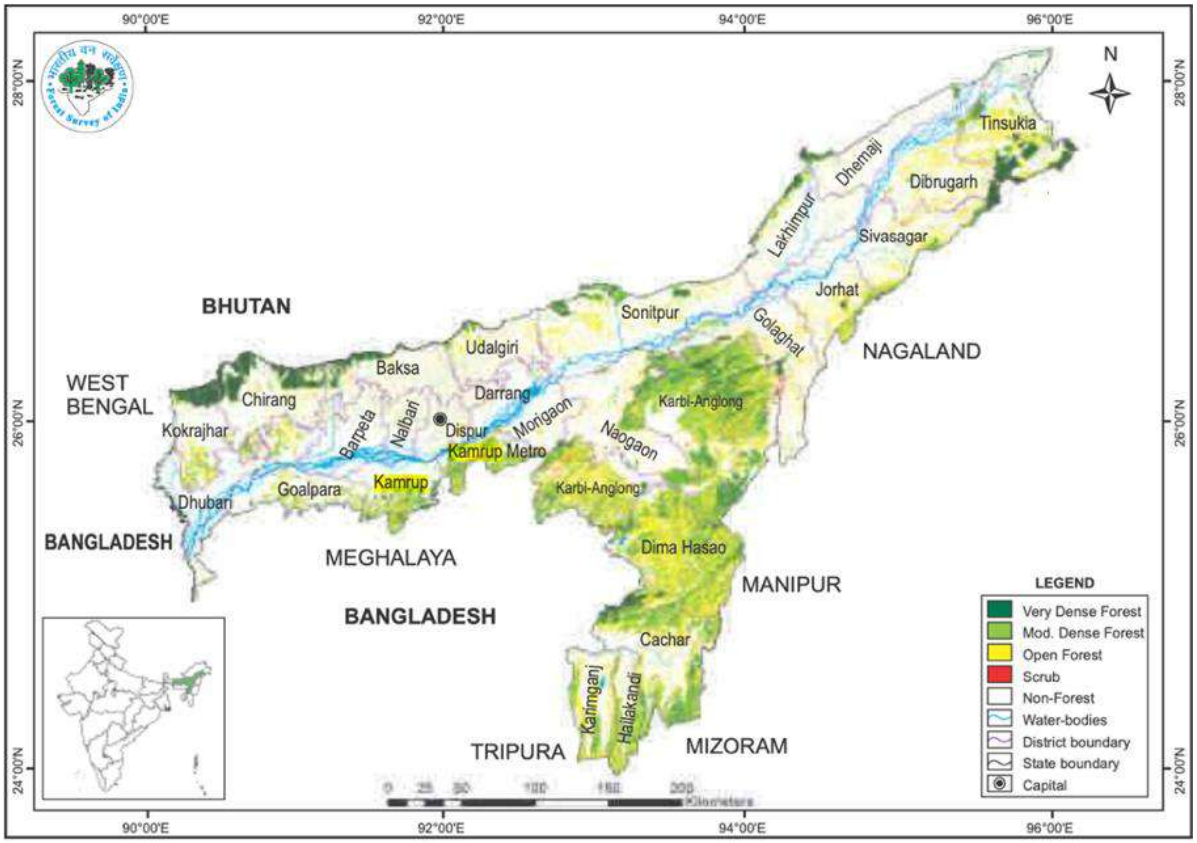
Source: LASA Biodiversity Assessment and Ecology Survey Report, 2023

3. Forests

197. The total recorded forest area (RFA) in the State is 26,836 sq km. which is 34.21 % of the total geographical area of the State. Out of the total RFA, 17,864 sq. km is Reserve Forest and 8,972 sq. km is unclassed forests. The Forest Cover of the State is 28,311.51 sq. km. which is 36.09 % of total geographical Area excluding the 227.94 sq. km . of Scrub Forest Area. The Very Dense Forest Area is 3016.67 sq. km., Moderate Dense Forest is 9991.02 sq. km. and Open Forest is 15,303.82 sq. km.

[31] The Bherjan-Borajan-Podumoni Wildlife Sanctuary was notified by 'Expert Committee for Declaration of ESZ Around Wildlife Sanctuaries/ National Park vide Minute of the meeting held on 4th July'2016 in MoEFCC at Indira Paryavaran Bhawan, New Delhi.

Figure 5-29: Forest Cover Map of Assam



Source: http://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-assam.pdf and India State of Forest Report, 2021,

198. The forest in Assam can be described into following types/sub types:[32]

- Tropical Wet Evergreen Forests
- Tropical Semi Evergreen Forests
- Tropical Moist Deciduous Forests
- Sub-tropical Broadleaf Hill Forests.
- Sub-tropical Pine Forests
- Littoral and Swamp Forests
- Grassland and Savannahs

Table 5-24: Statement of Forest Land in Project Districts

District/State	Geographical Area km²	Forest Area	
		Total km²	% Total Forest Area in State
Dibrugarh	3381	758.52	22.43
Goalpara	1824	404.61	22.18
Kamrup	3105	966.70	31.13

[32] https://environmentandforest.assam.gov.in/information-services/biodiversity-of-assam-0

District/State	Geographical Area km²	Forest Area	
		Total km²	% Total Forest Area in State
Morigaon	1551	176.41	11.37
Tinsukia	3790	1583.38	41.78
Assam	**78,438**	**38,311.51**	**36.09**

Source: India State of Forest Report, 2021, Forest Survey of India

199. As per Champion and Seth categorization, the project area falls in Moist Deciduous Forest type. In these forest Sal grows in association with Lagerstroemia species (Jarul, Ajar), Schima Wallichii (Ghugra), Stereospermum personatum (Paruli), Adina cordifolia (Haldu), Artocarpus species (Sam), Ficus species(Bor, Dimoru, Dhupbor, Bot, Athabor, tengabor, Lotadioru, Khongaldimoru), Bischofia javanica (Uriam), Gmelina arborea (Gomari), Michelia champaca (*Teeta champa*), Terminalia species (Hilikha, Bhomora, Bohera). Toona ciliate (Poma) etc.

200. As per the primary survey, the forest type reported in the subproject area Dibrugarh and Tinsukia are tropical wet evergreen forest[33]. The dominant tree species are Hollong (Dipterocarpus macrocarpus), Borpat, Jutuli, Sam, Dewa sam, Nahar, Teeta chap, Bhelu, Mekai etc. The Uppar Assam is rich in avifauna distribution. It harbours local and migratory birds from Uppar Himalayan mountain during winter. Birds also migrate in this region from central Asia during winter season.

201. No notified forest under The Indian Forest Act 1927; Forest (Conservation), Act 1980 and The Assam Forest Regulation Act 1891 were located within project construction zone or adjacent to the project area.

4. Wetlands

202. In Assam, approximately 7% of total land surface is covered by wetlands. Total wetland area in Dibrugarh District is 72,461 ha that includes 535 small wetlands (<2.25 ha). River/stream occupies 95.43% of wetlands. The other major wetland type is Ox-bow lakes (1.79%). There are 11 lake/pond (locally called as Beels) with 590 ha area. In the Tinsukia District the percentage is remarkably high. Total wetland area in the district is 40,626 ha that includes 478 small wetlands. River/stream occupies 87.81% of of wetlands. The other major wetland types are waterlogged - natural (4.08%), riverine wetland (2.83%), waterlogged-natural (4.15%) and ox-bow lakes (3.44%). Total wetland area in the Dibrugarh District is 72,461 ha that includes 535 small wetlands (<2.25 ha). River/stream occupies 95.43% of wetlands. The other major wetland type is Ox-bow lakes (1.79%). There are 11 lake/pond (locally called as Beels) with 590 ha area.

Table 5-25: Area Estimates of Wetlands in Dibrugarh District

Wetland Category	No. of Wetlands	Total Wetland Area (Ha.)	Percentage of wetland area	Open Water (Ha.)	
				Post-monsoon Area	Pre-monsoon Area
Inland Wetlands - Natural					
Lakes/Ponds	11	590	0.81	115	45
Ox-bow lakes/Cut-off meanders	64	1295	1.79	700	456
High altitude wetlands	-	-	-	-	-
Riverine wetlands	11	146	0.20	0	42
Waterlogged	31	656	0.91	103	248

[33] https://asbb.assam.gov.in/information-services/biodiversity-of-assam#:~:text=Assam's%20mammalian%20diversity%20is%20represented,isolated%20pockets%20and%20protected%20areas.

Wetland Category	No. of Wetlands	Total Wetland Area (Ha.)	Percentage of wetland area	Open Water (Ha.)	
				Post-monsoon Area	Pre-monsoon Area
River/Stream	76	69,149	95.43	27,232	35,856
Inland Wetlands - Man-made					
Reservoirs/Barrages	-	-	-	-	-
Tanks/Ponds	-	-	-	-	-
Waterlogged	14	45	0.06	45	41
Total - Inland	9	45	0.06	45	45
Sub-Total	216	71,926	99.26	28,240	36,733
Wetlands (<2.25 ha), mainly Tanks	535	535	0.74	-	-
Total	**751**	**72,461**	**100.00**	**28,240**	**36,733**

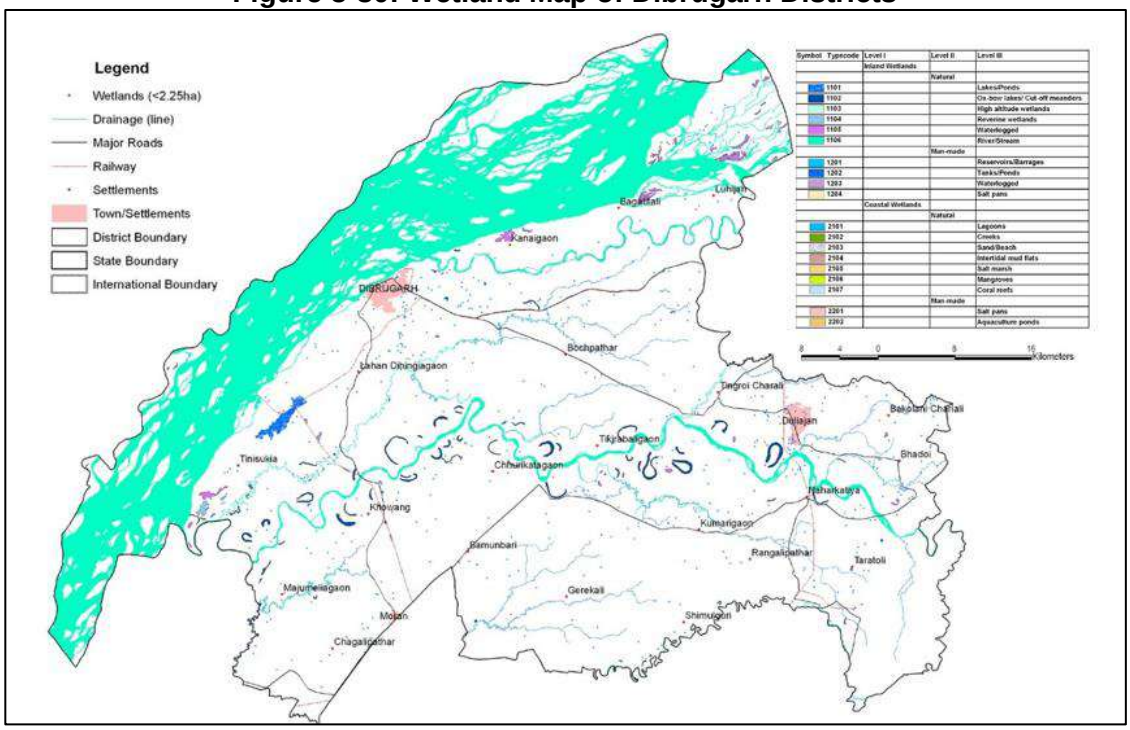
Source: National Wetland Atlas: Assam, SAC/RESA/AFEG/NWIA/ATLAS/18/2010, Space Applications Centre (ISRO), Ahmedabad, India, 174p.

Table 5-26: Area Estimates of Wetlands in Tinsukia District

Wetland Category	No. of Wetlands	Total Wetland Area (Ha.)	Percentage of wetland area	Open Water (Ha.)	
				Post-monsoon Area	Pre-monsoon Area
Inland Wetlands - Natural					
Lakes/Ponds	20	147	0.36	48	41
Ox-bow lakes/Cut-off meanders	59	1399	3.44	148	367
High altitude wetlands	-	-	-	-	-
Riverine wetlands	30	1151	2.83	290	483
Waterlogged	43	1685	4.15	323	500
River/Stream	5	35672	87.81	16825	21382
Inland Wetlands - Man-made					
Reservoirs/Barrages	-	-	-	-	-
Tanks/Ponds	23	63	0.16	57	55
Waterlogged	4	31	0.08	21	26
Sub-Total	184	40148	98.75	17712	22854
Wetlands (<2.25 ha), mainly Tanks	478	478	1.18	-	-
Total	**662**	**40626**	**99.92**	**17712**	**22854**

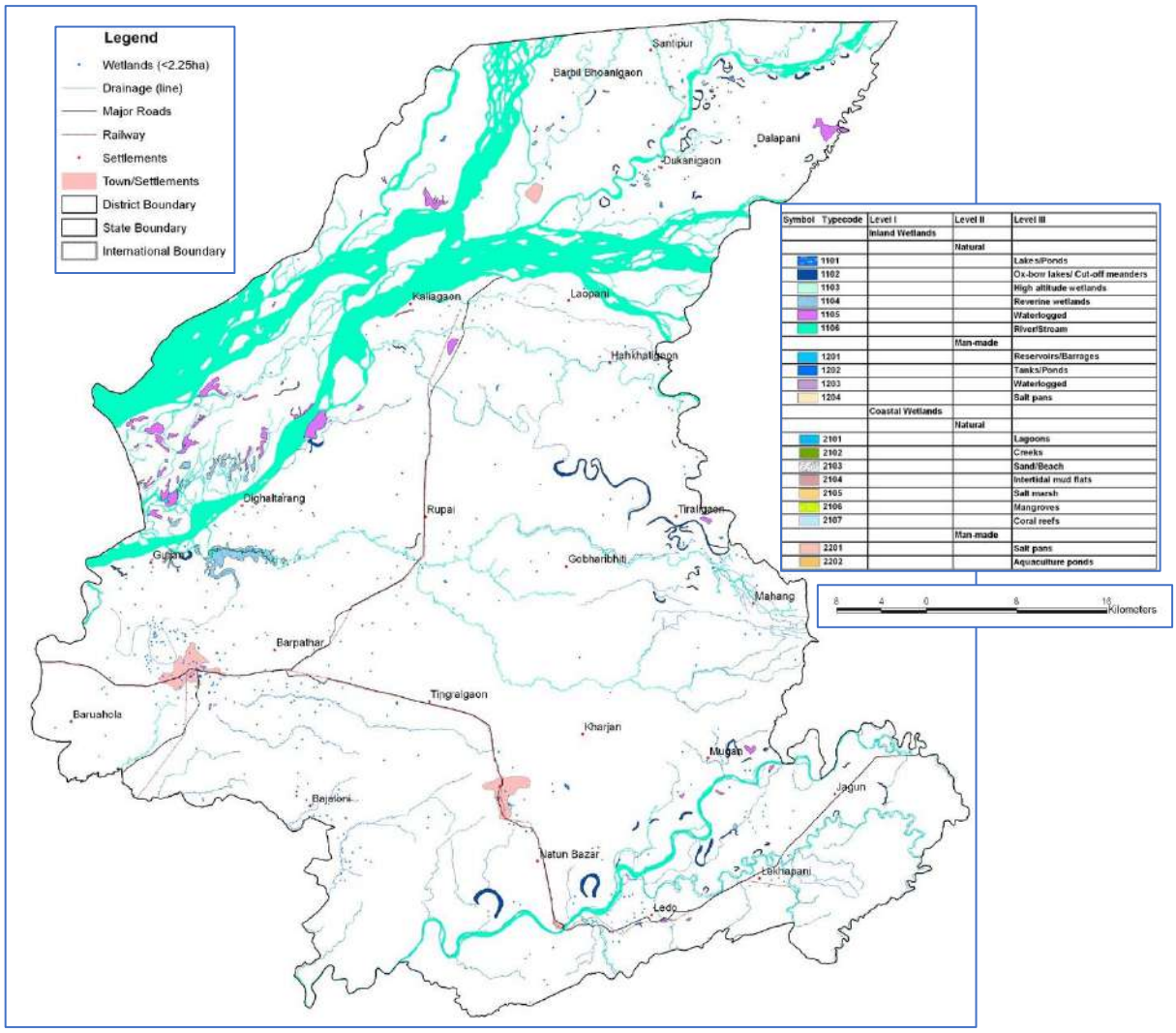
Source: National Wetland Atlas: Assam, SAC/RESA/AFEG/NWIA/ATLAS/18/2010, Space Applications Centre (ISRO), Ahmedabad, India, 174p.

Figure 5-30: Wetland Map of Dibrugarh Districts



Source: National Wetland Atlas: Assam, SAC/RESA/AFEG/NWIA/ATLAS/18/2010, Space Applications Centre (ISRO), Ahmedabad, India, 174p.

Figure 5-31: Wetland Map of Tinsukia District



Source: National Wetland Atlas: Assam, SAC/RESA/AFEG/NWIA/ATLAS/18/2010, Space Applications Centre (ISRO), Ahmedabad, India, 174p.

5. Wetlands around Project Sites

203. There are very few perennial wetlands available near the subproject area. The existing wetlands are Maguri-Motapung Beel in Tinsukia and Maijan Beel in Dibrigarh.

204. **Maijan Beel in Dibrugarh** Majuli Beel, also known as Maijan Beel, is a significant wetland located in Dibrugarh District, Assam, India. It is a freshwater marshland that serves as a vital habitat for a diverse range of flora and fauna.

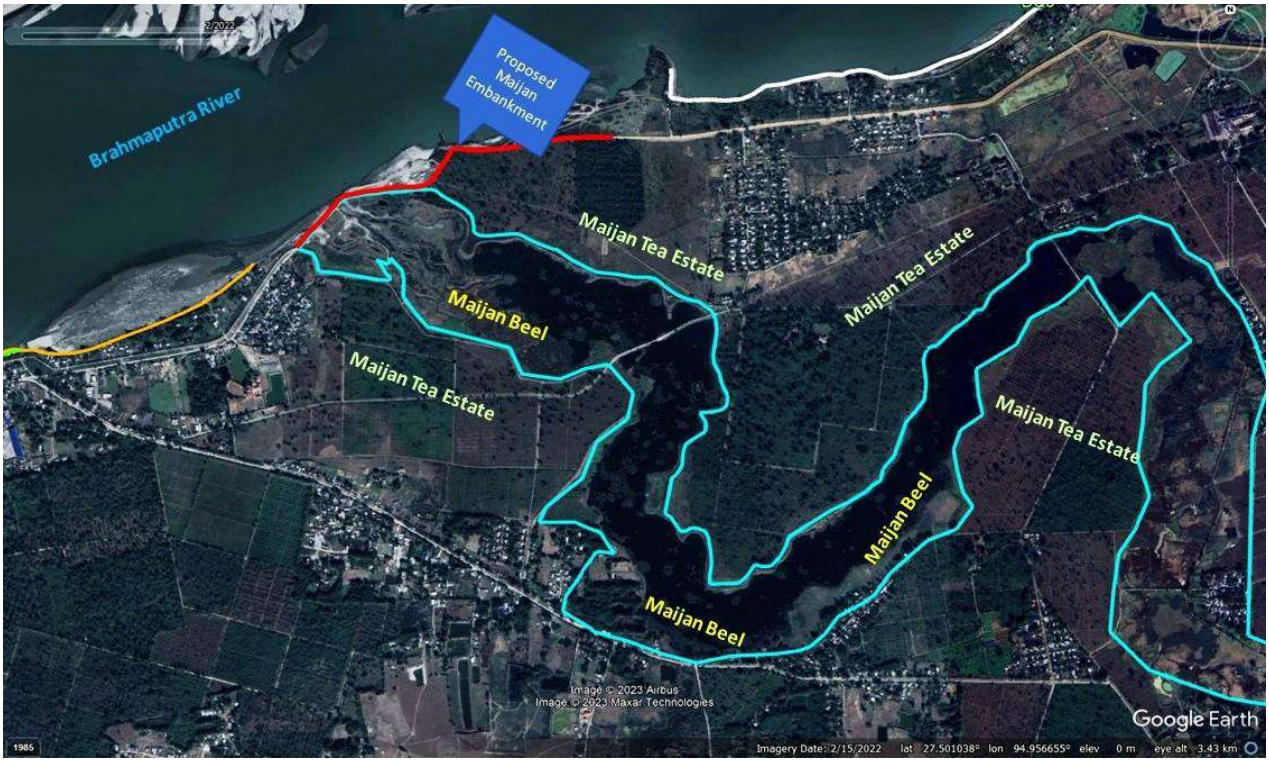
205. The water in this beel is feed from Brahamaputra River (Back water) when flooding occurs. The Maijan Beel towards project witnesses' growth of hydrophytes and shrubs. Small water ponds were noticed. Stream from the beel flows towards Brahmaputra River over which bridge exists. This beel is known for it ecological values. It harbours wide variety of plankton (Phyto and

zooplanktons[34]). A total of 42 macrophytes have been recorded under 34 genera belonging to 28 families from the Maijan wetland, Assam during February 2013 to March 2014[35].

206. The Maijan beel is located adjacent to the proposed embankment (Reach 2 Maijan) of length 1200 m. The location of the Maijaan Beel with respect to the proposed embankment is indiated in figure 5-32. The project would involve development of earthen embankment to prevent the surrounding from flooding.

207. A RCC triple shutter sluice gate in Maijan Beel embankment in Dibrugarh with regulator and fish pass is proposed to be Installed. Triple shutter sluice gates with fish passes and regulators is an environmentally friendly hydraulic structures that balance human water management needs with the conservation of aquatic ecosystems. By considering the requirements of both water users and aquatic species, the proposed structures will contribute to sustainable water resource management of Maijan Beel.

Figure 5-32: Location of Maijan Beel with respect to nearest subproject site

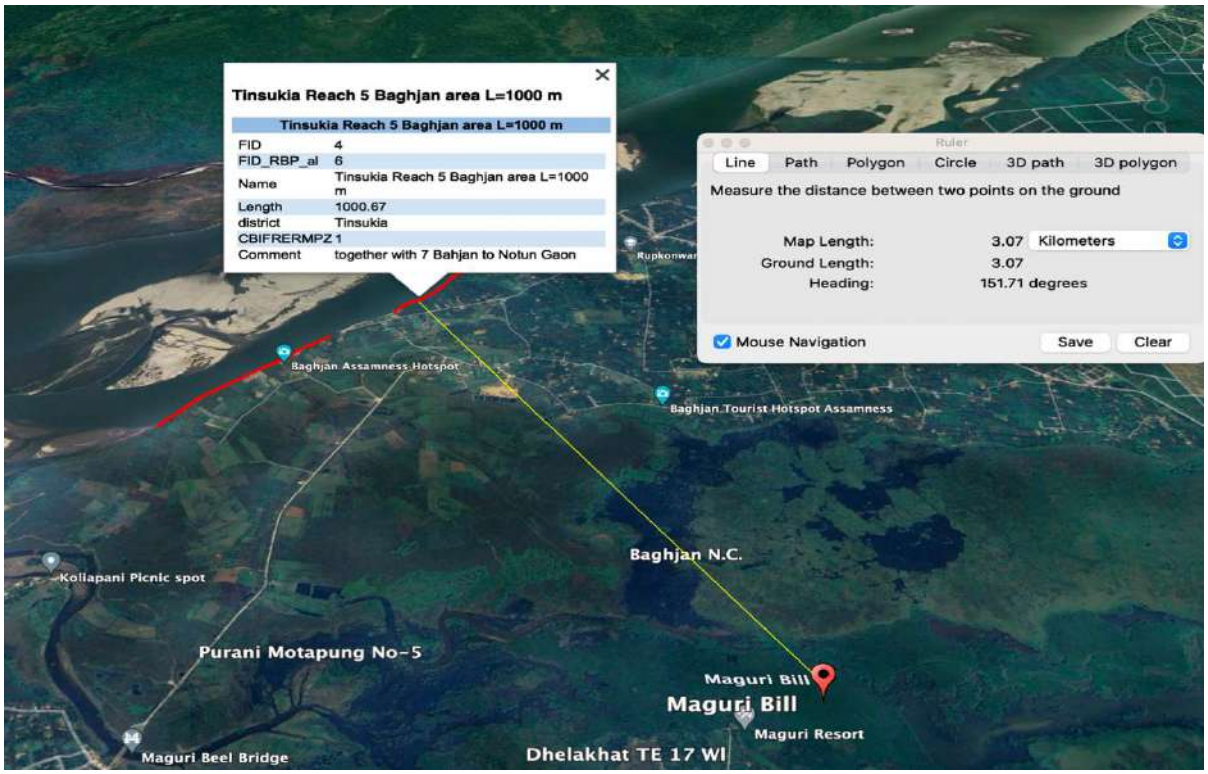


Source: LASA Biodiversity Assessment and Ecology Survey Report, 2023

208. **Maguri-Motapung Beel in Tinsukia District** Maguri-Motapung Beel in Tinsukia District, Assam, is recognized as an important wetland area. It is known for its ecological significance and is considered a haven for migratory and resident bird species. The beel (a local term for a wetland) provides vital habitat for birds, including endangered and threatened species. The Maguri-Motapung Beel is situated at an aerial distance of approximately 3.07 kilometers from nearest subproject site Tinsukia Bhagjan reach 5 as indicated in the Figure 5-33.

[34] https://www.researchgate.net/publication/304180101_DiversityyoffPlanktonninnMaijan _Upper_Assam_Beel
[35] Diversity of macrophytes in Maijan wetland, Upper Assam, India., Abujam, S. S. ; Shah, R. K. ; Deori, D. J. ; Biswas, S. P.

Figure 5-33: Location of Maguri Beel with respect to nearest subproject site



Source: ADB TA Consultant

6. Ecology in Project Area

209. The Brahmaputra River has structured the terrestrial and aquatic ecosystem of the floodplain zones. People living in the floodplain of the river depend on the ecological supports of the Brahmaputra River and its monsoon flood. Almost every year, river water inundates the entire low-lying areas of the floodplains and thus rejuvenates the land with natural fertilizer and biodiversity components.

210. Favourable geographical location, diversified topography and ideal climatic conditions have made Assam very rich in biodiversity. The vegetation of Assam is primarily of tropical type covering areas of evergreen, semi-evergreen, grasslands, deciduous forests, grasslands and riverside forests. Some important tree species found in Assam are Hoooong (*Dipterocarpus macrocarpus*), Gurjan (*Dipterocarpus tubinatus*), Mekai (*Shorea assamica*), Kurta (*Palaquium polyanthum*), Nahar (*Mesua ferrea*), Sia-nahar (*Keyea assamica*), Sissoo (*Dalbergia sissoo*), Khair (*Acacia catechu*) etc.

211. The river has created large numbers of wetlands in the floodplain within a range of 10 km distance from the major river system. These wetlands have supported numerous aquatic biodiversity resources including ecologically and commercially important butterflies, moths, fishes, amphibian, reptiles, mammals, birds and economically important aquatic plants, ornamental plants, medicinal plants etc.[36] and created life support systems of the traditional peoples living in the floodplains. The major human dependable biodiversity resources, which have regularly been supported the human livelihood management of the rural folks are supported by the river created wetland ecosystems.

[36] Saikia, P. K. and P. C. Bhattacharjee 1995. Status, and decline of water birds in Brahmaputra Valley, Assam, India. Pp. 20-27, in Verghese, A. S., Sridharand, A. Chakravarty, K. [ED.]. Proceedings: Published by Zafar Futhehaly, Bird Conservation Strategies for the Nineties and Beyond. OSI, OSI Liaison Officer, No. 10. Vishnuchittam, Sirur Park Road, Seshadripuram, Banglore-560020, India., Mani, M. S. 1986. Butterflies of the Himalaya. Oxford and IBH Publishing Co., New Delhi. and Mani, M. S. 1974. Ecology and Biogeography in India. Dr. W. Junk B.V. Publishers, The Hague

These wetlands were formed due to continuous interaction of land and water, so without water sources, no wetland ecosystem would exist in the floodplain zones.

212. Evergreen and semi evergreen forests are found in the subproject districts which consists of several types of trees. These are mainly Sal, Kydia, Udal, Sioa, Bombax, Bahera. The common herbs and shrubs are ageratum conyzoides. Species of *Circuma, Cardx beacrispa* etc. are found here.

7. Methodology of Baseline Data Collection

213. LASA was appointed by FREEMA to conduct biodiversity assessment and collect primary ecology data. The LASA carried out the surveys between 31st March 2023 to 01st April 2023 in Dibrugarh subproject area and 2nd April 2023 to 4th April 2023 in Tinsukia subroject area. The biodiversity assessment report and the primary ecological data collected by LASA is appended in Appendix 7. The study area was 1 km from the project interventions, dividing the study into three zone; Core (project interventions works), Inner Buffer Zone (500 meters from the core) and Outer Buffer Zone (500 meters to 1 km area). Methods adopted for Survey and data collection included:

1. Walk Through methods for both floral and faunal surveys
2. Transect line methods for both floral and faunal surveys
3. Spot methods for avifauna
4. Call detection methods for avifauna
5. Pug mark of animals on sandy riverbeds for fauna
6. Quadrant analysis – for floral species reporting and identification, trees quadrant size (10m X 10m); shrubs and herbs (1m x 1m) were selecte
7. Fishing point – Bamboo Net Traditional Fishing Net (Veshal) Point. Daily fishing point in project villages

To record the species distribution a total of 10 transect lines were laid. The walk-through locations were same, it is recording species sighted beyond transect lines. The location of Spot methods was same as proposed for 15 Quadrants, out of these 15 selected locations species of avifauna are reported in 9 locations (spots).

214. Secondary data like forest working plan for respective forest divisions, publications, similar reports etc. were also used to compile and conform the data.

8. Terrestrial Flora

215. The subproject area is dominated by growth of shrubs followed by tress. Invasive shrubs species dominate the ground covered. The species of trees, shrubs, herbs, climbers and grasses are recorded adopting line transect methods. About eight lines transect in Tinsukia and nine lines Transect were laid in subproject study area.

216. Based on the line transect study about 26 species of herbs and shrubs reported from the study area. They are castor (*Ricinus communis*), Lantana (*Lantana camara*), *Datura stramonium*, *Datura innoxia*, *Datura metel*, *Zizyphus Rugosa*, Apple of sodem (*Calotropis procera*), bair (*Ziziphus nummularia*), *Dentella repens*, *mimosa pudica*, *Sida cordiflia, Xanthium indicum, cryptolepis sinensis, Ficus clavata, Ixora acuminata, Laportea crenulata, Litsea lancifolia, Mimosa himalayana, Solanum khasianum, Canscora andrographiodes, Commelina obliqua, Cymbidium flexus, Eupatorium wallichii , Hedyotis costata, Polygonum serrulatum , Sarcopyramis nepalensis, Arundo Donax, Phragmites Karka* etc. Due to extensive growth, hardy and widely distributed, Lantana camara is posing threat to Tea Estate[37].

[37] Weeds of tea field and their control. - https://www.researchgate.net/publication/273145437

217. 23 climber's species have been reported long the trench and buffer zone are *Stephania harnondifolia* (Tubuki lata), *Zanthoxylum hamiltonianum* (Tej-muri), *Cuscuta reflexa* (Akashi Lata), *Illegeriakhasiana* (Kerkeri lata), *Dioscorea hamilttoni* (Bonoria alu), *Smilax macrophylla* (Tikoni boral), *Calamus erectus* (Jati bet), *C. gracilis* (Wahing bet), *C. latifolius* (Motha bet), *Enanthemum album*. *Ficus villosa, Gnetum scandens, Mikania micrantha, Piper attenuatum, Polygonum chinense, Stemona tuberosa, Tetrastigma planicaulata, Vitis capriolata, Pothos cathcartii*, etc.

218. 20 grasses species reported along the trenches are Ipomoea carnea (*Behaya*), Parthenium hysterophorus (*Congress grass*), *Cynodon dactylon, Eriachne aristidea, Aristida purpurea, Saccharum spontaneum, Saccharum ravennae, Tripidium bengalense, Bambusa balcooa, Bambusa cacharensis, Bambusa polymorpha, Arundinella bengalensis (Spreng.), Bambusa cacharensis) Cyrtococcum patens var. latifolium Isachne, Melocalamus indicus Panicum khasianum Munro, Aristida fusca , Isachne albeus, Panicum brevifolium*, etc.

219. The presence of these climber, shrubs, herbs and grasses has been conformed from data available with forest department[38].

220. Species of trees reported in the buffer zone i.e one km radius excluding the core zone (25 to 30meters work) are mostly planted and few naturally growing. About 52 species of trees species are reported from the buffer zone. These trees are reported in the orchids, on agriculture furrow, bunds, banks of river, scrub land and tea gardens etc. Line transect and walk through methods were adopted to carry out floral survey in study area. The common trees reported are classified as fruit bearing, timber tress and shade trees. The species of trees were Banyan trees (*Ficus benghalensis*), siris (*Albizia lebbeck*), Semal (*Bombax ceiba*), Teak (*Tectona grandis*), Sal (*Shorea robusta*), Jack fruit (*Artocarpus heterophyllus*), Sissu (*Dalbergia sissoo*), Betel nut *(Areca catechu*), Sum (*Sterculia urens*), Date (*Phonix sylvestris*), Banana (*Musa sp.),* Mango (Mangifera indica), Coconut (*Cocos nucifera*), Peepal (*Ficus religiosa*), Cluster Fig (*Ficus glomerata*), Kadamb (*Anthocephalus cadamba*), Arjun (*terminalia arjuna*), Guava (*Psidium guajava*), Gulmohar (*Delonix regia*), drum stick (*Moringa oleifera*), *Alstonia scholaris, Spondias Mangifera, Bauhania purpurea, Cassia fistula, Erythrina variegate, Bambusa balcooa, Bambusa tulda, Malocanna hamiltonii, Dendrocalamus giganteus, Plectomia bractealis, Terminalia chebula, Cassia sophera, Artocarpus chaplasha, Dendrocalamus hamiltonii, Syzygium oblatum, Cassia sophera, Ficus fistulosa, Albizzia procera, Artocarpus chaplasha, Castanopsis indica, Ficus clavate, ajar* (*Lagerstroemia speciosa*), *Litsea citrate, Maesa indica, Ficus fistulosa, Mangifera indica, Melia azedarach, Azadirachta indica*, etc. The species of trees reported in project are common type, planted all over the districted.

221. Among species recorded, Teak (*Tectona grandis*) which are not naturally, but planted by the locals as timber trees are Reported as Endangered (EN) by IUCN Red Data Book category. Based on IBAT report, species of trees which may be located in the study area (Buffer zone) specially in Tinsukia sites (Ecologically Appropriate Area of Analysis), were *Magnolia rabaniana, Magnolia gustavii, Philautus microdiscus, Nardostachys jatamansi, Magnolia pealiana.* These species were categorised as Critically Rare except Magnolia pealiana which is categorized as Endangered under IUCN Red Data Book. These species were not reported during survey but may be present in Dibru - Saikhowa National Park Core area and Eco- Sensitive Zone. The EZA and National Park Boundary is within 1 km radius for project located in Tinsukia. Hence these species are ecological importance and needs conservations.

222. The Project site within study area were dominated by Tea Estate. During primary survey within tea estate 15 species of trees reported planted at sparce. The species of trees reported were *Albizzia odoratissima, Albizzia stipulate, Albizzia procera, Albizzia moluccana and Albizzia chinensis. Albezzia lebbeck, Dalbergia sericea, Dalbergia assamica, Derris robusta, indigofera*

[38] Working Plan for Dibrugarh Forest Division for 2021-22 to 2031-32.

teysmani, Glyricidia sepium, Leucaena glauca, Erythrina subumbrans and *Erythrina lithosperma,* etc. Some of these trees has already reported in past research work carried out on tea gardens[39].

223. The project entails cutting of trees in subproject area due to construction of new embankment and some anti-erosion works and other project activities. The number of trees to be felled is yet to be determined as of the time of prepareation of the IEE. The number will be finalized at the pre-construction stage. Information on the number of trees to be cut will be indicated in the environmental monitoring report.

224. **Canopy Cover (Core Zone)** Quadrant analysis was adopted to record the species and their distribution in impact zone. Based on Quadrant Analysis Methods, the dominant Trees reported within the protection work (25 to 30 meters) and within embankment zone were *Semal (Bombax ceiba), Ficus Hispida, Alstonia scholaris, Teak (Tectona grandis), ficus oppositifolia, Mimosops elengii, Jack fruit (Artocarpus heterophyllus), Azadirachta indica, Betel nut (Areca catechu), Terminalia belerica, Date (Phonix sylvestris), Banana (Musa sp.), Coconut (Cocos nucifera), Terminalia chebula, Syzygium macrocarpa, Terminalia chebula, Peepal (Ficus religiosa), Emblica officinalis , Cluster Fig (Ficus glomerata), Morinda aungustifolia, Ficus fistulosa, Kadamb (Anthocephalus cadamba), Arjun (terminalia arjuna), Syzygium fruiticosa , Bambusa balcooa, Bambusa tulda, Malocanna hamiltonii, Dendrocalamus giganteus, Plectomia assamica, Plectomia bractealis, Cassia sophera, Albizzia procera, Artocarpus chaplasha, Castanopsis indica, Ficus clavate, F. fistulosa, Syzygium oblatum* etc.

225. The population density per meter sq. is highest for species like banana which is 0.036/m^2 followed by betel nut which is 0.02/m^2.

226. Among species recorded, Teak *(Tectona grandis)* which are not naturally, but planted by the locals as timber trees are Reported as Endangered *(EN)* by IUCN Red Data Book category.

227. **Ground Cover** The ground cover flora within the core area are shrubs, herbs and grasses. About 17 species of shrubs are reported within the impact zone. The dominant species of shrubs reported are lantana *(Lantana camara), Jhar Bair (Ziziphus nummularis), caster (Ricinus communis), Calotropis procera), Calotropis gigantea, Pennisetum purpuream, Datura (Datura metel), Datura innoxia, tea (Camellia sinensis), Solanum torvum, Solanum indicum, Ardisia depressa. Saprosma ternatum, Casearia veraca, Citrus aurantium, Laportea crenulate, Solanum khasianum, Zizyphus Rugosa etc.*

228. *20 species of herbs reported within the core zone are Dentella repens, Eclipta prostat, Mimosa pudica, Bar manmuni, Sida cordiflora, Solanum tornum, Xanthium indicum, Ranunculus cantoniensis, Beria ammanniodes, Hypericum japonicum, hydrocera trifloral, Aeschynomere aspera, Aeschynomere india, Ludwigia prostrata, Dichrocephala integrifolia Enhydra fluctuans, Ageratum conyzoides, Alpinia purpurata, Amaranthus viridis, Colocasia affinis,* etc

229. 12 species of grasses reported covering the ground are mainly weeds, they are *Parthenium hysterophorus, Cyperus cephalotes, Cyprus difformis, Cyprus diffuses, Cyprus haspana, Brachiaria mutica, Echinochloa stagnina, Eragrostia atrovirens, Paspalum scropiclatum, Phragmites karkar, Saeciolepis interrupta, Aristida fusca, Munj asp.,etc.*

230. 7 tall grasses reported within the core zone in fragmented cluster form, covering the ground were *Bambusa balcooa, Bambusa tulda, Malocanna bacciferra, Dendrocalamus hamiltonii, Dendrocalamus giganteus, Plectomia assamica and Plectomia bractealis* etc.

231. **Invasive Plant Species** The non-native species (Invasive species) reported form the study area are *Parthenium hysterophorus, Mimosa, Mikania, Eupatorium spp, lantana (Lantana camara), Mimosa invisa, Mikania micrantha, Chromolaena odorata, Ludwigia peruviana Ipomoea carnea, Calotropis gigantea, Calotropis procera, Datura metel, Alpinia. Nigra, Imperata cylindrica,*

[39] http://ecoursesonline.iasri.res.in/mod/page/view.php?id=14128

Dysophylla auriculariaetc. The dominant species reported is *Lantana and congress grass.* They are cosmopolitan in distribution. These speceis are reported in core zone in scrub land, orchids in the study area. In the marshy area and water ponds dominant invasive hydrophytes reported are *Eichhornia crassipes, Echinochloa colona, Saccharum*. *Spontaneum, Echinochloa cruspavonis, Ipomoea carnea, Pistia stratiotes, Salvinia molesta, Lemna minor*, etc are infesting all the water bodies. These are dominant speceis reported in all water bodies in project area. All the above species reported have congregator nature of growth. Cover whole of the surface in patched. These are dominant species reported in all water bodies in project area.

Figure 5-34: Photographs of Some Floral Species in the subproject area

Amaranthus spinosa

Colocasia esculenta

Datura metel

Ricinus communis

Ipomoea carnea along with *Xanthium strumarium*

Mikania micrantha

Eichhornea crassipes (Water Hyacinth)

Grangea maderaspatana

Lucas aspera

Saccharum sponteneum

Source: ADB TA Consultant

232. **Aquatic Flora.** Brahmaputra River is famous for its riparian habitat which keeps on changing due to high current in watter and annual flooding during monsoon. There exists no well-established riparian habitat. This is due to large portion of the bank are cut annually. During primary survey, the locals fears that the existing portion where we are doing survey may not exists due to cutting and erosions of banks. Walk through and transect methods were adopted to record the hydrophytes reported within the core zone. The sandbars formed in the Brahmaputra bank were also surveyed to study the establishment of grass land and for herbaceous habitats. The species reported during survey were elephant grass (*Pennisetum purpureum), Phragmites karkar, Ipometa aquatica, Ipomea carnea, Eichhornia crassipes, Sagittaria sagittifolia, Colocasia alocasia,* etc.

233. **Sandbars and Sandy Riverbeds vegetative Cover** The floristic survey on the sandbars within Brahmaputra Riverbank has not been carried out due to monsoon spell as at most. Of the sites visisted, no sandbards or char land was notice, except at Milanpur to. Hatiguli (27.761020°; 95.559537°). Sandbar at Milanpur to Hatighuli is located within the ESA of Dibru-Saikhowa National Park. Entry restriction under Wildlife (Protection), Act 1972. Hence survey limited to 100 meters from riverbank. During survey grasses like *Parthenium hysterophorus (Congress grass), Cynodon dactylon, Eriachne aristidea, Aristida purpurea, indicus Panicum, khasianum Munro, Aristida fusca Isachne albeus, Panicum brevifolium,* etc. were noticed in scatter form.

9. Terrestrial and Aquatic Fauna

234. **Butterflies** Assam has rich floral diversity. This result in large varieties of butterflies. Large number of butterflies were reported during primary survey within the core zone and from buffer zone. Spot methods, walk through and transect methods were adopted to record the butterflies in study. About 22 species off butterflies were reported. Eleven species of bufferflies are reported from core zone and 18 species are reported in buffer zone. The most commonly reported bufferfly area small grass yellow, common grass yellow and lemon pansy. Table below gives the list of butterflies reported in study area.

Table 5-27: List of Butterflies Reported During Primary Survey in the subproject area.

Sl. No.	Common Name	Scientific Name	IUCN Red Data Book	IWPA -1972
1	Burara jaina	*Orange Awlet*	NA	-
2	Lime blue	*Chilades lajus*	LC	-
3	Bush Hopper	*Ampittia discorides*	NA	-
4	Lesseer glass blue	*Chilades lajus*	LC	-
5	Common Palm Dart	*Telicota colon*		-
6	Lemon pansy	*Junonia lemonias*	LC	-
7	Grey pansy	*Junonia lemonias*	LC	-
8	Common grass yellow	*Eurema hecabe*	LC	
9	Common Mormon	*Papilio polytesromulus*	DD	-
10	Lime Swallowtail	*Papilio demoleus*	DD	-
11	Common Brush Brown	*Mycaless perseus*	LC	Schedule I
12	Common tiger	*Danaus genutia*		Schedule I
13	Plain tiger	*Danaus chrysippus*	LC	Schedule I
14	Peacock Pansy	*Junonia almana*		Schedule I
15	Common sergeant	*Athyma perius*	LC	-
16	Lime butterfly	*Papilio demoleus*	DD	-
17	Indian cabbage white	*Pieris canidia*	DD	Schedule I
18	Small grass yellow	*Eurema brigitta*	LC	-
19	Common Albatross	*Appias albina darada*	LC	-
20	Lesser gull	*Cepora nadina*	DD	-
21	Indian Cabbage White	*Pieris canidia canidia*	LC	-
22	Common grass yellow	*Eurema hecabe*	LC	-

Source: LASA Biodiversity Assessment and Ecology Survey Report, 2023

235. **Amphibians** The species of amphibian reported form the study area are *Duttaphrynus melanostictus, Polypedates teraiensis, Philautu ssp., Hoplobatrachus tigerinus, Euphlyctis cyanophlyctis, Hylarana nigrovittata,* etc. None of the Amphibian species reported falls under IUCN RET list.

236. **Reptilan Species** Five species of Reptiles are reported from the buffer zone. They are common Indian skink, house gecko, garden lizard, rat snake and cobra.

237. Based on IBAT report for Ecologically Appropriate Area of Analysis i.e both fresh water and Terrestrial habitat exists. It can be assumed that species like Black Softshell Turtle (*Nilssonia nigricans*) - CR, Assam Roofed Turtle (*Pangshura sylhetensis)* - CR, Spotted Pond Turtle - EN, Indian Softshell Turtle (*Nilssonia gangetica*) – EN and King Cobra – VU Category of IUCN Red Data Book.

238. **Fishes** About 14 species reported from the study area in Brahmaputra River are *Labeo gonius, Bagarius bagarius, Cirrhinus mrigala, Cirrhinus reba, Labeo bata, Labeo calbasu, Labeo*

rohita, Mystus. tengra, Channa marulius, Channa. punctata, Rita rita, etc, Species of fishes reported based on secondary source were *Mystus bleeker, Wallago attu, Channa bleeheri.* These are sold in local markets. Fish like *Wallago attu* and *Bagarius bagarius* has been listed under Vulnerable Category of IUCN Red Data Book.

239. Based on IBAT report and interpretation of Ecologically Appropriate Area of Analysis by LASA, it can be expected that in addition to above mention fish, other species which may be present in study area are *Devario horai (EN), Lepidocephalichthys arunachalensis (VU), Amblyceps arunchalensis (VU), Aborichthys tikaderi (VU), Pseudecheneis sirenica (VU)* in Brahamaputra River. These fished are listed under IUCN Red Data List. However, no presence of these species was reported during the study conducted by LASA

240. **Avifauna** Assam is one of the "endemic bird areas" in the world. Based on primary survey and secondary findings, 61 species of birds are reported. Five vulnerable (VU) species i.e *Ciconia episcopus, Ortygornis gularis, Halcyon smyrnensis and Ceryle rudis, Streptopelia turtur* are noted. One Near Threatened (NT) i.*e Ephippiorhynchus asiaticus* and remaining 54 species of birds are listed under Least Concern (LC) as per IUCN Red Data Book List publishes in 2022.

241. Two species i.e Woolly Necked stork and Black necked Stork is listed under Schedule -I and one bird like common Myna is listed under Schedule -V. The remaining 56 species of birds are listed under schedule -IV of the Wildlife (Protection), Act -1972.

242. Based on Habitat distribution about 15 bird species are reported from marshy area. These birds are *Ephippiorhynchus asiaticus, Chrysocolaptes lucidus, Anastomus oscitans, Bubulcus ibis. Alcedo atthis, Ardeola grayii, Halcyon smyrnensis, Ceryle rudis, Merops orientalis, Plegadis falcinellus, Amaurornis phoenicurus, Porphyrio porphyrio, Gallinula chloropus, Actitis hypoleucos and Tringa nebularia.* The remaining birds are terrestrial and are reported from settlements, Orchids and agricultural, scrub land and grass land.

Table 5-28: List of Avifauna Reported in subproject area.

Sl. No.	Common Name	Scientific Name	Reported	IUCN Red list	WPA-72
1	Black headed munia	*Lonchura malacca*	Secondary source	LC	-
2	White Wagtail	*Motacilla alba*	Sighted	LC	Sch -IV
3	Jungle babbler	*Turdoides striata*	Sighted	LC	Sch-IV
4	Red Jungle flow	*Gallus gallus*	Sighted	LC	Sch- IV
5	Ruddy shelduck	*Tadorna ferruginea*	Sighted	LC	Sch-IV
6	Woolly Necked stork	*Ciconia episcopus*	Sighted	VU	Sch-I
7	Black necked Stork	*Ephippiorhynchus asiaticus*	Secondary Source	NT	Sch-I
8	Woodpecker	*Chrysocolaptes lucidus*	Sighted	LC	Sch-IV
9	Swamp francolin	*Ortygornis gularis*	Secondary Source	VU	-
10	Blue Throated Barbet	*Megalaima asiatica*	Sighted	LC	Sch-IV
11	Common Hoopoe	*Upupa epops*	Sighted	LC	Sch-IV
12	Asian openbill	*Anastomus oscitans*	Sighted	LC	Sch-IV
13	Cattle Egret	*Bubulcus ibis*	Sighted	LC	Sch-IV
14	India roller	*Coracus benghalensis*	Sighted	LC	Sch-IV
15	Common Kingfisher	*Alcedo atthis*	Sighted	LC	Sch-IV

Sl. No.	Common Name	Scientific Name	Reported	IUCN Red list	WPA-72
16	Pond Heron	*Ardeola grayii*	Noise	LC	Sch-IV
17	White Throated King fisher	*Halcyon smyrnensis*	Noise	VU	Sch-IV
18	Pied Kingfisher	*Ceryle rudis*	Sighted	VU	Sch-IV
19	Green bee eater	*Merops orientalis*	Sighted	LC	Sch-IV
20	Pied cuckoo	*Clamator jacobinus*	Sighted	LC	Sch-IV
21	Indian cuckoo	*Cuculus Micropterus*	Sighted	LC	Sch-IV
22	Glossy ibis	*Plegadis falcinellus*	Sighted	LC	Sch-IV
23	Asian koel	*Eudynanmys scolopacea*	Sighted	NA	Sch-IV
24	Rose Ringed parakeet	*Psittacula krameria*	Sighted	LC	Sch-IV
25	Asian Palm Swift	*Cypsiurus balasiensis*	Sighted	LC	Sch-IV
26	House swift	*Apus nipalensis*	Sighted	LC	Sch-IV
27	Spotted owlets	*Athene brama*	Sighted	LC	Sch-IV
28	Laughing Dove	*Spilopelia senegalensis*	Sighted	LC	Sch-IV
29	Spotted dove	*Spilopelia chinensis*	Sighted	LC	Sch-IV
30	Oriental turtle dove	*Streptopelia orientalis*	Sighted	LC	Sch-IV
31	Eurasian collared dove	*Streptopelia decaocto*	Sighted	LC	Sch-IV
32	White breasted waterhen	*Amaurornis phoenicurus*	Sighted	LC	Sch-IV
33	Purple swamphen	*Porphyrio porphyrio*	Sighted	LC	Sch-IV
34	Common moorhen	*Gallinula chloropus*	Sighted	LC	Sch-IV
35	Common sandpiper	*Actitis hypoleucos*	Noise	LC	Sch-IV
36	Red wattled lapwing	*Vanellus indicus*	Sighted	LC	Sch-IV
37	Common greenshank	*Tringa nebularia*	Noise	LC	Sch-IV
38	Pariah kite	*Milvus migrans*	Noise	LC	Sch-Iv
39	Darter	*Anhinga melanogaster*	Sighted	LC	Sch-IV
40	Little cormorant	*Microcarbo niger*	Sighted	LC	Sch-IV
41	Indian cormorant	*Phalacrocorax fuscicollis*	Sighted	LC	Sch-IV
42	Great egret	*Ardea alba*	Sighted	LC	Sch-IV
43	Indian pond heron	*Ardeola grayii*	Sighted	LC	Sch-IV
44	Long tailed shrike	*Lanius schach*	Sighted	LC	Sch-IV
45	House crow	*Corvus splendens*	Sighted	LC	Sch-IV
46	Jungle crow	*Corvus culminatus*	Sighted	LC	Sch-IV
47	Black drongo	*Dicrurus macrocercus*	Sighted	LC	Sch-IV
48	Common woodshrike	*Tephrodornis pondicerianus*	Sighted	LC	Sch-IV
49	Oriental magpie robin	*Copsychus saularis*	Sighted	LC	Sch-IV
50	Brahminy starling	*Sturnia pagodarum*	Sighted	LC	Sch-IV
51	Indian pied Myna	*Gracupica contra*	Sighted	LC	Sch-IV
52	Common Myna	*Acridotheres tristis*	Sighted	LC	Sch-V

Sl. No.	Common Name	Scientific Name	Reported	IUCN Red list	WPA-72
53	Red whiskered bulbul	*Pycnonotus jocosus*	Sighted	LC	Sch-IV
54	Red vented bulbul	*Pycnonotus cafer*	Sighted	LC	Sch-IV
55	Grey breasted prinia	*Prinia hodgsonii*	Sighted	LC	Sch-IV
56	Plain prinia	*Prinia inornata*	Sighted	LC	Sch-IV
57	Reed warbler	*Acrocephalus scirpaceus*	Sighted	LC	Sch-IV
58	Striated babbler	*Turdoides earlei*	Sighted	LC	Sch-IV
59	House sparrow	*Passer domesticus*	Sighted	LC	Sch-IV
60	Common Iora	*Aegithina tiphia*	Sighted	LC	
61	European Turtle-dove	*Streptopelia turtur*	Sighted	VU	-

LC – Least Concern; VU – vulnerable, NT- Near Threatened; WPA – Wildlife (Protection), Act – 1972

Source: LASA Biodiversity Assessment and Ecology Survey Report, 2023

243. IBAT Proximity Report interpretation for subproject area and Assessment for Ecologically Appropriate Area of Analysis for distribution of Avifauna, it can be concluded that floral profile within 1 km radius can be suitable habitat for presence of Manipur Brush Quail (Perdicula manipurensis) Great Adjacents (Leptoptilos dubius), Awamp grass babbler (Laticilla cinerascens), Common Pochard (Aythya farina) – VU and Lesser Adjutant (Leptoptilos javanicus). All listed under Vulnerable Category as per IUCN red data book. These species may be present in study area but were not reported during primary survey.

244. **Terrestrial Mammals**. The project sites within 1 km study area have PAs. Based on interaction with forest officials and locals 11 species are reported in the study area. These include 2 EN and schedule I (Elephant and Tiger), 1 VU species (Sambar). The others are other LC, NT or DD species as per IUCN Red Data Book and includes Jungle cat (Felis chaus), Wild pig (Sus scrofa), Rhesus macaque (Macaca mulatta) etc.

245. **Aquatic Mammals** Brahmaputra River is famous for aquatic mammalian species i.e freshwater dolphins (*Platanista gangetica*). It is reported all over Brahmaputra River were depth of water and counter current for fish hunting exist. Dolphins fall under Schedule -I as per IWPA-1972. It is categorized as Endangered (EN) as per IUCN Red Data Book.

246. Based on IBAT report – Proximity Report, *Ganges River Dolphin (Platanista gangetica)* has been reported within 1 km radius. The subproject area is Ecologically Appropriate Area of Analysis for presence of Ganges River Dolphi*n (Platanista gangetica).*

247. The survey was conducted between 2nd April 2023 to 4th April 2023 in Dibrugarh subproject area and on 31st March 2023 to 1st April 2023 in Tinsukia subproject area from morning 9.15 AM to 6.35 PM. For the survey, a combination of point survey method (standing at one fixed location for an hour) and walk through survey methods along the river course in the subproject locations, to record Dolphins were adopted. The survey was conducted during lean period and depth of water near project sites were less. No Dolphins were sighted during the primary survey.

248. Distribution of Dolphins in project area is highlighted in Table 5-29. The finding is mainly based on interactions with locals and fisherman.

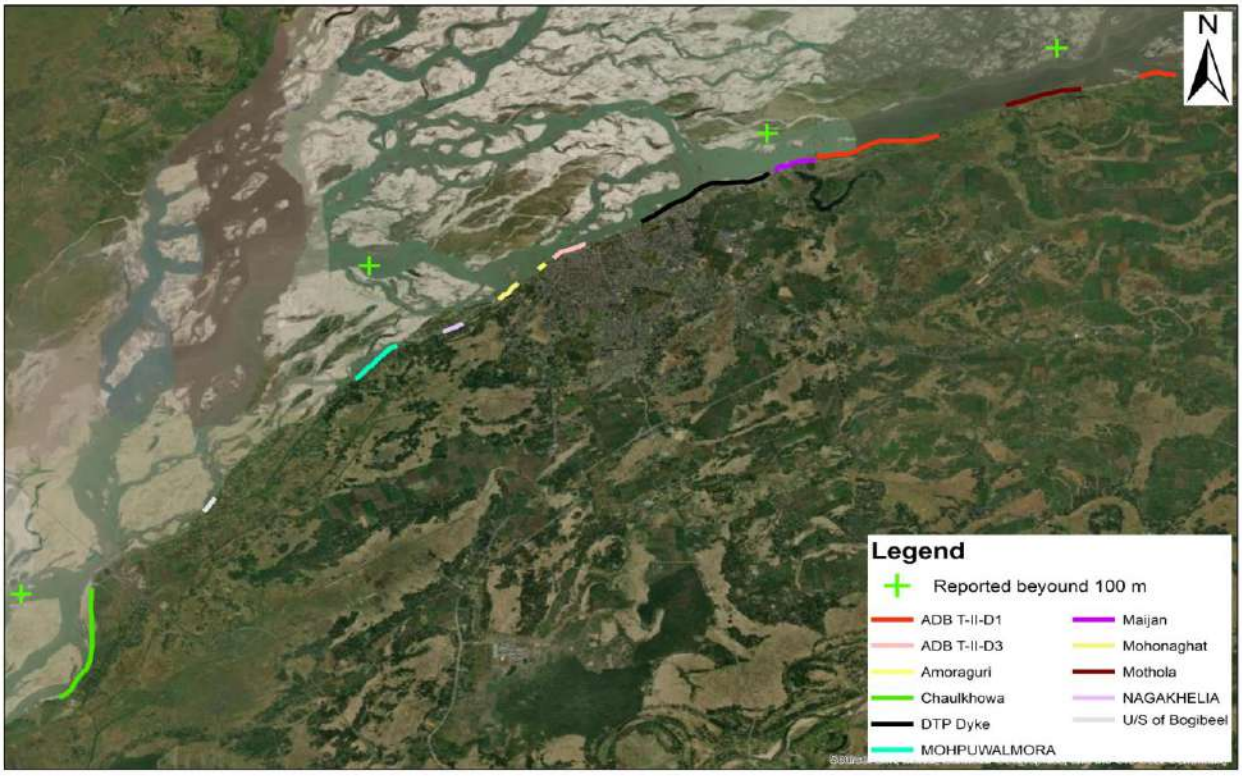
Table 5-29: Distribution of Dolphins in Study Area

Sl. No.	Project	LAC	Dolphins Distribution	
			Within 100m	Beyond 100m to 1 km
1	Chaulkhowa	Moran	-	+
2	Milanpur to Hatighuli	Doomdooma	-	+
3	Nagaglulit	lathowal	-	-
4	Maijan Reach. -2	lathowal	-	+
5	Nagakhelia	Dibrugarh	-	-
6	Baghjan to Notungaon	Chabua/Doomdooma	-	-
7	Simalugurisara	Doomdooma	+	+
8	Mohanaghat	Dibrugarh	-	-
9	Amoragurd	Dibrugarh	-	-
10	ADB T-I-Mothala	Lahowal	-	+
11	ADB T-II, D-3	Dibrugarh	-	-
12	Gariating gaon	Doomdooma	-	-

Symbol: - Not Reported; + Reported; ©Reported during monsoon

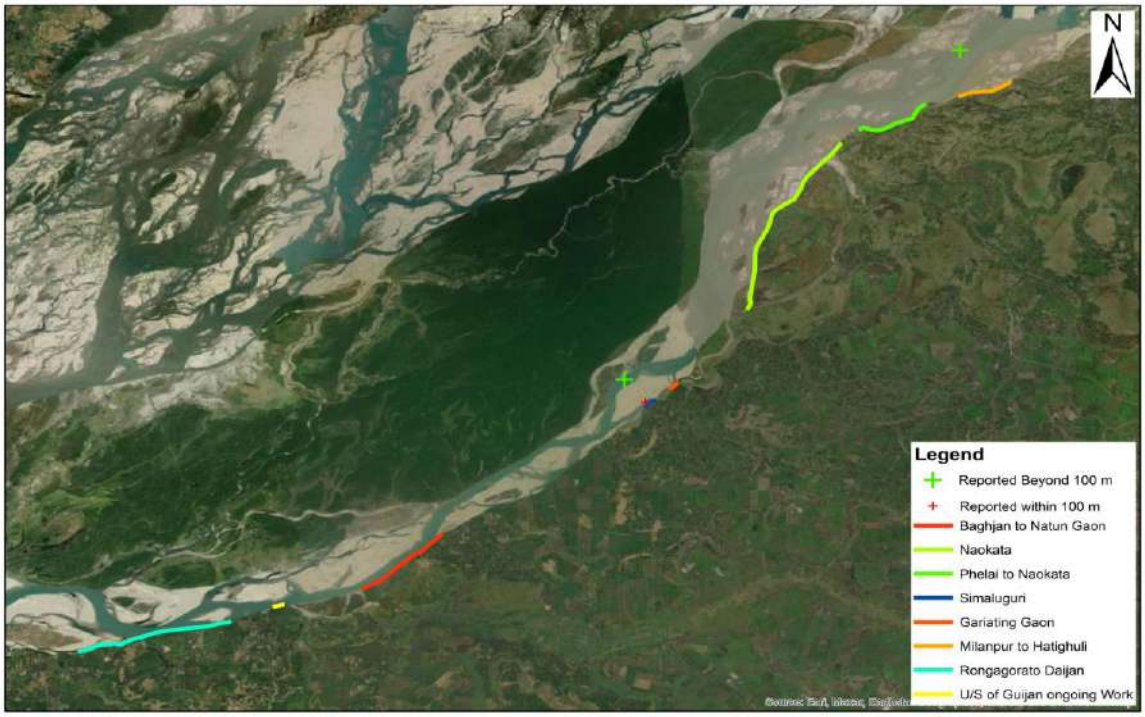
Source: LASA Biodiversity Assessment and Ecology Survey Report, 2023

Figure 5-35: Map depicting Dolphins Presence within study area (Dibrugarh)



Source: LASA July, 2023

Figure 5-36: Map depicting Dolphins Presence within study area (Tinsukia)



Source: LASA July, 2023

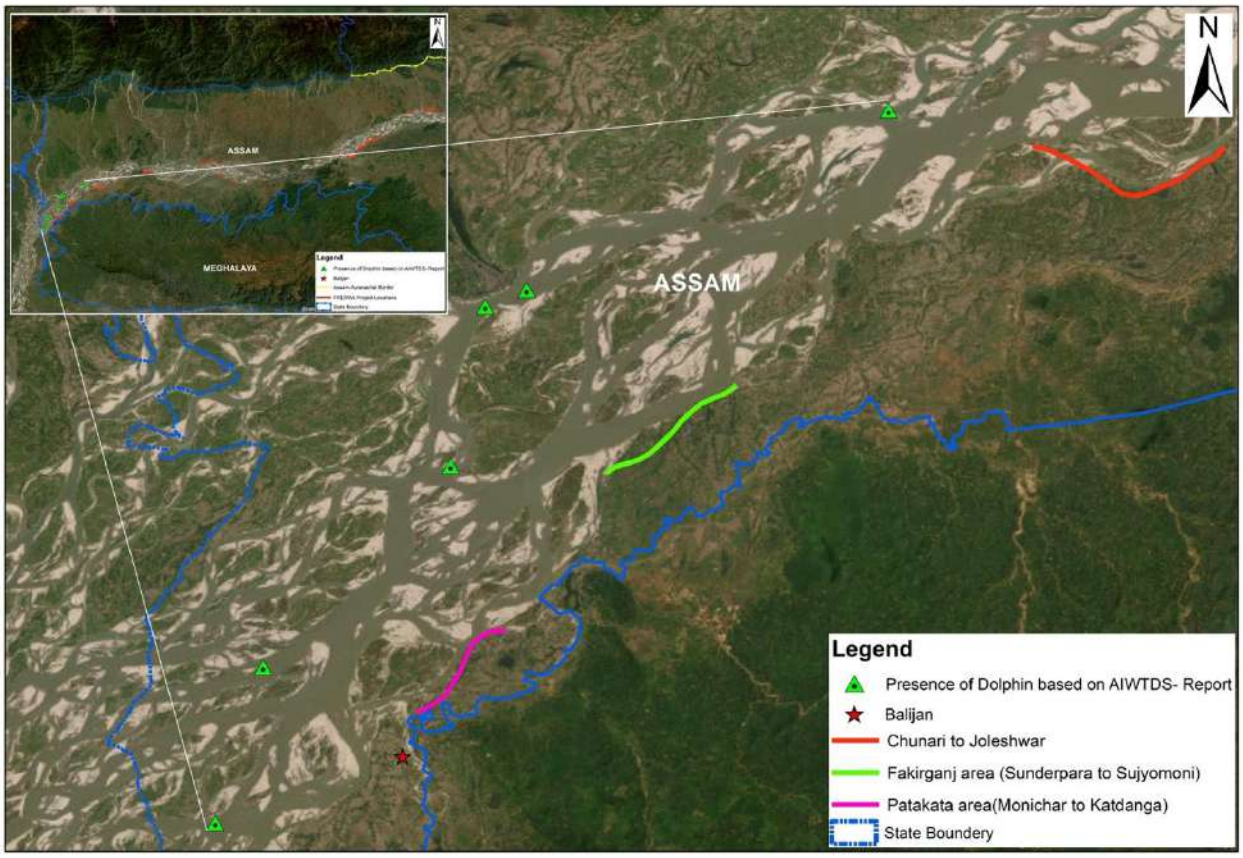
249. Based on a report prepared by Wakid, A. and Braulik, G. (2009) Under Sir Peter Scott Fund of IUCN, the Dolphin population around the subproject area is given in Table 5-30.

Table 5-30: Abundance of Dolphin in Brahmaputra mainstream in subproject area

Sl. No.	Distribution	Length (km)	Best estimate
1	Assam border to Balijan	136	25
	Total	**136**	**25**

Source: Wakid, A. and Braulik, G. (2009): Protection of endangered Gangetic dolphin in Brahmaputra River, Assam, India. Final report to IUCN-Sir Peter Scott Fund. Pp 44.

Figure 5-37: Map of subproject sites depicting presence of Dolphins.



Source: LASA, July 2023

10. Migratory Route of Fauna

250. Since some sections of the project area falls within the notified ESZ of Dibru - Saikhowa NP, there might be some mammalian wildlife migratory route in the subproject area. The Chief Wildlife Warden's office has partially shared the boundaries of the ESZ and PAs in the entire project areas of the 4 subproject areas. The ESZ and wildlife routes for Dibru Saikhowa NP is awaited from the Chief Wildlife Warden's office and once confirmed, the IEE shall be accordingly updated. The entire Assam falls under Central Asian Flyway and East Asian – Australian flyways. Thus, there are many migratory bird species that migrates through the project areas.

Figure 5-38: Asian Migratory Bird Flyways

Source: Wikipedia. https://en.wikipedia.org/wiki/East_Asian%E2%80%93Australasian_Flyway -/media/File:Central_Asian_Flyway_Map.pngCentral Asian Flyway Map - East Asian–Australasian Flyway - Wikipedia

251. The migratory fish species like Hilsa and Anguilla, which have been encountered show anadromous and catadromous migratory behavior, respectively, migrating through the main channel of the river to the deeper zones of the river[40]. Therefore, the proposed project interventions will not have adverse effects on the migratory route. Other fish species like *Crossocheilius* sp. and *Tor* sp. show only local migration from upper to lower reaches of the river.

River Dolphin and its Behavior Patterns

252. Gangetic river Dolphins[41] prefers deep waters, in and around the confluence of two or more rivers.[42] River dolphins are reported within 100m – 1 km in the subproject area as per the report of LASA. Thus, these species shall not be impacted as there are no confluences of rivers in the

[40] ADB. India: AIFRERMIP Project 2, IEE Report (Palasbari Subproject–- Palasbari and Gumi Reach, Kamrup District). May 2018

[41] The Gangetic Dolphin (*Platanista gangetica*), an extremely docile and graceful creature is an endemic species of the Ganges, Meghna, and Brahmaputra River systems in India, Nepal, and Bangladesh. Commonly known as 'Shihu' in Assam, the Gangetic Dolphins are among the four freshwater Dolphins found in the world - the others are Irrawaddy dolphin in the Irrawaddy, Mekong and Mahakam Rivers in Myanmar, Cambodia; and Indonesia respectively, the Bhulan of the Indus in India and Pakistan and Boto of the river Amazon (2 genus) in Latin America. The Baiji has been declared as functionally extinct. The presence of river dolphin in a river system signifies a healthy ecosystem. Since the river dolphin is at the apex of the aquatic food chain, its presence in adequate numbers symbolizes greater bio diversity in the river system. IUCN declared river dolphins as endangered in 1996, following which the Ganges River dolphin has been included in the Schedule - I of the Indian Wildlife Protection Act, 1972.

[42] Assam Inland Water Transport Project, Dolphin Study Report 2019

subproject area and the works are within 30m from the bank. These works furthermore shall be taken up in the dry season.

253. However, Gangetic River Dolphins have developed a unique side swimming behavior which is an adaptation to help them navigate through shallow waters,[43] thus, it may be likely that this species of dolphins can occasionally venture within 30m of the riverbanks. The impact would occur due to accidental hitting of the dolphins by the barges carrying materials for the subproject and by being stuck in the shallow waters. However, the Dolphins have capacity of echolocation as validated by Herald, E. S., et al and hence the probability of the dolphins getting accidentally hit by the barges is unlikely. Similarly, the probability of dolphins getting stuck in the shallow water near the banks is also less.

11. IBAT Screening Assessment

254. **Dibrugarh** As per information made available from IBAT[44], there are 99 IUCN red listed species within 50 km radius of the subproject areas in Dibrugarh District. These includes 17 CR (3 floral, 1 amphibian, 8 avian, 4 reptilian and 1 mammalian species), 30 EN (2 floral, 8 reptilian, 2 Pisces, 9 avian and 9 mammalian species) and 52 VU species (5 floral, 1 arthropodan, 1 amphibian, 5 reptilian, 7 fishes, 19 avian and 14 mammalian species).

255. **Tinsukia** As per information made available from IBAT[45], there are 105 IUCN red listed species within 50 km radius of the subproject areas in Tinsukia District. These includes 21 CR (7 floral, 1 amphibian, 8 avian, 3 reptilian and 2 mammalian species), 35 EN (3 floral, 7 reptilian, 4 Pisces, 9 avian and 12 mammalian species) and 49 VU species (5 floral, 1 amphibian, 4 reptilian, 6 Pisces, 18 avian and 15 mammalian species).

Table 5-31: Summary of Endangered Species Report in Study Area from IBAT Report

Sl. No	Common Name	Scientific Name	IUCN Status	Reported Area	Habitat	Location
1	Ganges River Dolphin	*Platanista gangetica*	EN	Inner Buffer & Buffer Area	Aquatic	Dibrugarh & Tinsukia
2	-	*Devario horai*	EN	Buffer Area	Aquatic	Dibrugarh & Tinsukia
3	-	*Amblycepsarunchalensis*	EN	Inner Buffer & Buffer Zone	Aquatic	Dibrugarh & Tinsukia
4	-	*Aborichthystikaderi*	VU	Inner Buffer & Buffer	Aquatic	Dibrugarh & Tinsukia
5	-	*Pseudecheneissirenica*	VU	Inner Buffer & Buffer	Aquatic	Dibrugarh & Tinsukia
6	Boal	*Wallago attu*	VU	Inner Buffer & Buffer	Aquatic	Dibrugarh & Tinsukia
7	Devil Catfish	*Bagarius bagarius*	VU	Inner Buffer & Buffer	Aquatic	Dibrugarh
8	Assam Roofed Turtle	*Pangshurasylhetensis*	CR	Buffer	Aquatic	Tinsukia

[43] Herald, E. S., Brownell, J. R. L., Frye, F. L., Morris, E. J., Evans, W., E., & Scott, A. B. (1969). Blind river Dolphin: first side-swimming cetacean. Science, 166, 1408-1410.

[44] IBAT Proximity Report. Generated under license 5840-42026 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

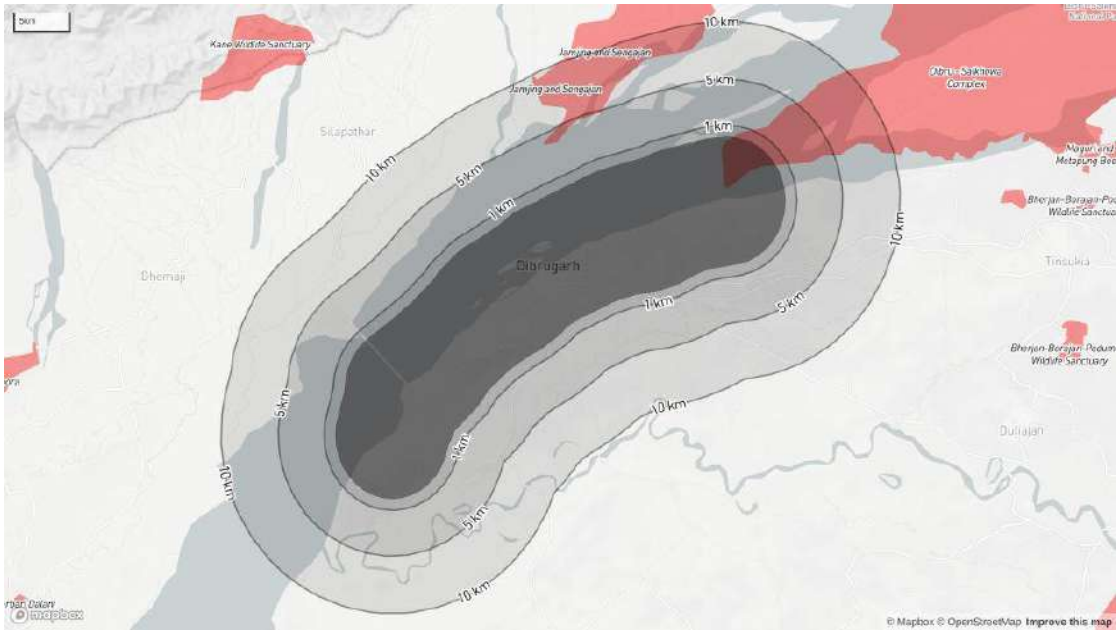
[45] IBAT Proximity Report. Generated under license 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

Sl. No	Common Name	Scientific Name	IUCN Status	Reported Area	Habitat	Location
9	Spotted Pond Turtle	*Geoclemys hamiltonii*	EN	Buffer	Terrestrial Aquatic	Dibrugarh & Tinsukia
10	Indian Softshell Turtle	*Nilssoniagangetica*	EN	Inner Buffer & Buffer	Terrestrial Aquatic	Dibrugarh & Tinsukia
11	King Cobra	*Ophiophagus hannah*	VU	Buffer	Terrestrial	Dibrugarh & Tinsukia
12	Masked Finfoot	*Heliopaispersonatus*	CR	Buffer	Terrestrial Aquatic	Tinsukia
13	Baer's Pochard	*Aythya baer*	CR	Buffer	Freshwater	Tinsukia
14	Slender billed Vulture.	*Gyps tenuirostris*	CR	Buffer	Terrestrial	Tinsukia Dibrugarh
15	Red-headed Vulture	*Sarcogyps calvus*	CR	Buffer Area	Terrestrial	Tinsukia
16	White Rumped Vulture	*Gyps bengalensis*	CR	Buffer	Terrestrial	Tinsukia
17	Bengal Florican	*Houbaropsis bengalensis*	CR	Buffer	Terrestrial	Tinsukia
18	Yellow breasted Bunting	Emberizaaureola	CR	Buffer	Terrestrial Aquatic	Tinsukia
19	White-bellied Heron	*Ardea insignis*	CR	Buffer	Terrestrial Aquatic	Tinsukia Dibrugarh

Note: Buffer Zone / Area: Boundary of Right of Way of Project up to 1 km; Inner Buffer Zone / Area: Boundary of Right of Way of Project up to 500m; Outer Buffer Zone / Area: Area between 500m to 1 km

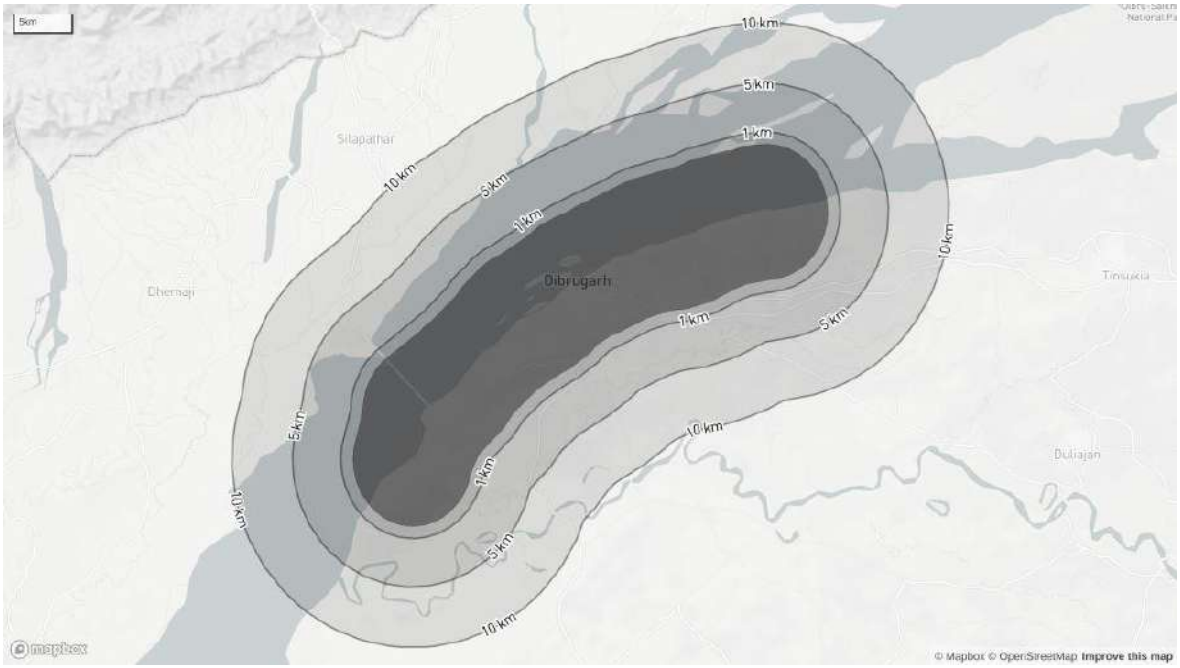
Source: LASA Biodiversity Assessment & Ecology Survey Report, 2023 & IBAT Proximity Report

Figure 5-39: IBAT Screening Map of KBAs in Dibrugarh District's Subproject Area



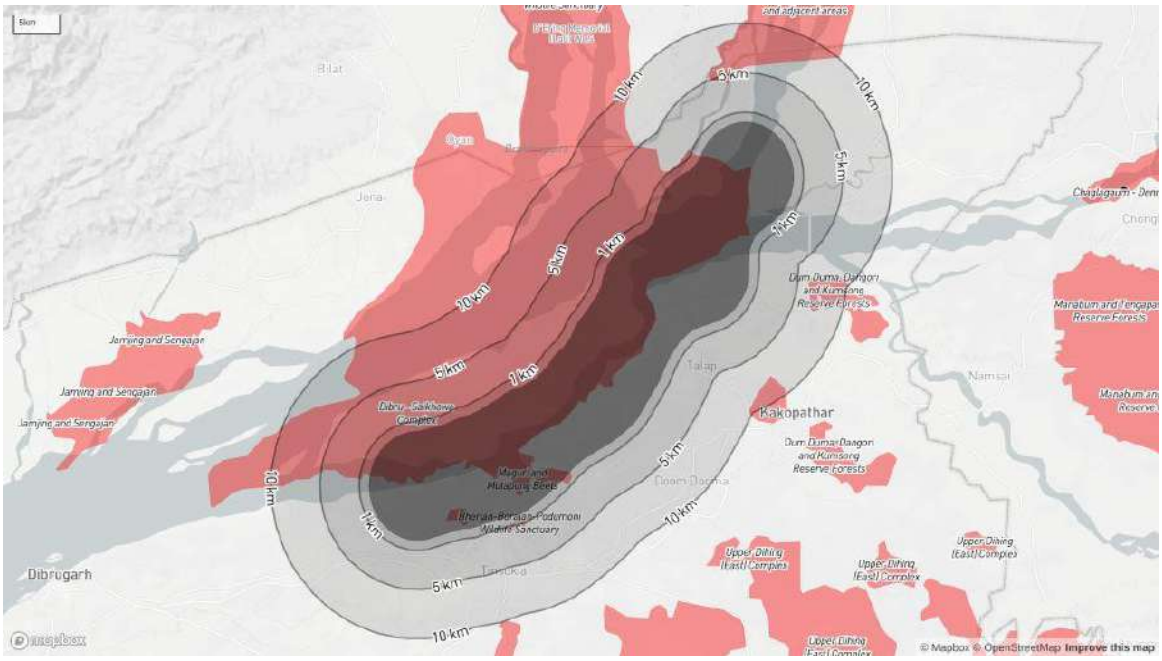
Source: IBAT Proximity Report. Generated under license 5840-42026 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

Figure 5-40: IBAT Screening Map of Protected Areas in Dibrugarh District's Subproject Area



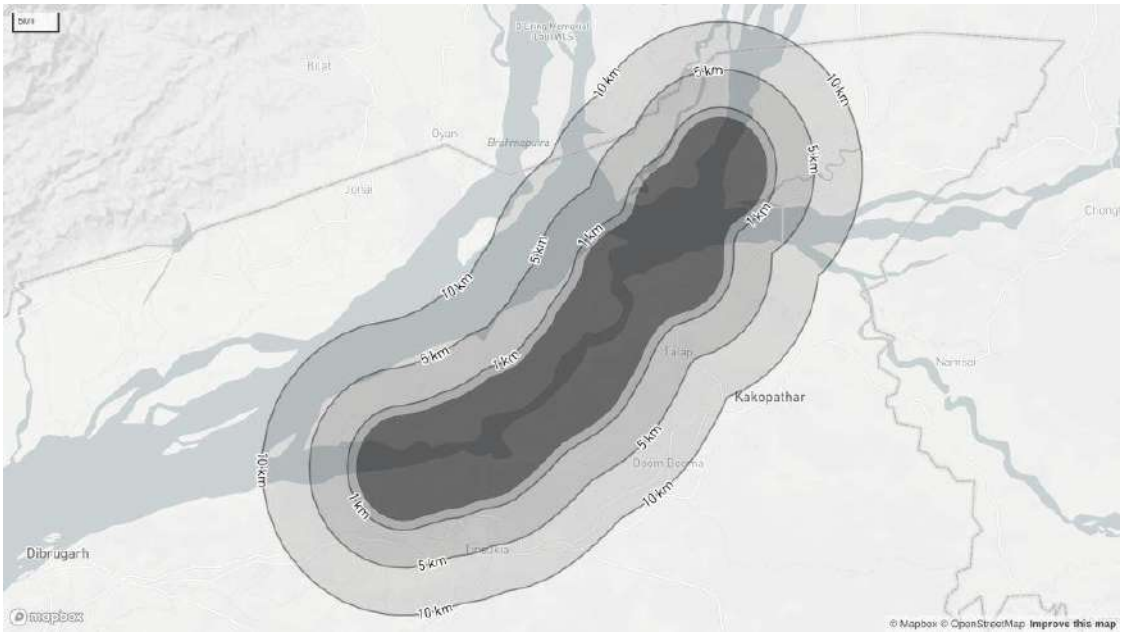
Source: IBAT Proximity Report. Generated under license 5840-42026 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

Figure 5-41: IBAT Screening Map of KBAs in Tinsukia District's Subproject Area



Source: IBAT Proximity Report. Generated under license 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

Figure 5-42: IBAT Screening Map of Protected Areas in Tinsukia District's Subproject Area



Source: IBAT Proximity Report. Generated under license 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

12. Critical Habitat (CH) Assessment

256. The area of analysis (i.e., 1 km) for critical habitat assessment has been taken up for all subprojects. In addition to the protected areas and IBA, considering International Finance Corporation (IFC) Performance Standard 6 thresholds, it is determined presence of Ganges River Dolphin (an IUCN endangered species) may trigger critical habitat. The primary surveys were carried out summer period (March – April 2023), and couldn't sight any Ganges River Dolphin in the subproject areas. The presence of this species was noted through secondary data sources (i.e. consultations with locals and fishermen). The secondary data doesn't conclusively establish the presence of ≥ 0.5% of the global population AND ≥ 5 reproductive units of the Dolphins in the subproject areas (Criteria 1a and 1c for critical habitat, IFC). The project is in a highly modified area, where anthropogenic activities are found around the riverbanks such as fishing, agriculture, tea gardens and settlements. There may be potential impact to Ganges River Dolphins due to transport of materials for the works through barges. However, construction works will be done during dry season when dolphins are in the deep channels and not nearby river banks. On the other hand, subproject is critical habitat due to fishing activities of local people - areas having biodiversity of significant social, economic, or cultural importance to local communities. The Dibrugarh subproject also triggers possible critical habitat due to proximity to Dibru-Saikhowa National park. ADB SPS, 2009 requires no net loss of biodiversity for a critical habitat area. The project will demonstrate measures on the lesser impacts to biodiversity through Nature-based solutions (NbS) such as bioengineering techniques of planting reeds along embankment slopes. A Biodiversity Action Plan (BAP) was prepared to provide actions in managing risks against wildlife in the area (see BAP in CH Assessment/Appendix 15). It is also proposed that PISC shall be conducting a detailed biodiversity and ecology survey and assessment for the entire project area (encompassing the four subproject areas) during the project implementation period. The data collected from the surveys will further bolster the population census data of the Ganges River Dolphin. The PISC and PMU shall subsequently include the results and any revisions of the BAP to update IEE and submitted to ADB for necessary actions for disclosure.

Table 5-32: Summary of Species Assessment to trigger Critical Habitat in Subproject Area

Sl. No.	Species	Assessment	Remarks
1	*Platanista gangetica* (Ganges River Dolphin) - EN	Possible to trigger CH, however no enough data to prove Criterion 1a (Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥0.5% of the global population AND ≥ 5 reproductive units GN16 of a CR or EN species) and 1c (areas containing important concentrations of a nationally or regionally listed EN or CR species)	Direct reporting by consultees within 100m - 1km from the project intervention areas and data from Assam Inland Water Transport Development Society

Source: ADB TA Consultant

Table 5-33: Summary of Critical Habitat Assessment

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Applicable Subproject
Areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species	a. Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units). b. Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a). c. As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species	(a) There are presence in the AOA. Possible critical habitat for 1 species (Ganges River Dolphin - EN). (b) No (c) No	(a) All subprojects (b) None (c) None
Areas having special significance for endemic or restricted-range species	Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.	No	None
Sites that are critical for the survival of migratory species Areas supporting globally significant	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at	(a) No sufficient data hence inconclusive	(a) None

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Applicable Subproject
concentrations or numbers of individuals of congregatory species	any point of the species' lifecycle. (b) Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.	(b) No sufficient data hence inconclusive	(b) None
Areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services		No	None
Areas having biodiversity of significant social, economic, or cultural importance to local communities		Yes, due to fishing activities for local people	All Subprojects
Areas either legally protected or officially proposed for protection.	Such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.	Possible critical habitat due to proximity to Dibru-Saikhowa National Park	Dibrugarh

CR = Critically Endangered, EN = Endangered, IUCN = International Union for Conservation of Nature, PAI = project area of influence, VU = vulnerable

Source: ADB TA Consultant

257. Out of the 7 CR, EN & VU floral species, none was found to trigger CHA at present, based on the report of LASA and other secondary sources. Critical habitat is likely for Ganges River Dolphin (EN) and possible critical habitats due to Black Softshell Turtle (CR); *Magnolia pealiana* and *Bagarius bagarius* (EN); and Swamp grass babbler, and Greater and Lesser Adjutants (VU).

13. Key Biological Aspects

258. Summary of the key biological aspects in the PAI are given in Table 5-33.

Table 5-34: Summary of Biological Setting of the PAI

Particular	Key Features in PAI
Habitat type	• Modified/natural degraded habitat
Protected Areas in 10 km	• Presence of Dibru -Saikhowa NP and Bherjan-Borajan-Podumoni WLS within 1km and 5 km of the subproject areas, respectively

Particular	Key Features in PAI
Key biodiversity area and IBA in 10km	• Dibru -Saikhowa NP, Jamjing and Sengajan in Dibrugarh District • Dibru - Saikhowa NP, Bherjan-Borajan-Podumoni WLS, Maguri and Motapung Beels, Dibang Reserve Forest and adjacent areas in Tinsukia District
Forest land	No sites within forest area
Wetlands	• Maijan Beel in Dibrugarh District • Maguri-Motapung Beel in Tinsukia District
Surface water bodies	• Other than the Brahmaputra River, there are some ponds within PAI of subproject
Trees to be lost	Yet to be finalized as of the time of preparation of the IEE. Shall be finalized during pre-construction stage and IEE shall be accordingly updated
Critical habitat	The subproject is critical habitat due to having biodiversity of significant social, economic, or cultural importance to local communities, particularly due to fishing activities in the target sites. See Appendix 15 for CH Assessment

AOA = area of analysis, ESZ = ecologically sensitive zone, IBA = important bird area, KBA = Key Biodiversity Areas, NP = National Park, PAI = project area of influence, WLS = wildlife sanctuary

Source: ADB TA Consultant

F. Socio-Economic Settings

259. The Dibrugarh subproject falls in Dibrugarh and Tinsukia Districts of Assam. Dibrugarh District is bounded by Dhemaji District on the north, Tinsukia District on the east, and Sibsagar District on the north and south-west. The area stretches from the north bank of the Brahmaputra, which flows for a length of 95 km through the northern margin of the district, to the Patkai foothills on the south. The Burhi Dihing, a major tributary of the Brahmaputra with its network of tributaries and wetlands flows through the district from east to west.

260. Tinsukia District covers an area of 3790 sq.km (Rural: 3728.504 sq.km. and Urban: 61.496 sq.km.) The northern, eastern and southern part of Tinsukia District is totally captured by the next state. The south border is shared by the Changlang District, north by East Siang District and Lower Dibang valley District and east by Lohit District. To the north-western part of Tinsukia District lies the Dhemaji District. And then again, to the southwestern part lies Dibrugarh District.

1. Recent History

261. Dibrugarh, like the rest of India, gained independence from British colonial rule in 1947. In the years following independence, Dibrugarh continued to flourish as the tea industry expanded and other sectors such as oil and gas emerged. Over the years, Dibrugarh has seen significant development in infrastructure, education, healthcare, and other sectors. Dibrugarh University, established in 1965, has played a vital role in higher education in the region. The city has also witnessed growth in industries such as oil refining, power generation, and small-scale manufacturing. Today, Dibrugarh is a major urban center and an important commercial and educational hub in northeastern India. Its history, deeply rooted in tea and the contributions of various communities, has shaped its cultural, economic, and social fabric.

262. Tinsukia District was originally a part of Lakhimpur District and thereafter it was a part of Dibrugarh District. Tinsukia was finally formed as a separate district in 1989. Tinsukia District has seen improvements in its infrastructure to support economic activities and enhance connectivity. Tinsukia District has experienced notable economic growth and diversification. The district's economy is primarily driven by industries such as tea, oil and gas, coal mining, and agriculture.

2. Administrative Set Up

263. Dibrugarh District is an administrative district of Assam with headquarter located in Dibrugarh town. Dibrugarh district is an administrative district of Assam with headquarter located in Dibrugarh town. Dibrugarh District has an area of 3381 sq.km. (Rural: 3335.52 sq.km and Urban: 45.48 sq.km.) The Dibrugarh District has a single subdivision and seven circles. The revenue circles are Dibrugarh East, Dibrugarh West, Chabua, Tengakhat, Naharkatia, Tingkhong, and Moran. There are 9 towns which includes three statutory towns and 6 census towns. The district has seven Community Development Blocks comprising a total of 1348 villages spread over all the Revenue circles.

264. Tinsukia District that lies at the end of the state of Assam in the north direction. For the administrative purposes, the entire district is divided into three sub-divisions viz., Tinsukia, Margherita and Sadiya. Each sub-division is divided into revenue circles and under revenue circles there are Mouzas comprising revenue villages. There are total 4 revenue circles and 1168 villages. The names of revenue circles are Sadiya, Doom Dooma, Tinsukia, Margherita. It has 86 Gaon Panchayats and 7 Community Development Blocks. There are 13 towns which includes 5 Statutory Towns and 8 Census Towns.

3. Demography

265. Dibrugarh is an industrial city in Upper Assam with sprawling tea gardens. As per the 2011 census[46], Dibrugarh District has a population of 1,326,335 of which 676,434 were male and 649,901 were female. The majority of the population in Dibrugarh District belongs to the Assamese ethnic group, with other ethnic communities such as Tea Tribes, Bengalis and Nepalese also. The district also has a relatively higher sex ratio (961 per 1000 male) compared to Assam (958 per 1000 male) and India (940 per 1000 male) indicating a more balanced gender distribution. The district has 7 Development Blocks comprising a total of 1,314 revenue villages spread over all the Revenue circles. Dibrugarh District has an area of 3,381 sq. km. The literacy rate of Dibrugarh District is 76.0 % of which 82.8% is for males and 69.0% is for females.

266. Considering the distribution of Scheduled Castes (SC) and Scheduled Tribes (ST) population in the district, we find that there are 58876 SC persons comprising of 30517 males and 28359 females. The percentage of Schedules Castes population to total population is 4.4. The total Scheduled Tribes population in the district is 102871 comprising of 51835 males and 51036 females. The percentage of ST population to total population in the district is only 7.8.

267. There are total 4 villages identified for the study. The demographic details of the 4 selected villages are provided in the table below:

Table 5-35: Demographic details of the 4 selected villages

Sl. No.	Villages	Geographical Area	Households	Total Population	Male Population	Female Population	Sex Ratio
1	Mothola	6.29	137	554	296	258	871
2	Borasaikia Village	180.57	305	1486	741	745	1005
3	JaparaGaon Ward	132.89	215	920	488	432	885
4	Bihiacehita Village	103.67	196	955	499	456	913
Total		**423.42**	**853**	**3915**	**2024**	**1891**	**836**

Source: Lea Associates South Asia Pvt. Ltd. (LASA), 2023

[46] The Census of India is yet to publish the provisional and final reports for the census in 2022. Thus, the official census records of 2011 were relied upon

268. Tinsukia District covers an area of 78438 sq. kms. The district is bounded by the Brahmaputra and Arunachal on the North, Arunachal on the eastern and southern sides and Dibrugarh District on the western side. The population of the district is 1,327,929 which increased with a rate of 15.47% in 2011. Total male and female population of the district is 680,231 and 647,698 respectively; total child population under the age of six is 181,826. The density of the district is 350 persons per sq.km of which is lower than the state average density of 398 persons per sq.km. The sex ratio is 952 as that of state it is 958 which marks as downward trend from the state. As per census 2011, worker population of Tinsukia District is 557,196 which is either main or marginal workers. Out of the total working population 366,623 are male and 190,573 are female. Total main workers are 410,188, out of which male main workers are 297,578 and female main workers are 112,610. Total marginal workers of the district are 147,008. The literacy rate of Tinsukia District is 69.66% of which 77.19% is for males and 61.73% is for females.

269. There are total 5 villages identified for the study. The demographic details of the 5 selected villages are provided in the table below:

Table 5-36: Demographic details of the 9 selected villages

Sl. No.	Villages	Geographical Area	Households	Total Population	Male Population	Female Population	Sex Ratio
1	3 no. Kordoiguri	109.71	21	118	56	62	1107
2	1 no. Kordoiguri	444.67	380	2,235	1,138	1,097	963
3	Dighal Tarang T.E. 20/123/215	344.79	79	459	239	220	920
4	Rongagorah T.E. 18/179 ORR NLR	357.17	476	2,378	1,200	1,178	981
5	Khamti Gohali T.E. 106/FS T.E.	147.61	452	2,212	1,110	1,102	992
Total		**1655.89**	**1671**	**8833**	**4454**	**4379**	**996**

Source: Lea Associates South Asia Pvt. Ltd. (LASA), 2023

4. Religion and Caste/Tribes

270. In Dibrugarh District Hinduism is the major religion followed by Islam, Christianity and Buddhism and Sikhism. Most of the Hindus are either Vaishnavites or followers of Sakti. Vaishnavites again may be divided into the Mahapurishia and Bamunia or other Vaishnavas.

271. While as in Tinsukia District the hindus form 90.2% of the total pulation of the district in 1991 is the major religion. The Muslims and Christians occupy only 4.9% and 3.1 % respectively in the district. All the remaining three religions consist of less than 2.0% only. Tinsukia, being a diverse city, consists of people from various castes. Prominent among the castes is Ahom followed by Brahmins, Kalita, Mishra, and other scheduled castes known as Dalits.

5. Indigenous Peoples/Scheduled Tribe in Assam

272. The proposed project area Dibrugarh District and Tinsukia District does not fall in any Autonomous District Council Area.[47]

[47] Autonomous District Councils are autonomous bodies constituted under the 6th Schedule of the constitution which within the administrative boundaries of the state with powers to make laws, rules and regulations in certain areas and powers to levy taxes

273. In Dibrugarh District the total Scheduled Tribes (ST) population in the district is 102871 comprising of 51835 males and 51036 females. The ST population of the district is 7.8%. The Scheduled Castes (SC) population of Dibrugarh is that 58876 persons comprising of 30517 males and 28359 females. The Schedules Castes population is 4.4%.

274. In Tinsukia District the total Scheduled Tribes population in the district is 82066 comprising of 41769 males and 40297 females. The ST population of the district is 6.18%. The population belonging to the Scheduled Caste (SC) in Tinsukia is 37688 persons comprising of 19443 males and 18245 females. The Schedules Castes population is 2.84%.

6. Language and Literacy

275. The primary language spoken in Dibrugarh and Tinsukia Districts, as well as the entire state of Assam, is Assamese. Assamese is an Indo-Aryan language and serves as the official language of Assam. It is widely spoken by the majority of the population and used in government, education, and day-to-day communication. In addition to Assamese, people in Dibrugarh and Tinsukia may also speak other languages like Hindi, Bengali, and English etc.

7. Transportation and connectivity

276. The district is connected by a network of well-maintained roads that link it to various parts of Assam and neighboring states. As per statistical handbook of Assam 2021, in Dibrugarh District, there are 109 km state highway, 163 km major district road, 1,784 km rural road and 77 km urban road which accounts to a total of 2,133 km (excluding National Highway). Dibrugarh is also served by Dibrugarh Airport, which has regular flights to major cities in India, facilitating air connectivity. In terms of rail connectivity, Dibrugarh is an important railway junction and serves as a gateway to the upper Assam region. During rainy season, most of the roads are unpassable due to muddy or flooded conditions which renders many settlements isolated. Assam has a total road length of approximately 69,000 kilometers which accounts for approximately 60% of the total road length in the North-east.

277. Tinsukia District is also well connected by a network of well-maintained roads that link it to various parts of Assam and neighboring states. Tinsukia is accessible via air, road and railway. It is 532 kms away from the capital of the state, Dispur. As per statistical handbook of Assam 2021, in Dibrugarh District, there are 41 km state highway, 171 km major district road, 1,784 km rural road and 81 km urban road which accounts to a total of 2,077 km (excluding National Highway). The total length of National Highway in Tinsukia is 218.424. Tinsukia's railway is connected through Dibrugarh Railway Junction which is an important railway which serves as the gateway to Upper Assam. The nearest airport is around 40 kms away from Tinsukia which is at Mohanbari, Dibrugarh with regular flights from important cities like Delhi, Guwahati and Kolkata.Agriculture Development and Industry

8. Income generation

278. Dibrugarh District in Assam has a diverse economy with multiple sources of income, contributing significantly to the overall economy of the state. The district is renowned for its tea industry, with numerous tea gardens producing high-quality tea leaves for both domestic and international markets. Additionally, Dibrugarh has a growing tourism industry, with attractions such as national parks, historical sites, and cultural heritage drawing tourists from within and outside the state. The district also has a significant presence of oil and gas industries, with oil refineries and exploration activities being prominent contributors to its economy. Moreover, agriculture, handloom, and handicrafts also play a vital role in the income generation of the district. Some of the challenges faced in Dibrugarh District are uneven economic growth, unemployment, and socio-economic disparities, and efforts are ongoing to promote sustainable and inclusive economic development in the district and across the state.

279. In Tinsukia District the main sources of income generation in the district are agriculture, tea plantation, and small-scale industries. The fertile soil and suitable climate of Tinsukia support the cultivation of various crops such as rice, jute, mustard, and pulses. Tea plantation is also a major contributor to the economy of the district, with several tea estates located in the region. The district is also home to small-scale industries such as handicrafts, handloom, and cottage industries which provide employment opportunities for the local population. Apart from these, the district has significant potential for tourism, with several scenic locations and historical landmarks. The district administration has taken steps to promote tourism in the region, which has led to the growth of the hospitality industry.

9. Peoples Dependence on Aquatic Fauna

280. Pisciculture is becoming popular among all section of the people day by day irrespective of caste and creed. Fisheries in both Dibrugarh and Tinsukia Districts are of various types. These are River, Beel, Swamp, Forest derelict and semi derelict, pond and tank fisheries. Beel and river fisheries can be either registered or unregistered.

281. Fishing is a primary occupation and a source of livelihood for many communities in both Dibrugarh and Tinsukia. The rivers, including the Brahmaputra and its tributaries, support a diverse range of fish species. Local fishermen engage in both commercial and subsistence fishing, using traditional fishing methods such as nets, hooks, and traps. Fish is an essential part of the local diet and is also sold in local markets.

10. Manufacturing Industries

282. Dibrugarh District in Assam has a diversified industrial profile, with a significant presence of Micro, Small, and Medium Enterprises (MSMEs) across various sectors. As per the statistical handbook 2021, the district has a total of 20 units under Industrial Estates and 9 units under Industrial Areas, providing a platform for industrial growth and development. The MSME sector in Dibrugarh District is vibrant, with 1795 Micro, 455 Small, and 17 Medium enterprises operating in various fields, including agro-based industries, engineering, and electronics. The district's agro-based industries comprise a major share of the MSME sector, with units engaged in the production and processing of tea, rice, oilseeds, and jute.

283. Tinsukia District is a principal commercial centre of Assam. It is mainly an industrial district and the economy of Tinsukia District includes several prominent industries. Tinsukia produces generous amounts of ginger, other citrus fruits and paddy. Tea is also an identifying produce of the area, where Tinsukia is famous for its tea garden. Coal mining is prevalent in the area and was started originally by the Assam Railways and Trading Company. Wood manufacturing is another manufacturing industry which can be found in places like Margherita.As per statistical handbook 2021, the district has a total of 50 units under Industrial Estates and 1 unit under Industrial Area, providing ample opportunities for industrial growth and development. The Micro, Small, and Medium Enterprises (MSMEs) sector in Tinsukia is thriving, with a total of 2201 Micro, 427 Small, and 11 Medium enterprises operating in the district across various sectors.

11. Water Supply

284. In Dibrugarh the main source of drinking water is groundwater. The district boasts of a network of water through tube wells, wells, hand pumps and river that cater to the water needs of the local population. The district's water supply system is comparatively well-developed and efficiently managed, ensuring a relatively reliable and adequate water supply to the residents as the tube wells that were dug by the government are now being maintained by the villagers. There are 2,527 households are with Functional Household Tap Connection (FHTC) connection. Whereas,

under Jal Jeevan Mission (JJM) 12,099 houses have Functional Tap Connection inside their household[48].

285. The Tinsukia District occupies part of the Brahmaputra valley and the Brahmaputra River flows on westerly direction along its northern boundary. The district is drained by several perennial rivers flowing from south to north. Rivers Burhi-Dihing and Dibru are two most important rivers. The recharge to the groundwater body mainly takes place though infiltration of rainfall and to a lesser extent from surface water sources. The range of fluctuation in water level between dry and wet seasons and infiltration rate, permeability and aquifer geometry are the important factors which controls the groundwater recharge. In Tinsukia District there are 1,189 households are with Functional Household Tap Connection (FHTC) connection. Whereas, under Jal Jeevan Mission (JJM) 7,587 houses have Functional Tap Connection inside their household.[49]

12. Sanitation Facilities

286. In Dibrugarh District as per the Statistical Handbook of Assam, 2021, there are 1,046 household toilets and 205 public toilets under Swachh Bharat Mission (Gramin) but when compared to Swachh Bharat Mission (Urban) there are 223 household toilets and 21 community toilets. However, villagers practice and prefer open defecation. In Dibrugarh Town, most of the slums are on the vicinity of embankment and have no sanitary facilities provided and hence also follow open defecation. Proper sanitation facilities (for example, toilets and latrines) promote health because they allow people to dispose of their waste appropriately, preventing contamination of their environment and reducing risk to themselves and their neighbors. As per the Statistical Handbook of Assam, 2021, there are 419 household toilets in Tinsukia and only 4 community toilets under Swachh Bharat Mission (Gramin) but when compared to Swachh Bharat Mission (Urban) there are 708 household toilets and 6 community toilets.

287. In Tinsukia District as per the Statistical Handbook of Assam, 2021, there are 419 household toilets in Tinsukia and only 4 community toilets under Swachh Bharat Mission (Gramin) but when compared to Swachh Bharat Mission (Urban) there are 708 household toilets and 06 community toilets.

13. Irrigation

288. Both Dibrugarh and Tinsukia Districts are located in the state of Assam in northeastern India, rely on irrigation for agricultural activities. The major rivers in the region, such as the Brahmaputra and its tributaries, provide a significant source of water for irrigation. Farmers in Dibrugarh and Tinsukia divert water from these rivers into canals and channels to irrigate their agricultural fields. This method of river irrigation is commonly practiced in the region besides the farmers also rely on an available network of canals and water channels that distribute water from the rivers to agricultural areas. Some areas in Dibrugarh and Tinsukia have reservoirs and tanks that serve as storage facilities for water used in irrigation. These reservoirs collect rainwater and provide a supplementary source of water during periods of low rainfall or when river water is not readily accessible. In the areas with limited surface water sources the farmers in Dibrugarh and Tinsukia itilize tubewells to extract groundwater for irrigation.

14. Electrification

289. Dibrugarh District is known for its significant power generation facilities that play a crucial role in meeting the electricity demand of the region. The district houses have several major power facilities, including thermal power plants, hydropower plants, and renewable energy installations. Dibrugarh District has electrified 50.1% households as per the Statistical Handbook of Assam, 2014.

[48]Source: The Statistical Handbook of Assam, 2020-21
[49]Source: The Statistical Handbook of Assam, 2020-21

And as per statistical handbook of Assam, 2021, there are196,968 numbers of domestic consumers and 11,744 numbers of commercial consumers. Power facility in the Dibrugarh area is available in most of the villages. Main sources of lighting are electricity (50.08%), kerosene (49.32%), solar (0.2%), other oils (0.07%) and no lighting facility (0.26%).

290. Tinsukia District lacks the ability to produce electricity. It must rely only on supply coming from outside the district. The Assam State Electricity Board is in charge of coordinating the district's power generation, transmission, and distribution activities. As per NFHS-5 95.7 % households have electricity connections. As per the Statistical Handbook of Assam, 2021, in Tinsukia District there are 270,373 are domestic consumers, 16,449 are commercial consumers, 31 smart street lighting, 2 rooftop solar PV station with 10 kW of plant capacity. In the district, wells, ponds and tube wells are the main sources of irrigation. Tube wells and wells are confined to the plain areas of the district. Under various plans and programmes, the State Government has taken up various small and medium irrigation schemes in the district.

15. Health Facilities

291. Dibrugarh District in Assam has relatively better medical and health facilities compared to many other districts in the state. Being a major urban center in Upper Assam, Dibrugarh has well-established hospitals, health centers, and medical colleges that provide comprehensive healthcare services to the local population. As per the Statistical Handbook of Assam 2020-21, 234 sub centres, 21 primary health centres (Rural), 9 state dispensaries, 10 community health centres (Rural), 24 nursing homes and 34 diagnostic centres. As per the Department of Health, Government of Assam (2019-2020), there are 231 no. of sub-centres (SC), 30 Primary Health Centre (PHCs) and 7 Community Health Centre (CHCs).

292. The health services of Tinsukia District include hospitals, PHC, dispensaries, rural family welfare planning centre and sub-centre. As per Statistical Handbook of Assam, 2021, Tinsukia has 1 civil hospital, 19 Primary Health Centre (PHC), 3 State Dispensaries (Rural), 8 CHCs and 166 sub-centres. Additionally, 22 poly clinic/nursing homes and 10 diagnostic centres exist in the district. Also, there are 153 Doctors in the district, 44 Pharmacist, 153 Nurses and 103 Midwives.

16. Education Status

293. The education status of Dibrugarh District in Assam, as per the 2011 census, showcases a relatively higher literacy rate of 76.05% compared to both Assam (72.19%) and India (74.04%). Dibrugarh District has a significant number of educational institutions including schools and colleges, contributing to a relatively higher literacy rate. There are 1248 lower primary schools, 187 upper primary and 148 high and higher secondary schools which are either Govt./Prov. schools.[50] The district has made efforts towards promoting education, with a higher enrollment rate and increased access to educational opportunities. However, despite the progress, Dibrugarh District also faces challenges such as high dropout rates, quality of education, and accessibility to education in remote areas.

294. The literacy rate of the Tinsukia District is 70% which also shows a decrease trend from that of the state (73%). Out of the total literate in the district 77.19% were male and 61.73% were female as per census 2011.There are 1,075 lower primary schools, 157 upper primary and 89 high and higher secondary schools which are either Govt./Prov. schools.[51]

17. Common Property Resources (CPR)

295. Common Property Resources (CPRs) in Dibrugarh District include forests, rivers, wetlands, grazing lands, and water bodies, which are collectively managed and utilized by local communities for various purposes such as agriculture, fishing, grazing, fuelwood collection, and cultural practices.

[50]Source: The Economic Survey of Assam 2022-23
[51]Source: Economic Survey of Assam, 2022 - 23

These CPRs not only provide direct livelihood opportunities but also contribute to the social and cultural fabric of the region. District faces challenges such as encroachment, over-exploitation, pollution, and degradation due to increasing population pressures, changing land use patterns, and inadequate governance.

296. Tinsukia District is blessed with a rich abundance of natural resources and biodiversity, including several common property resources that are shared and managed by local communities. The sustainable management of these common property resources is crucial for the conservation of biodiversity and the well-being of the local communities. Tinsukia District has a total forest cover of around 1,070 square kilometers, which includes community forests managed by the local communities. The district is also home to several wetlands, including the Dibru-Saikhowa National Park and the Dehing Patkai Wildlife Sanctuary, which cover a total area of around 765 square kilometers.

18. Intangible Culture

297. Dibrugarh District is known for its diverse folk traditions, music, dance forms, festivals, and culinary practices that have been passed down through generations. The intangible cultural heritage of Dibrugarh District reflects the unique cultural identity and rich cultural legacy of Assam, with influences from various ethnic groups and tribes residing in the region. From Bihu, the vibrant folk dance of Assam, to the traditional handloom and handicrafts, and the unique cuisine that features Assamese flavors, the intangible cultural heritage of Dibrugarh District is a treasure trove of cultural expressions.

298. The culture of Tinsukia consists of lively and colourful traditions of the people residing here in the district. The tribal communities dwelling in this part of Assam have their own indigenous heritage and culture and are very rich and diverse with a lot of festivals and fairs that are celebrated with spirit and zest by the people here. The traditional attires and folklore of this place has its own charm and beauty. Dehing Patkai Festival is organized at Lekhapani. This festival composes of tribal fairs, tea heritage tours, golfing, adventure sports, and wildlife pleasure trip. The most important dance and music form of the people here is the Bihu dance.

19. Key Socioeconomic Aspects

299. Summary of the key physical aspects in the PAI are given in Table 5-36.

Table 5-37: Key Socio-economic Features in PAI

Particulars	Key Features in PAI
Indigenous People	ST population Dibrugarh ST: 7.8%. ST population Tinsukia: 6.18%.
Economic Landownership and individual properties	548 in Dibrugarh and 115 in Tinsukia means a total of 663 private properties including residential, commercial and other properties are present in the subproject intervention area that shall be impacted
Nearest Habitation	**Dibrugarh**: Chabua, Moran, Duliajan, and Namrup **Tinsukia**: Makum, Digboi, Margherita, and Doomdooma
Road Access	NH 37 caters to both Dibrugarh and Tinsukia
Human use of surface and groundwater	Dibrugarh town has piped watersupply. The people of the subproject area living in the villages and close to the river mostly use river as their source of drinking water. Some of the villages have hand-pump/tube wells from which they collect water for drinking
Educational facilities	**Dibrugarh:** Literacy rate 76.05% (Lower primary schools -1248, Upper primary 187 and High and higher secondary schools: 148) **Tinsukia:** Literacy rate 70% (Lower primary schools: 1,075, Upper primary 157 and High and higher

Particulars	Key Features in PAI
	secondary schools 89)
Health facilities	**Dibrugarh**: 234 sub-centres, 21 primary health centres (Rural), 9 state dispensaries, 10 community health centres (Rural), 24 nursing homes and 34 diagnostics centres. **Tinsukia:** 1 civil hospital, 19 Primary Health Centre (PHC), 3 State Dispensaries (Rural), 8 Community Health Centres (CHC) and 166 Sub-centres. Additionally, 22 Poly Clinic/Nursing Homes and 10 Diagnostic Centres exist in the district.

Source: ADB TA Consultant

G. Physical Cultural Resource

300. Dibrugarh District is known for its rich cultural heritage of the region. The district is home to numerous historical sites, ancient temples, and cultural landmarks that reflect the diverse ethnicities, traditions, and customs of the people in Assam. Some of the notable cultural resources in Dibrugarh District include Namdang Stone Bridge, Shrikshetra Dhaam, Rukmini Island, and Dehing Satra, among others. These physical cultural resources hold immense significance for the local communities and attract tourists, researchers, etc.

301. The Tinsukia District has a rich cultural heritage and physical cultural resources. Some of the notable heritage sites and physical cultural resources in the district include the Tilinga Mandir, a Hindu temple famous for its thousands of bells, the Digboi Oil Refinery, which is the oldest operating refinery in Asia, and the historic Margherita Railway Station, which was built during the British colonial period. The district is also home to several traditional handloom weaving centers, producing high-quality textiles such as Muga silk and Assam silk. The conservation and promotion of these physical cultural resources are essential for preserving the district's cultural heritage and promoting tourism.

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

302. Potential environmental impacts of the proposed infrastructure components are presented in this section. Mitigation measures to minimize/mitigate negative impacts, if any, are recommended along with the agency responsible for implementation. Monitoring actions to be conducted during the implementation phase is also recommended to reduce the impact.

303. Screening of potential environmental impacts are categorized into four categories considering subproject phases: location impacts and design impacts (pre-construction phase), construction phase impacts and operations and maintenance phase impacts and mitigation is devised for any negative impacts.

(i) **Pre-Construction impacts** include impacts which are anticipated during construction works but planning is required for proposed mitigation measures before start of construction works i.e. during SIP period such as taking consents from various departments, planning for construction and workers camps, deployment of safety officer, arrangement of required barricades and caution boards etc.

   A. **Location impacts** include impacts associated with site selection and include loss of on-site biophysical array and encroachment either directly or indirectly on adjacent environments. It also includes impacts on people who will lose their livelihood or any other structures by the development of that site.

   B. **Design impacts** arise from investment program design, including technology used, scale of operation/throughput, waste production, discharge specifications, pollution sources and ancillary services

(ii) **Construction impacts** include impacts caused by site clearing, earthworks, machinery, vehicles and workers. Construction site impacts include erosion, dust, noise, traffic congestion and waste production.

(iii) **Operation and maintenance (O&M)** impacts include impacts arising from the operation and maintenance activities of the infrastructure facility. These include routine management of operational waste streams, and occupational health and safety issues.

304. Screening of environmental impacts has been based on the impact magnitude (i.e., negligible/moderate/severe – in the order of increasing degree) and impact duration (i.e., temporary/permanent).

305. This section of the Dibrugarh subproject IEE reviews possible project-related impacts, in order to identify issues requiring further attention and screen out issues of no relevance. ADB SPS (2009) require that impacts and risks will be analyzed during pre-construction, construction, and operational stages in the context of the project's area of influence.

306. The ADB Rapid Environmental Assessment Checklists have been used to screen the project for environmental impacts and to determine the scope of the IEE. An environmental and social risk analysis of the subproject was also conducted by LASA, to determine the impacts and its significance in the subproject interventions.

307. In the case of this Dibrugarh subproject (i) most of the individual elements involve straight forward construction and operation, so impacts are mainly localized and not greatly significant; (ii) most of the predicted impacts are associated with the construction process, and are produced because that process is invasive, involving excavation and earth movements; and (iii) being mostly located in an rural area and not falling in any environmentally sensitive zones except in some Forest land will not cause direct impact on biodiversity values. The project properties are held by the local

government and access to the project location is through public rights-of-way and existing village roads hence, land acquisition and encroachment on private property will be avoided. However, NOC is required for some identified location from concerned authority.

1. Pre-Construction Impacts

308. The proposed Dibrugarh subproject activities involve construction of apron, bank protection/anti-erosion for a total length of 26.26 km out of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia, adaptation works/Emergency contingency works for total of 4.65 km is proposed to be undertaken at 4 locations in Dibrugarh and launching of porcupine screens along the southern bank of the Brahmaputra River. 173 number of P.S.C porcupine in 3 layers are proposed to be launched in 5 locations in Dibrugarh and 2 locations in Tinsukia. Additionally, construction of 1.2 km (new) close gap in embankment at Maijan Beel in Dibrugarh is proposed. A RCC triple shutter sluice gate in Maijan Beel embankment with regulator and fish pass is also proposed. Adaption works of 4.65 km at 3 locations of Dibrugarh with geo-bags is also proposed.

(i) Protected Areas

309. There is 1 notified protected area (Dibru - Saikhowa NP) within 1 km of the project intervention areas in Dibrugarh District, and 2 PAs in Tinsukia District (Dibru - Saikhowa NP and Bherjan-Borajan-Podumoni WLS) within 1 km and 5 km of the project intervention areas as detailed out in Description of Environment Chapter, Biological settings section.

310. The Eco-Sensitive Zone (ESZ) of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites are adjacent to or within the notified area of the ESZ of the. No objection letter from the Office of the Principal Chief Conservator of Forest (Wildlife) and Chief Wildlife Warden, Assam for construction activities within the ESZ of Dibru - Saikhowa NP. As part of condition, the project will ensure that (i) no porcupines will be installed and no adverse impact shall be caused to Ganges River Dolphin (*Platanista gangetica*) and other riparian wildlife including their habitat during project implementation.

(ii) Impact Due to Location – Adjacent to the River

311. No impact during the design and preconstruction period is envisaged.

(iii) Environmental, Social and Culturally Sensitive Resources

312. There are presence of schools and religious properties near the Dibrugarh subproject locations. Dibrugarh and Tinsukia Districts are known for rich and diverse physical cultural resources that reflect the region's unique cultural heritage. These resources include ancient temples, monuments, archaeological sites, traditional arts and crafts, folk music and dance forms, and other cultural landmarks. Both districts have a long history of cultural heritage, with influences from various ethnic groups and communities that have inhabited the region for centuries. The Dibrugarh District is home to renowned cultural sites such as the Radha Krishna Mandi, Jagannath Temple, Dibru-Saikhowa Shiva Dham, Budua Namgha and Masjid-e-Swahid. While as in Tinsukia project area prominent places of cultural and religious include Devi Dham, Tilinga Mandir, Durga Puja Pandals, and Bherhan-Borajan Padumoni Wildlife Sanctury. Though Wildlife Sancturay is not a religious place per se, this wildlife sanctuary in Tinsukia is considered sacred by the local communities and is associated with traditional rituals and beliefs.

313. There are no archaeological monuments within 100m from the Dibrugarh subproject intervention locations. However, no impacts from the implementation of the project are envisaged during the design and preconstruction period and thus mitigation measures are not required. However, delay in the implementation may aggravate the erosion scenario and many properties may be adversely impacted.

(iv) Tree Cutting at Selected Project Sites

314. The project involves cutting of trees in Dibrugarh subproject area due to anti-erosion works and other project activities. The number of trees to be felled is yet to be determined as of the time of preparation of the IEE. The number will be finalized at the pre-construction stage and the IEE shall be accordingly updated. Trees shall be felled once the necessary permissions for felling are obtained. Compensatory plantation shall be done on 1:10 basis i.e.,10 trees plantation against each tree cut as per the state government's policy [52].

(v) Site selection of construction work camps, stockpile areas, storage areas, and disposal areas

315. The contractors to be appointed for the proposed works under Dibrugarh subproject shall identify locations for his work camps including labor camps, areas for stockpiling and storage of construction materials. In case these locations are established in a private land, necessary paper works including change of land use from the revenue department, lease agreements etc., CTE and CTOs, drinking water permissions etc. shall obtained before the start of actual works.

316. The contractors shall also identify disposal areas for solid wastes generated in the Dibrugarh subproject. For works in and around the town area of Dibrugarh and Tinsukia, the contractor can tie up with the local municipal authorities for collection and disposal of municipal and domestic solid wastes generated in the project. Most of the reaches where flood protection and anti-erosion works shall take place are in largely rural areas, the contractor can either tie up with the nearest municipal authorities and in case of none, identify suitable land and obtain necessary permissions from the panchayat and district administrations for use of disposal area. The contractor shall be required to maintain all necessary records for disposal of wastes.

(vi) Site selection of sources of materials

317. The materials required for the Dibrugarh subproject are:

- Type-A geo-bags which shall be procured by WRD and supplied to the contractor from its nearest storage facility
- PVC coated wire netting
- Porcupines to be procured by WRD and supplied to the contractor
- River sand for filling the geo-bags and if technically permitted by Engineer53 for embankment works – necessary permissions including mining permissions and prior EC from SEIAA to be obtained
- Broken stone bed media/stone aggregates to be procured from approved sources and copies of EC, mining permissions and crusher's CTO to be obtained from the approved sources mandatorily. In case, the contractor wishes to operate his own crusher/aggregate mine, he shall obtain all necessary permissions and clearances (EC, mining permissions and Crusher's CTE and CTO) before start of works
- Cement Concrete blocks -
    - Cement: Contractor to procure cement bags from WRD/FREMAA/Engineer approved sources and maintain necessary documents
    - Aggregates: Contractor to refer to para (v) above

[52] Government of Assam, Guidelines for Compensatory Afforestation, 2000. Guwahati. https://forest.assam.gov.in/sites/default/files/swf_utility_folder/departments/pccf_lipl_in_oid_4/menu/information_and_services/hand_book_vol-i_compendium.pdf

[53] Engineer is the designated authority as per the Works contract between FREMAA/WRD and the contractor, who shall decide and approve all technical, financial, legal and safeguard documents, issues and changes

- Earthworks - borrow earth areas to be identified by the contractor and necessary permissions obtained. He shall also follow the guidelines provided under borrow areas below
- Fly ash for use in embankment in lieu of borrow earth if technically permitted by Engineer and if there are sufficient available fly ash at nearest NTPC operated Namrup Thermal Power Station located in Namrup and Lakwa Thermal Power Station is located in Maibella, near Sivasagar in Assam
- Water – The contractor shall obtain permissions from the relevant authorities for use of ground and/or surface/river water for construction works. Since the river water has high sediments, the water quality to be tested as per guidelines of the Engineer to ensure that it can be utilized for concrete mixing. For earth works, river water can be used post obtaining permissions from relevant authority.
- Steel for all proposed works in Dibrugarh subproject shall be procured from Engineer approved sources. In case sluice gate shutters and allied parts and equipment are procured in whole then the same to be also obtained from Engineer approved source
- Barges (for placing geo-bags underwater) to be procured by WRD. The modality of the use of barges by the contractor in executing works under Dibrugarh subproject shall be spelled out in the works contract for the specific work.
- Equipment and machineries for nature-based solutions activities (pulp making machines, grass cutters, handloom, fence, etc.) to be procured by FREMAA and used by AADB
- Livelihood supplies (500 kg seeds, 50 sewing machines, 40 handlooms for the 8 weaving centers) to be procured by FREMAA/WRD and used by AADB and other agencies for the CRBIFRWRMP.

(vii) Borrow Area Location and Rehabilitation

318. Substantial quantity of the earth will be required for construction of the river embankment of about 1.8m above the High Flood Level (HFL) with a top width of minimum 10m (Crest width of 3m and 7m passage for vehicle) and a side slope of 1:2 which is designed for 100-year flood return period in the Dibrugarh subproject area. It is proposed that the demand for earth will be fulfilled by excavating borrow pits in the vicinity of the river embankment. During preconstruction period, the contractor has to identify the borrow area locations and obtain necessary permissions and clearances from various authorities. No major impacts are anticipated during the pre-construction period.

319. The borrow pits in the Dibrugarh subproject area shall be on river side since borrow pits on the riverside shall get silted up in the course of time whereas on the countrside remain a permanent disfiguration. Further the borrow pits next to embankment on the countryside can be a cause of inducing seepage to the foundations. Borrow pits on the countryside away from embankment shall be preferable even at the expense of comparatively long hauls, if required and approved by the Engineer. If sourcing earth from countryside is unavoidable, the preference to be given for the following options:

- Waste land or excavating or enlarging existing lank or any humps above general ground level
- Earth from retired embankment.
- Land which farmers wants to either convert into a fishpond or lowering the agriculture field level to increase its water retention capacity
- No land acquisition shall be made for borrow areas
- Exploring the option of using fly ash in lieu of borrow earth if technically permitted by Engineer and if there are easily and sufficient available fly ash from the nearest NTPC

operated Namrup Thermal Power Station located in Namru and Lakwa Thermal Power Station is located in Maibella, near Sivasagar in Assam

- Combination of soil and sand in embankment construction wherein sand is used as a filter in between soil
- Exploring the suitability of using dredge material from the channels where sluice gates are proposed to increase their water carrying capacity
- Exploring the option of using combination of soil and sand in embankment construction wherein sand is used as a filter in between soil
- Exploring technical feasibility of using soil from sandbars existing away from the bank
- Follow the WRD guidelines **Appendix 5** for locating borrow pits close to the embankment if at all it is to be located next to embankment. All efforts shall be made that no tree loss takes place due to borrowing. The trucks shall be covered while transporting the earth.
- Prior environmental clearance shall be obtained from SEIAA for borrow areas

320. The Indian Road Congress (IRC):10-1961 guideline may also be referred for selection of borrow pits. In all cases good engineering and construction practices shall be followed. The WRD Guidelines with respect to borrow area location are as below:

- For high embankments no excavation shall be done within 45 m of the river side toe of the embankment. From 45m to 60m the borrow pits must not be more than 1.8 m deep and from 60m to 90m not more than 2.4m deep and beyond 90m they can be of 3m depth
- If earth is to be taken from landside of the embankment, no borrow pits shall be excavated within 24m of the land-side toe of the embankment. The depth of excavation in 24m to 36m distance shall not be more than 0.6 m
- The borrow pits shall be staggered and on undisturbed ground 6 m wide left at regular intervals to prevent the velocity of flow through the riverside borrow pits. The staggering will also help in inducing silting and filling up of these borrow pits.
- On the countryside the water-logged areas (bandhis) shall be cut and interconnected to permit ordinary drainage. These shall be connected to the nearest drainage channel so as to carry away the drainage water
- The borrow areas selected for taking earth shall be cleared of all trees, shrubs, grass and vegetation mounds
- No borrow pits shall be made on roads, village tracks, graveyards, canals or embankments

321. The Indian Road Congress (IRC):10-1961 guidelines for selection of borrow pits and amount that can be borrowed is summarized below:

- Borrow areas shall not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth shall not exceed 45cm. The topsoil to a depth of 15cm shall be stripped and set aside for its later use for the purpose of turfing on slopes of the embankments. Thereafter, soil may be dug out to a further depth not exceeding 30cm and used in forming the embankment
- Borrow pit shall be selected from wasteland
- Priority shall be given to the borrowing from humps above the general ground level within the road land
- Priority shall be given to the borrowing by excavating/enlarging existing tanks
- Borrowing shall be from land acquired temporarily and located at least 500m away from the road

- Borrowing shall be from mounds resulting from the digging of well and lowering of agricultural fields in vicinity of the road
- In case of settlements, borrow pits shall not be selected within a distance 800m from towns or villages. If unavoidable, earth excavation shall not exceed 30cm in depth
- The haulage distance from site shall ideally not be too far

322. The construction contractor shall submit the borrow area identification details along with borrow area rehabilitation plan in advance during the pre-construction period to the Engineer for approval.

2. Construction and Operation Phase's Impacts

(i) Land Use Change due to Project Activities and Borrow Area

323. **Impacts.** The unplanned selection of borrow areas/no rehabilitation of borrow areas may lead to loss of productive use of the land. The transportation of borrow earth in Dibrugarh subproject area may also cause air pollution, if transported in uncovered trucks. Due to such construction activities along the riverbank, the land use of about 100 m buffer (30m for embankment plus borrow areas towards countryside) around the embankment is likely to be affected or changed.

324. The access to the embankment construction site in the Dibrugarh subproject area is mostly through the single lane semi-urban/rural roads (paved and unpaved both). These roads would require strengthening to sustain the heavy trucking load. In addition, it is recommended that a minimum of 1-2 construction camp (even though local laborers shall be preferred and utilized, a construction camp along with labour camp is envisaged for the 2.075 km stretch, is likely to be located, close to the embankment. This will also temporarily change the land use of the area; however, the impact would be temporary and reversible.

325. Due to the proposed interventions in the Dibrugarh subproject area, most of the agricultural land, tea gardens, and homestead around the embankment site and construction camp areas may be affected adversely. Loss of topsoil is one of the most potential impacts with respect to borrowing of earth from countryside of the embankment. Besides this compaction of soil along the haulage route may also take place, if proper mitigation measures are not employed.

326. During operation phase encroachment on embankment for habitation and cultivation purpose may affect embankment stability in the Dibrugarh subproject area. Rain cuts also destabilizes embankments, if regular maintenance is not undertaken. the Villagers also cut the embankment to create approach to river side for their movement for toileting, cattle grazing, and farming. Borrow areas, if not rehabilitated may have landscape and accidental hazards.

327. **Mitigation Measures.** Diversion of land for Dibrugarh subproject purposes is minimized to 30m in order to reduce the impact zone around the embankment which covers productive land used for cultivation. Adjacent cultivable lands shall not be occupied for storage and/or handling of construction materials. Construction camps in Dibrugarh subproject area shall preferably be located on uncultivated area. All requisite facilities (drinking water supply, sanitation, domestic solid waste collection anddisposal, fuel supply) shall be provided at these camps. The land used for construction camp shall be made reusable/cultivable after closure of construction camp. No construction debris shall be deposited on agricultural land. Loss of crops for construction camp area shall be compensated to the landowners.

328. Provision shall be made in the embankment design of closegap embankment in Maijan Beel for providing access to the riverbank. The construction contractor shall ensure rehabilitation of borrow area before handing over the project. The WRD/FREMAA shall ensure that regular maintenance is undertaken for the new embankment. All squatters and encroachers in the existing and new embankments shall be removed with the help of district administration.

- **Borrow Area Rehabilitation**

329. **Impacts and Mitigation Measures.** For Dibrugarh subproject soil material from borrow pits shall be required for the construction of new closegap embankment at Maijan Beel and slope stabilization for undertaking anti-erosion and flood protection works. The Borrow pits shall be rehabilitated after borrowing. The WRD guidelines for rehabilitation of the pits shall be strictly followed. The construction contractor shall submit the borrow area rehabilitation plan for each borrow area in advance in consultation with the community during the pre-construction period along with the borrow area identification details to the Engineer for approval. He shall prepare the rehabilitation plans for the borrow areas as per the EMP and the direction and guidance of the environmental specialist of the Engineer.

330. The borrow areas in Dibrugarh subproject area shall be restored to a safe and secure area usable to the public enabling safe access and entry to the restored site. Some indicative rehabilitation measures could be community water storage facility, pisciculture ponds, recreational spots, landscape enhancement, use as waste disposal area (with proper mitigation measures) and rehabilitation by re-vegetation of the borrow area. Where re-vegetation is done, it should be ensured that:

- Vegetative cover is established on all affected land
- Topsoil is placed, seeded and mulched within 30 days of final grading if it is within a current growing season or within 30 days of the start of the next growing season.
- Vegetative materials to be used are grasses, legumes, herbaceous or woody plants or a mixture thereof
- Plant material must be planted during the first growing season following the reclamation phase
- Selection and use of vegetative cover should take into account soil and site characteristics such as drainage, pH, nutrient availability and climate to ensure permanent growth. Choice of plant species for the planting program shall be made in consultation with ecological consultant and local forest department
- The planning of trees and shrubs results in a permanent stand or regeneration and succession rate, sufficient to assure a 75% survival rate
- The planning results in 90% ground coverage
- The site should be inspected when the planting is completed and again at one year to ensure compliance whit the reclamation plan

(ii) Land use Change due to construction material sourcing (Quarrying)

331. **Impacts.** A significant amount of construction material would be required for the execution of this subproject located partly in Dibrugarh District and Tinsukia District. Illegal quarrying may lead to land use change, unstable rock formation, air and noise pollutions. The WRD/FREMAA may hand over the new embankment to the state Public Works Department (PWD) for allow the construction of road over it, later on. The aggregate demand for construction of the new embankment with passage for vehicle movement will be met through approved stone quarries. The environmental aspects and control of pollution due to quarrying operation of these approved quarries are controlled and monitored by SPCB. Thus, adverse impacts as a result of quarrying operations are not envisaged in the proposed project.

332. **Mitigation Measures**. Aggregates required for construction of new closegap embankment at Maijan Beel and roads shall be procured from quarries approved by Pollution Control Board Assam (PCBA). Air and noise emissions from quarry shall be well within the prescribed limits. Setting up of stone crushers, if required, shall be done only after obtaining consent from Pollution Control Board Assam and taking adequate measures for air pollution control. Where materials are

obtained from 3rd party vendors, contractors to submit all necessary documents including permission, EC documents, CTO, etc. to the Engineer before obtaining source approvals. If new quarries and stone crushers are to be set up for the Dibrugarh subproject, the contractor shall obtain the necessary Prior EC from SEIAA/MoEF&CC and the CTO from the PCBA and taking adequate measures for air pollution control. While finalizing the site, proper land use assessment shall be done. The land to be earmarked for dumping construction waste if any shallbe free from any social or Resettlement and Rehabilitation (RandR) issue.

(iii) Soil Environment

Soil Erosion

333. **Impacts.** Soil erosion potential of an area depends on its topography, geological structure, rainfall, soil type and land use/land cover. In the Dibrugarh subproject area, the topography of the terrain covering the alluvial plain is mostly flat plain except a few forested hills with elevation between 40 to 50 meters. The Dibrugarh subproject area also includes a large number of riverine tracts and sandy river island in the Brahmaputra River. Possibility of occurrence of gully and rill erosion is expected in the uncovered side slopes of embankments and other freshly cut or deposited areas.

334. **Mitigation Measures.** Following mitigation measures can prevent the soil erosion:

- Construction shall be scheduled such that large areas of soil particularly at borrow areas near the embankment are not laid bare during the monsoon. The construction methodology and the schedule shall be approved by the Engineer before start of work.
- Exposed surface shall be resurfaced and stabilized as soon as possible. This shall also be covered by straw or mulch to avoid soil loss in the intervening period. Ground disturbances shall be phased so that it is limited to workable size
- Stabilizations of soil around approach roads/slopes shall be done by turfing and tree plantation in ROW
- The embankment and road design shall incorporate adequate engineering measures so that the construction could withstand the severe earthquakes
- Various soil conservation measures shall be undertaken by AADB later on to prevent erosion.
- Soil erosion shall be visually checked on potential erosion zones during construction phase. In case soils erosion is found, suitable measures shall be taken to control the same

Operation Phase

335. **Impacts.** Due to bank erosion, the bank line at various sections throughout the Dibrugarh and Tinsukia reaches has shifted rapidly. In the last 20 years the river not only eroded eitire villages but also engulfed a huge area of the villages like. Despite the protection measures taken as part of ADB project AIFRERMIP Tranches I and II in Dibrugarh District the problem of erosion persists in some patches like Nagaghuli, Kosuoni, Mohanghat, and the Bogibeel area. The Brahmaputra River on the southern bank is in the process of aggradation. More precisely, the Nagaghuli area faced severe damage in the flood wave of 2022. The Mohanaghat area is also vulnerable to erosion by the Brahmaputra River, and it is needless to highlight the severe damages that occurred in the Nagakhelia and Bogibeel area in the year 2022 which is now in a very critical condition.

336. Similarly, Tinsukia is also badly affected by the erosion and during the flood of 2019 and 2020, severe erosion has been observed at Fulbari Laopani, Naokota, Gariating, Simaluguri Satra, Tamuli and Laina area washing away several numbers of houses, tea gardens, roads, etc. This belt comprises over 10000 Hectares of fertile and homestead lands including animal husbandry and fish farms with a population of about 50,000. This entire stretch from Milanpur to Naokota is undergoing devastating bank erosion since 2010 and the land loss has amounted to about 3000 hectares since then. Erosion at Hatighuli and Phelai area poses a critical threat to the people. Due to erosion at

Baghjan area, several houses, tea gardens, roads etc. have been awashed away. Rangagora Tea factory in Tinsukia is quite vulnerable and faces a threat of complete destruction to the erosion.

337. The proposed Dibrugarh subproject will have net benefits in terms of soil erosion and preventing progression of land loss. The proposed project will not only protect a vast area comprising of thickly populated area in Dibrugarh between Nagaghuli to Chaulkhowa and Tinsukia between Milanpur to Dinjan. Approximately, 26819 hectares and 40000 hectares of valuable land in Dibrugarh and Tinsukia respectively will be benefited from this project. Soil erosion may still occur during the operation phase and early detection and remedial measures shall need to be taken for safety of the embankment and roads.

338. **Mitigation Measures.** Periodic checking shall be carried out to assess the effectiveness of stabilization measures. A detailed study to assess the location, reasons of soil erosion along the embankment during third year of the operation phase shall be undertaken. Suitable strengthening measures shall be implemented to prevent reoccurrence of soil erosion at existingerosion prone locations and prevent erosion at newer locations in Dibrugarh subproject area.

(iv) Soil Compaction and Contamination

Construction Phase

339. **Impacts.** Soil around construction site, haulage road, construction camp, and workshop, will get compacted due to transportation of man, machine and materials. Considering about 4.42% and 11.14% of land in the 1km of the project interventions in Dibrugarh and Tinsukia respectively is used for agricultural purposes in the subproject area, and implementation period is for 6 years, the agricultural yield will be reduced substantially due to soil compaction. Soil may also get contaminated around construction site, machine maintenance area, fueling station, construction camp, hot mix plant site, and haulage road.

340. **Mitigation Measures.** The movement of construction vehicles, machinery and equipment shall be restricted to the embankment site and pre-defined haulage road in the Dibrugarh subproject area. Adequate provision for approach roads capable of handling movement and haulage of heavy vehicles and machineries shall be made to avoid damage to existing village roads, crop lands and settlement areas. The non-usable, non-saleable, non-hazardous construction waste shall be disposed-off in the properly delineated places. Usable or saleable waste shall not be disposed of to landfill.

341. All efforts shall be made to prevent soil contaminations. Following measures shall be taken to prevent the same:

- The construction vehicle shall be fueled or repaired/serviced at the designated place with proper arrangement of waste collection and disposal. The arrangement shall include cemented floor with dyke around for fuel storage and filling as well repairing of construction equipment. To avoid the soil contamination at the wash down and re-fueling areas, "oil interceptors" shall be provided.
- The demolition waste if any shall also be used to the extent feasible for construction.
- Oil and grease spill and oil-soaked materials shall be sold off to Pollution Control Board Assam (PCB)/MoEF CC authorized vendors.
- Oil spill kits should be available at the site to minimize the damage to soil quality in case of spillage
- Fuel and waste oil should be stored in isolated locations on paved areas only to minimize the soil contamination. These areas should be provided with the garland drains provided with the oil interceptors

Operation Phase

342. **Impacts.** During the operation phase, contamination of soil in Dibrugarh subproject area is not likely to happen other than due to accidental spillage from vehicle movement on the embankment.

343. **Mitigation Measures**. Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the concerned authorities.

(v) External Impacts on Flood and Drainage

Operation Phase

344. **Impacts**. The proposed structural flood protection works consist of anti-erosion works, construction of embankment, launching porcupine screens, some adaptation works and also providing sluicegate. The proposed works will essentially confirm existing flooding behavior and provide better protection from mainstream flooding to flood-liable areas behind the embankments. The proposed anti-erosion, pro-siltation works, and flood protection works will not significantly change flood behavior, gross cross-section-wide sediment behavior of river morphology, however, the adverse impacts of the floods will be addressed considerably. The proposed bank protection measures will stabilize the banks and have no discernable effect on flood behavior. The new embankment near Maijan in Dibrugarh shall have a length of 1.20 km and is an extension of the existing embankment near the Dibrugarh town. No discernible change in downstream flood levels is envisaged. The proposed bank protection measures will stabilize the banks and have no discernable effect on flood behavior. It is also to be noted that the proposed works include construction of 3 gated drainage sluices to mitigate drainage congestion within the protected areas. It is also to be noted that the proposed works include construction of RCC triple shutter sluice gate with regulator and fish passes in Maijan Beel embankment to mitigate drainage congestion within the protected areas.

345. **Mitigation Measures.** Under the Dibrugarh subproject, it is proposed to develop and use a numerical hydraulic model to investigate flooding and drainage behavior, both within and outside the protected areas, associated with mainstream, tributary and local flooding. PIU and PISC will carryout numerical hydraulic modelling during the constrction and operation stages. This model will be used to ensure that there is adequate freeboard against embankment overtopping and that adequate provision has been made for sluice gates to facilitate drainage from the protected areas. Natural drainage systems shall be left undisturbed to the greatest extent possible; the flooding behavior of beels and wetlands will be assessed and where possible improved and/or preserved. Adequate provisions shall be made in designing embankments to withstand extreme meteorological and other geophysical events.

(vi) Changes in Water Levels

Operation Phase

346. **Impacts.** The conveyance capacity of the Brahmaputra opposite the Dibrugarh subproject area is enormous - and will remain unchanged by the proposed works on the southern bank. Accordingly, the proposed works will have no discernable effect on river water levels. Changes in channel conveyance brought about by the natural processes of riverbank erosion, accretion and channel avulsion will play a much greater role in any future change in water levels. An improved embankment network will reduce the risk of sudden devastating flooding in the districts of Dibrugarh and Tinsukia and as such provide more predictable and stable water levels on the flood plains (especially from temporary local inundation during the flood season).

347. **Mitigation Measures.** Changes in cross-section will be monitored at regular intervals to detect any changes and initiate corrective measures. The project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies. Under the Project, the numerical hydraulic model of the Dibrugarh subproject area will be used to identify low lying areas with a potential risk of deep inundation when major floods occur.

(vii) Effect on Flow Velocity/Discharge Intensities

Operation Phase

348. **Impacts.** The proposed interventions in Dibrugarh subproject area are not expected to have any significant effect on the overall velocity profile of the river as the works are limited to the bank or near shore areas of the river and a combination of largely passive river training and flow regulating measures will be taken up to provide an optimum flow velocity in the section. Recognizing instability and unpredictability of the Brahmaputra River, clearly two different scales need to be distinguished for studying effects of flow velocity and discharge changes: (i) the total river cross section, many kilometers in width, and (ii) the cross section of the near bank channel, typically below one kilometer in width. Limited interventions along the bank do not change the cross section average flow velocities in alluvial rivers. Areas of faster flow are compensated through areas of slower flow and lower discharges, which on average even out. The average flow velocity and discharge is affected by different river stages with increasing discharges resulting in increasing flow velocities. The lack of systematic measurements limits the present ability of quantifying this satisfactorily.

349. The magnitude and variation of discharge in the Brahmaputra River undergoes drastic changes on seasonal as well as annual basis due to the unique hydro-meteorological and geophysical characteristics of its basin. The potential increase of these natural perturbations in the river hydrograph in the wake of unfolding climate change scenario appears to be more significant compared to any minor change that may be introduced as a result of the proposed activities on or near the riverbank. The river being very wide with appreciable channel roughness due the presence of multitudes of sandbars and bed forms, transmission of any minor disturbance in the flow close to the bank to areas midstream or across the channel to the other bank appears quite unlikely. Only major proactive river training interventions like spurs protruding into the river may have direct impact on the flow pattern and channel configuration affecting it significantly.

350. **Mitigation Measures.** Flow velocity changes along the bank line will be systematically monitored as part of the near-bank surveys. This includes establishing systematic records of discharges and flow velocities during the hydrological cycle. It is expected that this monitoring will contribute to a better understanding and a gradual optimization of the layout of structural flood and erosion countermeasures. Open revetments, such as multi-layers of sand filled Type A geo-bags and CC blocks (Only in the stretch of area in the subproject area of Dibrugarh) placed on geotextile filters shall be used. Impermeable bituminous or interlocked revetments are not preferred and used as they have impact on the natural environment by interrupting exchange between flowing water and groundwater.

(viii) Impacts of Development Works in Upstream Catchments

351. **Impacts.** A large number of hydroelectric projects are under various stages of implementation in the upstream parts of the Brahmaputra basin in India (Table 6-1). It is likely that these projects will have impacts on flood behavior in the subproject areas. The upstream dams, albeit mostly run-of-the-river schemes, would reduce flood peaks while acting as sediment traps that will lessen the outflow of sediments (until these reservoirs are filled up over the years). Likewise, improved watershed management pursued in upstream catchment will contribute to reduction of flood peaks and sediment transport over the long term. Any effect of this reduction in sediment inflows on the Brahmaputra mainstream channel cross sections and flood behaviors is difficult to predict, but any effects are likely to lead to a reduction in flood levels and aggradation, since reduced sediment loads supports a more stable channel pattern with deeper channels characterized by

higher conveyance. The project CRBIFRERMP ADB loan shall further develop key agencies' knowledge base by improving various decision support tools initiated under AIFRERMIP and will strengthen the state's institutional capacity to deliver FRERM, thereby promoting disaster resilience of the state and affected communities.

Table 6-1: Hydroelectric projects upstream of the Brahmaputra basin in India

Sl. No.	Name	Location	District	Capacity (MW)	Status
1	Dibang Multipurpose Project	Dibang River	Lower Dibang Valley	2,880	Pre-construction
2	Etalin HEP	Dibang River	Dibang Valley	3,097	
3	Upper Siang HEP	Siang River	Upper Siang	10,000	Under construction
4	Kameng HEP	Kameng River	West Kameng	600	
5	Ranganadi HEP	Ranganadi River	Papum Pare & Lower Subansiri	405	Commissioned
6	Pare HEP	Dikrong River	Papum Pare	110	
7	Subansiri Lower HEP	Subansiri River	Lower Subansiri, North Lakhimpur	2,000	Under construction
8	Karbi Langpi HEP	Langpi River	Karbi Anglong	180	
9	Kopili HEP	Kopili River	Dima Hasao	275	

HEP: Hydroelectric Project

Source: ADB TA Consultant

352. **Mitigation Measures.** Systematic monitoring and analysis of hydrological and geo-morphological parameters will help identify any measures that may have to be considered to adapt to any unexpected changes over the longer term. The project will also promote holistic catchment management through statewide planning and coordinated implementation.

(ix) Impact on Silt Deposition and Bed Level Change

Operation Phase

353. **Impacts.** The Brahmaputra River carries the second highest sediment load of all major rivers in the world. The high amount of sediment is largely mobilized during the high flood season flows and often leads to dramatic changes of the platform (river appearance on maps). While the riverbed is largely formed by the coarser sediments especially sand and more upstream gravel, the floodplains are built from finer silts and clay. The latter constitute the wash load in the river, which means they are transported within the channels to the sea without settlement. Only after inundation and in areas without noticeable flow do the finer sediments settle.

354. Problematic at this moment are breaches in the existing embankments in Dibrugarh subproject area, which result in high velocities in the breach area allowing the flowing water to transport coarser, infertile sand through the breached section. This sand gets deposited downstream where the area widens, and the flow velocities drop. The resulting sand carpets are disastrous for the overwhelmingly small and marginal farmers as they render the fertile floodplain land unusable and can only be removed at great cost.

355. **Mitigation Measures.** The bank stabilization and retirement of the embankment system and construction of new closegap embankment at Maijan Beel and other anti-erosion measures in the subproject area will reduce the risk of embankment breaches with associated deposition of infertile

land in the breach. This will help in supporting agriculture and livelihood of the dominant small and marginal farmers. The dynamic pattern of silt deposition in the river and areas adjacent to the bank, especially in the vicinity of anti-erosion and river training works, will be monitored at regular intervals to contribute to the knowledge base and understanding of the Brahmaputra morphology, and initiate necessary corrective measures if required.

(x) Effect on Subproject Drainage System

Operation Phase

356. **Impacts.** The existing embankment system in the districts of Dibrugarh and Tinsukia along the Brahmaputra River acts as a barrier for the drainage of accumulating countryside water into the Brahmaputra during the monsoon season. The proposed works will have no additional adverse impacts on drainage. In fact, the installation of sluice gate at Maijan Beel in Dibrugarh will relieve drainage congestion and inundation during heavy rainfall in Dibrugarh District.

357. **Mitigation Measures.** Under this Dibrugarh subproject the numerical hydraulic model will be used to undertake a comprehensive analysis of the existing natural drainage system to identify drainage behavior and problems, key drainage channels/systems and drainage congestion areas by the PIU and PISC during the construction and operation stages. This model will be used to investigate the optimum location, size and method of operation of the sluice gates. The cost-effectiveness of various remedial measures will be assessed with the object of improving drainage conditions. As part of this investigation, the preservation and/or improvement of the environmental flooding regime of wetlands and beels will be investigated.

(xi) Effect on Wetlands/Beels within the Subproject

Operation Phase

358. **Impacts.** Maijan Beel is the only wetland which has direct connection with the Brahmaputra River along the Dibrugarh reach. A RCC triple shuttle sluice gate with regulator and fish passes is proposed to be provided under the project at the mouth where it meets the proposed embankment at Maijaan in Dibrugarh. During heavy rains during monsoon water gets accumulated in the catchment of the sluice gate. The proposed embankment will not impede the functioning of the beel, as it is not impeding the connection between the beel and the Brahmaputra River. The other wetlands located in the subproject area is Maguri-Motapung Beel in Tinsukia District, which is approximately 3.07 kilometers from nearest subproject site/intervention and shall thus not be affected by the proposed project activities.

359. With the flood protection measures in place, farmers may use more fertilizers and grow more crops in the fields. The fertilizers and pesticides could reach the wetland as the land slopes towards the latter. This increases the tendency of eutrophication in the wetlands. The flood water is essential to the wetlands for flushing the pollutants in the wetlands.

360. **Mitigation Measures**. Since, various terrestrial and aquatic wildlife species depend on the wetlands, due care shall be taken to ensure that no direct or indirect impact like siltation or flow of waste/debris is caused to any wetland located in the close vicinity of project construction activities.

(xii) Water Quality

Construction Phase

361. **Impacts**. The major source of surface water pollution during project construction phase in the Dibrugarh subproject area will be sewage and wastewater generated from labor camps as well as workshop areas. The project implementation period is estimated for a period of 6 years. The contractor is expected to hire the local unskilled and semiskilled laborers, while the bulk of the skilled labourers are expected to be migrant. For the outside labourers the contractor will establish a labour camp and it is expected that 100 – 200 laborers shall stay in each construction/labor camps. Central

Public Health and Environmental Engineering Organization (CPHEEO) recommends a maximum of 135 LPD (0.135 KLPD)[54] of water for domestic use. It can be safely assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 108 LPD (0.108 KLPD). However, it may pollute land and other nearby water bodies if discharged untreated, especially during the low flow season.

362. As per the primary monitoring data conducted by FREMAA no arsenic and floride pollution is noticed either in river water or groundwater in the Dibrugarh subproject area. Hence no impact of arsenic is anticipated.

363. As significant quantity of groundwater is not likely to be extracted as part of this project, any appreciable quantitative impact on groundwater because of the construction activities is also ruled out. In addition to that groundwater is easily available in 5 m BGL even during the lean periods. Impact on groundwater quality is not likely due to the project activities as the wastewater generated from the project will be trapped for treatment before it will discharge/ percolate from the project sites.

364. **Mitigation Measures.** Septic tanks shall be provided in each camp to treat the domestic sewage. Provision of mobile toilets also shall be considered with the provision of channeling the sewage to septic tank in a closed loop system. Discharge of untreated domestic sewage to the Brahmaputra River or to any natural waters will not be permitted. No debris shall be dumped in the water bodies like Maijan Beel and Brahmputra River.

Operation Phase

365. **Impacts.** No impact is anticipated due to the project in this phase.

(xiii) Climate

Construction Phase

366. **Impacts.** Short term impact in terms of minor increase in temperature may happen in the immediate vicinity of the embankment due to cutting of trees located within the project intervention zone in Dibrugarh subproject area. However, most of these trees and grasses belong to fast-growing species like Simul, Bamboo (grasses) and the like.

367. The impact of climate change screening is based on the geographic data set, compiled from the latest scientific information on current geological, climate and related hazards together with projected changes for the future where available. These data are combined with the project's sensitivities to hazard variables, returning information on the current and potential future risks is medium. High flood is expected in future.

368. **Mitigation Measures**. The maximum possible efforts must be made for minimizing cutting of the trees while designing the embankment. The project will adopt a policy of compensatory tree plantation of planting 10 trees against each tree cut this is over and above compensatory plantation as per the state government policy.[55] Special design consideration were made keeping water level rise due to climate change.

Operation Phase

369. **Impacts.** No direct impact is anticipated on the climate of the study area due to the proposed Dibrugarh subproject. However, changes in the catchments area of the river and extreme events due to possible climate change (global warming) can have indirect impacts on project and project

[54] Government of India, Ministry of Housing and Urban Affairs, Central Public Health and Environmental Engineering Organisation (CPHEEO). 1999. Manual on Water Supply and Treatment.

https://cpheeo.gov.in/upload/uploadfiles/files/3_40.pdf

[55] The rate of compensatory afforestation as per Assam Govt guidelines is 1:3.

area. With respect to the proposed project, climate change can play a major role due to its implications on water resources, water availability, and inland/freshwater wetlands.

370. During the AIFRERMIP tranche 2, India's Initial National Communication (Natcom 1) Project's data was studied to understand the climate change impacts on water resources of the entire country. It was found during the study that climate change impacts for inland wetlands depends on a number of variables which includes temperature increase, evaporation rate, precipitation changes in the catchment area etc. and is a very complex issue. It was established that an increase in temperature shall alter the thermal cycles of lakes, oxygen solubility and other compounds, and thus affect the ecosystem and thus an increased evaporation of water and reduced inflow from rainfall could damage the wetlands.

371. General Circulation Model (GCM) projections (by HadCM2) for India indicate an increase in precipitation by up to 30% for the north-eastern region in addition to a relatively moderate increase in temperature of about 2°C by the period 2041-2060. This could increase the incidence of flooding in the Brahmaputra basin. Since, there are divergent views on the above findings; these cannot be taken into consideration for any design change at this stage till more specific and dependable information related to climate change effect on river hydrology in this region is available.

372. **Mitigation Measures**. The likely impact framework shown above is generalized. However, more information needs to be collected based on newer studies and monitoring data. The flood pattern needs to be closely analyzed during proposed life span of the embankment and take appropriate timely protective measures in case the flood levels increase due to climatic changes.

(xiv) Air Quality

373. **Impacts**. The ambient air quality of the Dibrugarh subproject area is good and the levels of $PM_{2.5}$, PM_{10}, CO, SO_2 and NO_2 are under the limits as per National Ambient Air Quality Standard (NAAQS) for air pollutants as per Table 5-18. While various construction activities will increase the ambient air quality, but the level is likely to remain within the prescribed standards.

374. During the construction phase, there will be two main sources of air emissions, i.e., mobile sources and stationary sources. Mobile sources are mostly vehicles involved in construction activities, whereas emissions from stationary sources include construction equipment and machinery, batching plants, diesel generator sets, excavation/grading activities etc. In addition to these, fugitive emissions will also form a major proportion of air pollution in the form of particulate matter from storage and handling of construction material.

375. Fugitive dust sources associated with construction phase include vehicular traffic generating fugitive dust on paved and unpaved roads and aggregate handling.

376. The emission of particulate matter during the construction phase will be generated from the activities like clearing and grubbing, earthworks, movement of stone aggregates, road dust emissions etc. In addition to that emissions from various construction machinery fueled by diesel and from mobile source will be in the form of PM_{10}, VOC, CO, NO_x and SO_2. The emissions from stationary and mobile diesel engines with respect to their working/movement are presented in table below:

Table 6-2: Exhaust Emissions for Stationary and Mobile Machinery

Source	PM_{10}	VOC	CO	NO_X	SO_2
Diesel Exhaust emissions (idle)	0.043 g/min	0.208 g/min	1.57 g/min	0.917 g/min	18.8 g/l
Diesel Exhaust emissions (idle)	0.4 g/mile	3.18 g/mile	18.82 g/mile	8.5 g/mile	18.8 g/l

Source: ADB. India: AIFRERMIP Project 2, IEE Report (Palasbari Subproject - Palasbari and Gumi Reach, Kamrup District). May 2018 https://www.adb.org/sites/default/files/project-documents/38412/38412-033-iee-en_6.pdf

377. **Mitigation Measures**. Batching plants shall be located away from the populated areas of Dibrugarh and Tinsukia subproject areas and be fitted with the air pollution control devices, the emission shall meet Pollution Control Board standards. Further, the batching plants must be sited at least 1 km in the downwind direction from the nearest human settlement.

378. It shall be ensured that the dust emissions from the crusher and vibrating screen of the stone quarries, if new ones are opened and operated for the project, do not exceed the standards. For procurement of the material from the market/third parties the contractors shall ensure that the material is procured from the legal complaint sources. The compliance certificates (i.e., valid CTO of crusher, EC of mines etc.) of the approved third parties shall be submitted to the Engineer by the contractor before commencing the procurement of material.

379. Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing road. Water may be sprayed on earthworks, on a regular basis. During and after compaction of the sub-grade, water will be sprayed at regular intervals to prevent dust generation.

380. The following mitigation measures will also be taken to mitigate the dust entrainment and fugitive emissions from the various sources in the Dibrugarh subproject area:

- Covering of loads in trucks, and the paving of access areas are examples of preventive measures. Mitigation measures including sprinkling of the on the dust prone work areas and construction yard with water is recommended at regular interval to arrest dust
- Redistribution of loose material onto the travel lanes will produce a short-term increase in the emissions. In general, preventive controls are usually more cost effective than mitigation controls
- Regular maintenance of machinery and equipment will be carried out
- Ambient air quality monitoring shall be carried out during construction and the first 3 years of operation phase as per the Environmental Monitoring Plan (EMoP) through National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited/MoEF&CC recognized laboratories and the test reports shared with the Engineer and reported in the periodic Environmental Monitoring Reports (EMR). If monitored parameters are above the prescribed limits, suitable control measures must be taken
- Care shall be taken to keep all material storages adequately covered and contained so that they are not exposed to situations, where winds on site could lead to dust/particulate emissions
- Fabrics and plastics for covering piles of soils and debris is an effective means to reduce fugitive dust from the material stores/warehouses
- Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled materials do not become a source of fugitive emission
- All slopes and embankments will be turfed as per best engineering practices to help minimize the dust generation during operation. Plantation along the embankment shall be maintained. AADB shall pilot the NbS on the selected embankments under this project and the model will be replicated at a later date
- Speed restrictions shall be maintained for the construction vehicles while travelling on unpaved roads. The contractor shall also maintain the access roads regularly by way of (a) paving or (b) adding gravel or slag to a dirt road

Operation Phase

381. **Impacts.** The prime source for air pollution during operation phase will be the vehicular movement on the road around the Dibrugarh subproject area, which will be used for transportation by general public as well as for maintenance of the embankment. However, during the operation

phase, the roads and embankments will be strengthened and will be covered with turf and construction of paved roads by PWD will reduce the fugitive emissions. Due to all these developments, impact on air quality during operation phase will beneficial.

382. **Mitigation Measures.** Plantation along the new closegap embankment at Maijan Beel and existing embankment constructed under ADP project AIFRERMIP and turfing on the embankment slopes should be maintained, and their survival rates should be monitored. In addition to that regular maintenance of the road on the top of existing embankments as well as connecting roads shall be done for reducing fugitive emissions.

(xv) Noise

Design and Construction Phase

383. **Impacts.** During construction phase, noise will be generated from various activities such as clearing and grubbing, excavation, earthworks, borrow works, etc. The general noise levels during construction phase such as due to working of heavy earth moving equipment and machineries installation may sometimes go up to 100 dB(A) or more at the work sites. As per the proposed plan and given the nature of the work, manual labor is likely to be preferred with limited use of machinery.

384. Considering expected noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point. As per studies conducted for AIFRERMIP Tranche II, an increase in noise levels due to operation of various construction equipment is expected to increase the noise level from 100.3 dB (A) at a distance of 1 m to 52.4 dB (A) at a distance of 250 m from the sources. The increase in noise levels due to operation of various equipment is presented in table below.

Table 6-3: Increase in Noise Levels due to Operation of various Construction Equipment

Distance (m)	Ambient Noise Levels dB (A)	Increase in Noise Level dB (A)	Increase in Ambient Noise Level dB (A)
1	51.0	100.3	49.3
10		80.3	29.3
50		66.3	15.3
100		60.3	9.3
150		56.8	5.8
200		54.3	3.3
250		52.4	1.4

Source: ADB. India: AIFRERMIP Project 2, IEE Report (Palasbari Subproject - Palasbari and Gumi Reach, Kamrup District). May 2018 https://www.adb.org/sites/default/files/project-documents/38412/38412-033-iee-en_6.pdf

385. In addition to the above, there will be significant increase in vehicular movement for transportation of construction material. At present, vehicular movement near the project site near Dibrugarh town comprises predominantly of two wheelers and some single axle vehicles (mainly official/private vehicles). During construction phase, the increase in vehicular movement due to movement of construction vehicles is expected to increase multifold as major activities are in the vicinity of the Dibrugarh town area. The number of vehicles in subproject sites other than Dibrugarh town, presently are a lesser than Dibrugarh town as these sites are away from the town area. The increase of construction vehicles shall though increase but lesser than Dibrugarh town area. However, some movement of the construction materials is proposed to take place through the river using barges which shall be procured by WRD.

386. During construction phase, thus an increase in noise level is expected. However, the increase in noise levels will be localized, temporary in nature and mostly will be during daytime only.

387. **Mitigation Measures.** Following noise control measures shall be adopted, and included in the civil work contracts:

- Site Controls: Stationary equipment shall be placed along uninhabited stretches meeting the National Noise Quality standard, particularly for residential areas (Category C) and silence zones (Category D: hospitals, educational institutions, courts, religious places, etc.). In case the noise levels are not meeting the norms, the Engineer shall guide the contractor to adopt and establish the required measures as per the norms and as stipulated in the EMP; (i) maintain the required distance of least 150m (Category C) and 250m (Category D), (ii) to make use of appropriate temporary noise barriers especially near noise sensitive receptors identified near the construction zone
- Construction activities shall be prohibited between 9.00 pm and 6.00 am near residential areas throughout the subproject stretch
- Appropriate PPE devices like ear plugs or ear muffs will be provided to the workers operating in the vicinity of high noise generating machines
- Construction equipment and machinery shall be fitted with silencers and regularly maintained
- Regular noise monitoring measurements shall be carried out as per the EMoP during the construction period and 1st year of the operation phase
- Use of manual labor where ever feasible over machines shall be encouraged

Operation Phase

388. **Impacts**. The prime source of noise pollution during operation phase will be the vehicular movement. However, as the roads will be paved and will provide smooth traffic movement, the impact due to vehicular movement will be less significant.

389. **Mitigation Measures**. Adequate signage shall be provided restricting the use of pressure horn particularly in near noise sensitive locations e.g., schools, hospitals and populated areas. Noise measurements shall be carried out along the road to ensure the effectiveness of mitigation measures. Tree barriers between the road and village, semi urban and urban area shall be developed in a layered manner as suggested under air environment mitigation measures.

(xvi) Terrestrial Ecology

- **Disturbance to Vegetation**

Design and Construction Phase

390. **Impacts**. There would be no major impact on terrestrial flora except cutting of trees during project intervention in the Dibrugarh subproject area. There is no diversion of forest land. There is 1 notified protected area (Dibru - Saikhowa NP) within 1 km of the project intervention areas in Dibrugarh District and 2 PAs in Tinsukia District (Dibru - Saikhowa NP and Bherjan-Borajan-Podumoni WLS) within 1 km and 5 km of the project intervention areas. No negatve impacts are envisaged on any of the PA as the proposed works shall be beneficial in arresting the erosion of the PA areas. The natural terrestrial ecosystem has already been damaged by the heavy floods and erosions in the past in this area. The present vegetation is primarily planted by the locals and can be easily compensated by afforestation program. It is expected that with the compensatory plantation of 1:10 and prevention of further destruction of vegetation from erosion due to the project interventions, the proposed project shall help to improve the terrestrial biodiversity of the area.

391. The major species that are likely to be affected in the Dibrugarh subproject area are Semal (*Bombax ceiba*), Teak (*Tectona grandis*), Jackfruit (Artocarpus heterophyllus), Betel nut (Areca catechu), Date (*Phonix sylvestris*), Banana (*Musa sp*.), Coconut (*Cocos nucifera*), Peepal (*Ficus religiosa*), Cluster Fig (*Ficus glomerata*), Kadamb (*Anthocephalus cadamba*), Arjun (*terminalia*

arjuna), *ziziphus mauritiana*, Mango (Mangifera indica), various species of bamboo (*Bambusa balcooa, Bambusa tulda, Melocanna hamiltonii*, *Dendrocalamus giganteus*) *Plectomia assamica, Plectomia bractealis, Cassia sophera* etc.

392. **Mitigation Measures**. Efforts shall be made to minimize the tree loss. Provision shall be made for planting trees in a ratio of 1:10 per tree cut. Plantation program shall run parallel to the construction activity. Indigenous and existing vegetation like those impacted including various species of Bamboo, Jackfruit, Ficus, Mango and Semal shall be preferred. Afforestation shall be undertaken with community participation.

Operation Phase

393. **Impacts.** No direct impact is anticipated during operation stage except accidental damages or absence of tree management.

394. **Mitigation Measures.** Arrangement shall be made for effective tree management to ensure survivability of the tree plantation. AADB along with the social forestry wing of the Forest Department may be involved in this program. A tree survivability audit shall also be conducted at least once in a year to assess the effectiveness of the program.

(xvii) Habitat Fragmentation and Destruction

Construction and Operation Phase

395. **Impacts and Mitigation Measures.** No habitat fragmentation and destruction are envisaged due to the project activities in the Dibrugarh subproject area. The construction of sluice gate at closegap embankment at Maijan Beel shall not fragment the aquatic habitat as normal flow of the water in the channels shall not be obstructed and the purpose of the sluice gate is to drain the rainwater from the countryside during monsoon. Thus, no measures are proposed.

(xviii) Animal Distribution/Migratory Route

Construction Phase

396. **Impacts.** There may be migratory route of mammalian wildlife species in the project stretch and thus some impacts are envisaged like man animal conflict (distruction of standing crops, hutments etc.,). Winter migratory birds are reported at Maijan Beel in Dibrugarh District within the vicinity of the subproject area. Winter migratory birds are also reported in Maguri-Motapung Beel in Tinsukia District but the beel is at sufficient distance from the proposed subproject area. Winter migratory birds may also use the riverine charland/islands/sand bars and some impacts may be envisaged like poaching by construction laborers. River Dolphins and other aquatic animals use the river for movement from one stretch to other. The river Dolphins are reportedly found mainly in the main channel of the Brahmaputra River and the proposed anti-erosion and flood protection works shall be limited within 30m of the riverbanks. However, river Dolphins have developed a unique side swimming behaviour which is an adaptation to help them navigate through shallow waters, thus, it may be likely that these Dolphins can occasionally go within 30 m of the riverbanks[56], during the lean season, and thus get impacted by the construction works. No impacts are envisaged, even if the river Dolphins enter the secondary channels close to the riverbanks. The only impacts that are probable are that of accidental hitting by the barges that shall carry materials for the project and being stuck in the shallow waters. However, the Dolphins have capacity of echolocation as validated by Herald, E. S., et al (the same paper referred in the footnote) and hence the probability of the Dolphins getting accidentally hit by the barges is very low. Similarly, the probability of getting stuck

[56] Herald, E. S., Brownell, J. R. L., Frye, F. L., Morris, E. J., Evans, W., E., & Scott, A. B. (1969). Blind river dolphin: first side-swimming cetacean. Science, 166, 1408-1410.

in the shallow water near the banks is also less. No or minimal impacts on the movement and migration routes of the aquatic animals and avifauna are envisaged.

397. **Mitigation Measures**. In case of accidental trappings of the river Dolphin due to construction works in shallow water, the wildlife department shall be immediately contacted for necessary actions. Poaching, hunting, and fishing by the construction workers shall be strictly prohibited and awareness workshops for the laborers shall be conducted by the contractor. All care shall be taken to ensure that construction waste does not find its way to water and pollute it. Care shall also be taken to ensure that channels are not permanently obstructed during the construction period in any way outside the work zone. If river Dolphins are sighted in the secondary channels near to the riverbanks, during the construction period, works shall be temporarily suspended till the Dolphins move out into the main channel. The sightings of the Dolphins shall be recorded and the wildlife department shall also be intimated.

Operation Phase

398. **Impacts.** No impact is anticipated during operation stage with regards to animal distribution and migration.

(xix) Endangered Species

Design and Construction Phase

399. **Impacts.** No negative impact is anticipated on any endangered species as the works shall be restricted on the riverbanks.

400. As per information made available from IBAT [57], there are 99 IUCN red listed species within 50 km radius of the subproject areas in Dibrugarh District. These includes 17 CR (3 floral, 1 amphibian, 8 avian, 4 reptilian and 1 mammalian species), 30 EN (2 floral, 8 reptilian, 2 Pisces, 9 avian and 9 mammalian species) and 52 VU species (5 floral, 1 arthropodan, 1 amphibian, 5 reptilian, 7 fishes, 19 avian and 14 mammalian species). In case of Tinsukia District subproject areas based on the information made available from IBAT [58], there are 105 IUCN red listed species within 50 km. These includes 21 CR (7 floral, 1 amphibian, 8 avian, 3 reptilian and 2 mammalian species), 35 EN (3 floral, 7 reptilian, 4 Pisces, 9 avian and 12 mammalian species) and 49 VU species (5 floral, 1 amphibian, 4 reptilian, 6 Pisces, 18 avian and 15 mammalian species).

401. **Mitigation Measures**. In case of accidental trappings due to construction works or sightings of the endangered species, the wildlife department shall be immediately contacted for necessary actions. Poaching, hunting, and fishing by the construction workers shall be strictly prohibited and awareness workshops for the laborers shall be conducted by the contractor. All care shall be taken to ensure that construction waste does not find its way to water and pollute it. Care shall also be taken to ensure that channels are not permanently obstructed during the construction period in any way outside the work zone.

(xx) Aquatic Ecology

- **Effect on Fishing Activities/productivity**

Design and Construction Phase

402. **Impacts.** There are no major fish landing sites in the Dibrugarh subproject area hence fishing activities and productivity will not be disturbed during the project implementation period. Locals were

[57] IBAT Proximity Report. Generated under license 5840-42026 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

[58] IBAT Proximity Report. Generated under license 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

found to be fishing on the bank of the river with bamboo poles and nets and also using boats to lay nets across the smaller channels. Temporary flushing of the fish species towards the deeper part of the river may happen during the anti-erosion and flood protection works. The construction work will not affect the fish activity in the river as they move with the river current. The construction activity may increase the turbidity on the bank temporarily, however the impact is temporary and reversible.

403. **Mitigation Measures**. Adequate provision shall be made in the design to ensure access to the temporary ghats. Adequate requisite facilities shall be restored or maintained for undisturbed movement of the fisherman. During the construction, the contractors must provide a clear signage to guide which areas that fishing boat should not pass by or make a temporary landing.

Operation Phase

(i) **Impacts.** No impact is anticipated during operation stage with regards to fish activities.

- **Effect on Riverine Dolphins**

Construction Phase

404. **Impacts.** The primary studies conducted at the eight identified reaches for anti-erosion and flood protection works under the proposed Dibrugarh subproject have noted from the local fishermen that the river dolphins are reported within 1 km at four reaches out of twelve. The dolphin sightings 100 to 1 km of the riverbank at Chaulkhowa, Milanpur to Hatighuli, Maijan reach-2, Simalugutisara (within 100 m) and ADB T1 Mothala. A technical study report for IUCN estimated 25 dolphins at the best in between Assam boarder to Balijan stretch of the Brahmaputra River (where the subproject district of Dibrugarh and Tinsukia are located).[59] The river Dolphins are reportedly found mainly in the main channel of the Brahmaputra River and the proposed anti-erosion and flood protection works shall be limited within 30m of the riverbanks. However, river Dolphins have developed a unique side swimming behaviour which is an adaptation to help them navigate through shallow waters, thus, it may be likely that these Dolphins can occasionally go within 30 m of the riverbanks, during the lean season, and thus get impacted by the construction works. No impacts are envisaged, even if the river Dolphins enter the secondary channels close to the riverbanks. The only impacts that are probable are that of accidental hitting by the barges that shall carry materials for the project and being stuck in the shallow waters. However, the Dolphins have capacity of echolocation as validated by Herald, E. S., et al (the same paper referred in the footnote) and hence the probability of the Dolphins getting accidentally hit by the barges is very low. Similarly, the probability of getting stuck in the shallow water near the banks is also less. No or minimal impacts on the movement and migration routes of the aquatic animals and avifauna are envisaged.

405. **Mitigation Measures**. Works shall be limited to 30m from the riverbanks into the low flow level (LFL) of the river channels. The reported sightings of the dolphin are at a distance and away from the riverbanks mainly in the main channel of Brahmaputra River. In case river Dolphins are sighted in the secondary channels near to the riverbanks, during the construction period, works shall be temporarily suspended till the Dolphins move out into the main channel. No works are to be done during the monsoon season. In case of accidental trappings of the Dolphins due to construction works, the wildlife department shall be immediately contacted for necessary actions. The sightings of the Dolphins shall be recorded, and the wildlife department shall also be intimated.

[59] Wakid, A. and Braulik, G. (2009): Protection of endangered Gangetic dolphin in Brahmaputra River, Assam, India. Final report to IUCN-Sir Peter Scott Fund. Pp 44.

(xxi) Migratory Routes

Design and Construction Phase

406. **Impacts.** There is no migratory route of fishes in the Dibrugarh subproject area, which can be affected due to the proposed project. The migratory fish species like Hilsa (anadromous) [60] and Anguilla (catadromous) [61] migrate through the main channel of the river i.e., through the deeper zones of the river. Therefore, project will not have any impact on the migratory route of these fishes. Other fish species like *Crossocheilius spp., Tor spp.* also show only local migration from upper to lower reaches of the river, but these also normally migrate in the deeper zone of the river. The construction works involved in the project will not have any effect on the migratory routes.

(xxii) Effect on Spawning and Breeding Grounds

Design and Construction Phase

407. **Impacts**. Studies conducted during the AIFRERMIP project have observed that all fish species do not breed in same place. Breeding grounds varies from fish to fish as well as location. It has been reported in the AIFRERMIP project IEE reports that most of the riverine smaller fish species, prefer the shallow courses of river for breeding and spawning. Some fish species like *Channa* spp., Labeo spp. and major carps prefer wetlands and beel for breeding. Fish spawning seasons also vary from fish to fish. However, most normal seasons for almost 80% of fish species starts from April and ends in August (i.e., during pre-monsoon and monsoon seasons).

408. Increase in siltation due to construction activity in the Dibrugarh subproject area particularly during the breeding season, may disturb the breeding activities. However, anti-erosion works shall primarily be executed in the riverbed and LFL area during the winter season.

409. **Mitigation Measures.** The construction of the anti-erosion works in the Dibrugarh subproject area shall primarily be executed in the riverbed and LFL area during the winter season. The construction activity in the riverbed shall be prohibited during the breeding period of April to August. All care shall be taken to ensure that construction waste does not find its way to water in these area and cause pollution.

Operation Phase

410. **Impacts.** No impact is anticipated during operation stage with regards to fish activities.

(xxiii) Effect on Pond Fisheries

Design and Construction Phase

411. **Impacts**. No pond fisheries activities were found along the proposed project intervention area. However, pond fisheries are found in the study areas in Dibrugarh and Tinsukia Districts. The current productivity of these places is low. Once flood scenario is stabilized, siltation problems will be minimized, and the fish productivity of these areas will be improved.

412. **Mitigation Measures.** The fish productivity can be improved substantially with use of better fish culture and increasing the capacity of fishponds as well institutional strengthening support. Fish productivity audit may also be undertaken to assess the effect of institutional support.

[60] Migration of fish from sea to fresh water for breeding.

[61] Fish that lives in fresh water and breeds in sea.

(xxiv) Socio Economic

Construction and Operation Phases

413. **Impacts and Mitigation**. A large number of households are affected by flood and erosion. The proposed project will bring relief to the entire population in this Dibrugarh subproject area. The subproject will also provide employment to a large number of people during the construction period and thus will boost the local economy as small businessmen and entrepreneurs will provide the daily needs of the workers and officers of the proposed subproject.

414. With the stabilization of the area and prevention of land loss due to erosion every year, land availability for multiple crops will increase bringing positive impact on the local economy. Since the Dibrugarh subproject interventions shall have a positive impact on the socio economics of the area, no mitigation measures are warranted.

(xxv) Land Acquisition and Resettlement

Design, Construction and Operation Phases

415. **Impacts.** The land acquisition and resettlement impacts are likely triggered in both the anti-erosion works, flood protection works, and the new embankment constructions involving both legal title holders and squatters.

416. **Mitigation Measures**. The Resettlement Plan (RP) prepared parallelly for the Dibrugarh subproject shall cover the details of the households likely to be affected and compensation to the affected persons as applicable per ADB SPS, national and state laws.

(xxvi) Social conflict

Construction Phases

417. **Impacts.** Most of the unskilled and semi-skilled workers will be from the local areas with some skilled migrant workers for which contractor may establish a labor camp. They may conflict in culture and lifestyle and compete with local laborers over some job opportunities and may also create potential health issues such as HIV/AIDS.

418. **Mitigation Measures.** Early consultations will be made by the contractor with the local communities of the Dibrugarh subproject area to determine the appropriate location of work camp sites. The contractor shall ensure that all migrant laborers are housed in the labor camps. Preference shall be given to locals for employment as unskilled and semi-skilled workers. All migrant workers will undergo workshop/briefings to sensitize them on local culture and lifestyle awareness. Appropriate measures for addressing potential health issues such as HIV/AIDS shall be taken as stipulated in the EMP.

(xxvii) Establishment and Operation of Construction Camps and Workers Facilities

419. **Impacts.** It is likely that the contractor may employ some skilled workers from outside subproject area, and therefore may provide temporary workers accommodation during the construction phase. Proper provision and maintenance of facilities is necessary for proper living conditions and avoid health, environment, and safety issues. Workers camps may also pose adverse impacts on surrounding communities. Operation of construction camps can cause temporary air and noise pollution from machine operation, water pollution from storage and use of fuels, oils, solvents, and lubricants. Potential impacts are negative but short-term and reversible by mitigation measures.

420. **Mitigation Measures.** Ensure conditions of livability at work camps established for the Dibrugarh subproject area are maintained at the highest standards possible at all times; living quarters and construction camps shall be provided with standard materials (as far as possible to use portable ready to fit- in reusable cabins with proper ventilation); thatched huts, and facilities

constructed with materials like GI sheets, tarpaulins, etc., shall not be used as accommodation for workers; accommodation shall meet the IFC standards for workers accommodation[62] which include: provision of safe housing, availability of electricity, plumbing, water and sanitation, adequate fire protection and dormitory/room facilities; accommodation shall be in the range from 10 to 12.5 cubic meters (volume) or 4 to 5.5 square meters (surface) per worker, a minimum ceiling height of 2.10 meters; a reasonable number of workers are allowed to share the same room – (standards range from 2 to 8 workers); workers with accompanying families shall be provided with a proper and safe accommodation. Prohibit employees from poaching wildlife and cutting of trees for firewood;

(xxviii) Establishments

Design and Construction Phase

421. **Impacts**. A number of houses and establishments are located close to the proposed project interventions in the Dibrugarh and Tinsukia Districts and some shall be directly impacted and may be required to be relocated. The RP prepared for the subproject shall cover the details of the properties likely to be affected and compensation to the affected properties as applicable per ADB SPS, national and state laws. Various educational, physical, or religious properties are located close to the subproject area and may be affected partially or fully due to project. The summary is provided in Table 6-4 below:

Table 6-4: Educational and Religious properties Imapacted in Subproject interventions

Facility	Impacted
Dibrugarh	
Religious Structure (Temple, Shrine, Mosque, etc.)	8
Government Structure (School and govt. offices etc.)	2
Subtotal	**10**
Tinsukia	
Namghar (Prayer halls)	8
Other Religious (Chabutra and shrines etc)	3
Subtotal	**11**
Total	**21**

Source: Project Census Surveys, 2023

422. **Mitigation Measures**. Efforts shall be made to prevent any relocation or demolition of these establishments, unless absolutely required. Where required, the social infrastructure shall be rehabilitated taking account of social and cultural values in consultation with the local community and district/local administrations. Temporary noise barriers will be installed close to school and place of worship during the construction stage at Dibrugarh subproject.

(xxix) Archaeological Sites to be impacted

423. **Impacts.** There is no ASI protected archaeological sites located within 500m of the proposed subproject reaches in Dibrugarh and Tinsukia Districts and thus there shall be no impact due to the proposed project interventions.

424. Any chance findings shall be immediately reported to the PIU, PMU and district administrations and necessary measures directed by the Engineer shall be implemented. A chance find protocol shall be prepared (sample is provided in Appendix 12).

[62] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_workersaccommodation

(xxx) Places of Pilgrimage and Tourism to be impacted

425. There is no pilgrimage or tourist spot along the Dibrugarh subproject intervention area. In fact, with the strengthening of flood protection and anti-erosion works and improvement of roads and embankment will have positive impact on the accessibility of the villages along the reach.

(xxxi) Water Supply and Sanitation

Design, Construction and Operation Phase

426. **Impacts**. Local residents, except for the people residing in Dibrugarh town are dependent on groundwater for meeting their drinking water supply. The quality of groundwater in the project reach was found fit for drinking purposes. They do though use the river water for other domestic purposes including washing and bathing. The proposed subproject activities are not likely to affect the water supply of the area.

427. Sanitation facilities are poor in the Dibrugarh subproject area especially in the rural areas. People residing near the embankments usually go to the riverbank for their daily needs. Drinking water and sanitation becomes one of the major problems during floods. Another problem in the embankment construction is that it complicates the draining of runoff water from the countryside to the riverside. Several points along the existing embankment in subproject area also used as unauthorized disposal site for plastics, bottles and other municipal solid wastes. The need for disposal sites should be considered in the design of the embankment. The geo-bags and other material used by the WRD as emergency flood protection measures needs to be properly disposal.

428. **Mitigation Measures.** Awareness should be created among the residents about the upkeep of the embankment. Garbage generated during construction and especially at construction camps shall be collected at designated locations. The contractor may tie up with the local municipal authorities for disposal of the municipal wastes. Incineration of wastes shall be prohibited. Construction labor camps shall have toilets along with septic tanks. The proper disposal of the geo-bags and other material used earlier by WRD as temporary anti-erosion and flood protection measures shall be ensured contractor as stipulated in the EMP. During operation phases, encroachment and squatters shall be prevented by WRD with active assistance of the district administration.

(xxxii) Accidents and Safety

Design and Construction Phase

429. **Impacts.** The risks associated with the proposed Dibrugarh subproject are minimal. However, roads being narrow near the subproject interventions, efforts shall be made that no hazardous traffic conditions are created due to construction vehicle movement. Locals may out of curiosity crowd around the construction camp and zones and get hurt.

430. **Mitigation Measures.** The construction zones and the camps in the Dibrugarh subproject area shall be barricaded, and proper fences provided. Drivers shall be provided adequate trainings to drive in narrow roads. Adequate lighting and signage (including road signages) to be provided at the construction sites to aware the locals of the dangers. All signage shall be in multiple language (Assamese, Hindi/Bengali besides English, if Engineer desires). Speed limits shall be prescribed for construction vehicular movement on the access road to avert the accidents.

431. The workers shall be provided with necessary personal protective equipment and a firstaid unit including adequate supply of dressing materials, transport means, nursing staff and an attending doctor, shall be available at each construction site. Regular health checkup camps to be organized at a frequency defined in EMP. Mandatory health checkups of laborers to be done during joining and periodically during the construction phase.

Operation Phase

432. **Impacts.** Due to improved road condition and development of road on the new embankment constructed in the Dibrugarh subproject area, drivers may have tendency to drive fast on embankment road resulting in accidents.

433. **Mitigation Measures.** Speed limits shall be prescribed for vehicular movement on the embankment road to avert the accidents. Adequate signage and light reflectors shall be placed along the roadside.

(xxxiii) Navigation

Design and Construction Phase

434. **Impacts.** This river section under Dibrugarh subproject area is navigated by people for moving from one place to another located at riverbank and moving to char lands for fishing and farming. They use small motorboats and fish landing sites or ghats for these movements. These landing sites/ghats could be temporarily disturbed due to project activities. However, there will not be any impact on the general navigability of the river due to the project since subproject activities are limited to riverbank and beyond.

435. **Mitigation Measures.** During construction phase, contractors shall provide alternate landing sites (ghats) with berthing facilities, access, and other common infrastructure, as part of the tender documents. In places the riverbank protection will provide steps to facilitate landing of local boats in support of trade and river crossings in Dibrugarh subproject.

(xxxiv) Occupational Health and Safety Plan due to COVID-19 Pandemic

436. **Impacts.** Though the effect of COVID-19 pandemic has subsided in India, but the threat remains that the COVID-19 outbreak may reoccur. In case of recurrence of the COVID-19 outbreak the local community members involved in project activities may be at a heightened risk of virus exposure.

437. **Mitigation Measures.** Project shall also adhere to necessary protocols in response to infectious diseases such as the corona virus disease (COVID-19) consistent with the guidelines of relevant government healthcare agencies and the World Health Organization. Ensure that the Dibrugarh subproject related staff at all levels are appropriately vaccinated. Ensure project staff, consultants, contractors, and workers have in their mobile devices the Aarogya Setu App, which is a mobile application developed and recommended by the Government of India to proactively reach out to and inform the users of the app regarding risks, best practices and relevant advisories pertaining to the containment of COVID-19. In case of the recurrent outbreak of the pandemic mandatory isolation of the personnel or workers, either asymptomatic or showing symptoms, who have had direct contact with anyone tested positive for COVID-19. The isolation procedures issued by the government shall be followed along with proper disposal of used PPE following guidelines and procedures issued by the government.

B. Summary of Impacts

438. Almost all the impacts are occurred during the construction period and the physical intervention associated with the civil works are not significant, therefore, the environmental impacts are temporary and reversible. With implementation of proposed mitigation measures, most of the impacts will be minimized, and no residual and cumulative impact is expected.

VII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Overview

439. The active participation of stakeholders including local community, NGOs/CBOs, and the media in all stages of project preparation and implementation is essential for successful implementation of the project. It will ensure that the subprojects are designed, constructed, and operated with utmost consideration to local needs, ensures community acceptance, and will bring maximum benefits to the people. Public consultation and information disclosure are a must as per the ADB policy.

440. Most of the main stakeholders have already been identified and their representatives consulted during preparation of this IEE, and any others that are identified during project implementation will be brought into the process in the future. Primary stakeholders in the subproject are local residents, farmers, shopkeepers, and business people who reside and work nearby embankments of Brahmputra River, particularly where anti-erosion and river protection works are proposed under this subproject. The secondary stakeholders are the government and utility agencies responsible for provision of services in project area, PCBA, Forest and Wildlife Department, Agriculture and Fisheries departments, Brahmaputra Board, Assam Inland Waterways Transport Development Society (AIWTDS), Assam Rural Infrastructure and Agricultural Services (ARIAS) Society, Assam Agribusiness and Rural Transformation Project (APART), Assam Project on Forest and Biodiversity Conservation Society (APFBCS) etc., NGOs and CBOs working in the area (i.e. BOSCO Reach Out (Don Bosco), TERI-NERC, Aide et Action and Gramya Unnayan Sanstha). Both primary and secondary stakeholders were consulted during the preparation of this IEE.[63]

441. Public consultation meetings were held at few of the project intervention locations that are proposed under this subproject. Consultations with the inhabitants of the subproject area were carried out through March 2023 and April 2023 at Borasokia Gaon Dibrugarh, Maijan Village Dibrugarh, Khamti Guwali, Tinsukia, Dighal Tarang, Kardoiguri, Khamti Gohali, with exclusively with local women group and general population. Stakeholder's consultations were also held on in between February - April 2023 with the Forest and Wildlife department, Pollution Control Board Assam, Agriculture and Fisheries department, Botany and Zoology departments of Guwahati University, Chief Wildlife Warden and Member Secretary of Assam Biodiversity Board.

B. Public Consultation

442. ADB's SPS requires that FREMAA carry out consultations with affected people and other concerned stakeholders and facilitate their informed participation. Meaningful consultation goes beyond information disclosure. It involves two-way communication between FREMAA and the affected communities and stakeholders, and active participation of affected communities and stakeholders in project design and implementation. Consultations includes presentations on environmental impacts, benefits, mitigation measures and project interventions.

443. The public consultation and disclosure program are a continuous process throughout the project implementation, including project planning, design and construction.

1. Consultation during Project Preparation

444. Institutional consultations were conducted with the relevant governmental departments such as, Forest and Wildlife Department, Guwahati University, Brahmaputra Board, AIWTDS, ARIAS, APART and APFBCS. The subproject proposals are formulated in consultation with WRD, FREMAA

[63] including various departments of Guwahati University, community in general, forest and wildlife department, fisheries and agriculture department, PCBA, the executing and implementing agencies (FREMAA, WRD, AADB,).

and AADB officials, concerned district administration, and local administrative bodies to suit their requirements.

445. **Focus-group discussions** with affected persons and other stakeholders were conducted to learn their views and concerns over the proposed subproject. A socio-economic household survey has been conducted in the subproject area, covering sample households, to understand the household characteristics, health status, and the infrastructure service levels and their demand. General public who are the people residing along the target subproject activity areas were consulted during visits. Formal panchayat-level consultation meetings were conducted in April 2023 in the subproject areas. Besides, several other meetings also conducted at village-level with communities. The details of consultation are provided in Appendix 9. Main issues discussed are:

(i) Brief introduction about the Project components
(ii) Benefits of Project for the economic and social upliftment of Community
(iii) Labour availability in the Project area or requirement of outside labour involvement
(iv) Possible environmental Impacts due to the project activity
(v) Local disturbances due to Project Construction Work;
(vi) Necessity of tree felling etc. at project sites
(vii) Challenges during flooding season if any
(viii) Climatic Conditions
(ix) Movement of wild animals and elephant corridor
(x) Forest and sensitive area nearby the project site
(xi) Dolphin habitat
(xii) Fish caught in their net
(xiii) Pollution level during construction period specially dust and noise pollution
(xiv) Health and Hygiene
(xv) Safety of residents during construction phase
(xvi) Solid waste disposal system and
(xvii) Requirement of enhancement of other facilities and discussion about ghat.

446. In line with the ADB's requirements, consultations were conducted with key stakeholders and community people pertaining to environmental and social considerations. These consultations helped in identifying felt needs/concerns and apprehensions of the communities related to the subproject and their priorities. Consultations were held with stakeholders including temporarily affected persons, farmers, beneficiaries/local people, poorest of poor households (non-titleholders on government land), gram panchayat pradhans, panchayat members/public representatives, FREMAA, WRD engineers and field staff.

447. Public consultation meetings were held at some of the subproject component locations and the Table 7-1 provides a summary of the locations, and participants in the consultation meetings. A total of 200 participants were present in the consultation meetings out of which 75.5 % were female participants. Summary of Stakeholder consultation are provided in Appendix 9.

448. Consultations were also held with various institutional stakeholders at their offices. Table 7-2 provides the details of the consultations, the issues and the suggestions provided by the stakeholders. Since the consultations are an ongoing procedure, the column related to issues, suggestions and request shall be updated on the progress of various requests and suggestions that may be received through official channels.

Table 7-1: Summary of Public Consultation Held for Subproject

Sl. No.	Date	Location	Total number of participants	Total number of female participants
1	31.03.2023	Borasoikia Gaon, Dibrugarh	19	18
2	31.03.2023	Maijan Village, Dibrugarh	33	18
3	03.04.2023	Khamti Guwali Tinsukia	61	53
3	12.04.2023	Dighal Tarang	13	1
4	12.04.2023	Dighal Tarang	13	13
5	12.04.2023	Kardoiguri-1	13	13
6	12.04.2023	Kardoiguri-3	10	10
7	12.04.2023	Kardoiguri-3	13	13
8	12.04.2023	Khamti Gohali	12	12
9	12.04.2023	Khamti Gohali	13	-

Source: LASA, 2023

Table 7-2: Consultations held with Institutional Stakeholders

Sl. No.	Name	Designation	Date	Issues, Suggestions and Requests
1	Mr Rajendra Singh Bharati IFS	Division Forest Officer (IFS) Doomdooma Tinsukia	5th June, 2023	• Was apprised about the project locations and its intervention • Was intimated absence of notified animal corridor in the proposed project locations • Suggested to prepare a mining plan for use of the river sand for the purpose of riverbank protection work. Was intimated that the same shall be undertaken by the contractor • Advised that the embankment be properly compacted as head experienced earlier embankments were damaged due to rain cuts resulting from improper compactions
2	Mr Khanindra Kalita,	ACF Dibrugarh Forest Division	3rd June 2023	
3	Mr. Biren Baishya	GIS Expert, Assam State Disaster Management Authority	24th April, 2023	• Apprised the project, project locations and interventions proposed • Advised, to follow the Flood Hazards Atlas for Assam State (1998-2015), A geospatial Approach. This is the latest published study and the next study on Assam flood is under process and will be published in 2024
4	Mr Sandeep Kumar, IAS	Chief Wildlife Warden and Member Secretary, Assam Biodiversity Board	25th April 2023	• The Chief Wildlife Warden was apprised about the project interventions in the subproject districts, and the warden welcomed the project • FREMAA requested to share kmz/ kml files of all notified protected areas (PAs) in the project districts • FREMAA requested to share the flora and fauna in the project districts especially outside the PAs and preferably along the Brahmaputra River

Sl. No.	Name	Designation	Date	Issues, Suggestions and Requests
				• The Chief Wildlife Warden requested for an official letter for flora and fauna data to initiate sharing of information. Also requested to apprise the procedure for obtaining necessary permissions for works if project sites are within 10km of PA (where ESZ are notified) • FREMAA requested for suggestions, if any for conservations of IUCN Red listed species (CR, EN and VU) and scheduled species. Warden will revert, and on learning about the project interventions, was optimistic that no negative impacts are envisaged on biodiversity
5	Dr. Niraj Agarwal,	Assistant Professor, Department of Botany, Guwahati University	25th April 2023	• The professor apprised about the project interventions in the subproject districts and welcomed the project • The professor suggested a consultancy cell run by the Geology department of the university who undertakes EIA and associated studies, where FREMAA may utilisze their services. FREMAA intimated that environmental study and reports are prepared with ADB's assistance and the services may be procured in future, if required • The assistant professor may share all relevant information and studies that have been done in the project areas
6	Dr. Kuldeep Sarma	Assistant Professor, Department of Zoology, Guwahati University	25th April 2023	• The Assistant Professor was apprised about the project interventions in the subproject districts and welcomed the project • He was happy to note that ecology especially aquatic ecology was considered for the study report as this is the most ignored section in IEE/EIA studies • He was interested in learning how various primary data are collected at field, and how these shall be analysed. There was an interest from the professor to know how the department can be involved with the project. However, there is an apprehension with the available studies and reports as these may be away from the reaches of proposed interventions • The Assistant Professor promised to share all relevant information and studies done in the project districts in the last 5 years • There shall not be any major negative impacts on the fauna (aquatic, riparian and terrestrial) due to the project

Sl. No.	Name	Designation	Date	Issues, Suggestions and Requests
				interventions according to the professor
7	Mr. M D Adhikary	Sr. Env. Scientist, Head, Water Section, Pollution Control Board Assam	4th April 2023	• The Sr. Env. Scientist was briefed about the project in details including project locations and interventions • He apprised that the water quality of the Brahmaputra River is satisfactory • He intimated that PCBA monitors the quality of the river every month at 11 different locations starting from upstream at Dibrugrah to downstream at Dhubri • Since April 2023, PCBA has added 2 more locations at upstream (Dholasodia at Tinsukia District) and downstream (Morinoi, Goalpara District) to monitor the water quality • Also intimated that turbidity had increased in the Brahmaputra River till Tinsukia section. However, the river water quality is normal.
8	Mr. Tarun Hararika	Deputy Director of Agriculture (B/A), Department of Agriculture and Horticulture, Directorate of Agriculture	6th April 2023	• The deputy director was briefed about the project • He welcomed the project's interventions in protecting land from erosion and advised to meet the concerned district officers of the department, as they have all the data of loss due to the flood in the respective districts
9	Mr. Ajim Ahmed	Pest Surveillance Officer, Department of Agriculture and Horticulture, Directorate of Agriculture	06th April 2023	• The officer was apprised and briefed about the project • He welcomed the project and stated that the project will help them to planning for agriculture activities as it will stop the erosion problem • He intimated that flood helps the farmer both positively and negatively, flood damage the agriculture during flood season, but the alluvial deposition in the agricultural field of act as a natural fertilizer and increase the agricultural production in next upcoming seasons or in dry season • He expressed concern as the riverbank protection work, may act as an artificial barer for alluvial deposition for the agricultural land and deprive from naturally fertilized form of flood alluvial deposition • Mr. Ahmed was apprised about the various interventions. The anti-erosion

Sl. No.	Name	Designation	Date	Issues, Suggestions and Requests
				works shall be helpful in preventing erosion of the riverbanks and loss of land and this shall be below the HFL and thus not disturb alluvial deposition from floods. New embankment works shall be in general an extension of existing embankments in order to protect settlements from flooding. Sluice gates shall be provided at locations to regulate water flow. Moreover, since the embankments are proposed near settlement areas, the impacts on the agricultural fields are minimal
10	Mr. Apurba Kumar Das	Joint Director of Fisheries, FFDA, Directorate of Fisheries	06th April 2023	• Mr. Das was briefed about the project • Mr. Das intimated that the department coordinates the various activities of fisheries in the state. The department is responsible for the implementation of Pradhan Mantri Matsya Sampada Yojana in the state • He also intimated that fishing in the Brahmaputra River is regulated by the Deputy Commissioner of the respective district • He expressed issues that the riverbank protection work might affect some habitat of fauna and the breading habitat of some species during the construction period • He was apprised that the interventions are noninvasive and impacts shall be temporary. The anti-erosion works shall be done in the river bed during the winter season when the water levels near the banks are low. No works are proposed during the breeding season during pre-monsoon and monsoon seasons

Source: FREMAA, WRD, LASA and ADB TA Consultant

449. The consultations primarily highlighted the proposed anti-erosion and flood protection interventions, perceived negative impacts and mitigation measures, and public participation during implementation. Community members largely spoke about the inconveniences faced during rainy season and flood situations. The people expressed concerns about the erosion of riverbank, and its threat to agriculture land and local people.

450. The participants conveyed their support for the project that benefits the community with improved flood protection measures, thus reducing the land erosion. The consulted people also expressed concern about frequent friction between the geo-bags and boats may affect the life of geo-bags. It was suggested that it would be helpful if stair-like structure provided with the river protection work near the ghat area for the local public to access the ghats. This will also save the geo-bags from wear and tear.

451. It has been observed that people's acceptance on the subproject, as they are facing severe problem of erosion and flood risk. People are very much willing to extend cooperation as the project will provide proper anti-erosion and flood protection functions. There are no negative impacts

perceived by the community, however, project team FREMAA explained likely issues during construction and proposed EMP to manage the negative impacts. Increasing traffic and disturbance to agricultural vehicle movement during the work were raised during the meetings, and FREMAA informed about proper measures to be taken for movement of construction vehicles. Prior information to people will be provided if necessary. FREMAA informed no road closures anticipated due to this work. The people expressed satisfaction towards the project due to expected creation of job opportunities. The mitigation measures are included in the EMP.

2. Consultation during construction

452. Prior to start of construction, FREMAA and WRD with the assistance of Project Implementation Support Consultant (PISC) will conduct information dissemination sessions at various places and solicit the help of the local community, leaders/prominent for the project work. At each neighborhood level, focus group meetings will be conducted to discuss and plan construction work with local communities to reduce disturbance and other impacts.

453. A constant communication will be established with the affected communities to redress the environmental issues likely to surface during construction phases and regarding the grievance redress mechanism. FREMAA/WRD and PISC will organize public meetings and will appraise the communities about the progress on the implementation of EMP. Meeting will also be organized at the potential hotspots/sensitive locations before and during the construction.

C. Information Disclosed

454. Executive summary of the IEE will be translated in local language-Assamese and made available at the offices of FREMAA/WRD, PIUs, Village Panchayat offices, and displayed on their notice boards. Hard copies of the IEE will be accessible to citizens to disclose the document and at the same time creating wider public awareness. Electronic version of the IEE in English and Executive Summary in Assamese will be placed in the official website of the FREMAA/PMU after approval of the IEE by the Government and ADB. Stakeholders will also be made aware of grievance register and redress mechanism.

455. Public information campaigns to explain the project details to a wider population will be conducted. Public disclosure meetings will be conducted at key project stages to inform the public of progress and future. Prior to start of construction, the PMU/PIU will issue Notification on the start date of implementation in local newspapers A board showing the details of the project will be displayed at the construction site for the information of general public.

456. Local communities will be continuously consulted regarding location of construction camps, access and hauling routes and other likely disturbances during construction. The road closure together with the proposed detours will be communicated via advertising, pamphlets, radio broadcasts, road signage, etc.

457. Project related information shall be disclosed through public consultation and making relevant documents available in public locations. PMU and PIUs shall provide relevant safeguards information in a timely manner, in an accessible place and in a form and languages understandable to affected person and other stakeholders. For illiterate people, other suitable communication methods will be used.

458. At minimum, the following documents shall be made available at the offices of project agencies – FREMAA, WRD, PMU, PIU and block level offices for public reference, and shall also be uploaded on respective websites.

1. Executive summary of the IEE (in Assamese);
2. Draft IEE Report (in English);
3. Final IEE Report (in English);

4. Updated/amended IEE, whenever updated/amended (in English);
5. Corrective action plans prepared during project implementation (English);
6. Annual Environmental Monitoring Reports (English).

459. A concise executive summary of project (in Assamese) and final IEE report, providing all necessary details of proposals, implementation arrangements, subproject locations, environmental impacts and mitigation and monitoring measures, and grievance redress mechanism, shall be made available to the stakeholders at consultation meetings. This should also provide contact information of project agency. This summary shall also be displayed at the notice boards of PMU, PIU and other public places. During project implementation, relevant information about any major changes to project scope will be shared with beneficiaries, affected persons, vulnerable groups, and other stakeholders. The above documents shall be submitted to ADB for disclosure on ADB website.

D. Adaptive Mechanism

460. In case of recurrence of COVID-19 pandemic adaptive mechanisms will be used to address limitations on environmental safeguard activities and consultations due to any government restrictions and COVID-19 risks. Surveys and data collection will be conducted through online platforms, brochures, questionnaires, and other forms of media as applicable to provide information and receive feedback from the people, beneficiaries, government agencies and other stakeholders.

VIII. GRIEVANCE REDRESS MECHANISM

A. Need for Project Specific GRM

461. A project-specific grievance redress mechanism (GRM) will be established to receive, evaluate and facilitate the resolution of displaced people's concerns, complaints and grievances about the social and environmental performance at the level of the Project. The GRM will aim to provide a time-bound and transparent mechanism to voice and resolve social and environmental concerns linked to the project. The project-specific GRM is not intended to bypass the government's own redress process, rather it is intended to address displaced people's concerns and complaints promptly, making it readily accessible to all segments of the displaced people and is scaled to the risks and impacts of the project. The complainant may access the formal legal system at any time.

462. During plan preparation, information regarding GRM will be disclosed as part of the public consultation process. Grievances related to the implementation of the project will be acknowledged, evaluated, and responded to the complainant with corrective action proposed. The outcome shall also form part of the annual monitoring report that will be submitted to ADB.

463. The GRM will work within existing legal and cultural frameworks, providing an additional opportunity to resolve grievances at the local and subproject level. The key objectives of the GRM are:

- Educate stakeholders on the GRM
- Receive and record the grievances
- Resolve and close the grievances
- Escalate unsolved grievances to concerned authority
- Notify/update the stakeholders of the solutions

464. The types of grievances the stakeholders may file for all the project components include, but are not limited to:

- Non-payment, or inadequate compensation and/or due resettlement and rehabilitation (RandR) assistances;
- Wrong measurement of land parcel
- Construction related impacts – damages to structures; dust damaging crops/trees
- Health and safety risks;
- Negative impacts on the environment;
- Negative impacts on communities
- Physical harm and nuisance from construction or operational activities;
- Impacts arising from migrant labor on local communities
- Exclusion from beneficiary lists
- Lack of information and opportunities for participation

465. Presently, FREMAA and WRD are also addressing grievances raised through the Centralized Public Grievance Redress and Monitoring System (CPGRAMS), which is an online portal implemented by the Govt. of India and hosted by National Informatics Centre (NIC). The Chief Minister of Assam can be contacted for any help at phone numbers 0361-2262222/2237043, Fax Number 0361-2262069 and email cm@assam.gov.in.

466. In the previous ADB (Tranche-II) Project, Grievance Redressal Committee (GRC) was established at three levels, one at the project (Division/PIU) level, another at the district level, and

the third at Executing Agency (PMU) level, to receive, evaluate and facilitate the resolution of affected person concerns, complaints, and grievances. The same three tire GRM process will be adopted under this Project.

467. The GRM system and the committees to be formed at various levels would be intended to address stakeholders' grievances and dissatisfaction about actual or perceived impacts and to find a satisfactory solution. The GRM will function throughout the project cycle for use by stakeholders to address concerns and complaints promptly and transparently. The Project specific GRM is not binding and the affected persons can approach the Judiciary any time if they wish to do so. Taking grievances to Judiciary will be avoided as far possible and the resettlement plan-implementing agency will make utmost efforts and reconciliation at the level of GRC.

B. Division/PIU Level GRC

468. The concerned Project Implementation Unit (PIU)/Water Resources Division (WRD) will nominate 1 (one) official to oversee the implementation of RP and to provide response to the grievances raised by the community and affected persons. The GRC at Division/PIU Level will be constituted with the following members:

Table 8-1: GRC Members at Division/PIU Level

Sl. No.	Members	Designation
1.	Executive Engineer (WRD) – concerned Division	Chairperson
2.	Assistant Executive Engineer (WRD) – concerned Division	Member-Secretary
3.	Nominated official from RP implementing NGO	Member
4.	Gaon Bura (Village Head) of the concerned village	Member
5.	Two Community Members (Female)	Members

Source: FREEMA

C. District Level GRC

469. The second level GRC will be constituted at each Project District headed by the Deputy Commissioner. The GRC at district level will be constituted with the following members:

Table 8-2: GRC Members at District Level

Sl. No.	Members	Designation
1.	Deputy Commissioner of the District or his reperesentative	Chairperson
2.	Additional Deputy Commissioner (LA)	Member-Secretary
3.	Revenue Circle Officer(s) – concerned Revenue Circles	Member
4.	Executive Engineer (WRD) – concerned Division	Member
5.	Nominated official from RP implementing NGO	Member
6.	Members of the Panchayat/ULB	Member
7.	One Representative of the Affected Person	Members

Source: FREEMA

470. There shall be not more than 7 (seven) members in the committee. There shall be minimum one-third women representation in the committee.

D. PMU Level GRC

471. The PMU level GRC will function as an appellate authority and ensure that the stakeholders have access to legitimate, reliable, transparent, and efficient institutional mechanisms that are responsive to their complaints. The unresolved grievances accelated to the PMU level GRC

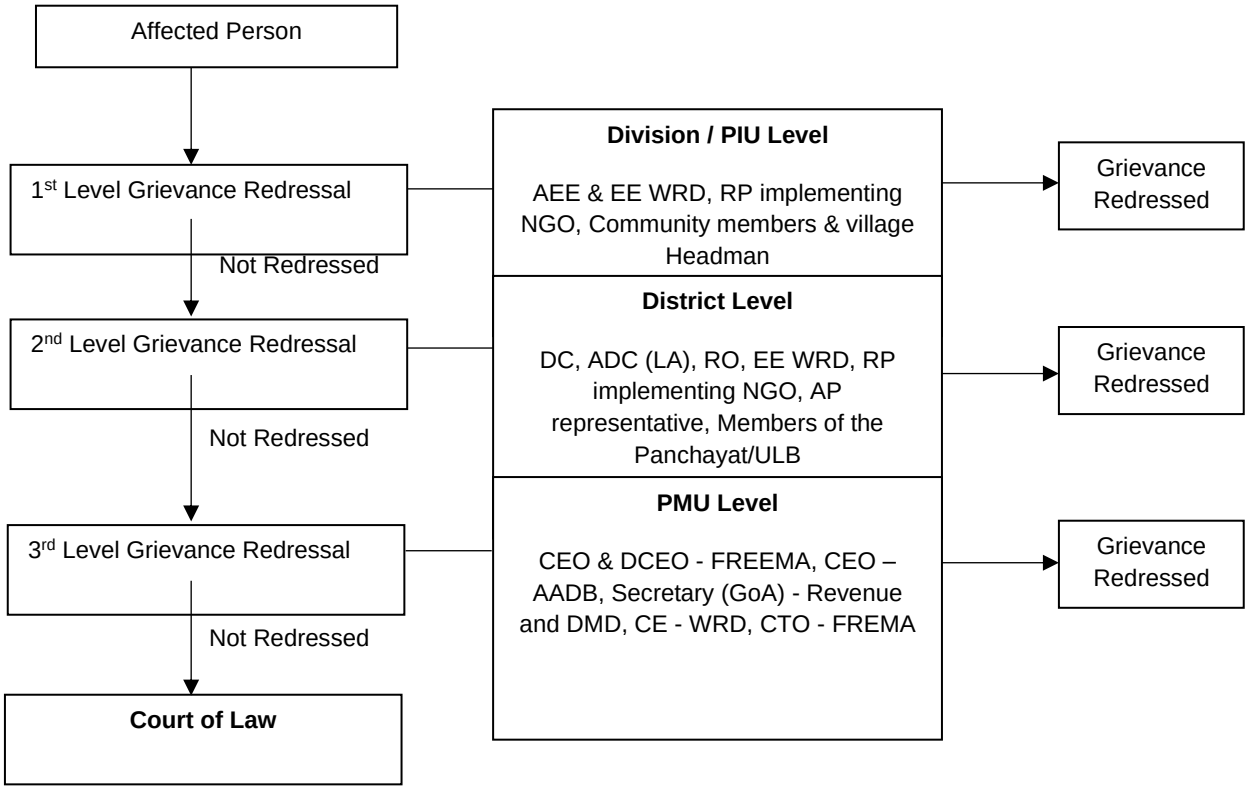
including grievances received through the previously mentioned platforms such as CPGRAMS are forwarded to WRD, which will in turn be placed before the PMU level committee for redressal.

Table 8-3: GRC Members at PMU Level

Sl. No.	Members	Designation
1.	Chief Executive Officer (CEO) FREMAA	Chairperson
2.	Chief Executive Officer (CEO) AADB	Member
3.	Secretary to the Govt. of Assam, Revenue and Disaster Management Department	Member
4.	Chief Engineer, WRD	Member
5.	Deputy Chief Executive Officer (DyCEO), FREMAA	Member-Secretary
6.	Chief Technical Officer (CTO)	Member

Source: FREEMA

Figure 8-1: Grievance Redress Process



Source: FREMAA

E. Key Elements of GRM under the project

472. The project GRM has the following key elements and procedures for satisfactory functioning:

473. **Flexible Grievance Registration Process:** The grievances can be registered by person, phone, text message, mail, email, via website, verbal, etc. Prior to registering the complaint/query, a procedural step will be in place to assess its eligibility and check that issues raised in the complaint fall within the scope that the GRM is mandated to address. Queries or complaints may be received in a variety of forms ranging from verbal communications to formal and written complaints; also, directly from APs or via third parties. Whatever the source and the form in which the query or complaint is received, it will be accepted by the focal points and registered in a grievance register

and online portal. It is also to be mentioned that uniformity will be maintained in the complaint registration systems across different sections and agencies of the project.

474. **Log of Grievances and Database**: A Grievance Register will be maintained in which all grievances are recorded and digitized and maintained as a database at the PIU level by the designated official to document the grievance as per the prescribed format attached including details of the date and type of grievance received, the date of personal hearing provided to the complainant, the date when grievance was redressed or if not redressed date of forwarding the grievance to GRC. Provision will be made to record and maintain grievances received directly on-site and incorporated in the Grievance Register. This register will be placed at the Executive Engineer's office of the concerned division. This will serve as the First Level of Grievance resolution.

475. **Redressal Durations and Disclosed Procedures:** The GRM procedures will be publicly advertised and popularized for use by the stakeholders. The GRM will also set out the length of time users can expect to wait for acknowledgement, response, and resolution of their grievances. The GRM system will be popularized among the communities through IEC campaigns, IEC material, wall writings, etc. In addition to this, the length of time the complaints can expect to wait for acknowledgment, response, and resolution of different types of grievances. The response time prescribed for the GRC would be three weeks at each level. Since the entire resettlement component of the project has to be completed before the construction starts for the whole project, the GRC will meet at least once a month, or as needed, to resolve the grievances. Sixty percent attendance of the committee members at all three levels will constitute the quorum for the meeting. However, in case of divisional and district level GRC, participation of community members and representative of APs and RP implementing agency will be mandatory. The PIU will also ensure installation of Display Boards at site with GRM information with support from the civil works contractors/implementing support NGO and in consultation with project Management Unit (PMU), FREMAA. The GRC will meet once in a month.

476. **Transparency and Good Governance:** The GRM procedures, governing structure and decision-making process will be popularized among the communities through IEC materials and campaigns. For transparency and good governance, community members are selected as members of the GRC at field level, Grievances that cannot be resolved at the PIU/ PMU level and in cases where the complainant is not satisfied with the decision, will be referred to the district level GRC. Consultative meetings along with distribution of leaflets with the community and APs will also be conducted to educate them on the GRM and its escalation matrix for resolving grievances to encourage them to use and access it in case of need. The PMU and PIU and adhere to the principle of confidentiality while informing the same to the district level GRC (if required) as the case may be. The designated official at the PIU will also be responsible to ensure that a mechanism is put in place to address grievances of labors and staff deployed at project sites by the Contractors.

477. **Escalation:** The project GRM provides for escalation at different levels, so that the unresolved grievances might be redressed at higher levels of GRM. Mediation is also encouraged as an option when the users are not satisfied with the grievance redressal.

478. Further, for land related grievances, the GRC will provide an opportunity to have their grievances redressed prior to approaching the State level LARR Authority, constituted by Government of Assam in accordance with Section 51(1) of the RFCTLARR Act, 2013. Decision of the District Level GRC will be final, unless an appeal is preferred with the PMU level. If the committee is unable to arrive at a decision through consensus, the matter will be referred to the appellate authority with a note on opinion of the committee members. Other than disputes relating to ownership rights and apportionment issues, on which the LARR Authority has jurisdiction, GRC will review grievances involving eligibility, valuation, all resettlement and rehabilitation benefits, relocation, and payment of assistances.

479. People who are, or may in the future be, adversely affected by the project may submit complaints to ADB's Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB's operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach the Accountability Mechanism.[64]

[64]For further information see: http://www.adb.org/Accountability-Mechanism/default.asp.

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. EMP and EMoP

480. An Environmental Management Plan (EMP) has been developed to provide mitigation measures to reduce all negative impacts to acceptable level and monitoring the same. This is presented in the Tables 9-1, which shows the potential environmental impacts, proposed mitigation measures and responsible agencies for implementation and monitoring.

481. The purpose of the environmental management plan (EMP) is to ensure that the activities are undertaken in a responsible, non-detrimental manner with the objectives of: (i) providing a proactive, feasible, and practical working tool to enable the measurement and monitoring of environmental performance on-site; (ii) guiding and controlling the implementation of findings and recommendations of the environmental assessment conducted for the project; (iii) detailing specific actions deemed necessary to assist in mitigating the environmental impact of the project; and (iv) ensuring that safety recommendations are complied with.

482. A copy of the EMP must be kept at work sites at all times. This EMP will be included in the bid documents and will be further reviewed and updated during implementation. The EMP will be made binding on all contractors operating on the site and will be included in the contractual clauses. Non-compliance with, or any deviation from, the conditions set out in this document constitutes a failure in compliance.

483. For civil works, the contractor will be required to (i) establish an operational system for managing environmental impacts (ii) carry out all of the monitoring and mitigation measures set forth in the EMP; and (iii) implement any corrective or preventative actions set out in safeguards monitoring reports that the employer will prepare from time to time to monitor implementation of this IEE and EMP. The contractor shall allocate budget for compliance with these EMP measures, requirements and actions.

484. The following tables 9-1 show the potential environmental impacts, proposed mitigation measures and responsible agencies for implementation and monitoring during pre-construction, Construction, and Operation and Maintenance phases.

Table 9-1: Stage Environmental Management Plan (EMP)

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
Pre-Construction Phase					
-	Protected areas	Project interventions in the subproject area is within notified ESZ/or within 10 km of protected areas, where ESZ not notified of the project Thus, some impacts on the protected areas are foreseen.	FREEMA shall obtain necessary permissions and clearances from the CWLW and or State Board of Wildlife for construction activities within the 10 km radius from the PA.	PMU	PMU-FREMAA
-	Location impacts (adjacent to the Brahmaputra River)	No impact during the design and preconstruction period is envisaged	-	-	-
-	Environmental, social and culturally sensitive resources	No impacts during the design and preconstruction envisaged	-	-	-
Preparatory works	Tree cutting at all work sites	The number of trees to be felled is yet to be determined as of the time of preparation of this IEE. The environmental monitoring reports shall disclose the number of trees to be cut when finalized	• Minimize removal of trees by adopting to site condition and with appropriate layout design of various components or select any other site without trees for construction/labor camps • Obtain prior permission for tree cutting at construction sites or at any other site that may require tree cutting during detailed design from forest department and district administration. • Plant and maintain 10 trees/seedlings for each tree that is removed	PIU/Contractor	PIU, PMU and Project Implementation Support Consultant (PISC)

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
Preparatory works	Consents, permits, clearances, NOCs, etc.	Failure to obtain necessary consents, permits, NOCs, etc. can result to design revisions and/or stoppage of works	• Obtain all necessary consents (including CTE and CTO for construction plants), permits, clearance, and NOCs prior to award of civil works. Following consents are required- 1. Tree cutting permissions from local authorities 2. Storage, handling and transport of hazardous materials if any from PCB Assam 3. Opening of new sand mining, quarries, borrow areas from Department of mines and Geology, SEIAA/MoEF&CC 4. Traffic diversion/road cutting from local authorities and police department • Ensure that all necessary approvals for construction from various authorities are obtained by contractor before start of construction • Submit all copies of the various consents, permissions, clearances and NOCs to the Engineer and submit regular reports on compliance all obtained consents, permits,	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			clearance, NOCs, etc. as required by the authorities • Include in detailed design drawings and documents all conditions and provisions if necessary • Obtain all necessary approvals from the Engineer including but not limited to setting up of labor camps, construction methodologies, and construction schedule before the start of construction		
Clearing and grubbing, site preparation	Disposal of solid waste and site preparation	Removal of solid waste and other nuisance materials	• Ensure that the project sites are cleared of solid waste or other nuisance materials • Dispose solid waste from existing sites and materials into designated locations (dumping in vacant lot is not allowed). • Garbage generated during construction and especially at construction camps shall be collected and disposed at designated locations. The contractor may tie up with the local municipal authorities for disposal of the municipal wastes. • Incineration of wastes shall	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			be prohibited. • Construction labor camps shall have toilets along with septic tanks, and garbage bins for segregation of wastes. • The proper disposal of the geo-bags and other material used earlier by WRD as temporary anti-erosion and flood protection measures shall be ensured by the contractor.		
Sourcing of materials	Extraction of materials	• Extraction of materials can disrupt natural land contours and vegetation resulting in accelerated erosion, disturbance in natural drainage patterns, ponding and water logging, and water pollution. • Illegal quarrying may lead to land use change, unstable rock formation, air and noise pollution	• Obtain materials from aggregate and sand quarries/crusher sites which has necessary permissions from the Department of Mines and Geology, Prior EC from SEIAA/MoEF&CC and CTO from PCBA • If other sites are necessary, contractor to verify the suitability of all material sources and to obtain the approval of Engineer • If additional quarries will be required after construction is started, contractor to obtain necessary approvals from Engineer • Aggregates required for	Contractor to prepare and submit list of approved quarry sites and sources of materials for the approval of Engineer	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			construction of embankment and roads shall be procured from quarries/crushers which has obtained EC and CTO from SEIAA/MoEF&CC and approved by PCBA • Where materials are obtained from 3rd party vendors, contractors to submit all necessary documents including permission, EC documents, and CTE and CTO to the Engineer before obtaining source approvals • Borrow earth areas to be identified by the contractor and necessary permissions obtained from Engineer • Fly ash for use in embankment in lieu of borrow earth if technically permitted by Engineer • Permissions from the relevant authorities for use of ground and/or surface/river water for construction works. Since the river water has high sediments, the water quality to be tested as per guidelines of the Engineer		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			to ensure that it can be utilized for concrete mixing. For earth works, river water can be used post obtaining permissions from relevant authority.		
Construction and Operation Phases					
Borrow pit excavations	Change in land use and borrow area	• Adverse effect on agricultural land and homestead around the site and construction camp areas • Unplanned selection of borrow areas/no rehabilitation of borrow areas may lead to loss of productive use of the land. • Transportation of borrow earth may also cause air pollution. • Restricted access to the embankment construction site. • Encroachment on embankment for habitation and cultivation • Cutting of embankment to create approach to river side	• Avoid adjacent cultivable lands for storage and/or handling of construction materials. • Ensure construction camps is preferably be located on uncultivated area. • Provision of all requisite facilities (drinking water supply, sanitation, domestic solid waste collection and disposal, fuel supply) at the camps. • Provision shall be made in the embankment design for providing access to riverbank close to the habitats	Contractor	PIU, PMU and PISC
Borrow pit excavations	Borrow area location and rehabilitation	• Loss of agricultural land and homestead plantation due to borrowing earth from	• Borrow pits shall be preferred on river side to embankment as these can get silted in the course of	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		countryside of embankment • Permanent disfiguration of land • Seepage to the foundations of embankment • Non- rehabilitation of borrow areas	time or earth from retired embankment • Preference shall be given to utilization of waste lands • Use of dredge material from river if technically permitted by the Engineer • Using fly ash in lieu of borrow earth if technically permitted by Engineer • Use the combination of soil and sand in embankment construction • Follow the WRD guidelines for locating borrow pits close to the embankment • Contractor shall ensure rehabilitation of borrow areas in line with WRD guidelines before handling over the subproject		
Quarrying and mining	Land use change due to construction material sourcing (quarrying)	• Illegal quarrying for fulfilling the requirement of significant amount of construction material may lead to land use change, unstable rock formation, air and noise pollutions. • Huge aggregate demand for construction of the new embankment and use of heavy machines and vehicles may lead to deterioration of water and	• Aggregates required for construction of embankment and roads shall be procured from quarries and crushers which have obtained Prior EC from SEIAA/MoEF&CC and CTO from PCBA • Where materials are obtained from 3rd party vendors, contractors to submit all necessary documents including	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		air. • Quarrying operations, if not regulated may lead to adverse impact on ambient environment.	permission, EC documents, CTO, etc. to the Engineer before obtaining source approvals • If new quarries and stone crushers are to be set up for the project, the contractor shall obtain the necessary prior EC from SEIAA/MoEF&CC and the CTO from the PCBA and taking adequate measures for air pollution control • While finalizing the site, proper land use assessment shall be done. The land to be earmarked for dumping construction waste if any shall be free from any social or R and R issue.		
Earthworks and borrow areas	Soil environment	<u>Construction phase:</u> • Soil erosion potential of an area depends on its topography, geological structure, rainfall, soil type and land use/land cover. • The topography of the terrain in subproject area covering the alluvial plain is nearly flat with a gentle gradient towards south west.	<u>Construction phase:</u> • Construction shall be scheduled such that large areas of soil particularly at borrow areas near the embankment are not laid bare during the monsoon. The construction methodology and schedule shall be approved by the Engineer before start of work • Exposed surface shall be	Contractor during implementation and Defect Liability Period (DLP). PIU and PISC during operation period	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		• The soils in the subproject area are easily eroded during heavy rainfall. • Possibility of occurrence of gully and rill erosion is expected in the uncovered side slopes of embankments and other freshly cut or deposited areas. <u>Operation Phase</u> • Likelihood of soil erosion during the operation phase resulting in shifting of bank line	resurfaced and stabilized as soon as possible and covered by straw or mulch to avoid soil loss in the intervening period. • Ground disturbances shall be phased so that it is limited to workable size • Stabilizations of soil around approach roads/slopes shall be done by turfing and tree plantation in ROW • The embankment and road design shall incorporate adequate engineering measures so that the construction could withstand the severe earthquakes • Various soil conservation measures shall be undertaken by AADB later on to prevent erosion. • Soil erosion shall be visually checked on potential erosion zones during construction phase. In case soils erosion is found, suitable measures shall be taken to control the same <u>Operation Phase:</u> • Periodic checking shall be		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			carried out to assess the effectiveness of stabilization measures. A detailed study to assess the location, reasons of soil erosion along the embankment during third year of the operation phase shall be undertaken. Suitable strengthening measures shall be implemented to prevent reoccurrence of soil erosion at existing erosion prone locations and prevent erosion at newer locations.		
Earthworks and activities in construction camps	Soil compaction and contamination	• Soil around construction site, haulage road, construction camp, and workshop, will get compacted due to transportation of man, machine and materials. • The agricultural yield will be reduced substantially due to soil compaction. • Soil may also get contaminated around construction site, machine maintenance area, fueling station, construction camp, hot mix plant site, if any and	<u>Construction phase:</u> • Restricting movement of construction vehicles, machinery and equipment to the embankment site and pre-defined haulage road. • Adequate provision for approach roads capable of handling movement and haulage of heavy vehicles and machineries shall be made to avoid damage to existing village roads, crop lands and settlement areas. The non-usable, non-	Contractor during implementation and DLP. PIU and PISC during operation period	PIU, PMU and PISC during construction PMU during operation

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		haulage road.	saleable, non-hazardous construction waste shall be disposed off in the properly designated places. Usable or saleable waste shall not be disposed of to landfill. • Following efforts to prevent soil contamination shall be made: i) The construction vehicle shall be fueled or repaired/serviced at designated places with proper arrangement of waste collection and disposal. The arrangement shall include cemented floor with dyke around for fuel storage and filling as well repairing of construction equipment. To avoid the soil contamination at the wash down and re-fueling areas, "oil interceptors" shall be provided. ii) The demolition waste if any shall also be used to the extent feasible for construction. iii) Oil and grease spill and oil-soaked materials shall be sold off to		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			Pollution Control Board Assam (PCB)/MoEF&CC authorized vendors. iii) Oil spill kits should be available at the site to minimize the damage to soil quality in case of spillage iv) Fuel and waste oil should be stored in isolated locations on paved areas only to minimize the soil contamination. These areas should be provided with the garland drains provided with the oil interceptors <u>Operation Phase:</u> • Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the WRD and District Administration.		
Subproject operations	External impacts on flood and drainage during operation phase	• The proposed anti-erosion, pro-siltation works, and flood protection works will not significantly change flood behavior, gross cross-	• Numerical hydraulic model to investigate flooding and drainage behavior, both within and outside subproject areas, associated with mainstream, tributary and	PIU/WRD and PISC	PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		section-wide sediment behavior of river morphology, however, the adverse impacts of the floods will be addressed considerably.	local flooding will be developed to ensure that there is adequate freeboard against embankment overtopping and that adequate provision has been made for sluice gates to facilitate drainage from the protected areas.		
Subproject operations	Changes in water levels during operation phase	• The proposed works will have no discernable effect on river water levels. Changes in channel conveyance brought about by the natural processes of riverbank erosion, accretion and channel avulsion will play a much greater role in any future change in water levels • An improved embankment network will reduce the risk of sudden devastating flooding and as such provide more predictable and stable water levels on the flood plains (especially from temporary local inundation during the flood season)	• Changes in cross-section will be monitored at regular intervals to detect any changes and initiate corrective measures. • Numerical hydraulic model of the subproject area will be used to identify low lying areas with a potential risk of deep inundation when major floods occur.	PIU/WRD and PISC	PMU
Subproject operations	Effect on flow velocity/discharge	• Only major proactive river	• Flow velocity changes	PIU/WRD and PISC	PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
	intensities during operation phase	training interventions like spurs protruding into the river may have direct impact on the flow pattern and channel configuration affecting it significantly	along the bank line will be systematically monitored as part of the near-bank surveys including establishing systematic records of discharges and flow velocities during the hydrological cycle. It is expected that this monitoring will contribute to a better understanding and a gradual optimization of the layout of structural flood and erosion countermeasures.		
Subproject operations	Impact on silt deposition and bed level change during operation phase	• The high amount of sediment in Brahmaputra River is due to the high flood season flows and often leading to changes of the river appearance. The deposition increases the siltation in the floodplains and creates sand bars/chars in the river • The transported silt gets deposited downstream where the area widens, and the flow velocities drop. The resulting sand carpets are disastrous for the overwhelmingly small and marginal farmers as	• The dynamic pattern of silt deposition in the river and areas adjacent to the bank, especially in the vicinity of anti-erosion and river training works, will be monitored at regular intervals to contribute to the knowledge base and understanding of the Brahmaputra morphology, and initiate necessary corrective measures if required.	PIU/WRD and PISC	PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		they render the fertile floodplain land unusable and can only be removed at great cost			
New embankments and anti-erosion (AE) works	Effect on subproject drainage system during construction and operation phase	• The existing embankment system near Dibrugarh town acts as a barrier for the drainage of accumulating countryside water into the Brahmaputra River during the monsoon season leading to flooding in the countryside.	• Under the project, construction of RCC triple shutter sluice gate in Maijan Beel emabankment is proposed to ease the flood in countryside of embankment during heavy rainfall and discharge the rainwater. • Numerical hydraulic model will be used to undertake a comprehensive analysis of the existing natural drainage system to identify drainage behavior and problems, key drainage channels/systems and drainage congestion areas. This model will be used to investigate the optimum location, size and method of operation of the sluice gates. Cost-effectiveness of various remedial measures will be assessed with the objective of improving drainage conditions. As part of this investigation, the preservation and/or	Contractor during construction phase PIU and PMU during operation	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			improvement of the environmental flooding regime of wetlands and beels will be investigated. • The construction related impacts are temporary and reversible which will be addressed by following best practices and implementation of EMP.		
Construction of embankment, AE works and activities within construction camps	Water quality	Construction phase • The major source of surface water pollution during project construction phase will be sewage and wastewater generated from labor camps as well as workshop areas. • It is expected that 100 – 200 laborers shall stay in each construction/labor camps. Total quantum of sewage generated is expected to be of the order of 108 LPD (0.108 KLPD). However, it may pollute land and other nearby water bodies if discharged untreated, especially during the low flow season.	Construction phase • Septic tanks shall be provided in each camp to treat the domestic sewage generated from the camps. • Provision of mobile toilets also shall be considered with the provision of channeling the sewage to septic tank in a closed loop system. • Discharge of untreated domestic sewage to the Brahmaputra River or to any natural waters will not be permitted. • No debris shall be dumped in the water bodies.	Contractor	PIU, PMU and PISC
Felling of trees	Micro-Climate	• Short term impact in terms of minor increase	Construction Phase • The maximum possible	Contractor during implementation and DLP.	PIU, PMU and PISC during

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		in temperature may happen in the immediate vicinity of the embankment due to cutting of trees located within the project intervention zone.	efforts must be made for minimizing cutting of the trees while designing the embankment. The project will adopt a policy of compensatory tree plantation of planting 10 trees against each tree cut this is over and above compensatory plantation as per the state government policy [65]. <u>Operation Phase</u> • The flood pattern needs to be closely analyzed from hydrological engineering perspective during proposed life span of the embankment and take appropriate timely protective measures in case the flood levels increase due to climatic changes.	PIU and PISC during operation period	construction and PMU during operation
Construction of embankment, AE works and activities within construction camps	Air quality	• Various construction activities will increase the ambient air quality, but the level is likely to remain within the prescribed standards. • Mobile sources of pollution are mostly	• Batching plants shall be located away from the populated areas and be fitted with the air pollution control devices, the emission shall meet Pollution Control Board standards. Further, the batching plants must be	Contractor during implementation and DLP. PIU and PISC during operation period	PIU, PMU and PISC

[65] The rate of compensatory afforestation as per Assam Govt guidelines is 1:3.

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		vehicles involved in construction activities, whereas emissions from stationary sources include construction equipment and machinery, batching plants, diesel generator sets, excavation/grading activities etc. In addition to these, fugitive emissions will also form a major proportion of air pollution in the form of particulate matter from storage and handling of construction material. • Fugitive dust sources associated with construction phase include vehicular traffic generating fugitive dust on paved and unpaved roads and aggregate handling. • The emission of particulate matter during the construction phase will be generated from the activities like clearing and grubbing, earthworks, movement of stone aggregates, road dust emissions etc. In addition to that emissions	sited at least 1 km in the downwind direction from the nearest human settlement. • It shall be ensured that the dust emissions from the crusher and vibrating screen of the stone quarries, if new ones are opened and operated for the project, do not exceed the standards. • For procurement of the material from the market/third parties the contractors shall ensure that the material is procured from the legal complaint sources. The compliance certificates (valid CTO of crusher, EC of mines etc.) the approved third parties shall be submitted to the Engineer by the contractor before commencing the procurement of material. • Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing road. Water may be sprayed on earthworks, on a regular		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		from various construction machinery fueled by diesel and from mobile source will be in the form of PM_{10}, VOC, CO, NO_X and SO_2. <u>Operation Phase</u> • The prime source for air pollution during operation phase will be the vehicular movement on the road on top of the embankment, which will be used for transportation by general public as well as for maintenance of the embankment. However, during the operation phase, the embankment will be strengthened and will be covered with turf and construction of paved roads by PWD will reduce the fugitive emissions. Due to all these developments, impact on air quality during operation phase will beneficial.	basis. During and after compaction of the sub-grade, water will be sprayed at regular intervals to prevent dust generation. The following mitigation measures will also be taken to mitigate the dust entrainment and fugitive emissions from the various sources in the subproject area: (i) Covering of loads in trucks, and the paving of access areas are examples of preventive measures. Mitigation measures including sprinkling of the on the dust prone work areas and construction yard with water is recommended at regular interval to arrest dust (iii) Regular maintenance of machinery and equipment will be carried out (iii) Ambient air quality monitoring shall be carried out during construction and the first year of operation phase as per the Environmental Monitoring Plan (EMoP) through		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited/ MoEF&CC recognized laboratories and the test reports shared with the Engineer and reported in the periodic Environmental Monitoring Reports (EMR). If monitored parameters are above the prescribed limits, suitable control measures must be taken (iv) Care shall be taken to keep all material storages adequately covered and contained so that they are not exposed to situations, where winds on site could lead to dust/particulate emissions (v) Fabrics and plastics for covering piles of soils and debris is an effective means to reduce fugitive dust from the material stores/warehouses (vi) Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled materials do not become a source of fugitive emission (vii) All slopes and		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			embankments will be turfed as per best engineering practices to help minimize the dust generation during operation. Plantation along the embankment shall be maintained. AADB shall pilot the NbS on the selected embankments under this project and the model will be replicated at a later date (viii) Speed restrictions shall be maintained for the construction vehicles while travelling on unpaved roads. The contractor shall also maintain the access roads regularly by way of (a) paving or (b) adding gravel or slag to a dirt road <u>Operation Phase</u> • Plantation along the embankment and turfing on the embankment slopes should be maintained, and their survival rates should be monitored. In addition to that regular maintenance of the road on the top of embankment as well as connecting roads shall be done for reducing fugitive emissions.		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
Construction of embankment, AE works and activities within construction camps	Noise levels	<u>Design and Construction Phase</u> • Noise will be generated from various activities such as clearing and grubbing, excavation, earthworks, borrow works, etc. • During construction phase, the increase in vehicular movement due to movement of construction vehicles is expected to increase multifold as major activities are in the vicinity of the subproject area. • During construction phase, thus an increase in noise level is expected. However, the increase in noise levels will be localized, temporary in nature and mostly will be during daytime only. <u>Operation Phase</u> • The prime source of noise pollution during operation phase will be the vehicular movement. However, as the roads	Following noise control measures shall be adopted, and included in the civil work contracts: • Site Controls: Stationary equipment shall be placed along uninhabited stretches meeting the National Noise Quality standard, particularly for residential areas (Category C) and silence zones (Category D: hospitals, educational institutions, courts, religious places, etc.). In case the noise levels are not meeting the norms, the Engineer shall guide the contractor to adopt and establish the required measures as per the norms and as stipulated in the EMP; (i) maintain the required distance of least 150m (Category C) and 250m (Category D), (ii) to make use of appropriate temporary noise barriers especially near noise sensitive receptors identified near the construction zone • Construction activities shall be prohibited between 9.00	Contractor during implementation and DLP. PIU and PISC during operation period	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		will be paved and will provide smooth traffic movement, the impact due to vehicular movement will be less significant.	pm and 6.00 am near residential areas throughout the subproject stretch • Appropriate PPE devices like ear plugs or earmuffs will be provided to the workers operating in the vicinity of high noise generating machines • Construction equipment and machinery shall be fitted with silencers and regularly maintained • Regular noise monitoring measurements shall be carried out as per the EMoP during the construction period and 1st year of the operation period • Use of manual labor where ever feasible over machines shall be encouraged <u>Operation Phase</u> • Adequate signage shall be provided restricting the use of pressure horn particularly in near noise sensitive locations e.g., schools, hospitals and populated areas. Noise		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			measurements shall be carried out along the road to ensure the effectiveness of mitigation measures. • Tree barriers between the road and village, semi urban and urban area shall be developed in a layered manner as suggested under air environment mitigation measures.		
Construction of embankment, AE works and activities within construction camps	Terrestrial ecology	Construction Phase • There would be no major impact on terrestrial flora except cutting of trees during project intervention in the subproject area Operation Phase • No direct impact is anticipated during operation stage except accidental damages or absence of tree management.	Construction Phase • Efforts shall be made to minimize the tree loss. • Provision shall be made for planting trees in a ratio of 1:10 per tree cut. Plantation program shall run parallel to the construction activity. Indigenous and existing vegetation like those impacted including various species of Bamboo, Jackfruit, Ficus, Mango and Semal shall be preferred. • Afforestation shall be undertaken with community participation. Prevention of further destruction of vegetation from erosion due to the project interventions, the proposed	Contractor during implementation and DLP. PIU and PISC during operation period	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			project shall help to improve the terrestrial biodiversity of the area <u>Operation Phase</u> • Arrangement shall be made for effective tree management to ensure survivability of the tree plantation. AADB along with the social forestry wing of the Forest Department may be involved in this program. A tree survivability audit shall also be conducted at least once in a year to assess the effectiveness of the program.		
Construction of embankment, and AE works	Animal distribution/migratory route	• Winter migratory birds are reported at Maijan beel in Dibrugarh adjacent to proposed embankment in Dibrugarh and Maguri-Motapung Beel in Tinsukia District which is is within 10km of Tinsukia subproject area. Winter migratory birds may also use the riverine charland/islands/sand bars. • River Dolphins and other	• In case of accidental trappings due to construction works or sightings of the endangered species, the wildlife department shall be immediately contacted for necessary actions. • Poaching, hunting and fishing by the construction workers shall be strictly prohibited and workshops for the laborers shall be conducted by the contractor.	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		aquatic animals use the river for movement from one stretch to other. The river Dolphins are reportedly found mainly in the main channel of the Brahmaputra River and the proposed anti-erosion and flood protection works shall be limited within 30m of the riverbanks. However, river Dolphins have developed a unique side swimming behavior which is an adaptation to help them navigate through shallow waters, thus, it may be likely that these Dolphins can occasionally venture within 30m of the riverbanks during the lean season, and thus get impacted by the construction works. No or minimal impacts on the movement and migration routes of the aquatic animals and avifauna are envisaged.	• All care shall be taken to ensure that construction waste does not find its way to water and pollute it. • Care shall also be taken to ensure that channels are not permanently obstructed during the construction period in any way outside the work zone. • If river Dolphins are sighted in the secondary channels near to the riverbanks, during the construction period, works shall be temporarily suspended till the Dolphins move out into the main channel.		
Construction of embankment and AE works	Endangered species	<u>Design and Construction Phase</u>	• In case of accidental trappings due to construction works or sightings of the	Contractor during implementation and DLP. PIU and PISC to conduct	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		• IBAT[66] there are 99 IUCN red listed species within 50 km radius of the subproject areas in Dibrugarh District. These includes 17 CR (3 floral, 1 amphibian, 8 avian, 4 reptilian and 1 mammalian species), 30 EN (2 floral, 8 reptilian, 2 Pisces, 9 avian and 9 mammalian species) and 52 VU species (5 floral, 1 arthropodan, 1 amphibian, 5 reptilian, 7 fishes, 19 avian and 14 mammalian species). • IBAT[67] there are 105 IUCN red listed species within 50 km radius of the subproject areas in Tinsukia District. These includes 21 CR (7 floral, 1 amphibian, 8 avian, 3 reptilian and 2 mammalian species), 35 EN (3 floral, 7 reptilian, 4	endangered species, the wildlife department shall be immediately contacted for necessary actions. • Poaching, hunting and fishing by the construction workers shall be strictly prohibited and workshops for the laborers shall be conducted by the contractor. • All care shall be taken to ensure that construction waste does not find its way to water and pollute it. Care shall also be taken to ensure that channels are not permanently obstructed during the construction period in any way outside the work zone. • Biodiversity and ecology assessment including surveys/census of IUCN Red listed species shall be carried out during the first monsoon season in the construction period for the entire project area (all the 4 subprojects) by specialized Ecologists appointed by PISC.	biodiversity and ecology assessment including survey/census of IUCN Red listed species	

[66] IBAT Proximity Report. Generated under license 5840-42026 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org
[67] IBAT Proximity Report. Generated under license 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		Pisces, 9 avian and 12 mammalian species) and 49 VU species (5 floral, 1 amphibian, 4 reptilian, 6 Pisces, 18 avian and 15 mammalian species).	• A second biodiversity and ecology assessment including surveys/census of IUCN Red listed species shall be carried out during the winter season in the operation period for the entire project area (all the 4 subprojects) by specialized Ecologists appointed by PISC/FREEMA		
Construction of embankment and AE works	Aquatic Ecology	<u>Design and Construction Phase</u> • Temporary impact on fishing by local resident during construction phase on the bank of the river with conventional methods anticipated. • Temporary flushing of the fish species towards the deeper part of the river may happen during the anti-erosion and flood protection works. • The construction activity may increase the turbidity on the bank temporarily, however the impact is temporary and reversible.	• Adequate provision shall be made in the design to ensure access to the temporary ghats. • Adequate requisite facilities shall be restored or maintained for undisturbed movement of the fisherman. • During the construction, the contractors must provide a clear signage to guide which areas that fishing boat should not pass by or make a temporary landing.	Contractor	PIU, PMU and PISC
Construction of embankment and AE works	Effect on Riverine Dolphins	• River Dolphins have developed a unique side swimming behavior which is an adaptation to help	• Works shall be limited to 30m from the riverbanks into the LFL of the river channels. The reported	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		them navigate through shallow waters, thus, it may be likely that these Dolphins can occasionally venture within 30m of the riverbanks during the lean season, and thus get impacted by the construction works. • Minimal impacts on the movement and migration routes of the are envisaged.	sightings of the dolphin are at a distance and away from the riverbanks mainly in the main channel of Brahmaputra River. • If river Dolphins are sighted in the secondary channels near to the riverbanks, during the construction period, works shall be temporarily suspended till the Dolphins move out into the main channel. • No works are to be done during the monsoon season. • In case of accidental trappings due to construction works, the wildlife department shall be immediately contacted for necessary actions.		
Construction of embankment and AE works	Effect on spawning and breeding grounds	<u>Design and Construction Phase</u> • Increase in siltation due to construction activity in the subproject area particularly during the breeding season, may disturb the breeding activities. However, anti-erosion works shall primarily be executed in the riverbed and LFL	• The construction of the anti-erosion works shall primarily be executed in the riverbed and LFL area during the winter season. The construction activity in the riverbed shall be prohibited during the breeding period of April to August. • All care shall be taken to ensure that construction	Contractor during implementation and DLP. PIU and PISC during operation period	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		area during the winter season	waste does not find its way to water in these area and cause pollution		
Construction of embankment, AE works and activities within construction camps	Social conflict	<u>Construction Phases</u> • Conflict in culture and lifestyle and competition with local laborers over some job opportunities may take place besides triggering potential health issues such as HIV/AIDS.	• Early consultations will be made by the contractor with the local communities to determine the appropriate location of work camp sites. • The contractor shall ensure that all migrant laborers are housed in the labor camps. Preference shall be given to locals for employment as unskilled and semi-skilled workers. • All migrant workers will undergo workshop/briefings to sensitize them on local culture and lifestyle awareness. • Appropriate measures for addressing potential health issues such as HIV/AIDS shall be taken like awareness and training, HIV testing, if required.	Contractor	PIU, PMU and PISC
Activities within construction camps	Establishment and operation of construction camps and workers facilities	• Proper provision and maintenance of facilities is necessary for proper living conditions and avoid health, environment and safety	• Ensure conditions of livability at work camps are maintained at the highest standards possible at all times • Living quarters and	Contractor	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		issues. • Operation of construction camps can cause temporary air and noise pollution from machine operation, water pollution from storage and use of fuels, oils, solvents, and lubricants. Potential impacts are negative but short-term and reversible by mitigation measures.	construction camps shall be provided with standard materials (as far as possible to use portable ready to fit- in reusable cabins with proper ventilation); thatched huts, and facilities constructed with materials like GI sheets, tarpaulins, etc., shall not be used as accommodation for workers; accommodation shall meet the IFC standards for workers accommodation[68] which include: provision of safe housing, availability of electricity, plumbing, water and sanitation, adequate fire protection and dormitory/room facilities; accommodation shall be in the range from 10 to 12.5 cubic meters (volume) or 4 to 5.5 square meters (surface) per worker, a minimum ceiling height of 2.10 meters; a reasonable number of workers are allowed to share the same		

[68] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_workersaccommodation

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			room – (standards range from 2 to 8 workers). • Proper beds with mosquito nets, potable drinking water, separate toilets for men and women connected to the septic tanks and soak pits, separate kitchen and dining facilities, Condom boxes/vending machines to be mandatorily provided in the labor camps. Laborers shall not be sleeping on the ground. Spraying of insecticides, carbolic acids etc. shall be done regularly (at least once a week). First aid boxes as per Factory Act and first aiders to be provided in the construction sites and labor camps • Prohibit employees from poaching wildlife and cutting of trees for firewood;		
Construction of embankment, AE works and activities within construction camps	Nearby establishments (educational and/or religious) and households	<u>Construction Phases</u> • A number of houses and establishments are located close to the proposed project interventions and some shall be directly impacted	• Efforts shall be made to prevent any relocation or demolition of these establishments, unless absolutely required. Where required, the social infrastructure shall be	Contractor during implementation and DLP.	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		and shall be required to be relocated. • Noise and emissions generating from the construction activity may adversely impact the establishments in the vicinity, however, the impact is temporary and reversible.	rehabilitated taking account of social and cultural values in consultation with the local community and district/local administrations. • Temporary noise barriers will be installed close to school and place of worship during the construction stage.		
Clearing and Grubbing, site preparation, construction of embankment, AE works and activities within construction camps	Accident and safety	<u>Design and Construction Phase</u> • Roads in subproject area being narrow may lead to hazardous traffic conditions due to movement of construction vehicles. • The execution of work on the river front and use of barges may lead to safety and accident risks. • Locals may out of curiosity crowd around the construction camp and zones and get hurt. <u>Operation Phase</u> • Due to improved road condition on the new embankment in Goalpara town area, drivers may have tendency to drive	<u>Design and Construction Phase</u> • Drivers shall be provided adequate trainings to drive in narrow roads. • Proper river safety gears shall be provided to the personnel working on the river front. • The construction zones and the camps shall be barricaded and proper fences provided. • Adequate lighting and signage (including road signages) to be provided at the construction sites to aware the locals of the dangers. • All signage shall be in multiple language (Assamese, Hindi/Bengali besides English, if	Contractor during implementation and DLP. PIU and PISC during operation period	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
		fast on embankment road resulting in accidents.	Engineer desires). • Speed limits shall be prescribed for construction vehicular movement on the access road to avert the accidents • The workers shall be provided with necessary personal protective equipment and a first aid unit including adequate supply of dressing materials, transport means, nursing staff and an attending doctor, shall be available at each construction site. • Regular health checkup camps to be organized at a frequency defined in EMP. • Mandatory health checkups of laborers to be done during joining and periodically during the construction phase. <u>Operation Phase</u> • Speed limits shall be prescribed for vehicular movement on the embankment road to avert the accidents. Adequate signage and light reflectors shall be placed along the		

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			roadside.		
Construction of embankment and AE works	Navigation	• People use small motorboats/country boats for navigations between fish landing sites or ghats for movements between 2 banks/chars. These landing sites/ghats could be temporarily disturbed due to project activities. However, there will not be any impact on the general navigability of the river due to the project since project activities are limited to riverbank and beyond.	• During construction phase, contractors will provide alternate landing sites (ghats) with berthing facilities, access, and other common infrastructure, as part of the tender documents • In places the riverbank protection will provide steps to facilitate landing of local boats in support of trade and river crossings	Contractor	PIU, PMU and PISC
Clearing and Grubbing, site preparation, construction of embankment, AE works and activities within construction camps	Occupational Health and Safety Plan. Due to COVID 19 Pandemic	• Though the effect of COVID-19 pandemic has subsided in the India but the threat remains as the pandemic like situation occurs in some countries globally. In case of recurrence of the COVID-19 pandemic in India the local community members involved in project activities may be at a heightened risk of virus exposure.	• In case of recurrence of pandemic ensure that the project related staff at all levels are appropriately vaccinated. • Ensure project staff, consultants, contractors, and workers have in their mobile devices the Aarogya Setu App, which is a mobile application developed and recommended by the government of India to proactively reach out to and inform the users of the app regarding risks, best	Contractor during implementation and DLP.	PIU, PMU and PISC

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			practices and relevant advisories pertaining to the containment of COVID-19. • Ensure mandatory isolation of the personnel or workers, either asymptomatic or showing symptoms, who have had direct contact with anyone tested positive for COVID-19. • The isolation procedures issued by the government shall be followed along with proper disposal of used PPE following guidelines and procedures issued by the government.		

Source: ADB TA Consultant

Table 9-2: Environmental Monitoring Plan (EMoP)

Environmental Component	Project stage	Parameter	Standards	Location	Duration/Frequency	Implementation	Supervision
Air Quality	Construction Phase	$PM_{2.5}$, PM_{10}, SO_2, NO_X, CO, Pb	National Ambient Air Quality Standards and CPCB guidelines for collection of samples and testing	At 4 locations within 100m of hot mix plant, construction camp, crusher and near sensitive locations/ settlements identified by the contractor and approved by the Engineer	Continuous 24-hourly, twice a week for two weeks. Twice every year (summer and winter) during construction period	Contractor through NABL accredited/MoEF&CC approved Environmental Laboratories	PMU, PIU and PISC
	Operation			At 4 locations near	Continuous		

Environmental Component	Project stage	Parameter	Standards	Location	Duration/Frequency	Implementation	Supervision
	Phase			sensitive locations/settlements identified by the contractor and approved by the Engineer	24-hourly, twice a week for two weeks. Only once in the first summer season of operation period/DLP at 4 locations		
Surface Water Quality inclusive of sampling for fisheries	Construction Stage	pH, BOD, COD, TDS, TSS, DO, Oil and grease and other physio-chemical and biological parameters	Grab sample collected from source and analyzed as per standard methods for examination of water and wastewater and CPCB Water Quality Criteria	At 4 locations including Brahmaputra River, wetlands/ponds at locations identified by the contractor and approved by the Engineer	Twice a year during pre-monsoon (between March - May) and post monsoon seasons (between October – December) every year during construction period	Contractor through NABL accredited/MoEF&CC approved Environmental Laboratories	PMU, PIU and PISC
	Operation Phase				Only once either during pre-monsoon (between March - May) or post monsoon seasons (between October – December) in the first year of operation period/DLP		

Environmental Component	Project stage	Parameter	Standards	Location	Duration/Frequency	Implementation	Supervision
Ground and surface water and Drinking Water Quality	Construction Stage	pH, BOD, TDS, DO, Fl, Cl, As, Cd, MG, Mn, total coliform and other physio-chemical and biological parameters	Grab sample collected from source and analyzed as per standard methods for examination of water and IS 10500:1991	At 4 locations including construction and labor camp sites and other locations/ settlements identified by the contractor and approved by the Engineer	Twice a year during pre-monsoon (between March - May) and post monsoon seasons (October – December) every year during construction period	Contractor through NABL accredited/MoEF&CC approved Environmental Laboratories	PMU, PIU and PISC
	Operation Phase			At 4 locations/ settlements identified by the contractor and approved by the Engineer	Only once either during pre-monsoon (between March - May) or post monsoon seasons (between October – December) in the first year of operation period/DLP		
Noise	Construction Phase	Noise levels in dB (A) for day, night, L_{10}, L_{90}, Lmax, Lmin	As per National Standards for Noise and CPCB guidelines for collection of samples and testing	At 4 locations including construction sites, equipment yards and other noise sensitive locations/settlements identified by the contractor and approved by the Engineer	One day hourly measurements for continuous 24 hours. Twice a year for every year (i.e., summer and winter seasons)	Contractor through NABL accredited/ MoEF&CC approved Environmental Laboratories	PMU, PIU and PISC

Environmental Component	Project stage	Parameter	Standards	Location	Duration/Frequency	Implementation	Supervision
					during construction period		
	Operation Phase			At 4 noise sensitive locations/settlements identified by the contractor and approved by the Engineer	Only once either during summer (between March - May) or winter seasons (between December - February) in the first year of operation period/DLP		
Soil quality	Construction Phase	Monitoring of NPK and heavy metals, grease and other baseline parameters	ICAR Criteria of Soil Quality	At 2 locations including agricultural fields identified by the contractor and approved by the Engineer	Twice a year during pre-monsoon (between March - May) and post monsoon seasons (between October – December) every year during construction period	Contractor through NABL accredited/MoEF &CC approved Environmental Laboratories	PMU, PIU and PISC
	Operation Phase				Once either during pre-monsoon (between March - May) or post monsoon seasons (between		

Environmental Component	Project stage	Parameter	Standards	Location	Duration/Frequency	Implementation	Supervision
					October – December) in the first year of operation period/DLP		
Terrestrial and aquatic ecology	Construction Phase	Census and Habitat Study	Wildlife Institute of India guidelines and Good Industry Practices	All throughout the project area (encompassing the four subproject areas)	One season during pre-construction phase (in the 1st monsoon season preferably) One season during the winter season in the operation period	PISC	PMU
Drainage Congestion	Construction Phase	Visual check	WRD guidelines	Project benefit area	Every year after first rains during construction period	PIU/WRD	PMU
	Operation Phase				Once after first rains during operation period		
River hydrology, morphology and sediment transport	All phases	Scientific techniques applicable to the monitoring of these components	Central Water Commission (CWC) and other scientific bodies' guidelines and standards	Entire subproject area at locations identified by the PIU/WRD as per CWC guidelines	Regular	PIU/WRD	PMU
Hydrology	All phases	Water level, discharge, river cross sections	Central Water Commission (CWC)	Entire subproject area at locations identified by the PIU/WRD as per	As per CWC guidelines	PIU/WRD	PMU PMU

Environmental Component	Project stage	Parameter	Standards	Location	Duration/Frequency	Implementation	Supervision
Morphology	All phases	Bank line profiles, sediment transport, velocity, float tracking etc.		CWC guidelines			
Tree Plantation	Construction period	Survival rate of trees, success of re-vegetation (The number of trees surviving during each visit shall be compared with the number of saplings planted. The survival rate should be at-least 75% below which re-plantation to be done)	Forest department, GoA guidelines and standards	Entire subproject area and areas where compensatory plantations have been done	Thrice a year during pre-monsoon, post monsoon and winter seasons	Contractor and Forest dept.	PMU, PIU and PISC
	Operation Phase				Every year for 3 years during operation period	PIU and Forest dept.	PMU and PISC

FREMAA- Flood and River Erosion Management Agency of Assam, CWC- Central Water Commission, dbA- Decibel, IS- Indian Standard, PCBA- Pollution Control Board Assam, WRD- Water Resource Department, Govt. of Assam.

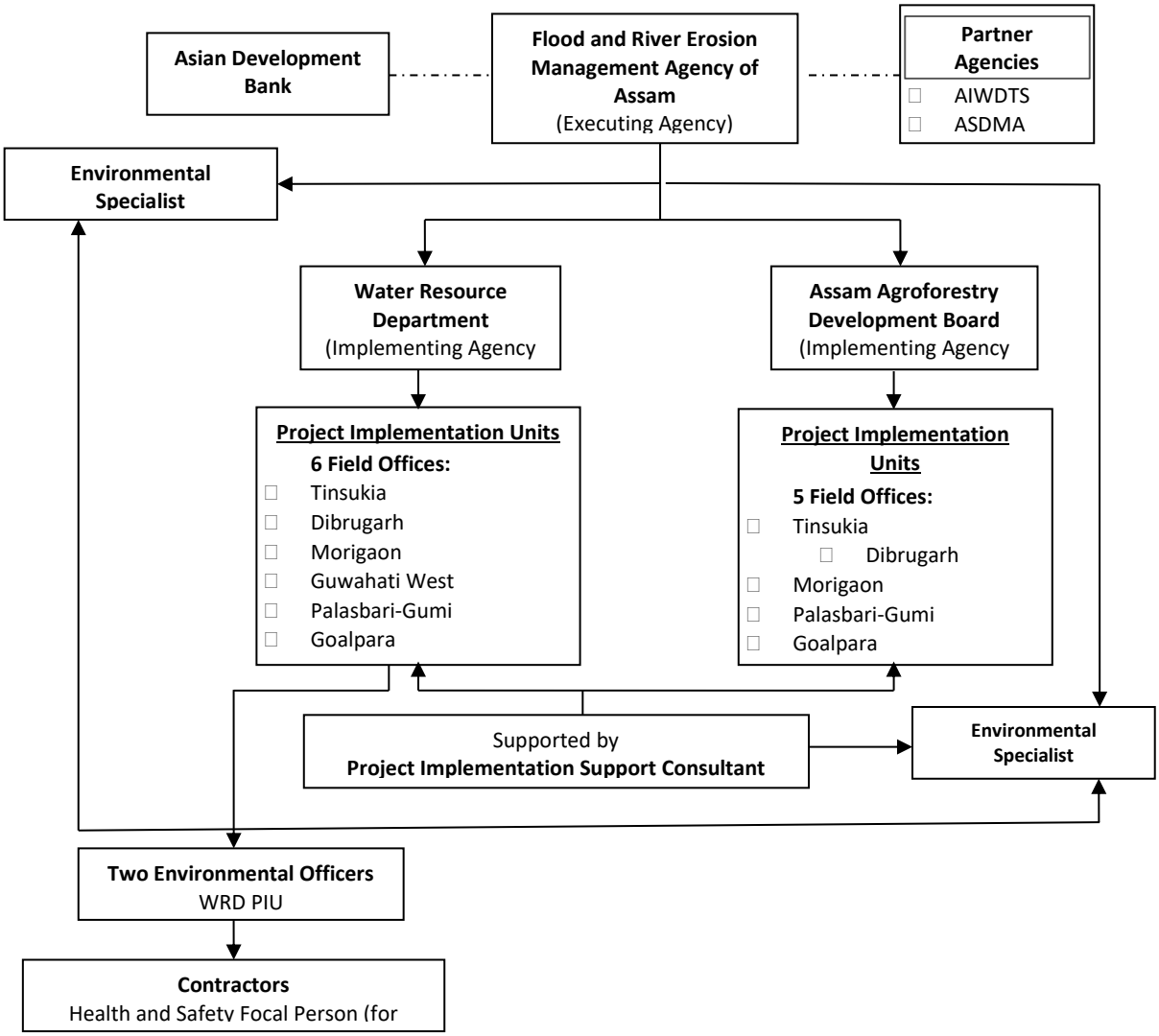
Source: ADB TA Consultant

B. Implementation Arrangement and Responsibilities of EMP implementation:

485. All the policy decisions, including incorporation of the EMP requirements in compliance to loan covenants shall be the responsibility of the recommended FREMAA as the executing authority which is registered under the Societies Act. The FREMAA is completed execution of ADB project AIFRERMIP and is currently executing World Bank project Assam Integrated Riverbank Management Program (AIRBMP).

486. The project management unit (PMU) FREMAA will have responsibility to implement overall EMP. The PMU is responsible for the full compliance of the project with the loan agreement, ADB's SPS, and all applicable laws and rules of the government. The PMU is supported by an environment specialist to ensure compliance with environmental safeguards. The PMU will be assisted by WRD and AADB as PIUs. WRD PIU will be supported by two Environment Officers for implementing the environmental safeguard requirements. There will be 6 PIUs at WRD for execution of anti-erosion and flood protection works and 5 PIUs at AADB for implementing nature-based solutions. The Organizational Structure for implementation of environmental safeguard requirements is indicated in **Figure 9-1.**

Figure 9-1: Organizational Structure for Environmental Safeguards



Source: WRD and FREMAA

487. The **PMU** will:

(i) comply with the government policies, standards, and other environment-related statutory requirements of the project;

(ii) review and approve the construction EMP(s) prepared by the contractor(s) with the support of PISC and PIUs;

(iii) be responsible for application of key documents and forwarding to government agencies for the processing of clearances and permits including, but not limited to environmental clearance certificate, forest clearance, tree cutting permit, and other relevant permits and license, prior to awarding any works contracts to any contractor;

(iv) ensure the preparation, review, and submission of EMRs (as stated on the loan agreement) for disclosure on the ADB and FREMAA websites;

(v) conduct training and workshops on environmental management, and site induction of all staff and workers involved in the project implementation. The staff and workers will include all engineers, and field supervisors and laborers of contractors;

(vi) guided by the IEEs submitted to ADB, implement effective environmental monitoring during pre-construction, construction, and operation phases. This includes, but is not limited to, inspections, review of monitoring forms prepared by the contractors, and documentation of the issues received through GRM;

(vii) take proactive and timely measures to address any environment safeguards related challenges at the national, state or district levels such as (a) delays in processing of clearances during pre-construction stage and (b) significant grievances during construction and operation stages);

(viii) review and approve, for submission to ADB, annual EMRs prepared by the PIUs and PISC;

(ix) lead in complying with disclosure of annual EMRs;

(x) review and approve corrective action plans (CAPs) for environment safeguard noncompliance.

(xi) inform ADB on any unanticipated environmental impact/s occurred during project implementation phase; and

(xii) ensure GRM, as envisaged in the IEEs and in this PAM, is in place and fully operational from the onset of project implementation.

488. As **PIU,** the WRD will:

(i) ensure that the project, and all contractors obtain permits, licenses, etc. for activities such as the operation of asphalt plants, quarries, borrow areas etc. before the implementation of the respective construction activity;

(ii) carry out regular field verification and review environmental compliances by the contractor during project implementation, in coordination with the PISC and the contractor's environmental focal person;

(iii) with PMU's support through environment specialist and field supervisors, provide and record environmental observations during any site visits that may include, but not limited to, excessive dust, loud noises, improper disposal of wastes, chemical/oil spills, camp hygiene, health and safety, and improper borrow area management; and

(iv) in case of potential risks and hazards to health, environmental quality, and properties that may result from poor EMP implementation, immediately instruct the contractor to cease the construction activities that pose risk and conduct immediate containment and mitigation activities.

489. If there are any unanticipated environment impacts during project implementation, the PMU, with support from the PISC, will update the IEE/s and EMP/s. Both documents will be reviewed by ADB and disclosed on ADB's website.

490. **Contractor:** The contractor is the principal agent to implement the EMP and environmental quality monitoring during the pre- and construction, and operation stages. Specifically, the contractor will:

(i) appoint the contractor's environment, health and safety focal person and attend the site induction workshop to be organized by the PMU and WRD;

(ii) obtain necessary environmental license(s), permits etc. from relevant agencies as specified in the IEE and this PAM for the ancillary facilities such as quarries, tree cutting, etc. prior to commencement of works;

(iii) as part of detailed survey, collect the baseline data on environmental quality of the construction sites before the start of physical works and continue collection of information (e.g., air quality, noise level, and water quality) during civil works as per the initial EMP;

(iv) revise and finalize the construction EMP and environmental quality monitoring plan;

implement and document all mitigation measures in the EMP and environmental quality monitoring plan;

(v) ensure that all workers, site agents, including site supervisors and management, participate in all environmental safeguard related training sessions;

(vi) ensure compliance with environmental statutory requirements and contractual obligations;

(vii) participate in resolving issues as a member of the GRM;

(viii) respond promptly to grievances raised by the local community or any stakeholder and implement environmental corrective actions or additional environmental mitigation measures as necessary and inform WRD; and

(ix) based on the results of EMP monitoring, cooperate with WRD to implement environmental corrective actions and corrective action plans, as necessary.

491. If there are any environment safeguard non-compliance during project implementation, the PMU will prepare necessary Corrective Action Plans (CAP) and reflect them in the periodic Environmental Monitoring Reports (EMRs). ADB will monitor WRD performance on the CAP.

492. ADB is responsible for the following:

(i) review EMRs, and disclose the final reports and on ADB's website;

(ii) explain policy requirements and safeguard covenants in the loan and project agreements to PMU and PIUs;

(iii) monitor implementation of the EMP through due diligence missions;

(iv) assist PMU and PIUs, if required, in carrying out its responsibilities and in building capacity for safeguard compliance;

(v) monitor overall compliance of the subprojects to this PAM; and

(vi) if necessary, provide further guidance to PMU and PIUs on the format, content, and scope of the periodic monitoring reports for submission to ADB.

493. The environmenetal safeguards roles and responsiblties of AADB's PIU are yet to be defined at the stage. The IEE shall be updated later to Include the roles and responsibilities of AADB.

494. The environmental management plan and resettlement plan will be updated from time to time during project implementation, upon availability of detailed engineering design, and to reflect adaptive management of project changes and unforeseen circumstances or in response to project performance, ensuring that standards originally planned are not lowered.

495. **Capacity Building and Training:** Executing and implementing agencies need to have a sustained capacity to manage and monitor environmental safeguards. Although specialist consultants support will be available to PMU and PIUs, it is necessary to mainstream safeguards in day-to-day working. Therefore, PMU and PIUs require capacity building measures for (i) a better understanding of the project-related environmental issues; and (ii) to strengthen their role in preparation of IEE, implementation of mitigation measures, and subsequent monitoring. Trainings and awareness workshops are included in the project with the primary focus of enabling the PMU and PIU staff to understand impact assessments and carry out environmental monitoring and implement EMPs. After participating in such activities, the participants will be able to review environmental assessments, conduct monitoring of EMPs, understand government and ADB requirements for environmental assessment, management, and monitoring (short- and long-term), and incorporate environmental features into future project designs, specifications, and tender documents and carry out necessary checks and balances during project implementation.

496. The PISC will facilitate the implementation of capacity building program for the PMU, PIU, and contractors, with specific topics on environmental safeguards such as but not limited to the list below. The contractors will be responsible for conducting site-specific/work-specific orientation on environmental safeguards for their workers prior to deployment to work sites. Typical modules would be as follows: (i) sensitization; (ii) introduction to environment and environmental considerations in water supply projects; (iii) review of IEEs and integration into the project detailed design; (iv) improved coordination within nodal departments; (v) monitoring and reporting system; and (vi) project GRM. Specific modules customized for the available skill set will be devised after assessing the capabilities of the target participants and the requirements of the project. The proposed training program along with the frequency of sessions, is presented in Table 9-3.

Table 9-3: Capacity Building Program on EMP Implementation

Description	Target Participants and Venue	Estimate (INR)	Cost and Source of Funds
1. Introduction and Sensitization to Environmental Issues (1 day) • ADB Safeguards Policy Statement • Subproject selection criteria, categorization etc., • Government of India and Government of Assam applicable environmental safeguard laws, regulations and policies including but not limited to core labor standards, OEHS, Covid -19, safety etc. • IEE preparation and EMP formulation • Incorporation of EMP into the project design and contracts • Monitoring, reporting and corrective action planning	Participants: All staff and consultants involved in the project Venue: PMU, FREMAA	200,000 (Lump sum)	PMU cost
2. Implementing EMP (1/2 day - once at the beginning and at a frequency of once in six months during implementation) • Site-specific mitigation and monitoring measures • Roles and responsibilities • Public relations, Consultations and Grievance redress	Participants: All staff and consultants involved in the subproject. All contractors immediately after mobilization of the contractor Venue: PIUs	200,000 (Lump sum)	PMU cost

Description	Target Participants and Venue	Estimate (INR)	Cost and Source of Funds
• Monitoring and corrective action planning • Reporting and disclosure • Construction site standard operating procedures (SOP) • Chance findings (archeological) protocol • Traffic management plan • Waste management plan • Site clean-up and restoration			
3. Contractors Orientation to Workers (1/2 day) • Environment, health and safety in project construction (OEHS, Covid-19 safety, core labor laws, spoils management, etc.)	Participants: Once before the start of work, and thereafter regular briefing every month once. Daily briefing on safety prior to start of work to all workers (including unskilled laborers)	100,000 (Lump sum)	Contractor's cost

Source: ADB TA Consultant

497. Summary of Capacity Building cost for EMP Implementation

- Contractor Cost - INR 100,000.00
- PMU Cost - INR 400,000.00
- **Total** **- INR 500,000**.00

498. **Environmental Monitoring Reports (EMRs).** The EMRs will be submitted annually to document the progress on the EMP implementation. The PMU and PIUs will be supported by the PISC to monitor EMP implementation (pre- construction, construction and and postconstruction) and implementation of nature-based solutions. An outline of the EMR is in Appendix 10. This outline is a template but additions, such as additional text, tables, charts, figures, may be made to ensure appropriate documentation of (i) project implementation progress, (ii) compliance with safeguard measures and their progress, and (iii) necessary corrective actions. The annual EMRs will be due for submission to ADB within one month following the end of the EMR period. The submission of EMRs to ADB will continue until the project completion report is issued by ADB.

499. The EMRs will be disclosed on the ADB's and FREMAA's websites after review and acceptance by ADB.

EMP Implementation Cost

500. Most of the mitigation measures require the contractors to adopt good site practice, which should be part of their normal procedures already, so there are unlikely to be major costs associated with compliance. There are some of the provisions in bid documents like compliance of the requirements of health and safety during construction works as per applicable labor laws, labor insurance, equipment fitness, provision of labor welfare facilities, healthcare facilities etc. which are unanimously bound to contractor bidding for the project therefore it is understood that costs for such requirements are bound to contractor and no need to consider as cost of EMP implementation. Regardless of this, any costs of mitigation by the construction contractors or consultants are included in the budgets for the civil works and do not need to be estimated separately here. Mitigation that is the responsibility of PMU/PIU will be provided as part of their management of the

project, Cost for the capacity building program is included as part of the project. Cost of environmental management is given in Table 9-4.

Table 9-4: EMP Cost

Sl. No.	Particulars	Stages	Unit	Total Number	Rate (INR)	Cost (INR)	Costs Covered By
A.	**Mitigation Measures**						
1	Provision for tree cutting and compensatory plantation (1:10) measures, monitoring and maintenance	Pre-Construction and Construction	Per tree	7,000	4,000	2,80,00,000	Civil works contract
2	Obtaining and submission of copies (to PMU) all consents, permits, clearances, no objection clearances or NOCs, tree cutting permissions, and other relevant permits from various authorities before the start of construction	Pre-Construction and Construction	Lump sum	-	-	5,00,000	Civil works contract
3	Disposal of existing old geo-bags and other materials used as temporary anti-erosion and flood protection measures, and disposal of all solid wastes during construction to designated locations and/or use of local municipal services	Pre-Construction and Construction	Lump sum	-	-	30,00,000	Civil works contract
4	Provision of all requisite facilities (i.e., drinking water supply, sanitation, domestic solid waste collection and disposal, fuel supply etc.) at construction camps. Ensuring rehabilitation of borrow areas and other impacted lands in line with WRD guidelines and decommissioning of construction camp before handling over the subproject.	Construction and Operation	Lump sum	-	-	30,00,000	Civil works contract
5	Traffic management at work sites (i.e., pavement markings, channelizing devices, arrow panels and warning lights) along with construction and/or strengthening of landing ghats for barges	Construction	Lump sum	-	-	30,00,000	Civil works contract
6	Water sprinkling for dust suppression, barricading,	Construction	Lump	-	-	30,00,000	Civil works

Sl. No.	Particulars	Stages	Unit	Total Number	Rate (INR)	Cost (INR)	Costs Covered By
	temporary noise barriers, and provision of personal protective equipment (such as boots, life-saving-jackets, etc.)		sum				contract
7	Implementation of biodiversity action plan and other biodiversity conservation and mitigation measures	Construction and Operation	Lump sum	-	-	1,00,00,000	Civil works contract
Subtotal (A)						**5,05,00,000**	
B.	**Monitoring Measures**						
1	Air quality monitoring	Construction and Operation	Per sample	80	10,000	8,00,000	Civil works contract
2	Noise levels monitoring	Construction and Operation	Per sample	20	6,000	1,20,000	Civil works contract
3	Surface water monitoring	Construction and Operation	Per sample	20	15,000	3,00,000	Civil works contract
4	Drinking water monitoring	Construction and Operation	Per sample	20	15,000	3,00,000	Civil works contract
5	Groundwater monitoring	Construction and Operation	Per sample	20	15,000	3,00,000	Civil works contract
6	Soil monitoring	Construction and Operation	Per sample	12	10,000	1,20,000	Civil works contract
Subtotal (B)						**19,40,000**	
C.	**Capacity Building**						
1	Training on EMP Implementation, COVID-19 protocols and other health and safety topics	Pre-construction and Construction	Lump sum	-	-	10,00,000	Civil works contract
2	Preparation of plans and protocols (i.e., traffic management plan, waste or spoil management plan, chance find protocol, and other relevant activities)	Pre-construction and Construction	Lump sum	-	-	5,00,000	Civil works contract
Subtotal (C)						**15,00,000**	
Total (A+B+C)						**5,39,40,000**	
Miscellaneous, provisional sum and contingency @ 5% of the subtotal						**26,97,000**	
					Grand Total	**5,66,37,000**	

Source: ADB TA Consultant

X. CONCLUSIONS AND RECOMMENDATIONS

501. The conclusions are based on Environmental Assessment carried out for the Dibrugarh subproject (including Tinsukia District), which is one of the four subprojects identified under proposed ADB CRBFRERMP. The identification and selection of subprojects is based on the vulnerability of the area to flood and erosion of the Brahmaputra River in Assam. The subproject is needed to safeguard the people, property and environment from frequent and devastating floods of the Brahmaputra River.

502. The Dibrugarh subproject including Tinsukia was considered as environmental category B under ADB SPS 2009 and the findings of the IEE study support this categorization as no significant impact are anticipated to be generated from the subproject.

503. To protect the community in Dibrugarh and Tinsukia Districts from land erosion of Brahmaputra, riverbank revetment is necessary. Erosion protection by construction of bank revetment and apron for a total length of 21.26 km is proposed out of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia. Adaptation works/emergency contingency works total of 4.65 km is proposed to be undertaken at 4 locations in Dibrugarh. Also, a total of 173 numbers of P.S.C porcupine over 3 layers are proposed to be launched in 5 locations in Dibrugarh and 2 locations in Tinsukia. In 5 locations of Dibrugarh 72 number of porcupines and 2 locations of Tinsukia a total of 101 number of Porcupines are proposed to be launched. Additionally, construction of 1.2 km close gap in embankment at Maijan Beel in Dibrugarh, RCC triple shutter sluice gate in Maijan Beel embankment with regulator and fish pass and is also proposed. Adaption works of 4.65 km at 3 locations of Dibrugarh with geo-bags are also proposed.

504. Nature-based solutions (NbS) e.g., bioengineering techniques such as the planting of reeds will be pilot tested to be applied to embankment slopes to reduce maintenance requirements from the risk of rain cuts and to provide local stakeholders with income generating activities opportunities. AADB will establish a PIU which will be responsible for implementing the nature-based solutions under the proposed ADB project CRBFRERMP. AADB will develop, implement, improve, guide, and supervise pilot nature-based solutions including relevant research and dissemination of research results. The pilots will provide employment opportunities for riverine rural poor and as the pilots can be upscaled to broader implementation, more employment opportunities will be created in the next phases. The purposes of the AADB pilots are to prevent erosion of the slopes of embankments, to plan and promote wetland revival and biodiversity, and to promote siltation on possibly reclaimed land. Presently for the pilot project, AADB shall focus on providing NbS for embankments and riverbanks and Wetland conservation. AADB shall be identifying the final locations for NbS pilots along with FREEMA and WRD based on land availability (government owned land), proximity to existing forest nurseries, budget finalization and approvals etc. Once these pilot plots are identified, this IEE shall be updated accordingly. FREMAA shall assist AADB for procurement of all goods and services.

505. All potential impacts associated with proposed anti-erosion and flood protection works were identified in relation to pre-construction, construction, and operation phases. Planning principles and design considerations have been reviewed and incorporated into the site planning and design process wherever possible.

506. Construction activities will be confined to the selected sites along the banks of Brahmaputra River spread over Dibrugarh and Tinsukia Districts, and the interference with the general public and community around is minimal. There will be temporary negative impacts, arising mainly from construction dust and noise, hauling of construction material, waste and equipment on local roads (traffic, dust, safety etc.), mining of construction material, occupational health and safety aspects. During the construction phase impacts will arise from the dust and noise, increase in traffic by the

construction vehicles, and from the need to dispose of large quantities of waste soil and also the disposal of geo-bags used earlier for temporary flood protection works by WRD. The social impacts (access disruptions) due to construction activities are negligible as most of the works are confined to the inhabited riverbanks. There shall though be some impacts on properties and CPRs. A RP for the subproject areas has been prepared and shall be part of the bidding document which shall address the social concerns. General temporary reversible impacts around inhabited subproject area due to setting up of the construction camp by the contractor are expected, and there are well developed methods of mitigation that are suggested in the EMP. Other specific measures include safe handling of wastes, minimize tree cutting and vegetation removal at various sites.

507. The subproject area is primarily a rural area and no subproject component is located in protected or sensitive environmental areas such as forest areas, national parks, wildlife sanctuaries, Ramsar wetlands or archeologically protected areas.

508. There is 1 notified protected area (Dibru - Saikhowa NP) within 1 km of the project intervention areas in Dibrugarh District and 2 PAs in Tinsukia District (Dibru - Saikhowa NP and Bherjan-Borajan-Podumoni WLS) within 1 km and 5 km of the project intervention areas. The Eco-Sensitive Zone (ESZ) of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites are adjacent to or within the notified area of the ESZ of the Dibru - Saikhowa NP. The ESZ of Bherjan-Borajan-Podumoni WLS is notified as well, and no subproject site is within its ESZ. On 14th July 2023, FREEMA obtained no objection letter from the Office of the Principal Chief Conservator of Forest (Wildlife) and Chief Wildlife Warden, Assam for construction activities within the ESZ of Dibru - Saikhowa NP. As part of condition, the project will ensure that (i) no porcupines will be installed and no adverse impact shall be caused to Ganges River Dolphin (*Platanista gangetica*) and other riparian wildlife including their habitat during project implementation.

509. As per information made available from IBAT[69], there are 99 IUCN red listed species within 50 km radius of the subproject areas in Dibrugarh District. These includes 17 CR (3 floral, 1 amphibian, 8 avian, 4 reptilian and 1 mammalian species), 30 EN (2 floral, 8 reptilian, 2 Pisces, 9 avian and 9 mammalian species) and 52 VU species (5 floral, 1 arthropodan, 1 amphibian, 5 reptilian, 7 fishes, 19 avian and 14 mammalian species). In case of Tinsukia District subproject areas based on the information made available from IBAT[70], there are 105 IUCN red listed species within 50 km. These includes 21 CR (7 floral, 1 amphibian, 8 avian, 3 reptilian and 2 mammalian species), 35 EN (3 floral, 7 reptilian, 4 Pisces, 9 avian and 12 mammalian species) and 49 VU species (5 floral, 1 amphibian, 4 reptilian, 6 Pisces, 18 avian and 15 mammalian species).

510. Dolphin and other endangered species and other nearby areas are recorded in the Brahmaputra River by government reports and studies, however not exclusive to the project site and no findings during surveys. No damage to the habitat of these species is anticipated. There are no other environmental sensitive resources found in the project area which is likely to be affected by the project. Biodiversity and ecology assessment including census of IUCN Red listed species (or surveys) shall be carried out during the 1st monsoon season of the construction period for the entire project area under CRBFRERMP (all the 4 subprojects) by specialized expert/s appointed by PISC. The methodology shall, but not limited to, include belt and transect walks, point counts, and quadrat methods as per approved standard methodologies. PISC shall obtain necessary permissions from the forest and wildlife departments before start of the assessment surveys. The assessments shall be undertaken within a 1km radius of the proposed interventions in the subproject including, but not limited to riverine chars, bank lines, beels having direct connection with the

[69] IBAT Proximity Report. Generated under license 5840-42026 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

[70] IBAT Proximity Report. Generated under license 5840-42027 from the Integrated Biodiversity Assessment Tool on 14 April 2023 (GMT). www.ibat-alliance.org

Brahmaputra River in the subproject area and at other locations identified by the Engineer. In case of any affected species in the project areas (i.e., 4 subprojects) findings that requires mitigation measures, BAP will be implemented, and the IEE shall be updated by PISC & FREEMA and submitted to ADB for necessary actions.

511. A second biodiversity and ecology assessments including census of IUCN Red listed species shall be carried out during the winter season in the operation period for the entire project area (all the 4 subprojects) by specialized expert/s appointed by PISC/FREEMA adopting similar methodologies and at similar locations where surveys were carried out during construction period to ascertain the benefits of the BAP and necessary course corrections. The assessment report and the status of the monitoring shall be part of the environmental monitoring reporting.

512. The project entails various impacts on the environmental setting of the area. While some are negative, there are many bearing benefits, these include the following:

(i) The Brahmaputra River carries more water per unit area of basin than any other river in the world, The subproject area experiences heavy rainfall during monsoon with average annual rainfall of 2819 mm in Dibrugarh District and 2323 mm in Tinsukia District. The proposed project, through strengthening the reliability of the existing embankments and riverbank protection works will prevent people from the impacts of devastating floods.

(ii) The selected Dibrugarh subproject area is prone to extreme hazards of bank erosion, and embankment breaches. This results in loss of productive agriculture land, infrastructure and damage to environment. The proposed project will result in protecting loss of precious agriculture productivity.

(iii) The project area falls within 1 km of Dibru - Saikhowa NP in Dibrugarh District and 2 protected areas Dibru - Saikhowa NP and Bherjan-Borajan-Podumoni WLS in Tinsukia District. The Eco-Sensitive Zone (ESZ) of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites are adjacent to or within the notified area of the ESZ of the. Dibru - Saikhowa NP. The ESZ of Bherjan-Borajan-Podumoni WLS is notified as well, however no subproject sites located within its boundaries. FREEMA obtained no objection from the Office of the Principal Chief Conservator of Forest (Wildlife) and Chief Wildlife Warden, Assam for construction activities within the ESZ of Dibru - Saikhowa NP.

(iv) The afforestation will not only help in compensating losses of trees but also increase tree cover in the long run due to the compensatory afforestation at the rate of 1:10 as per the state government policy.

(v) There are large number of wetlands, beels and other water bodies (fishponds) in the study area, however these are not likely to be affected by the project intervention. The proposed project is likely to enhance the fish productivity in these water bodies due to protection from flooding and siltation under this project.

(vi) The people are largely poor in the area, many of them depend on fisheries, agricultural activities and forest resources. The area is vulnerable to the floods and erosion and the subproject is aimed at strengthening the flood protection measures in the area and addressing the soil erosion problem. The economic gain is expected to be high.

513. Provided that the recommended mitigation measures are implemented, no impact is anticipated on endangered species like River Dolphin due to project activities. Some of the trees along the embankment are likely to be cut. But, if the proposed compensatory afforestation plans are effectively implemented, and survival rate is monitored and sustained, the positive benefits are likely to be accrued. The project is likely to bring positive impact to wetlands around the subproject

area, pond fisheries and agricultural productivity due to protection from flood and reduced sedimentation. Project activities are likely to generate some adverse environmental impacts during construction. However, these will be temporary. Implementation of the prescribed mitigation measures will minimize the adverse impacts. Moreover, the impacts shall be monitored continually by implementing and updating the EMP and EMoP.

514. The project is welcomed by all the stakeholders. Stakeholders were involved in developing the IEE through face-to-face discussions, on site meetings, and village level consultation workshops, which was conducted for larger public participation in the project. Views expressed by the stakeholders were incorporated into the IEE and the planning and development of the project. The IEE will be made available at public locations and will be disclosed to a wider audience via the PMU and ADB websites. The consultation process will be continued during project implementation to ensure that stakeholders are engaged in the project and have the opportunity to participate in its development and implementation. The project's grievance redress mechanism will provide the citizens with a platform for redress their grievances, and describes the informal and formal channels, time frame, and mechanisms for resolving complaints about environmental performance.

515. There is a possibility that the subproject area may be affected by the impacts of climate change and other external events including major earthquakes and upstream development works such as hydropower development. While the impacts of these events may well extend beyond the economic life of the subproject investments (of 30 years), available study indicates the possible climate change impact of increased precipitation by up to 30% in the north-eastern region by 2040-60, although diverse anticipation still coexists. A large-scale earthquake (and landslides) may exacerbate the sediment loads of the Brahmaputra, whereas the hydropower dams upstream may reduce the sediment inflow. On these accounts, the systematic monitoring of the river dynamics to be strengthened under the project will facilitate the identification and implementation of necessary measures to adapt to any emerging changes in the construction and post-construction phase of the subproject.

516. The project involves strip acquisition of land for strengthening the existing embankments and associated structural relocation. The concerned land acquisition and resettlement cases will be addressed following the Government of India's and Government of Assam's laws and regulations, and ADB's Involuntary Resettlement Policy, which has been stipulated in the resettlement framework, based on which resettlement plans are being parallelly prepared and implemented to address all the cases. Extensive public consultation has been carried out, consistent with state guidelines. For affected people, support will be provided to improve, or at least restore, the pre-intervention income and livelihoods standards, and productive capacity. In addition, the subproject will provide construction labor opportunities and community development assistance to nearby communities and to landowners whose land will be acquired, or structures be affected, including non-title holders.

517. Though the impact of COVID-19 pandemic has subsided with a sustained vaccination campaign and following of appropriate behavior. The recurrence of pandemic like situation cannot be ruled out. In case of recurrence of the COVID-19 pandemic in India the local community members involved in project activities may be at a heightened risk of virus exposure. Project shall also adhere to necessary protocols in response to infectious diseases such as the corona virus disease (COVID-19) consistent with the guidelines of relevant government healthcare agencies and the World Health Organization.

518. The IEE and EMP will be included in the bid and contract documents to ensure compliance with the conditions set out in this document. The EMP will assist the PMU, PIU, PISC, and contractors in mitigating the environmental impacts, and guide them in the environmentally sound execution of the proposed project. The EMP will also ensure efficient lines of communication between PIU, PMU, PISC, and contractor. The EMP shall be made binding on all contractors

operating on the site and will be included in the contractual clauses. Non-compliance with, or any deviation from, the conditions set out in this document shall constitute a failure in compliance. Copy of the EMP will be kept on site during the construction period at all times.

519. The subproject will benefit the general public by contributing to the long-term improvement of anti-erosion, flood protection, and community livability in the project coverage area. The potential adverse environmental impacts are mainly related to the construction period, which can be minimized by the mitigation measures and environmentally sound engineering and construction practices. Therefore, as per ADB SPS, the project is classified as environmental Category B and does not require further environmental impact assessment. However, to conform with government guidelines all necessary permissions and NOCs are to be obtained from the concerned departments prior to start of construction.

520. This IEE shall be updated by PMU to reflect any changes in design, locations, interventions, amendments etc. and will be reviewed and approved by ADB. Where unanticipated environmental impacts become apparent during subproject implementation, this IEE will be updated and its EMP, or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.

Appendix 1: Summary of Flood and Riverbank Erosion Assets to be constructed.

Type of Work	Dibrugarh (Including Tinsukia district)	Morigaon	PGP/Guwahati West	Goalpara	Total Project
New Embankment (km)	1.20	0.00	0.00	2.08	**3.28**
Upgrading Embankment (km)	0.00	1.15	0.00	0.00	**1.15**
Riverbank Revetment (km)	21.26	15.65	11.54	11.35	**59.80**
Adaptation Works/Emergency contingency (km)	4.65	0.25	8.75	0.25	**13.90**
Porcupine screen (no.)	173	7	8	6	**194**
Porcupine screen (km)	24.1	1.0	2.7	4.5	**32.3**
Regulator (no.)	1	0	0	3	**4**
Fish pass (no.)	1	0	0	0	**1**
Other works	• Revival of Maijan beel with nature-based solutions	-	• Pump house at Palasbari • Hostel for trainees next to Assam Water Center in Guwahati	-	**As listed**

Appendix 2: Details of Scope of Works

Subproject	New Embankments (km)		Upgrading Embankments (km)		Riverbank Revetments (km)		Adaption Works/Emergency contingency (km)		Porcupine screen (no.)	Porcupine screen (km)	Regulator (no.)		Fish pass (no.)	Other works
Dibrugarh (including Tinsukia district)	Close gap in embankment at Maijan Beel	1.20	0		Nagaghuli to Kachari Line	0.90	Kasuoni	1.00	173	24.1	RCC triple shutter sluice gate in Maijan Beel embankment	1	1	Revive of Maijan beel with nature based solutions
					Filunuguri to 7400 ft Spur	1.70	Mothola	2.40						
					DTP Dyke (Dibrugarh Town Area)	3.93	DTP dyke	1.00						
					DTP Dyke (Amoraguri)	0.27	Emergency	0.25						
					Mohanaghat	0.78								
					Nagakhelia	0.60								
					Chaulkhowa at D/S of Bogibeel Bridge	3.69								
					Milanpur to Hatighuli	1.50								
					Pheliai to Naokota	2.00								
					Gariating Gaon	0.40								
					Simaluguri Satra	0.40								
					Bahjan to Notun Gaon	2.10								
					upstream Guijan	0.30								
					Rungagorah to Dinjan	2.70								
Subproject Total	1.20		0		21.26		4.65		173	24.1	1		1	
Morigaon	0		Shifting/widening existing embankment at Kuptimari	0.70	Mikirgaon-Kathani-Tengaguri area	7.50	Emergency	0.25	7	1.0	0		0	
					Kuptimari-Balidunga area	1.90								
					Upstream of Panchali spur	0.25								
			Chutiagaon spur recoupment	0.45	Downstream of Panchali spur to Baralimari	2.00								
					Gagalmari-Garubandha area	4.00								
Subproject Total	0		1.15		15.65		0.25		7	1.0	0		0	

Subproject	New Embankments (km)		Upgrading Embankments (km)	Riverbank Revetments (km)		Adaption Works/Emergency contingency (km)		Porcupine screen (no.)	Porcupine screen (km)	Regulator (no.)		Fish pass (no.)	Other works
PGP/Guwahati West	0		0	Kalitapara	0.80	Palashbari	3.50	8	2.7	0		0	Pump house at Palishbari Hostel for trainees next to Assam Water Center in Guwahati
				Futuri	1.45	Guwahati West	5.00						
				Simina	0.64								
				Guimara	0.20								
				Gumi	0.85	Emergency	0.25						
				Borakhat	3.90								
				Panikhaity	1.10								
				Lotordia	2.60								
Subproject Total	**0**		**0**	**11.54**		**8.75**		**8**	**2.70**	**0**		**0**	
Goalpara	Embankment Goalpara town	2.08	0	Goalpara Town Two stretches, 2.35 km - Baladmari 3.00 km - Goalpara (geobags with PCC blocks)	5.35	Emergency	0.25	6	4.50	Goalpara town (1 shutter sluice and 4 shutters sluice)	2	0	
				Chinair to Jaleswar	6.00					Chunari (4 shutters)	1	0	
Subproject Total	**2.08**		**0**	**11.35**		**0.25**		**6**	**4.50**	**3**		**0**	
Project Total	**3.28**		**1.15**	**59.80**		**13.90**		**194**	**32.30**	**4**		**1**	**As above**

Appendix 3: Rapid Environmental Assessment (REA) Checklist

ADB
Asian Development Bank

Memorandum
South Asia Department
Environment, Natural Resources and Agriculture Division

2 December 2022

To: Bruno Carrasco 8-Dec-22
Director General concurrently Chief Compliance Officer, SDCC

Through: Bruce Dunn
Director, SDSS 8-Dec-22

Mio Oka (e-signed 2 December 2022)
Director, SAER

From: Olivier Drieu (e-signed 2 December 2022)
Senior Water Resources Specialist, SAER

Subject: **56283-001 India: Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project in Assam** — *Request for Approval of Environment Categorization*

Attached for your review and approval:

1. Environment (B)
2. REA Checklist
3. Climate Screening Checklist
4. COVID-19 Checklist for Environment

cc: B. Angeles, SAER; O. Joyce, SAER

ENVIRONMENT CATEGORIZATION

Date: 2 December 2022

A. Instructions

(i) The project team completes and submits the form to the Safeguards Division (SDSS) for endorsement by SDSS Director, and for approval by the Chief Compliance Officer (CCO). OM F1/OP on *Safeguard Review Procedures* (paras. 4–7) provides the requirements on environment categorization.
(ii) The classification of a project is a continuing process. If there is a change in the project components or/and site that may result in category change, the Sector Division submits a new form and requests for recategorization, and endorsement by SDSS Director and by the CCO. The old form is attached for reference.
(iii) In addition, the project team may propose in the comments section that the project is highly complex and sensitive (HCS), for approval by the CCO. HCS projects are a subset of Category A projects that ADB deems to be highly risky or contentious or involve serious and multidimensional and generally interrelated potential social and/or environmental impacts.

B. Project Data

Country/Project No./Project Title	:	IND: Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project in Assam
Department/ Division	:	South Asia / Environment, Natural Resources and Agriculture
Processing Stage	:	Project Concept Paper
Modality	:	

[x] Project Loan [ ] Program Loan [ ] Financial Intermediary [ ] General Corporate Finance
[ ] Sector Loan [ ] MFF [ ] Emergency Assistance [ ] Grant
[ ] Results-based lending[1] [ ] Other financing modalities

C. ENVIRONMENT CATEGORY [PLEASE TICK ONE CATEGORY BASED ON THE SET OF CRITERIA IN OMF1 (PARAS. 6–7)]

[X] NEW [ ] RECATEGORIZATION — PREVIOUS CATEGORY [ ]

[ ] Category A	[x] Category B	[ ] Category C	[ ] CATEGORY FI

D. Basis for Categorization/ Recategorization (please. attach supporting documents):

[x] REA Checklist
[x] Project and/or Site Description
[ ] Other: _____

E. Comments

Project team comments:	SDSS Comments:
The project aims to reduce economic vulnerability and social disruption induced by flood and riverbank erosion flood prone areas along the main stem of the Brahmaputra River in Assam. It will (i) stabilize identified critical locations within four river reaches by providing integrated climate resilient riverbank erosion and flood protection infrastructure to ultimately recover lost floodplain and charland and enhance navigation; (ii) strengthen institutional capacity; and (iii) support improved livelihoods of the most vulnerable riparian population and increase their resilience to shocks through inclusive economic empowerment. The project is categorized as "*B*". Subproject areas are in rural parts of Assam. No key biodiversity areas or national protected areas nearby the subprojects. None of the project components will have significant adverse environmental impacts because environmental risks are mostly temporary on air, water, soil and noise during construction periods. Mitigation measures will be	Based on the information provided during the categorization process the Category B for Environment can be confirmed. However, given the sensitivity of the Brahmaputra River which supports significant biodiversity interest and is itself a Key Biodiversity Area in a number of locations – further Critical Habitat Assessment needs to be done to establish whether CH is triggered for the areas where the works will be and to confirm that works must be done in a sensitive way to maintain water quality and flow. Given the size of the river in the relevant locations it seems unlikely that project risks will be significant. However detailed information in the EMP will be needed to ensure that project activities do not impact on the river.

[1] For Results-Based Lending (RBL) modality, please refer to the Staff Instruction on Business Processes for RBL for Programs issued on 17 March 2021. The supplemental checklist needs to be submitted to SDSS for confirmation of eligible activities under the RBL program by the CCO.

readily available and compliant with international standards and practices.	Nature-based Solutions should be explored as part of the schemes which appear to be largely traditional hard engineering solutions in the information provided. Duncan Lang Senior Environment Specialist, SDSS 08/12/22

F. Approval

Proposed by: **(e-signed 2 December 2022)** Olivier Drieu, Senior Water Resources Specialist SARD/SAER Project Team Leader Date: 2 December 2022 **(e-signed 2 December 2022)** Brando M. Angeles, Associate Environment Officer SARD/SAER Date: 2 December 2022	**Endorsed by**: Bruce Dunn, Director, SDSS Date: 8 December 2022	
Endorsed by: **(e-signed 2 December 2022)** Mio Oka, Director, SAER Date: 2 December 2022	**Approved by**: Bruno Carrasco Director General, SDOD concurrently Chief Compliance Officer Date: 8 December 2022	☐ Highly Complex and Sensitive Project

Rapid Environmental Assessment (REA) Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (SDES), for endorsement by Director, SDES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title: India: Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project in Assam

Sector Division: SAER/SARD

Screening Questions	Yes	No	Remarks
A. Project Siting Is the Project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural heritage site	✓		There is no cultural heritage site in the subproject areas. All the project related activities will be confined within 20-30m of right of way (RoW). However, there are temples, mosque (i.e. Namghar) in nearby villages with human settlements.
▪ Legally protected Area (core zone or buffer zone)		✓	Subproject areas do not fall into any core zone or buffer zone of legally protected area. In Morigaon subproject area, Orang National Park is located on the other side (ie: north bank) of the Brahmaputra River at an aerial distance of approximately 10 km. Pobitora Wildlife Sanctuary is located approximately 4 km from the end point of the reach downstream towards countryside. Moreover, the subproject area and the wildlife sanctuary are separated by human settlements, state highways and other human activities. Since the project related activities will be within the RoW at the southern bank of the Brahmaputra River, these areas will not have any impact that could potentially be caused by project activities. For the Dibrugarh subproject, the Dibru-Saikhowa National Park is more than 15 km upstream of the location of the proposed anti-

Screening Questions	Yes	No	Remarks
			erosion measures. The other proposed measures are located downstream of these anti-erosion measures. Thus, all the proposed works do not fall into any core zone nor buffer zone of the legally protected area.
▪ Wetland	✓		The subproject areas do not fall under any perennial wetlands. However, there are many wetlands and waterbodies nearby subproject areas, which become active during the rainy season.
▪ Mangrove		✓	Subprojects are not located along any coastal zones. Hence no such sensitive ecosystems exist nearby.
▪ Estuarine		✓	
▪ Special area for protecting biodiversity		✓	Target sites are not adjacent to or within any special area for biodiversity protection. At Palasbari-Gumi-Guwahati West subproject, vegetation cover exists along the highland of the Dakhala area which is a reserve forest. However, the project related activities for riverbank protection works will be limited to adjacent land along the riverbanks. Hence, no project impacts on the reserve forest are anticipated. Please see remarks above for the legally protected areas related to Dibrugarh and Morigaon subprojects.
B. Potential Environmental Impacts Will the Project cause…			
▪ impairment of historical/cultural areas; disfiguration of landscape or potential loss/damage to physical cultural resources?		✓	There are neither historical sites nor cultural areas in any of the four subproject areas.
▪ disturbance to precious ecology (e.g. sensitive or protected areas)?		✓	The project activities in the subproject areas will not cause disturbance to precious ecology such as sensitive or protected areas.
▪ alteration of surface water hydrology of waterways resulting in increased sediment in streams affected by increased soil erosion at construction site?		✓	The project activities in the subproject areas will not cause alteration of surface water hydrology of waterways by increased soil erosion at construction sites. Overall, the project activities, including launching of geotextiles bags, etc., will mitigate riverbank erosion and enhance land reclamation in the vicinity of the subproject sites.
▪ deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?	✓		Worker–based camps will be established away from the main channel towards country-side. These camps will generate minimal sanitary waste. Potential contamination of water induced by camp operations is expected, however these impacts are of local and temporary nature (i.e., during the construction periods only). Chemicals will not be used during the construction activities.
▪ increased air pollution due to project construction and operation?	✓		During the construction periods, increase of the air pollution may result due to construction activities such as movements of vehicles, potential use of generators in workers camps, etc..
▪ noise and vibration due to project construction or operation?	✓		The project activities are expected to increase noise and vibration levels

Screening Questions	Yes	No	Remarks
			associated with use of construction machineries (geotextile bags stitching machines, use of generators in workers camps) and use of vehicles.
▪ involuntary resettlement of people? (physical displacement and/or economic displacement)	✓		The project activities will be focused on the existing underwater and and immediate vicinity of above water bank of the Brahmaputra River. Hence, physical displacement and resettlement of people living on some of the embankments targeted under the project will be needed for their rehabilitation. Details will be confirmed after the Poverty and Social Impact Assessment studies during the project preparation stage.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		✓	Disproportionate impacts on the poor, women, children, indigenous peoples or other vulnerable groups are not anticipated due to the project activities. The project includes an output to specifically address people living on the embankments or chars in the subproject areas who are poor and destitute and negatively affected by river erosion or floods, especially women in these locations. After completion of the works in the subproject areas, there will be growth in economic activities in the area benefitting all riparian population.
▪ poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations?	✓		Establishment of construction camps will temporarily add to the population in the subproject areas and likely to have poor sanitation and solid waste disposal in the camps and work sites, where transmission of communicable diseases from workers to local populations are possible. As the workers are expected to be from the same or adjacent districts within the state which will maintain cultural balance among the workers and local populations.
▪ creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents?	✓		The project activities will not directly create any breeding habitats for diseases such as those transmitted by the mosquitoes and rodents. However, improper disposal of domestic solid waste generated by workers camps can provide suitable conditions for rodents and mosquitoes.
▪ social conflicts if workers from other regions or countries are hired?		✓	Workers will be recruited by the contractors from the same or adjacent districts.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		✓	Large population of workers is not expected considering the limited scope of works. Most of the labors will be hired locally and a few some may be from the nearby districts.
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?	✓		There are risks and vulnerabilities related to occupational health and safety due to physical hazards during construction.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		✓	No explosive will be used for any of the works. Fueling of vehicles used for the project purpose will be undertaken in the public gasoline stations.

Screening Questions	Yes	No	Remarks
• community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?	✓		During the construction phase, health and safety risk of nearby communities may have increase due to the operations of vehicles and machines.
• generation of solid waste and/or hazardous waste?	✓		Worker camps and storage facilities will only generate solid waste.
• use of chemicals?		✓	Chemicals will not be used for any of the project activities.
• generation of wastewater during construction or operation?	✓		During construction periods, worker camps will generate some wastewater.

A Checklist for Preliminary Climate Risk Screening

Country/Project Title: India: Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project in Assam

Sector : Environment, Natural Resources and Agriculture

Subsector: Rural flood protection; Rural water policy, institutional and capacity development

Division/Department: SAER, SARD

Screening Questions		Score	Remarks[1]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	0	Not likely. There is no alternative options for the subproject sites.
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc)?	2	Trends of increased 24-hour rainfall events and number of rainy days (ie: rainfall greater than 2.4 mm in 24 hours) have been observed and projected in Assam that could result in increases of river discharges and riverbank erosion rates associated with highly turbulent flows reaching the deeper levels of the river. The crest levels of the flood embankment to be built/rehabilitated will be derived from peak flood water levels and peak wind generated wave heights. Both of these may increase in the future. Additionally, with climate-induced increased discharges, current loading may increase. The design of the underwater and riverbank protection works will include parameters such as high flood levels and river flow velocity.
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of	1	Increase in flood water levels and more intense rainfall in the project area beyond the anticipated and designed levels will require higher embankments to provide the same level of protection. Also, increased river discharges and flow velocities induced by

[1] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

	project inputs over the life of project outputs (e.g. construction material)?		climate change may result in increased scouring, hence in increased scour protection elements along the riverbanks.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	2	The predicted increase in peak levels and volume of floods due to climate change will require more frequent monitoring, repair and maintenance activities by Water Resources Department and communities, as well as appropriate operation and maintenance budgets.
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	2	The predicted increase in peak levels and volume of floods due to climate change over the 30 years design life span of the assets poses threat to the communities behind the flood embankments. Activities under the project will include riverbank protection and flood embankments works as well as community-based flood risk management capacity building to increase resilience to flood and erosion and enable the communities to adapt to and be better prepared against the challenges of extreme flood events.

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response, will be categorized as high risk project.

Result of Initial Screening (Low, Medium, High): High

Other Comments:_____

_____

(e-signed 2 December 2022)
Prepared by: Olivier Drieu

7

PROJECT DESCRIPTION
INDIA: CLIMATE RESILIENT BRAHMAPUTRA INTEGRATED FLOOD AND RIVERBANK EROSION RISK MANAGEMENT PROJECT IN ASSAM

Rationale

Combining structural and nonstructural measures, the project will be implemented in four high-priority flood- and erosion-prone subproject areas selected to contribute to the broader stabilization of the Baramaputra River in Assam.[1] The project will (i) stabilize identified critical locations within the four river reaches by providing integrated climate resilient riverbank erosion and flood protection infrastructure to ultimately recover lost floodplain and charland and enhance navigation2; (ii) strengthen the institutional capacity for climate and disaster resilient FRERM supported by an enhanced knowledge base to inform risk-based decisions related to disaster prevention and asset maintenance; and (iii) support improved livelihoods of the most vulnerable riparian population and increase their resilience to shocks through inclusive economic empowerment.

The project will focus on priority river reaches of the Brahmaputra Main Stem (Figure 1), and will inlcude a full range of structural and nonstructural measures in each reach.

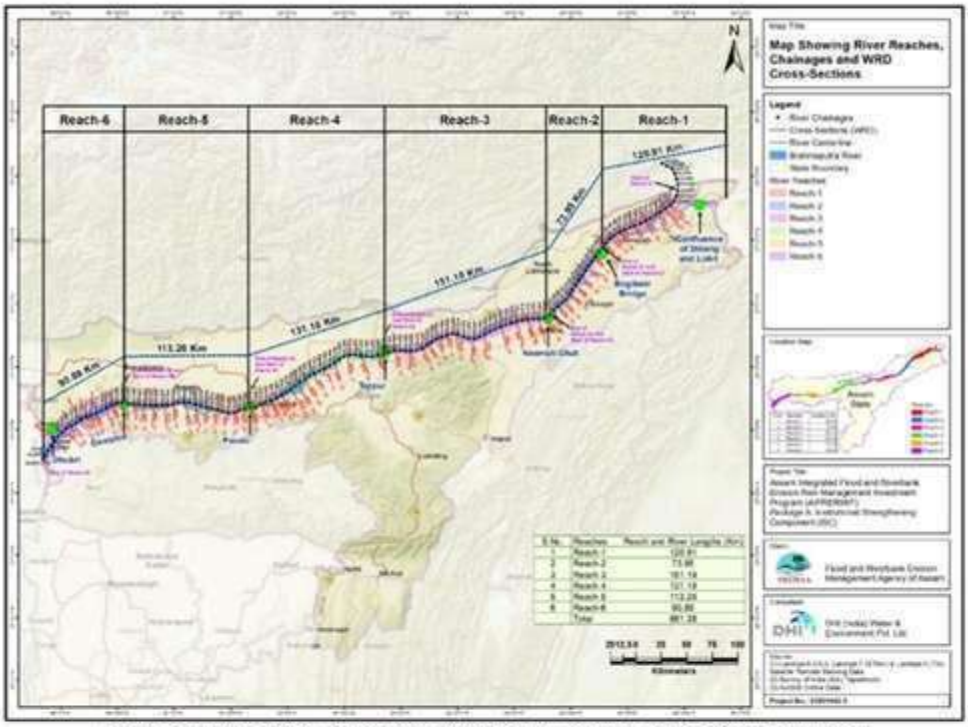


Figure 1. Map of the Reaches of the Brahmaputra Main Stem in Assam

Structural Measures

Riverbank protection. To cope with riverbank erosion on the Brahmaputra Main Stem, the project will dominantly follow the ADB-financed Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP)[3] approach of building long-guiding geotextile sand-filled bags (geo-

[1] The four high-priority subprojects are Dibrugarh, Morigaon, Palasbari-Gumi-Guwahati West, and Goalpara.
[2] An accretion in a river, the chars are valuable to the economy as additional cultivable areas.
[3] The multitranche financing facility (MFF) to India for the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program was approved by ADB in 2010 to increase the reliability and effectiveness of flood

bags) revetments in an adaptive way. These combine the stabilization of riverbanks at erosion locations and guide the river over some length, hence contributing to larger river stabilization. Also, activities will include provisions for adaptation of existing Water Resources Department (WRD) and AIFRERMIP works in the selected reaches to accelerate the stabilization process of longer river reaches.

Flood embankments. The project will aim at providing riverbank protection first, and then building/rehabilitating climate-resilient modern multi-purpose flood protection embankments, including systematic geotechnical engineering to reduce future risk of breaches. Multi-purpose embankments are primarily characterized by separating the flood protection function (through a separate crest at the river side) and the transport function (through a road on a lower lying land-sided shoulder). The embankment design will be based on morphological river modelling accounting for a range of possible river morphologies which could result in different flood water levels for the same return periods.

Land reclamation via channel closures. Land reclamation benefits are important aspects to enhance socio-economic development, especially in the Dibrugarh and Palasbari-Gumi reaches. It will be investigated further whether reclamation could also be feasible in other reaches. Land reclamation will involve channel closures through dredging ('sand overloading') and pro-siltation measures ('porcupines') but also bioengineering measures to trap fine sediments during the flood season. The closed channels might be equipped with upstream intakes for a defined water flow to be used for example for wetland conservation/restoration, dry season irrigation purposes, and local drainage.

Ancillary structures. Embankments will be provided with openings ('sluice gates') to enable water to flow onto and from the floodplain. Sluice gates will be provided with fish passes, where required, to enable interconnectivity of floodplain and river and enhance biodiversity.

Nonstructural Measures of the Project

Flood forecasting and early warning. In continuation of AIFRERMIP, State Government of Assam water level forecasting and warning measures will be continued and expanded along the Brahmaputra Main Stem. These measures will be developed in parallel to a World Bank project. The measures to be developed by the project can be integrated later into a comprehensive system for the Brahmaputra floodplain.

Flood mapping. This includes covering the flood and erosion risk, but also providing information, such as inundation (extents, depth, duration), vulnerability to flooding of the affected population and of assets (including critical assets) in urbanized areas (for example Gumi and Dibrugarh). Flood hazard assessment for rural areas will enable to assess the potential of flooding (depth and duration) during different embankment breach scenarios and for different combinations of high river flood levels and rainfall events.

Surveys and river monitoring. The project will establish baseline information through systematic surveys of all river channel in one reach during successive flood seasons[1] and high-resolution topographic surveys providing the baseline digital elevation models or DEM for accurate flood hazard and flood risk assessment. The baseline surveys will also improve the accuracy of the flood forecasting and warning models for the Brahmaputra Main Stem.

Capacity building. The project will support WRD in expanding the capacity of a specialized design wing, including preparation of a guideline for river and flood management measures in Assam. This guideline is expected to accelerate the planning process for riverbank protection in the future and assist the transition from piecemeal work to holistic integrated systematic river stabilization measures.

Erosion prediction model. The model developed under AIFRERMIP will be expanded to incorporate other reaches of the Brahmaputra Main Stem. It is anticipated to conduct annual erosion prediction for the

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and riverbank erosion risk management systems in flood-prone areas in Assam, through structural and nonstructural interventions, policy strengthening, and institutional and knowledge bases. The second and final tranche of the MFF was physically completed on 18 October 2020.

[1] The survey will include bathymetric surveys, water levels, and water and sediment discharge surveys

Brahmaputra Main Stem and to combine the results with inundation maps as a planning tool for the districts and potential emergency works as well as future State Government investments.

Asset management system. The system developed under AIFRERMIP will be expanded to cover the selected river reaches of the Brahmaputra Main Stem. An operation and maintenance module comparing the actual condition of the assets with their design status will enable to derive annually a risk-based prioritized maintenance program and identify rivers sections that require major strengthening or adaptation works.

Community-based flood risk management (CbFRM) and flood shelters. Drawing on the experience and lessons learned under AIFRERMIP, activities will focus on disaster preparedness of riparian communities as well as population located behind flood embankments (which can breach). In areas not embanked, the construction of flood shelters and disaster-resilient access to them will be investigated further for possible incorporation in the project design.

Proposed Subproject Areas

(i) Morigaon Subproject

The proposed subproject area is in Morigaon District of Assam, which is southern bank of Brahmaputra River. The proposed antierosion activities for a length of 37.44km will include mainly launching of geo-bags for riverbank protection works.

The proposed project area does not fall under any eco-sensitive zone. Orang National Park is in the other side of the Brahmaputra at Odalguri district with aerial distance of more than 10km. Pobitora Wildlife Sanctuary is located approximately 4km downstream towards the countryside from the end point of the project locations. There is no animal corridor near the project area.

Pokoriya River flows from the southern side of subproject site. The river confluences with the Brahmaputra River approximately 1km downstream from the end point of the subproject's reach.

Rainy season is from the month of June to October. November to May is the active working season for construction.

Table 1. Geocoordinates[1] and length of the subproject.

Name of Division	Name location/Village	geocoordinates		Reach Length (m)
		From	To	
Morigaon	Chutiagaon to Teteligurin(Near Kasasila)	26°26'21.04"N 92°20'0.44"E	26°16'35.96"N 92° 3'17.85"E	37,440

[1] The details are yet to be endorsed by the WRD.

Figure 2. Map (Google Earth) of the subproject site showing the starting and end points at Morigaon Subproject.

(ii) Palasbari-Gumi Subproject

With 4 reaches for antierosion works, the Palasbari-Gumi (PGP) proposed subproject area is located at Kamrup District as well. The target reaches under the subproject are approximately 25km from Guwahati. The proposed activities will have a length of 3.09km and include launching of geo-bags as river bank protection works. Vegetation cover exists along the Dakhala reaches which is a highland area in the bank of Brahmaputra River. Rests of the three reaches are located mainly in the sandbar of the Brahmaputra with very minimal vegetation. Human settlements are adjacent in the subproject area towards southern direction. The proposed project site does not fall under any eco-sensitive zone. There is no dedicated animal corridor near the project area.

Table 2. Geocoordinates and length of the subproject area

Name of Division	Name location/Village	Co-ordinate		Reach Length (m)
		From	To	
PGP	Dakhala (Kalitapara)	26°7'3.10"N	26°7'1.08"N	800.00
		91°30'49.7"E	91°30'24.82"E	
	Guimara	26°7'2.3"N	26°7'1.9"N	200.00
		91°28'9.7"E	91°28'13.8E	
	Simina	26°7'17.9"N	26°7'21.5"N	640.00
		91°27'23.6"E	91°27'8.4"E	
	Makadhuj to Futuri	26°7'41.6"N	26°7'28.5"N	1450.00
		91°26'3.3"E	91°26'43.8"E	

(a) (b)

(c)

Figure 3. Location map of: (a) Dakhala Reach, (b) Guimara Reach and (c) Simina and Makadhuj-Futuri Reaches.

(iv) Dibrugarh Subproject

For the Dibrugarh Subproject, there are 7 reaches for antierosion works and 1 reach for earthworks with triple shutter reinforced concrete (RCC) sluice gate. The proposed reaches under the are located approximately 25km from Guwahati. The proposed antierosion activities (i.e.14.88km) will include launching of geo-bags and geo matress for riverbank protection works. The reach for earthworks (with three shutter RCC sluice gate) will cover 1200m of embankments.

Dibru-Saikhowa National Park is 15km upstream of antierosion of Reach-1. The rest of reaches are downstream of the Reach-1, thus, all the reaches under the subprojects does not fall into any core zone of buffer zone of legally protected area. The proposed project site does not fall under any eco-sensitive zone.

Table 4. Geocoordinates and length of the subproject area

Name of Division	Name location/Village	Co-ordinate		Reach Length (m)	Remarks
		From	To		
Dibrugarh (Guijan to Mohanghat	Reach-1	27°31'33.01"N	27°30'54.34"N	3500	Geo-bags
		95° 0'41.88"E	94°58'43.77"E		
	Reach-2	27°30'54.34"N	27°30'43.54"N	1500	Geo-bags
		94°58'43.74"E	94°57'55.00"E		
	Reach-3	27°30'24.30"N	27°29'32.91"N	3925	Geo Mattress
		94°57'7.84"E	94°55'6.32"E		
	Reach-4	27°28'48.73"N	27°28'42.67"N	265	Geo Mattress
		94°53'34.94"E	94°53'28.25"E		
	Reach-5	27°28'28.43"N	27°28'10.00"N	785	Geo-bags
		94°53'8.96"E	94°52'50.44"E		
	Reach-6	27°27'47.68"N	27°27'37.74"N	600	Geo-bags
		94°52'17.05"E	94°51'58.89"E		
	Reach-7	27°23'14.86"N	27°21'9.07"N	4300	Geo-bags
		94°46'21.85"E	94°45'48.73"E		
	Reach-1	27°30'37.60"N	27°30'26.04"N	1200	Earth Work with Triple Shutter RCC Sluice
		94°57'51.68"E	94°57'12.67"E		

(a) (b)

(iii) Guwahati West Subproject

With 4 reaches for proposed antierosion works, the subproject area is located at Kamrup District of Assam. In the southern bank of Brahmaputra River, target reaches Guwahati West subproject are located approximately 40km from Guwahati.

For a length of 8.45km, proposed activities will include mainly launching of geo-bags for river bank protection works. All 4 reaches are located mainly in the sandbar of the Brahmaputra River with very minimal vegetation. Human settlements are adjacent to these locations, and towards the southern direction. The proposed subproject area have no eco-sensitive zone nor animal corridor nearby.

Table 3. Geocoordinates and length of the subproject area

Name of Division	Name location/Village	geocoordinates		Reach Length (m)
		From	To	
Guwahati West	Gumi	26° 5'55.4"N	26° 5'56.5"N	850
		91°20'26.1"E	91°20'18.7"E	
	Borakhat & Achalpara	26° 6'45.31"N	26° 7'40.31"N	3900
		91°15'6.97"E	91°12'57.75"E	
	Panikhaity	26° 9'15.87"N	26° 9'22.19"N	1100
		91°10'25.72"E	91° 9'40.51"E	
	Lotordia NC	26° 9'28.28"N	26° 9'59.59"N	2600
		91° 9'10.73"E	91° 7'48.01"E	

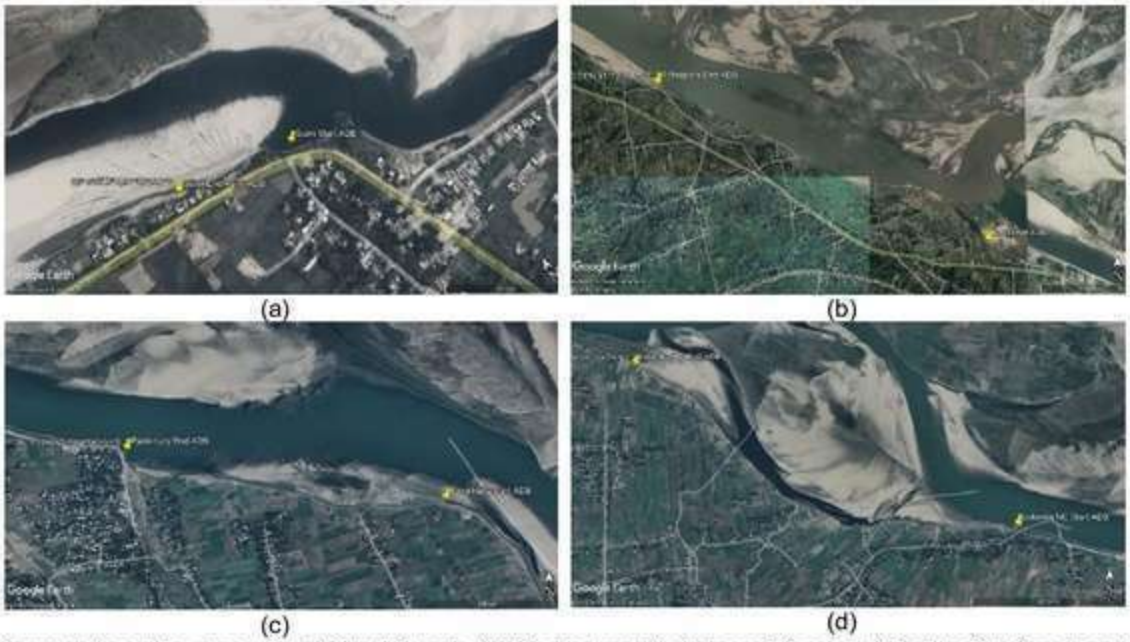


Figure 4. Location maps of: (a) Gumi Reach, (b) Borkhat and Achalpara Reach, (c) Panikhaity Reach and (d) Lotordia NC Reach

Figure 5. Location maps of: (a) Reaches 1 and 2, and Earthworks in Reach-1, (b) Reach-3, (c) Reach-4, (d) Reach-5, (e) Reach-6, and (f) Reach-7

Figure 6. Dibru-Saikhowa National Park and Dibrugarh Subproject reaches

Risk Screening for Environmental Safeguards Assessment during the COVID-19 Pandemic

- This risk screening form must be submitted for projects under preparation and with Management Review Meeting (MRM) or Staff Review Meeting (SRM) planned on or after 1 July 2021.
- If the environment categorization form of the project has already been approved by the Chief Compliance Officer (CCO), project teams must submit only this risk screening form. Project teams do not need to resubmit the environment safeguard categorization forms.
- For projects that have not submitted the environment categorization forms to SDCC, project teams must complete this risk screening form and submit it together with the Environment categorization form.

PROJECT DATA	
Country/Project Title:	IND: Climate Resilient Brahmaputra Flood And Erosion Risk Management Project
Sector Division:	South Asia Department (SARD) / Environment, Natural Resources and Agriculture Division (SAER)
	(e-signed 2 December 2022) Olivier Drieu Senior Water Resources Specialist SARD/SAER 2 December 2022
	(e-signed 2 December 2022) **Brando M. Angeles** Associate Environment Officer SARD/SAER 2 December 2022
Endorsed by:	**(e-signed 2 December 2022)** **Mio Oka** Director SARD/SAER 2 December 2022

Table 1: Project COVID-19 Risk Screening for Environmental Safeguards Assessments

Risk screening questions	Yes	No	Not sure	Remarks
1. Will project preparation be affected by the inability of experts/consultants, to visit the project site because of the pandemic?		✓		Flood and River Erosion Management Agency of Assam (FREMAA) staff and its environment specialist (consultant) have no concern on visiting the subproject sites, perform environmental risks screening and collect relevant information for categorizing the project.
2. Is the project likely to face challenges in achieving meaningful consultations because of the pandemic? If yes, please clarify the types of consultations to be affected and at what stages of environmental safeguards planning and implementation. *Examples: Project consultants are unable to travel to the project site and meet with project stakeholders. Face to face consultations with project affected people cannot be organized due to travel restrictions or social distancing requirements.*		✓		There is no perceived issue on achieving meaningful consultations in the near future.
3. Is the project likely to face challenges in preparing safeguards assessments/planning instruments and/or implementing environmental safeguards plans because of the pandemic? Please be as specific as you can in the remarks section. *Example: Collection of environmental baseline data is not possible as consultants are unable to travel and conduct field studies.*		✓		Currently, there are no concerns for preparing safeguards assessment. FREMAA and their experts can perform due diligence and environmental assessments during project processing phase.

Note.

- *If the answer is "no" to all three questions, project teams may continue preparing the project following standard methods of due diligence.*
- *If the answer is "yes" or "not sure" to any of the questions above, the project teams must follow Figure 2 of the Guidance Note on Safeguards Compliance during the COVID-19 Pandemic during further steps of project preparation.*
- *For further detailed guidance, please refer to the Guidance Note on Safeguards Compliance during the COVID-19 Pandemic*

Additional comments from the Project Team (if any)

Currently, there are no perceived challenges on achieving the requirements of ADB SPS 2009. In case of any challenges to achieve SPS 2009 in the near future, FREMAA will utilize adaptive mechanisms to perform public consultations, collection of environmental baseline information, and environmental risks analysis of the project.

SDSS Comments

No issues identified.

Duncan Lang
Senior Environment Specialist
Date: 8 December 2022

Endorsed by:

Bruce Dunn
Director, SDSS
Date: 8 December 2022

Appendix 4: National and International Environmental Quality Standards and Guidelines

NATIONAL ENVIRONMENTAL QUALITY STANDARDS

National Ambient Air Quality Standards

Pollutants	Time-weighted average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Areas (notified by Central Government)	
Particulate Matter (size less than 10 µm) or PM10 µg/m3	Annual*	60	60	• Gravimetric • Tapered Element Oscillating Microbalances (TOEM) • Beta attenuation
	24 hours**	100	100	
Particulate Matter (size less than 2.5µm) or PM2.5 µg/m3	Annual*	40	40	• Gravimetric • TOEM • Beta attenuation
	24 hours**	60	60	
Sulphur Dioxide (SO2) µg/m3	Annual*	50	20	• Improved West and Gaeke • Ultraviolet fluorescence
	24 hours**	80	80	
Nitrogen Dioxide (NO2) µg/m3	Annual*	40	30	• Modified Jacob and Hochheiser (Na-Arsenite) • Chemilumiscence
	24 hours**	80	80	
Carbon Monoxide (CO) (mg/m3)	8 hours**	2	2	• Non-Dispersive Infra-Red (NDIR) spectroscopy
Ozone (O3) µg/m3	8 hours**	100	100	• UV photometric • Chemiluminescence • Chemical Method
	1 hour**	180	180	
Lead (Pb) µg/m3	Annual*	0.5	0.5	• Atomic Absorption Spectrophotometry/ Inductively Coupled Plasma (AAS/ICP) method after sampling on EPM 2000 or equivalent filter paper • Energy Dispersive X-ray Fluorescence (ED-XRF) using Teflon filter
	24 hours**	1	1	
	1 hour**	4	4	
Ammonia (NH3) µg/m3	Annual*	100	100	• Chemiluminescence • Indophenol Blue Method
	24 hours**	400	400	
Benzene (C6H6) µg/m3	Annual*	5	5	• Gas chromatography based continuous analyzer • Adsorption and Desorption followed by Gas Chromatography (GC) analysis
Benzo(a) Pyrene Particulate	Annual*	1	1	• Solvent Extraction followed by High performance liquid chromatography (HPLC)/ GC analysis

Pollutants	Time-weighted average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Areas (notified by Central Government)	
Phase only ng/m3				
As ng/m3	Annual*	6	6	• AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
Ni ng/m3	Annual*	20	20	• AAS/ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week, 24 hourly at uniform interval.; ng: nano gram

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or monitoring and further investigation.

Source: MoEF&CC Notification dated 16 November 2009

Emission Standards for Diesel Engines ≤ 800 kW for DG sets (2014)

Power Category	Emission limits (g/kW-hr)			Smoke Limit (Light absorption coefficient, m-1)
	CO	NOx + HC	PM	
P ≤ 19 kW	≤ 3.5	≤ 7.5	≤ 0.3	0.7
More than 19 kW up to 75 kW	≤ 3.5	≤ 4.7	≤ 0.3	0.7
More than 75 kW up to 800 kW	≤ 3.5	≤ 4.0	≤ 0.2	0.7

Notes:

1.The abbreviations used in the Table shall mean as under: NOx – Oxides of Nitrogen; HC – Hydrocarbon; CO – Carbon Monoxide; and PM – Particulate Matter.

2. Smoke shall not exceed above value throughout the operating load points of the test cycle.

3.The testing shall be done as per D2 – 5 mode cycle of ISO: 8178- Part 4.

4.The above-mentioned emission limits shall be applicable for Type Approval and Conformity of Production (COP) carried out by authorised agencies.

5.Every manufacturer, importer or, assembler (hereinafter referred to as manufacturer) of the diesel engine (hereinafter referred to as 'engine') for genset application manufactured or imported into India or, diesel genset (hereinafter referred to as 'product'), assembled or imported into India shall obtain Type Approval and comply with COP of their product(s) for the emission limits which shall be valid for the next COP year or, the date of implementation of the revised norms specified above, whichever earlier. Explanation — The term 'COP year' means the period from 1 April to 31 March.

6. Stack height (in metres), for genset shall be governed as per Central Pollution Control Board (CPCB) guidelines

Source: MoEF&CC Notification dated 11th December 2013, g/kW-hr: gram per kilowatt hour

Noise Standards

National Ambient Noise Quality Standards

Category of Area/Zone	Limits in dB(A) Leq	
	Day Time	Night-time
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence Zone	50	40

Note: (1) Day time shall mean from 6.00 a.m. to 10.00 p.m. (2) Nighttime shall mean from 10.00 p.m. to 6.00 a.m. (3) Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority (4) Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

Source: Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2000 vide S.O. 1046(E), dated 22.11.2000 and by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2002 vide S.O. 1088(E), dated 11.10.2002, under the Environment (Protection) Act, 1986.

National Occupational Noise

Occupational permissible exposure limit is permitted to 90 dB(A) for 8 hours/day and shall not be exposed to a noise level exceeding 115 dB(A) at any time. The permissible levels for noise exposure for work zone areas have been prescribed under the Model Rules of the Factories Act,1948:

Peak sound pressure level in dB	Permitted number of impulses or impacts/day
140	100
135	315
130	1000
125	3160
120	10000

Notes: No exposure in excess of 140 dB peak sound pressure level is permitted. For any peak sound pressure level falling in between any figure and the next higher or lower figure as indicated in column 1, the permitted number of impulses or impacts per day is to be determined by extrapolation on a proportionate basis.

Source: https://moef.gov.in/wp-content/uploads/2017/06/moef_gov_in_citizen_specinfo_noise_html.pdf

Total time of exposure to sound pressure level (continuous or a number in dB(A) of short-term exposures) per day, in hours	Sound pressure level in dB(A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	107
0.25	110

Notes: No exposure in excess of 115 dB(A) is to be permitted. For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column 1, the permissible sound pressure level is to be determined by extrapolation on a proportionate basis.

Source: https://moef.gov.in/wp-content/uploads/2017/06/moef_gov_in_citizen_specinfo_noise_html.pdf

National Ambient Noise Quality Standards for DG sets

Category	Limits in dB(A) Leq
Diesel generator sets (up to 1000 KVA) manufactured on or after the 1 January 2005 at 1 meter from the enclosure surface	75

Source: Noise Limit for Generator Sets run with Diesel were notified by Environment (Protection) second Amendment Rules vide GSR 371(E), dated 17 May 2002 at serial no.94 and its amendments vide GSR No 520(E) dated 1 July 2003; GSR 448(E), dated 12 July 2004; GSR 315(E) dated 16 May 2005; GSR 464(E) dated 7 August 2006; GSR 566(E) dated 29 August 2007 and GSR 752(E) dated 24 October 2008; G.S.R. 215 (E), dated 15 March, 2011 under the Environment (Protection) Act, 1986

Water Quality Standards

Surface Water Quality Standard

Sl. No.	Designated Best Use	Class of Water	Criteria
1	Drinking Water source (with conventional treatment)	A	• Total Coliform MPN/100 ml shall be 50 or less • pH between 6.5 to 8.5 • Dissolved Oxygen 6 mg/l or more • Biochemical Oxygen demand (BOD) 5 days 20°C 2 mg/l or less
2	Outdoor bathing (organised)	B	• Total Coliform MPN/100 ml shall be 500 or less • pH between 6.5 to 8.5 • Dissolved Oxygen 5 mg/l or more • Biochemical Oxygen demand (BOD) 5 days 20°C 3 mg/1 or less
3	Drinking Water source (without conventional treatment)	C	• Total Coliform MPN/100 ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4 mg/l or more • Biochemical Oxygen demand (BOD) 5 days 20°C 3 mg/1 or less
4	Propagation of Wildlife	D	• pH between 6.5 to 8.5 for fisheries • Dissolved Oxygen 4 mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
5	Irrigation, Industrial Cooling, Controlled Waste	E	• pH between 6.0 to 8.5 • Electrical Conductivity at 25°C µmhos/cm Max. 2250 • Sodium absorption rations Max. 26 • Boron, Max.2 mg/l

Source: CPCB (1999). Bio mapping of rivers, Parivesh New Letter, 5 (iv), Central Pollution Control Board, Delhi, PP.20.

General Standards for Discharge Of Environmental Pollutants: Effluents[71]

Sl. No.	Parameter	Inland surface water	Public sewers	Land for irrigation	Marine/coastal areas
1	Colour and odour	All efforts should be made to remove colour and unpleasant odour as far as practicable		All efforts should be made to remove colour and unpleasant odour as far as practicable	All efforts should be made to remove colour and unpleasant odour as far as practicable
2	Suspended solids mg/l, max.	100	600	200	(a) For process wastewater (b) For cooling water effluent 10 per cent above total suspended matter of influent.
3	Particle size of suspended solids	Shall pass 850 micron IS Sieve	-	-	(a) Floatable solids, solids max. 3 mm (b) Settleable solids, max 856 microns
4	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
5	Temperature	shall not exceed 5oC above the receiving water temperature	-	-	shall not exceed 5oC above the receiving water temperature
6	Oil and grease, mg/l max,	10	20	10	20
7	Total residual chlorine, mg/l max	1.0	-	-	1.0
8	Ammoniacal nitrogen (as N),mg/l, max.	50	50	-	50
9	Total kjeldahl nitrogen (as N) ;mg/l, max. mg/l, max.	100	-	-	100
10	Free ammonia (as NH3), mg/l, max.	5.0	-	-	5.0
11	Biochemical oxygen demand (3 days at 27oC), mg/l, max.	30	350	100	100
12	Chemical oxygen demand, mg/l, max.	250	-	-	250
13	Arsenic(as As).	0.2	0.2	0.2	0.2
14	Mercury (As Hg), mg/l, max.	0.01	0.01	-	0.01

71 These standards shall be applicable for industries, operations or processes other than those industries, operations or process for which standards have been specified in Schedule of the Environment Protection Rules, 1989

Sl. No.	Parameter	Inland surface water	Public sewers	Land for irrigation	Marine/coastal areas
15	Lead (as Pb) mg/l, max	0.1	1.0	-	2.0
16	Cadmium (as Cd) mg/l, max	2.0	1.0	-	2.0
17	Hexavalent chro-mium (as Cr + 6),mg/l, max.	0.1	2.0	-	1.0
18	Total chromium (as Cr) mg/l, max.	2.0	2.0	-	2.0
19	Copper (as Cu) mg/l, max.	3.0	3.0	-	3.0
20	Zinc (as Zn) mg/l, max.	5.0	15	-	15
21	Selenium (as Se)	0.05	0.05	-	0.05
22	Nickel (as Ni) mg/l, max.	3.0	3.0	-	5.0
23	Cyanide (as CN) mg/l, max.	0.2	2.0	0.2	0.2
24	Fluoride (as F) mg/l, max.	2.0	15	-	15
25	Dissolved phos-phates (as P),mg/l, max.	5.0	-	-	-
26	Sulphide (as S) mg/l, max.	2.0	-	-	5.0
27	Phenolic compounds (as C6H50H)mg/l, max.	1.0	5.0	-	5.0
28	Radioactive materials: (a) Alpha emitters micro curie mg/l, max. (b)Beta emitters micro curie mg/l	10-7 10-6	10-7 10-6	10-8 10-7	10-7 10-6
29	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
30	Manganese	2 mg/l	2 mg/l	-	2 mg/l
31	Iron (as Fe)	3mg/l	3mg/l	-	3mg/l
32	Vanadium (as V)	0.2mg/l	0.2mg/l	-	0.2mg/l
33	Nitrate Nitrogen	10 mg/l	-	-	20 mg/l

Notes:

Annexure 1: the state boards shall follow the following guidelines in enforcing the standards specified under Schedule IV:

The wastewater and gases are to be treated with the best available technology (BAT) in order to achieve the prescribed standards.

The industries need to be encouraged for recycling and reuse of waste materials as far as practicable in order to minimize the discharge of wastes into the environment.

The industries are to be encouraged for recovery of biogas, energy and reusable materials.

While permitting the discharge of effluents and emissions into the environment, State Boards have to take into account the assimilative capacities of the receiving bodies, especially water bodies so that quality of the intended use of the receiving waters is not affected. Where such quality is likely to be affected, discharges should not be allowed into water bodies.

The central and state boards shall put emphasis on the implementation of clean technologies by the industries in order to increase fuel efficiency and reduce the generation of environmental pollutants.

All efforts should be made to remove color and unpleasant odour as far as practicable.

The standards mentioned in this Schedule shall also apply to all other effluents discharged such as mining, and mineral processing activities and sewage.

The limit given for the total concentration of mercury in the final effluent of caustic soda industry, is for the combined effluent from (a) cell house; (b) brine plant; (c) chlorine handling; (d) hydrogen handling; and (e) hydrochloric acid plant.

All effluents discharged including from the industries such as cotton textile, composite woollen mills, synthetic rubber, small pulp and paper, natural rubber, petrochemicals, tanneries, paint, dyes, slaughterhouses, food and fruit processing and dairy industries into surface waters shall conform to the BOD limit specified above, namely, 30 mg/l. For discharge of an effluent having a BOD more than 30 mg/l, the standards shall conform to those given above for other receiving bodies, namely, sewers, coastal waters and land for irrigation.

Bioassay shall be made compulsory for all the industries, where toxic and nonbiodegradable chemicals are involved.

In case of fertilizer industry, the limits in respect of chromium and fluoride shall be complied with at the outlet of chromium and fluoride removal units respectively.

In case of pesticides.

a. The limits should be complied with at the end of the treatment plant before dilution.

b. Bio-assay test should be carried out with the available species of fish in the receiving water, the COD limits to be specified in the consent conditions should be correlated with the BOD limits.

c. In case metabolites and isomers of the pesticides in the given list are found in significant concentrations, standards should be prescribed for these also in the same concentration as the individual pesticides.

d. Industries are required to analyze pesticides in wastewater by advanced analytical methods such as GLC/HPLC.

The chemical oxygen demand (COD) concentration in a treated effluent, if observed to be persistently greater than 250 mg/l before disposal to any receiving body (public sewer, land for irrigation, inland surface water and marine coastal areas), such industrial units are required to identify chemicals causing the same. In case these are found to be toxic as defined in the Schedule-I of the Hazardous Rules, 1989, the state boards in such cases shall direct the industries to install tertiary treatment stipulating time limit.

Standards specified in Part A of Schedule VI for discharge of effluents into the public sewer shall be applicable only if such sewer leads to a secondary treatment including biological treatment system otherwise the discharge into sewers shall be treated as discharge into inland surface waters.

Source: GSR 801 (E), EPA, 1986, dated 31 December 1993

Drinking Water Specifications: IS 10500:2012

Sl. No.	Substance/ Characteristics	Requirement (acceptable limit)	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate source	Methods of Test (ref. To IS)	Remarks
Essential Characteristics						
1	Colour, Hazen Units, Max.	5	Above 5, consumer acceptance decreases	15	IS 3025 (Part 4)	Extended to 15 only if toxic substances, in absence of alternate sources.
2	Odour	Agreeable	-	Agreeable	IS 3025 (Part 5)	A test cold and when heated. Test at several dilution
3	Taste	Agreeable	-	Agreeable	IS 3025 (Part 7 and 8)	Test to be conducted only after safety has been established
4	Turbidity NTU, Max.	1	Above 5, consumer acceptance decreases	5	3025 (Part 10): 1984	
5	pH value	6.5 to 8.5	Beyond this range the water will not affect the mucous membrane and/or water supply system	No relaxation	IS 3025 (Part 11)	
6	Total hardness (as CaCO3) mg/1, Max.	300	Encrustation in water supply structures an adverse effect on domestic use	600	IS 3025 (Part 21)	
7	Iron (as Fe) mg/l Max.	0.3	Beyond this limit taste/appearance are affected has adverse effect on domestic uses and water supply structures and promotes iron bacteria	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
8	Chlorides (as Cl) mg/1 Max.	250	Beyond this limit, taste corrosion and palatability are affected	1000	IS 3025 (Part 32)	

Sl. No.	Substance/ Characteristics	Requirement (acceptable limit)	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate source	Methods of Test (ref. To IS)	Remarks
9	Residual, free chloride, mg/1 Min.	0.2		1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be Min. 0.5 mg/1
Desirable characteristics						
1	Dissolved solids mg/1 Max.	500	Beyond the palatability decreases and may cause gastrointestinal irritation	2000	IS 3025 (Part 16)	
2	Calcium (as Ca) mg/1 Max.	75	Encrustation in water supply structure and adverse effects on domestic use	200	IS 3025 (Part 40)	
3	Magnesium (as Mg) mg/1, Max.	30	Encrustation in water supply structure and adverse effects on domestic use	100	IS 3025 (Part 46)	
4	Copper (as Cu) mg/1 Max.	0.05	Beyond taste, discoloration of pipes, fitting and utensils will be caused beyond this	1.5	IS 3025 (Part 42)	
5	Manganese (as Mn) mg/1, Max.	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures.	0.3	IS 3025 (Part 59)	
6	Sulphate (as SO4), mg/1, Max.	200	Beyond this causes gastro-intestinal irritation when magnesium or	400	IS 3025 (Part 24)	May be extended up to 400 provided (as Mg) does

Sl. No.	Substance/ Characteristics	Requirement (acceptable limit)	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate source	Methods of Test (ref. To IS)	Remarks
			sodium are present			not exceed 30
7	Nitrate (as NO3) mg/l, Max.	45	Beyond this methaemoglobinemia take place	No relaxation	IS 3025 (Part 34)	To be tested when pollution is suspected
8	Fluoride (as F) mg/1, Max.	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5	IS 3025 (Part 60)	To be tested when pollution is suspected
9	Phenolic compounds (as C6H5OH) mg/1, Max.	0.001	Beyond this it may cause objectionable taste and odour	0.002	IS 3025 (Part 43)	To be tested when pollution is suspected
10	Mercury (as Hg) mg/1, Max.	0.001	Beyond this the water becomes toxic	No relaxation	IS 3025 (Part 48)	To be tested when pollution is suspected
11	Cadmium (as cd), mg/1, Max.	0.003	Beyond this the water becomes toxic	No relaxation	IS 3025 (Part 41)	To be tested when pollution is suspected
12	Selenium, (as Se). mg/l, Max.	0.01	Beyond this the water becomes toxic	No relaxation	IS 3025 (Part 56)	To be tested when pollution is suspected
13	Arsenic (As) mg/1, Max.	0.01	Beyond this the water becomes toxic	0.05	IS 3025 (Part 37)	To be tested when pollution is suspected
14	Cyanide (as CN) mg/1, Max.	0.05	Beyond this the water becomes toxic	No relaxation	IS 3025 (Part 27)	To be tested when pollution is suspected
15	Lead (as Pb), mg/1, Max.	0.01	Beyond this the water becomes toxic	No relaxation	IS 3025 (Part 47)	To be tested when pollution is suspected
16	Zinc (as Zn) mg/1, Max.	5	Beyond this limit it can cause astringent taste and an opalescence taste and an opalescence in water	15	IS 3025 (Part 49)	To be tested when pollution is suspected

Sl. No.	Substance/ Characteristics	Requirement (acceptable limit)	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate source	Methods of Test (ref. To IS)	Remarks
17	Anionic detergents (as MBAS) mg/1, Max.	0.2	Beyond this it can cause a light froth in water	1	Annex K of IS 13428	To be tested when pollution is suspected
18	Chromium (as Cr6+) mg/1, Max.	0.05	May be carcinogenic above this limit	No relaxation	IS 3025 (Part 52)	To be tested when pollution is suspected
19	Poly nuclear aromatic hydra carbons (as PAH) mg/1, Max.	0.0001	May be carcinogenic above this limit	No relaxation	APHA 6440	-
20	Mineral oil mg/1, Max.	0.5	Beyond this limit undesirable taste and odour after chlorination take place.	0.03	IS 3025 (Part 39)	-
21	Pesticides mg/1, Max.	-	Toxic	-	-	-
22	Radioactive material	-	-	-	IS 14194	-
23	Alpha emitters bq/1, Max.	0.1	-	No Relaxation	-	-
24	Beta emitter pci/1, Max.	1.0	-	No Relaxation	-	-
25	Total alkalinity (as CaCO3), mg/l, max	200	Beyond this limit taste becomes unpleasant	600	IS 3025 (Part 23)	-
26	Aluminium (as Al) mg/1, Max.	0.03	Cumulate effect is reported to cause dementia	0.2	IS 3025 (Part 55)	-
27	Boron mg/1, Max.	0.5	-	1.0	IS 3025 (Part 57)	-

Source: Indian Standard Drinking Water Specification – IS 10500:2012

INTERNATIONAL (WB/IFC- EHS GUIDELINE) ENVIRONMENTAL QUALITY STANDARDS[72]

WHO Ambient Air Quality Guidelines

	Averaging Period	Guideline value in mg/m3
Sulfur dioxide (SO_2)	24-hour 10 minutes	125 (Interim target-1) 50 (Interim target-2) 20 (guideline) 500 (guideline)
Nitrogen dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)
Particulate Matter PM_{10}	1-year	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline)
	24-hour	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
	24-hour	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

Source: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines

Ambient Noise Level Guidelines

Receptor	One Hour LAeq (dBA)	
	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational73	55	45
Industrial; commercial	70	70

Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

72 https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines

73 For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).

Noise Limits for Various Working Environments

Location/activity	Equivalent level LAeq,8h	Maximum LAmax, fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light industry (decreasing demand for oral communication)	50-65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45-50 dB(A)	-
Individual offices (no disturbing noise)	40-45 dB(A)	-
Classrooms, lecture halls	35-40 dB(A)	-
Hospitals	30-35 dB(A)	40 dB(A)

Source: Guidelines for Community Noise, World Health Organization (WHO), 1999

Water Quality

Indicative Values for Treated Sanitary Sewage Discharges

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD mg/l 30	mg/l	30
COD mg/l 125	mg/l	125
Total nitrogen mg/l 10	mg/l	10
Total phosphorus mg/l 2	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/100 ml	400

MPN = Most Probable Number

Source: https://www.ifc.org/wps/wcm/connect/3d9a54ae-c44c-488d-9851-afeb368cb9f9/1-3%2BWastewater%2Band%2BAmbient%2BWater%2BQuality.pdf?MOD=AJPERESandCVID=ls4Xbfn

Appendix 5. WRD Guidelines for Locating, Operating, And Rehabilitating Borrow Pits Near the Embankment

Follow the WRD guidelines for locating borrow pits near the embankment. All efforts shall be made to avoid or minimize tree loss due to borrowing. The trucks shall be covered while transporting the earth.

While borrowing the earth top soil shall be preserved. The borrow pits shall be rehabilitated after borrowing the earth. The WRD guidelines for rehabilitation of the pits shall be strictly followed. The Indian Road Congress (IRC):10-1961 guideline will govern the selection of borrow pits. In all cases good engineering and construction practices shall be followed. The construction contractor shall submit in advance the borrow area identification details along with borrow area rehabilitation plan.

WRD Guidelines with respect to borrow area location and rehabilitation:

(i) For high embankments no excavation shall be done within 45 m of the riverside toe of the embankment. From 45 m to 60 m the borrow pits must not be more than 1.8 m deep and from 60 m to 90 m not more than 2.4 m deep and beyond 90 m they can be of 3 m depth.

(ii) If earth is to be taken from land-side of the embankment, no borrow pits shall be excavated within 24 m of the land-side toe of the embankment. The depth of excavation in 24 m to 36 m shall not be more than 0.6 m. For low embankments the borrow pits on the riverside and on the land-side shall not be located at less than 24 m from the toe.

(iii) For low embankments the borrow pits on the river-side and on the land-side shall not be located at less than 24 m from the toe.

(iv) The borrow pits shall be staggered and on undisturbed ground 6 m wide left at regular intervals to prevent the velocity of flow through the river-side borrow pits. The staggering will also help in inducing silting and filling up of these borrow pits.

(v) On the country-side the waterlogged areas (bandhis) shall be cut and interconnected to permit ordinary drainage. These shall be connected to the nearest drainage channel so as to carry away the drainage water.

(vi) The borrow areas selected for taking earth shall be cleared of all trees, shrubs, grass and vegetation mounds.

(vii) No borrow pits shall be made on roads, village tracks, graveyards, canals or embankments.

Appendix 6: IBAT Analysis

IBAT

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT DIBRUGARH (A)

Country: India

Location: [27.5, 94.9]

Date of analysis: 14 April 2023 (GMT)

Size of site: 489 km^2

Buffers applied: 1 km | 5 km | 10 km

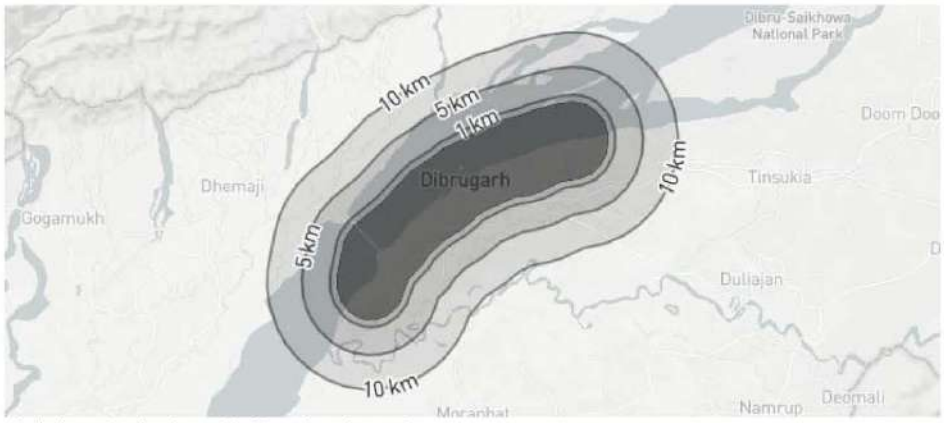
IUCN Red List Biomes: Freshwater, Terrestrial

Generated by: Arijit Choudhury

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	2
IUCN Red List	99



Displaying project location and buffers: 1 km, 5 km, 10 km

IBAT

About this report

This report presents the results of [5840-42026] proximity analysis to identify the biodiversity features and specieswhich are located within the following buffers: 1 km, 5 km, 10 km.

This report is one part of a package generated by IBAT on 14 April 2023 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features,and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. Thereishowever a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

Please note, sensitive species data are currently not included in IBAT reports in line with the Sensitive Data Access Restrictions Policy for the IUCN Red List. This relates to sensitive Threatened species and KBAs triggered by sensitivespecies.

Data used to generate this report

- UNEP-WCMC and IUCN, 2023. Protected Planet: The World Database on Protected Areas (WDPA)[On-line],Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - April 2023.
- BirdLife International (on behalf of the KBA Partnership), 2023. Key Biodiversity Areas - April 2023IUCN,
- 2022. IUCN Red List of Threatened Species - December 2022.
- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). https://www.iucnredlist.orgIUCN.
- Threats Classification Scheme (Version 3.2). (2019)
- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729(2020). https://doi.org/10.1038/s41586-020-2784-9

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Protected Areas

The following protected areas are found within 1 km, 5 km, 10 km of the area of interest.For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 5 km, 10 km of the area of interest.For further details please refer to the associated csv file in the report folder.

Area name	Distance
Dibru - Saikhowa Complex	1 km
Janjing and Sengajan	5 km

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Nilssonia nigricans	Black Softshell Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater
Gavialis gangeticus	Gharial	REPTILIA	CR	Increasing	Terrestrial, Freshwater
Pangshura sylhetensis	Assam Roofed Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater
Aythya baeri	Baer's Pochard	AVES	CR	Decreasing	Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Heliopais personatus	Masked Finfoot	AVES	CR	Decreasing	Terrestrial, Freshwater
Ardea insignis	White-bellied Heron	AVES	CR	Decreasing	Terrestrial, Freshwater
Emberiza aureola	Yellow-breasted Bunting	AVES	CR	Decreasing	Terrestrial, Freshwater
Manis pentadactyla	Chinese Pangolin	MAMMALIA	CR	Decreasing	Terrestrial
Manouria emys	Asian Giant Tortoise	REPTILIA	CR	Decreasing	Terrestrial
Magnolia gustavii		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Philautus microdiscus	Kobo Bubble-nest Frog	AMPHIBIA	CR	Decreasing	Terrestrial
Magnolia rabaniana		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Houbaropsis bengalensis	Bengal Florican	AVES	CR	Decreasing	Terrestrial
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial
Gyps tenuirostris	Slender-billed Vulture	AVES	CR	Decreasing	Terrestrial
Nardostachys jatamansi	Indian Nard	MAGNOLIOPSIDA	CR	Decreasing	Terrestrial

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Bubalus arnee	Wild Water Buffalo	MAMMALIA	EN	Decreasing	Terrestrial, Freshwater
Cuora amboinensis	Southeast Asian Box Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Geoclemys hamiltonii	Spotted Pond Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Morenia petersi	Indian Eyed Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Nilssonia gangetica	Indian Softshell Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Nilssonia hurum	Indian Peacock Softshell Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Platanista gangetica	Ganges River Dolphin	MAMMALIA	EN	Decreasing	Freshwater
Axis porcinus	Hog Deer	MAMMALIA	EN	Decreasing	Terrestrial, Freshwater
Cuora mouhotii	Keeled Box Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Amblyceps arunchalensis		ACTINOPTERYGII	EN	Unknown	Freshwater
Perdicula manipurensis	Manipur Bush-quail	AVES	EN	Decreasing	Terrestrial, Freshwater
Asarcornis scutulata	White-winged Duck	AVES	EN	Decreasing	Terrestrial, Freshwater

IBAT

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Sterna acuticauda	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater
Haliaeetus leucoryphus	Pallas's Fish-eagle	AVES	EN	Decreasing	Terrestrial, Freshwater
Leptoptilos dubius	Greater Adjutant	AVES	EN	Decreasing	Terrestrial, Freshwater
Laticilla cinerascens	Swamp Grass-babbler	AVES	EN	Decreasing	Terrestrial, Freshwater
Tor putitora		ACTINOPTERYGII	EN	Decreasing	Freshwater
Cuon alpinus	Dhole	MAMMALIA	EN	Decreasing	Terrestrial
Elephas maximus	Asian Elephant	MAMMALIA	EN	Decreasing	Terrestrial
Manouria impressa	Impressed Tortoise	REPTILIA	EN	Decreasing	Terrestrial
Melanochelys tricarinata	Tricarinate Hill Turtle	REPTILIA	EN	Decreasing	Terrestrial
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Nycticebus bengalensis	Bengal Slow Loris	MAMMALIA	EN	Decreasing	Terrestrial
Hoolock hoolock	Western Hoolock Gibbon	MAMMALIA	EN	Decreasing	Terrestrial
Magnolia pealiana		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial

IBAT

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Trillium tschonoskii	Tschonoskii's Wakerobin	LILIOPSIDA	EN	Decreasing	Terrestrial
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Ploceus megarhynchus	Finn's Weaver	AVES	EN	Decreasing	Terrestrial
Trachypithecus pileatus ssp. pileatus	Blond-bellied Langur	MAMMALIA	EN	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater
Prionailurus viverrinus	Fishing Cat	MAMMALIA	VU	Decreasing	Terrestrial, Freshwater
Rhinoceros unicornis	Greater One-horned Rhino	MAMMALIA	VU	Increasing	Terrestrial, Freshwater
Aonyx cinereus	Asian Small-clawed Otter	MAMMALIA	VU	Decreasing	Terrestrial, Marine, Freshwater
Liotelphusa quadrata		MALACOSTRACA	VU	Unknown	Freshwater
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aborichthys tikaderi		ACTINOPTERYGII	VU	Unknown	Freshwater
Devario acuticephala		ACTINOPTERYGII	VU	Unknown	Freshwater
Devario assamensis		ACTINOPTERYGII	VU	Unknown	Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Pseudecheneis sirenica		ACTINOPTERYGII	VU	Unknown	Freshwater
Ortygornis gularis	Swamp Francolin	AVES	VU	Decreasing	Terrestrial, Freshwater
Halcyon pileata	Black-capped Kingfisher	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Grus antigone	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila heliaca	Eastern Imperial Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Chrysomma altirostre	Jerdon's Babbler	AVES	VU	Decreasing	Terrestrial, Freshwater
Paradoxornis flavirostris	Black-breasted Parrotbill	AVES	VU	Decreasing	Terrestrial, Freshwater
Lissemys punctata	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Nanorana arunachalensis	Arunachal Cascade Frog	AMPHIBIA	VU	Decreasing	Terrestrial, Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater
Bos gaurus	Gaur	MAMMALIA	VU	Decreasing	Terrestrial
Helarctos malayanus	Sun Bear	MAMMALIA	VU	Decreasing	Terrestrial
Macaca arctoides	Stump-tailed Macaque	MAMMALIA	VU	Decreasing	Terrestrial
Neofelis nebulosa	Clouded Leopard	MAMMALIA	VU	Decreasing	Terrestrial
Panthera pardus	Leopard	MAMMALIA	VU	Decreasing	Terrestrial
Trachypithecus pileatus	Capped Langur	MAMMALIA	VU	Decreasing	Terrestrial
Ursus thibetanus	Asiatic Black Bear	MAMMALIA	VU	Decreasing	Terrestrial
Macaca leonina	Northern Pig-tailed Macaque	MAMMALIA	VU	Decreasing	Terrestrial
Arctictis binturong	Binturong	MAMMALIA	VU	Decreasing	Terrestrial
Rusa unicolor	Sambar	MAMMALIA	VU	Decreasing	Terrestrial
Oligodon erythrorhachis	Namsang Kukri Snake	REPTILIA	VU	Unknown	Terrestrial

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Ophiophagus hannah	King Cobra	REPTILIA	VU	Decreasing	Terrestrial
Elaphe taeniura	Cave Racer	REPTILIA	VU	Decreasing	Terrestrial
Mulleripicus pulverulentus	Great Slaty Woodpecker	AVES	VU	Decreasing	Terrestrial
Buceros bicornis	Great Hornbill	AVES	VU	Decreasing	Terrestrial
Aceros nipalensis	Rufous-necked Hornbill	AVES	VU	Decreasing	Terrestrial
Rhyticeros undulatus	Wreathed Hornbill	AVES	VU	Decreasing	Terrestrial
Apus acuticauda	Dark-rumped Swift	AVES	VU	Stable	Terrestrial
Columba punicea	Pale-capped Pigeon	AVES	VU	Decreasing	Terrestrial
Turdus feae	Grey-sided Thrush	AVES	VU	Decreasing	Terrestrial
Pellorneum palustre	Marsh Babbler	AVES	VU	Decreasing	Terrestrial
Argya longirostris	Slender- billed Babbler	AVES	VU	Decreasing	Terrestrial
Spelaeornis chocolatinus	Naga Wren-babbler	AVES	VU	Decreasing	Terrestrial
Ophiocordyceps sinensis	Chinese Caterpillar Fungus	SORDARIOMYCETES	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Oryza malampuzhaensis		LILIOPSIDA	VU	Decreasing	Terrestrial
Hoolock hoolock ssp. hoolock	Western Hoolock Gibbon	MAMMALIA	VU	Decreasing	Terrestrial
Paris polyphylla	Love Apple	LILIOPSIDA	VU	Decreasing	Terrestrial
Dalbergia thomsonii		MAGNOLIOPSIDA	VU	Unknown	Terrestrial
Fritillaria cirrhosa	Yellow Himalayan Fritillary	LILIOPSIDA	VU	Decreasing	Terrestrial

Recommended citation

IBAT Proximity Report. Generated under licence 5840-42026 from the Integrated Biodiversity Assessment Tool on April 2023 (GMT). www.ibat-alliance.org

How to use this report

This report provides an indication of the potential biodiversity-related features - protected areas, key biodiversity areasand species - close to the specified location. It provides an early indication of potential biodiversity concerns, and canprovide valuable guidance in making decisions. For example, this information can be helpful when assessing the potential environmental risk and impact of a site, categorising investments/projects, preparing the terms of referencefor an impact assessment, focusing attention on key species of conservation concern and sites of known conservationvalue, and reviewing the results of an impact assessment.

The report does not provide details of potential indirect, downstream or cumulative impacts. Furthermore, the report should be regarded as a "first-step", providing a set of conservation values sourced from global data sets, and is not substitute for further investigation and due diligence, especially concerning national and/or local conservation priorities.

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Integrated Biodiversity Assessment Tool

PROXIMITY REPORT TINSUKHIA (A)

Country: India

Location: [27.7, 95.5]

Date of analysis: 14 April 2023 (GMT)

Size of site: 587 km^2

Buffers applied: 1 km | 5 km | 10 km

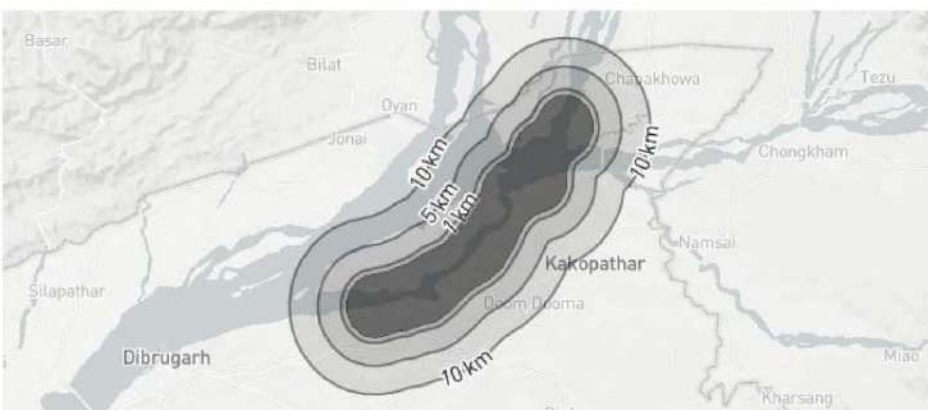
IUCN Red List Biomes: Freshwater, Terrestrial

Generated by: Arijit Choudhury

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	6
IUCN Red List	105



Displaying project location and buffers: 1 km, 5 km, 10 km

About this report

This report presents the results of [5840-42027] proximity analysis to identify the biodiversity features and specieswhich are located within the following buffers: 1 km, 5 km, 10 km.

This report is one part of a package generated by IBAT on 14 April 2023 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features,and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. Thereishowever a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

Please note, sensitive species data are currently not included in IBAT reports in line with the Sensitive Data Access Restrictions Policy for the IUCN Red List. This relates to sensitive Threatened species and KBAs triggered by sensitivespecies.

Data used to generate this report

- UNEP-WCMC and IUCN, 2023. Protected Planet: The World Database on Protected Areas (WDPA)[On-line],Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - April 2023.
- BirdLife International (on behalf of the KBA Partnership), 2023. Key Biodiversity Areas - April 2023IUCN,
- 2022. IUCN Red List of Threatened Species - December 2022.
- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). https://www.iucnredlist.orgIUCN.
- Threats Classification Scheme (Version 3.2). (2019)
- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729(2020). https://doi.org/10.1038/s41586-020-2784-9

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Protected Areas

The following protected areas are found within 1 km, 5 km, 10 km of the area of interest.For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 5 km, 10 km of the area of interest.For further details please refer to the associated csv file in the report folder.

Area name	Distance
Bherjan-Borajan-Podumoni Wildlife Sanctuary	1 km
Dibru - Saikhowa Complex	1 km
Maguri and Motapung Beels	1 km
Dibang Reserve Forest and adjacent areas	5 km
D'Ering Memorial Wildlife Sanctuary	10 km
Dum Duma, Dangori and Kumsong Reserve Forests	10 km

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.For the

full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Nilssonia nigricans	Black Softshell Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Gavialis gangeticus	Gharial	REPTILIA	CR	Increasing	Terrestrial, Freshwater
Pangshura sylhetensis	Assam Roofed Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater
Aythya baeri	Baer's Pochard	AVES	CR	Decreasing	Freshwater
Heliopais personatus	Masked Finfoot	AVES	CR	Decreasing	Terrestrial, Freshwater
Ardea insignis	White-bellied Heron	AVES	CR	Decreasing	Terrestrial, Freshwater
Emberiza aureola	Yellow-breasted Bunting	AVES	CR	Decreasing	Terrestrial, Freshwater
Biswamoyopterus biswasi	Namdapha Flying Squirrel	MAMMALIA	CR	Decreasing	Terrestrial
Manis pentadactyla	Chinese Pangolin	MAMMALIA	CR	Decreasing	Terrestrial
Magnolia gustavii		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Aquilaria malaccensis	Agarwood	MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Philautus microdiscus	Kobo Bubble-nest Frog	AMPHIBIA	CR	Decreasing	Terrestrial
Magnolia rabariana		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Houbaropsis bengalensis	Bengal Florican	AVES	CR	Decreasing	Terrestrial

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial
Gyps tenuirostris	Slender-billed Vulture	AVES	CR	Decreasing	Terrestrial
Nardostachys jatamansi	Indian Nard	MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Musa mannii	Indian Dwarf Banana	LILIOPSIDA	CR	Unknown	Terrestrial
Musa rubinea	Yunnan Dwarf Banana	LILIOPSIDA	CR	Decreasing	Terrestrial
Cylindrolobus gloensis		LILIOPSIDA	CR	Decreasing	Terrestrial
Bubalus arnee	Wild Water Buffalo	MAMMALIA	EN	Decreasing	Terrestrial, Freshwater
Cuora amboinensis	Southeast Asian Box Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Geoclemys hamiltonii	Spotted Pond Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Morenia petersi	Indian Eyed Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Nilssonia gangetica	Indian Softshell Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Nilssonia hurum	Indian Peacock Softshell Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Platanista gangetica	Ganges River Dolphin	MAMMALIA	EN	Decreasing	Freshwater
Axis porcinus	Hog Deer	MAMMALIA	EN	Decreasing	Terrestrial, Freshwater
Cuora mouhotii	Keeled Box Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Devario horai		ACTINOPTERYGII	EN	Decreasing	Freshwater
Lepidocephalichthys arunachalensis		ACTINOPTERYGII	EN	Unknown	Freshwater
Amblyceps arunchalensis		ACTINOPTERYGII	EN	Unknown	Freshwater
Perdicula manipurensis	Manipur Bush-quail	AVES	EN	Decreasing	Terrestrial, Freshwater
Asarcornis scutulata	White-winged Duck	AVES	EN	Decreasing	Terrestrial, Freshwater
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Sterna acuticauda	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater
Haliaeetus leucoryphus	Pallas's Fish-eagle	AVES	EN	Decreasing	Terrestrial, Freshwater
Leptoptilos dubius	Greater Adjutant	AVES	EN	Decreasing	Terrestrial, Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Laticilla cinerascens	Swamp Grass-babbler	AVES	EN	Decreasing	Terrestrial, Freshwater
Tor putitora		ACTINOPTERYGII	EN	Decreasing	Freshwater
Ailurus fulgens	Red Panda	MAMMALIA	EN	Decreasing	Terrestrial
Cuon alpinus	Dhole	MAMMALIA	EN	Decreasing	Terrestrial
Elephas maximus	Asian Elephant	MAMMALIA	EN	Decreasing	Terrestrial
Melanochelys tricarinata	Tricarinate Hill Turtle	REPTILIA	EN	Decreasing	Terrestrial
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Nycticebus bengalensis	Bengal Slow Loris	MAMMALIA	EN	Decreasing	Terrestrial
Hoolock hoolock	Western Hoolock Gibbon	MAMMALIA	EN	Decreasing	Terrestrial
Magnolia pealiana		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Trillium tschonoskii	Tschonoskii's Wakerobin	LILIOPSIDA	EN	Decreasing	Terrestrial
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Ploceus megarhynchus	Finn's Weaver	AVES	EN	Decreasing	Terrestrial
Hoolock hoolock ssp. mishmiensis	Mishmi Hills Hoolock Gibbon	MAMMALIA	EN	Decreasing	Terrestrial

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Trillium govanianum	Himalayan Trillium	LILIOPSIDA	EN	Decreasing	Terrestrial
Trachypithecus pileatus ssp. pileatus	Blond-bellied Langur	MAMMALIA	EN	Decreasing	Terrestrial
Macaca leucogenys	White-cheeked Macaque	MAMMALIA	EN	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater
Prionailurus viverrinus	Fishing Cat	MAMMALIA	VU	Decreasing	Terrestrial, Freshwater
Rhinoceros unicornis	Greater One-horned Rhino	MAMMALIA	VU	Increasing	Terrestrial, Freshwater
Aonyx cinereus	Asian Small-clawed Otter	MAMMALIA	VU	Decreasing	Terrestrial, Marine, Freshwater
Liotelphusa quadrata		MALACOSTRACA	VU	Unknown	Freshwater
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aborichthys tikaderi		ACTINOPTERYGII	VU	Unknown	Freshwater
Devario assamensis		ACTINOPTERYGII	VU	Unknown	Freshwater
Pseudecheneis sirenica		ACTINOPTERYGII	VU	Unknown	Freshwater
Ortygornis gularis	Swamp Francolin	AVES	VU	Decreasing	Terrestrial, Freshwater

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Halcyon pileata	Black-capped Kingfisher	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Grus antigone	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila heliaca	Eastern Imperial Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Chrysomma altirostre	Jerdon's Babbler	AVES	VU	Decreasing	Terrestrial, Freshwater
Paradoxornis flavirostris	Black-breasted Parrotbill	AVES	VU	Decreasing	Terrestrial, Freshwater
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Nanorana arunachalensis	Arunachal Cascade Frog	AMPHIBIA	VU	Decreasing	Terrestrial, Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater
Bos gaurus	Gaur	MAMMALIA	VU	Decreasing	Terrestrial

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Helarctos malayanus	Sun Bear	MAMMALIA	VU	Decreasing	Terrestrial
Macaca arctoides	Stump-tailed Macaque	MAMMALIA	VU	Decreasing	Terrestrial
Naemorhedus baileyi	Red Goral	MAMMALIA	VU	Decreasing	Terrestrial
Neofelis nebulosa	Clouded Leopard	MAMMALIA	VU	Decreasing	Terrestrial
Panthera pardus	Leopard	MAMMALIA	VU	Decreasing	Terrestrial
Trachypithecus pileatus	Capped Langur	MAMMALIA	VU	Decreasing	Terrestrial
Ursus thibetanus	Asiatic Black Bear	MAMMALIA	VU	Decreasing	Terrestrial
Macaca leonina	Northern Pig-tailed Macaque	MAMMALIA	VU	Decreasing	Terrestrial
Arctictis binturong	Binturong	MAMMALIA	VU	Decreasing	Terrestrial
Rusa unicolor	Sambar	MAMMALIA	VU	Decreasing	Terrestrial
Oligodon erythrorhachis	Namsang Kukri Snake	REPTILIA	VU	Unknown	Terrestrial
Ophiophagus hannah	King Cobra	REPTILIA	VU	Decreasing	Terrestrial
Elaphe taeniura	Cave Racer	REPTILIA	VU	Decreasing	Terrestrial
Tragopan blythii	Blyth's Tragopan	AVES	VU	Decreasing	Terrestrial

IBAT

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Lophophorus sclateri	Sclater's Monal	AVES	VU	Decreasing	Terrestrial
Mulleripicus pulverulentus	Great Slaty Woodpecker	AVES	VU	Decreasing	Terrestrial
Aceros nipalensis	Rufous-necked Hornbill	AVES	VU	Decreasing	Terrestrial
Columba punicea	Pale-capped Pigeon	AVES	VU	Decreasing	Terrestrial
Turdus feae	Grey-sided Thrush	AVES	VU	Decreasing	Terrestrial
Sitta formosa	Beautiful Nuthatch	AVES	VU	Decreasing	Terrestrial
Pellorneum palustre	Marsh Babbler	AVES	VU	Decreasing	Terrestrial
Spelaeornis badeigularis	Rusty-throated Wren-babbler	AVES	VU	Decreasing	Terrestrial
Ophiocordyceps sinensis	Chinese Caterpillar Fungus	SORDARIOMYCETES	VU	Decreasing	Terrestrial
Oryza malampuzhaensis		LILIOPSIDA	VU	Decreasing	Terrestrial
Hoolock hoolock ssp. hoolock	Western Hoolock Gibbon	MAMMALIA	VU	Decreasing	Terrestrial
Paris polyphylla	Love Apple	LILIOPSIDA	VU	Decreasing	Terrestrial

IBAT

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Fritillaria cirrhosa	Yellow Himalayan Fritillary	LILIOPSIDA	VU	Decreasing	Terrestrial

Recommended citation

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The report does not provide details of potential indirect, downstream or cumulative impacts. Furthermore, the report should be regarded as a "first-step", providing a set of conservation values sourced from global data sets, and is not substitute for further investigation and due diligence, especially concerning national and/or local conservation priorities.

Appendix 7: Biodiversity Survey Report by LASA

Conducted on 31st March 2023 to 1st April 2023 for the Dibrugarh subproject area, and 2nd April 2023 to 4th April 2023 for the Tinsukia subroject area

FLORAL SURVEY

METHODOLOGY ADOPTED FOR BASELINE DATA COLLECTION

To collected floral distribution in the project area, whole riverbank protection work stretch in Sub project (Zone -A) was split into five sections considering the revenue circle. There are five revenue circle i.e Dibrugarh East, Doomdooma, Tinsukia, Sadia and Dibrugarh West. The total length of bank protection work varies between 265m to 4600m.

Team during flora and Faunal survey at Gumi – 850 meters bank protection work.

The project site for data collection has been divided into sub zone. The details are as follows:

Core Zone: protection, embankment work area (Right of Way) of the project.

Inner Buffer Zone: Boundary of Right of Way of Project up to 500 meters of study area

Outer Buffer Zone: area delignated between 500 meters to 1000 meters (1 km area).

Site selection: 100% of sites given in the list were visited. Out of total length of bank protection work, about 100 % of total length for small length project where length varies between 265m to 1 km were visited on foot. For bigger of length more than 1 km to 4600 km the whole project were divided into segments. The visit include start point upto 500 meters walk followed by 1 km no survey, then again visit of 500 both side on walk, 1 km stretch avoided. And end point 500 meters walk survey. In short one km survey and one km no survey methods adopted. This selection of stretch is based on random survey methods.

For survey of embankment same survey methods were adopted.

Other work like PSC Procupine, adaption work, etc whole of sites were visited.

Methods adopted for Survey and data collection

- Walk Through methods
- Transect line methods
- Spot methods
- Call detection methods
- Pug mark of animals on sandy river beds
- Quadrant analysis
- Fishing point – Bamboo Net Traditional Fishing Net (Veshal) Point

Methodology adopted for Terrestrial Survey

Transect Methods: Path along which one counts and records occurrences of the objects of study. Transect can be for whole project stretch to part of project stretch randomly selected. It was adopted where growth of flora is spaced a part. only to record distribution of flora in study area. In other word In line transect sampling, a series of lines is distributed according to some design (usually a systematic grid of parallel lines and an observer travel along each line, searching for animals or plant clusters)[74].

Quadrant Methods: A quadrat is a frame, traditionally square, used in ecology, geography

and biology to isolate a standard unit of area for study of the distribution of an item over a large area. In other words, it is, a series of squares (quadrats) of a set size are placed in a habitat of interest and the species within those quadrats are identified and recorded[75]. Different Quadrant size has been adopted. Trees Quadrant size (10m X 10m); shrubs and herbs (1m x 1m). This sample size is adopted where population distribution per area is high.

Quadrant (Q3) Study Location (26.121301°; 91.455863°).

Transect and quadrant methods were adopted to record the floral profile within 1 km radius (direct impact zone and buffer Zone). The project sites harbours human induced Tea Estate, agricultural and settlements. During survey the direct impact zone harbours Tea Estate followed by cultivation. On the bunds of farm and in small,

[74] https://www.math.montana.edu/grad_students/writing-projects/2019/Owusu2019.pdf
[75] http://www.coml.org/investigating/home.html

patched plantation and growth of Banana, Mango, beetle nut, coconut, drum stick trees, etc was noticed.

STUDY AREA – SUBPROJECT ZONE (ZONE -A) – DIBRUGARH AND TINSUKIA

The project area falls in Upper Assam division in district Dibrugarh and Tinsukia. Based on the Biogeographic Classification Zoning Map of India , the project site falls in Zone 9 – North East and on the biases of Biogeographic Province map of India, the project sites falls in 9A- North -East (Brahmaputra Valley).

The forest type reported are tropical wet evergreen forest[76]. The dominant tree species are Hollong (Dipterocarpus macrocarpus), Borpat, Jutuli, Sam, Dewa sam, Nahar, Teeta chap, Bhelu, Mekai etc. The Uppar Assam is rich in avifauna distribution. It harbours local and migratory birds from Uppar Himalayan Mountain during winter. Birds also migrate in this region from central Asia during winter season.

Flora diversity of study area:

To establish floral distribution within one km radius, line transect methods followed by walk through methods were adopted. Based on the length of protection work and accessibility to site. Different length of line transect methods were adopted. In District Dibrugarh and Tinsukia, Tea Garden dominate project influence area followed by settlements (Specially Dibrugarh). Survey across tea garden along the bank of Brahmaputra River pose restriction in movement across defined line (Transect). This is because of intermediate fencing and deep drains in tea garden to drain of storm water. Continuous pre monsoon spell during survey period restrict movement near bank line. Insect like leeches were common in this area. Several leeches' bites were reported during survey. The locations of line transect methods is given in **Table 1.00** and in **Figure 1.00** to **Figure 2.00**.

Survey restrict in Tezpur District. All the Bank Protection sites are adjacent to or within the Eco-Sensitive Zone. No demarcation or any indication of boundary of Dibru-Saikhowa National Park exists. This area is declared protected under " The Wildlife (Protection), Act 1972. Hence any entry into the ESZ or Wildlife Boundary attract the provision of Act. Which may be imprisonment/fine or both. Prior permission for survey and data collection is required from Wildlife department. The actual boundary demarcation on ground is not known. Hence restriction in survey and data collection.

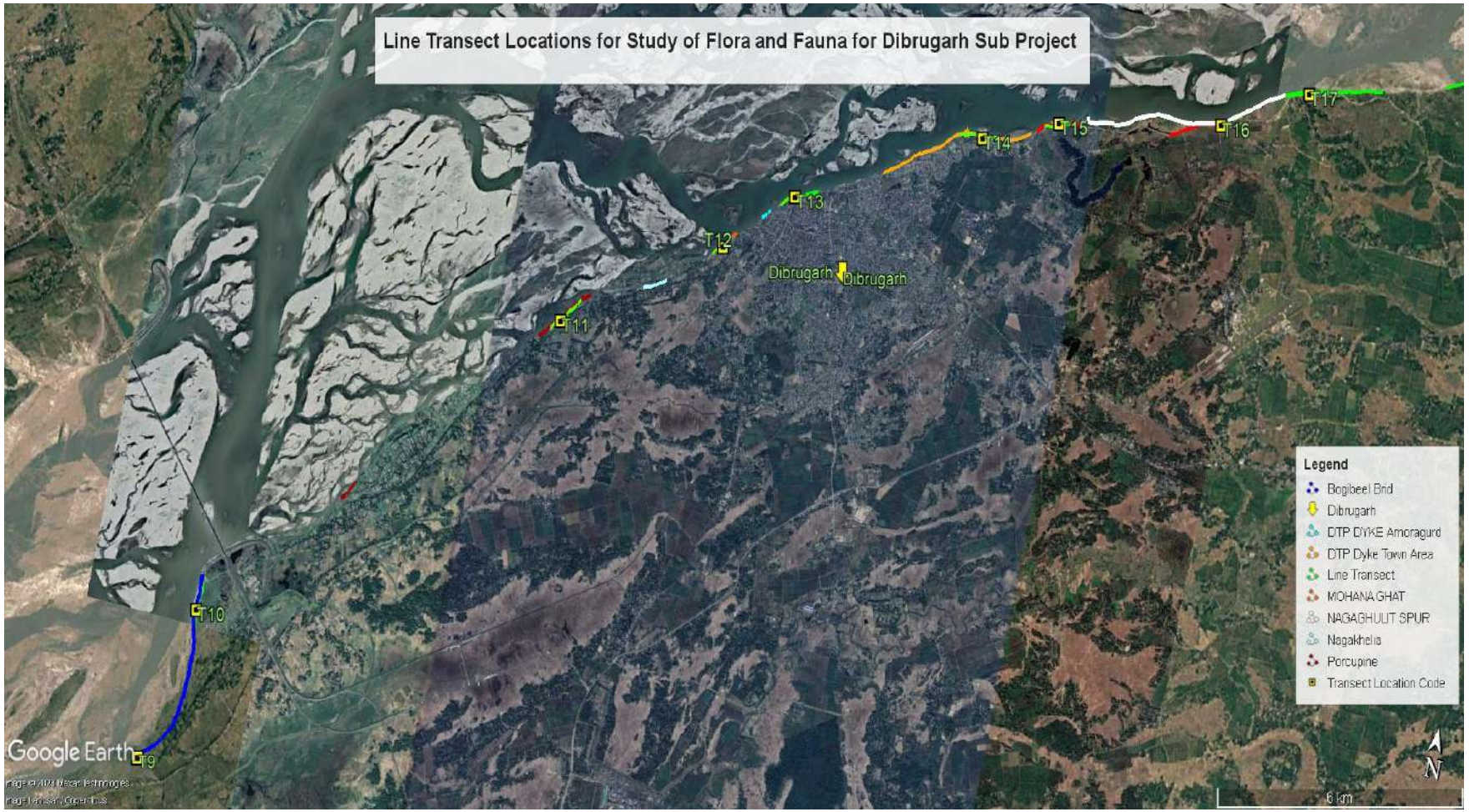
[76] https://asbb.assam.gov.in/information-services/biodiversity-of-assam#:~:text=Assam's%20mammalian%20diversity%20is%20represented,isolated%20pockets%20and%20protected%20areas.

Table 1.00: Gives Locations of Transect Methods adopted for Flora and Fauna Study

S. No	Project Name	Length to Protection Work (m)	District	Transect Code	Geographical Coordinate				Length of Transect (m)	Remarks
					Start Point		End Point			
					Latitude	Longitude	Latitude	Longitude		
1.	Simlaluguri Satra	400	Tinsukia	T1	27.651246°	95.450192°	27.652191°	95.452028°	250	Tea Garden
2.	Milanpur to Hatighuli	1500		T2	27.759092°	95.557025°	27.762248°	95.563669°	750	Agriculture Land
3.	Phelai to Naokota	2000		T3	27.747810°	95.527562°	27.749595°	95.532186°	500	Agriculture Land
4.				T4	27.743472°	95.517456°	27.745287°	95.522107°	500	
5.	Baghjan to Notun Gaon	2100		T5	27.599916°	95.379182°	27.603205°	95.382620°	500	Tea Garden
6.	Rungagora to Dinjan	1900		T6	27.573102°	95.302381°	27.573348°	95.307408°	500	Tea Garden
7.				T7	27.569901°	95.290579°	27.571672°	95.295193°	500	
8.		800		T8	27.567435°	95.278020°	27.567899°	95.283124°	500	
9.	Bogibeel Brid	3690	Dibrugarh	T9	27.350968°	94.767196°	27.351816°	94.764586°	500	
10				T10	27.377134°	94.773581°	27.385958°	94.773356°	1000	Waste Land
11	Porcupine Mohpuwal Mora			T11	27.455046°	94.851612°	27.448400°	94.845373°	1000	Agricultural
12	MOHANA GHAT	780		T12	27.469567°	94.880875°	27.472782°	94.884070°	500	Orchids
13	ADB T -II-D3	1000		T13	27.481821°	94.895349°	27.484395°	94.899530°	500	Settlement
14	DTP Dyke Town Area	3925		T14	27.504206°	94.944929°	27.502953°	94.934884°	1000	Settlement
15				T15	27.510257°	94.961493°	27.508654°	94.955058°	700	Tea Estate
16	NAGAGHULIT SPUR	2600		T16	27.516561°	94.992873°	27.520910°	95.003578°	1000	Tea Estate
17	ADB T-I-Mothola	2400		T17	27.525723°	95.012171°	27.528222°	95.021867°	1000	-

Figure 1.00 Map showing Location of Line Transects for Floral and Fauna Study – Tinsukia

Figure 2.00 Map showing Location of Line Transects for Floral and Fauna Study – Dibrugarh



The project site is dominated by growth of shrubs followed by tress. Invasive shrubs species dominate the ground covered. The species of trees, shrubs, herbs, climbers and grasses are recorded adopting line transect methods. About eight lines transect in Tinsukia and nine lines Transect were laid in Dibrugarh project study area. The length of line Transect varies between 250m to 1000m depending upon length of Projects. The Geographical Coordinate locations and Google Earth Image for line transect is Given in **Table 1.00 and Figure 1.00 and Figure 2.00.** Based on line transect study about 26 species of herbs and shrubs reported from the study area. They are castor (Ricinus communis), Lantana (Lantana camara), Datura stramonium, Datura innoxia, Datura metel, Zizyphus Rugosa , Apple of sodem (Calotropis procera), bair (Ziziphus nummularia), Dentella repens, mimosa pudica, Sida cordiflia, Xanthium indicum, cryptolepis sinensis, Ficus clavata , Ixora acuminata , Laportea crenulata , Litsea lancifolia, Mimosa himalayana, Solanum khasianum, Canscora andrographiodes, Commelina obliqua, Cymbidium flexus, Eupatorium wallichii , Hedyotis costata, Polygonum serrulatum , Sarcopyramis nepalensis, Arundo Donax, Phragmites Karka etc. Due to extensive growth, hardy and widely distributed, Lantana camara is posing threat to Tea Estate[77].

23 climber's species reported long the trench and buffer zone are Stephania harnondifolia (Tubuki lata), Zanthoxylum hamiltonianum (Tej-muri), Cuscuta reflexa (Akashi Lata), Illegeriakhasiana (Kerkeri lata), Dioscorea hamilttoni (Bonoria alu), Smilax macrophylla (Tikoni boral), Calamus erectus (Jati bet), C. gracilis (Wahing bet), C. latifolius (Motha bet), Enanthemum album. Ficus villosa, Gnetum scandens, Mikania micrantha, Piper attenuatum, Polygonum chinense, Stemona tuberosa, Tetrastigma planicaulata, Vitis capriolata, Pothos cathcartii, etc.

20 grasses species reported along the trenches are Ipomoea carnea (Behaya), Parthenium hysterophorus (Congress grass), Cynodon dactylon, Eriachne aristidea, Aristida purpurea, Saccharum spontaneum, Saccharum ravennae, Tripidium bengalense, Bambusa balcooa, Bambusa cacharensis, Bambusa polymorpha, Arundinella bengalensis (Spreng.), Bambusa cacharensis) Cyrtococcum patens var. latifolium Isachne, Melocalamus indicus Panicum khasianum Munro, Aristida fusca , Isachne albeus, Panicum brevifolium, etc.

The presence of these climber, shrubs, herbs and grasses has been conformed from data available with forest department[78].

[77] Weeds of tea field and their control. - https://www.researchgate.net/publication/27314543
[78] Working Plan for Dibrugarh Forest Division for 2021-22 to 2031-32.

Species of trees reported in the Buffer zone i.e one km radius excluding the core zone (25 to 30meters work) are mostly planted and few naturally growing. About 52 species of trees species are reported from the buffer zone. These trees are reported in the orchids, on agriculture furrow, bunds, banks of river, scrub land and tea gardens etc. Line transect and walk through methods were adopted to carry out floral survey in study area. The common trees reported are classified as fruit bearing, timber tress and shade trees. The species of trees were Banyan trees (Ficus benghalensis), siris (Albizia lebbeck), Semal (Bombax ceiba), Teak (Tectona grandis), Sal (Shorea robusta), Jack fruit (Artocarpus heterophyllus), Sissu (Dalbergia sissoo), Betel nut (Areca catechu), Sum (Sterculia urens), Date (Phonix sylvestris), Banana (Musa sp.), Mango (Mangifera indica), Coconut (Cocos nucifera), Peepal (Ficus religiosa), Cluster Fig (Ficus glomerata), Kadamb (Anthocephalus cadamba), Arjun (terminalia arjuna), Guava (Psidium guajava), Gulmohar (Delonix regia), drum stick (Moringa oleifera), Alstonia scholaris, Spondias Mangifera, Bauhania purpurea, Cassia fistula, Erythrina variegate, Bambusa balcooa, Bambusa tulda, Malocanna hamiltonii, Dendrocalamus giganteus, Plectomia bractealis, Terminalia chebula, Cassia sophera, Artocarpus chaplasha, Dendrocalamus hamiltonii, Syzygium oblatum, Cassia sophera, Ficus fistulosa, Albizzia procera, Artocarpus chaplasha, Castanopsis indica, Ficus clavate, ajar (Lagerstroemia speciosa), Litsea citrate, Maesa indica, Ficus fistulosa, Mangifera indica, Melia azedarach, Azadirachta indica, etc. The species of trees reported in project are common type, planted all over the districted.

Line transect methods for tree survey at Gariating Gaon (27.656880°; 95.457621°)

Walk Through Survey Methods at Bogibeel Brid - 27.350381°; 94.768536°

Among species recorded, Teak (Tectona grandis) which are not naturally, but planted by the locals as timber trees are Reported as Endangered (EN) by IUCN Red Data Book

category. Based on IBAT report, species of trees which may be located in the study area(Buffer zone) specially in Tinsukia sites (Ecologically Appropriate Area of Analysis), were Magnolia rabaniana, Magnolia gustavii, Philautus microdiscus, Nardostachys jatamansi, Magnolia pealiana, these species were categorised as Critically Rare except Magnolia pealiana which is categorized as Endangered under IUCN Red Data Book. These species were not reported during survey but may be present in Dibru - Saikhowa National Park Core area and Eco- Sensitive Zone. The EZA and National Park Boundary is within 1 km radius for project located in Tinsukia. Hence these species are ecological importance and needs conservations.

The Project site within study area were dominated by Tea Estate. During primary survey within tea estate 15 species of trees reported planted at sparce. The species of trees reported were *Albizzia odoratissima, Albizzia stipulate, Albizzia procera, Albizzia moluccana and Albizzia chinensis. Albezzia lebbeck, Dalbergia sericea, Dalbergia assamica, Derris robusta, indigofera teysmani, Glyricidia sepium, Leucaena glauca, Erythrina subumbrans and Erythrina lithosperma, etc* Some of these trees has already reported in past research work carried out on tea gardens[79].

Shade trees in project area – Nagaghulit; 5100 km protection work, Dibrugarh district- 27.510107°; 94.960111°

Invasive and Congregator Plant Species

Growth of Congregator and Invasive Plant (Lantana

[79] http://ecoursesonline.iasri.res.in/mod/page/view.php?id=14128

camara in proposed Milanput to Hatighuli section; 27.761399° 95.562111°

The non-native species (Invasive species) reported form the study area are Parthenium hysterophorus, Mimosa, Mikania, Eupatorium spp, lantana (Lantana camara), Mimosa invisa, Mikania micrantha, Chromolaena odorata, Ludwigia peruviana Ipomoea carnea, Calotropis gigantea, Calotropis procera, Datura metel, Alpinia

Nigra, Imperata cylindrica, Dysophylla auriculariaetc. The dominant species reported is Lantana and congress grass. They are cosmopolitan in distribution. These speceis are reported in core zone in scrub land, orchids in the study area.

In the marshy area and water ponds dominant invasive hydrophytes reported are Eichhornia crassipes, Echinochloa colona, Saccharum

Spontaneum, Echinochloa cruspavonis, Ipomoea carnea, Pistia stratiotes, Salvinia molesta, Lemna minor, etc are infesting all the water bodies. These are dominant speceis reported in all water bodies in project area.

All the above species reported have congregator nature of growth. Cover whole of the surface in patched. Most commonly reported area are wetland and riverbank where project has been proposed

FLORAL SPECIES REPORTED WITHIN CORE AREA

The project area is dominated by tea gardens, followed by settlement and less proportion of agriculture area. Few patches of non-use land were also noticed, especially in Bogibeel and ADB T-I and T-II project area. Within settlements, tea gardens and agricultural field, plantation and selection of trees species are as per the requirement. Plantation is mainly human induced.

Canopy Cover

To record the canopy cover and density of trees species, quadrant methods were used. About 10 Quadrants were laid in Tinsukia and 20 Quadrants were laid in Dibrugarh District. The geographical coordinate and location of Quadrants were given in **Table 2.00 and Figure 3.00 and Figure 4.00**. Due to poor weather condition, heavy rains the approach to site were limited. There were monsoon spell during survey period. Quadrant sites were randomly selected.

The 37 species of Trees were reported within the protection work (25 to 30 meters). The species were Semal (Bombax ceiba*), Ficus Hispida*, Alstonia scholaris, Teak (Tectona grandis), ficus oppositifolia, Mimosops elengii, Jack fruit (Artocarpus heterophyllus), Azadirachta indica, Betel nut (Areca catechu), Terminalia belerica, Date (Phonix sylvestris), Banana (Musa sp.), Coconut (Cocos nucifera), Terminalia chebula, Syzygium macrocarpa, Terminalia chebula, Peepal (Ficus religiosa), Emblica officinalis , Cluster Fig (Ficus glomerata), Morinda aungustifolia, Ficus fistulosa, Kadamb (Anthocephalus cadamba), Arjun (terminalia arjuna), Syzygium fruiticosa , Bambusa balcooa, Bambusa tulda, Malocanna hamiltonii, Dendrocalamus giganteus, Plectomia assamica, Plectomia bractealis, Cassia sophera, Albizzia procera, Artocarpus chaplasha, Castanopsis indica, Ficus clavate, F. fistulosa, Syzygium oblatum etc.

Peepal tree saved by adopting mitigation at Milanpur to Hatighuli, Tinsukia – 1500 meters bank protection work- 27.763188°; 95.564557°

Based on Quadrant analysis, given in **Table 3.00,** the population density per meter sq. is highest for species like banana which is 0.036/m² followed by betel nut which is 0.02/m².

Among species recorded, Teak (Tectona grandis) which are not naturally, but planted by the locals as timber trees are Reported as Endangered (EN) by IUCN Red Data Book category. They are reported to be impacted due to project development.

Ground Cover

The ground cover flora within the core area are shrubs, herbs and grasses. About 17 species of shrubs are reported within the impact zone. The dominant species of shrubs reported are lantana (Lantana camara), Jhar Bair (Ziziphus nummularis), caster (Ricinus communis), Calotropis procera), Calotropis gigantea, Pennisetum purpuream, Datura (Datura metel), Datura innoxia, tea (Camellia sinensis), Solanum torvum, Solanum indicum, Ardisia depressa. Saprosma ternatum, Casearia veraca, Citrus aurantium, Laportea crenulate, Solanum khasianum , Zizyphus Rugosa etc.

20 species of herbs reported within the core zone are Dentella repens, Eclipta prostat, Mimosa pudica, Bar manmuni, Sida cordiflora, Solanum tornum, Xanthium indicum, Ranunculus cantoniensis, Beria ammanniodes, Hypericum japonicum, hydrocera trifloral, Aeschynomere aspera, Aeschynomere india, Ludwigia prostrata, Dichrocephala integrifolia Enhydra fluctuans, Ageratum conyzoides, Alpinia purpurata,

Amaranthus viridis, Colocasia affinis, etc

12 species of grasses reported covering the ground are mainly weeds, they are Parthenium hysterophorus, Cyperus cephalotes, Cyprus difformis, Cyprus diffuses, Cyprus haspana, Brachiaria mutica, Echinochloa stagnina, Eragrostia atrovirens, Paspalum scropiclatum, Phragmites karkar, Saeciolepis interrupta, Aristida fusca, Munj asp., etc.

Munj asp. and bamboo Reported at Simaluguri, Tinsukia – 500 mts bank protection work - 27.652043°; 95.451373°.

7 tall grasses reported within the core zone in fragmented cluster form, covering the ground were Bambusa balcooa, Bambusa tulda, Malocanna bacciferra, Dendrocalamus hamiltonii, Dendrocalamus giganteus, Plectomia assamica and Plectomia bractealis etc.

Table 2.00: Quadrant location for Tree species and Avifauna Study in the Project Area

S.No	Project Name		Length to Protection Work (m)	Quadrant Code	Geographical Coordinate		Remarks
					Latitude	Longitude	
1.	Baghjan to Notun Gaon	Tinsukia	2100	TQ1	27.600433°	95.379446°	Orchids
2.				TQ2	27.595143°	95.372328°	Scrub land
3.				TQ3	27.604725°	95.383789°	Tea Estate
4.	Simaluguri Satra		400	TQ4	27.652003°	95.451503°	Tea Estate
5.	Gariating Gaon		400	TQ5	27.656880°	95.457621°	Tea Estate
6.	Milanpur to Hatighuli		1500	TQ6	27.762200°	95.563472°	Agricultural Habitat
7.				TQ7	27.759219°	95.557521°	
8.	Phelai to Naokota		2000	TQ8	27.749710°	95.532591°	Agricultural Habitat
9.				TQ9	27.744816°	95.521189°	
10.	Rungagorah to Dinjan		2700	TQ10	27.573454°	95.304074°	Tea Estate
11.	Nagaghulito Spur	Dibrugarh	2600	DQ1	27.525659°	95.011634°	
12.				DQ2	27.521307°	95.003698°	
13.				DQ3	27.514656°	94.977643°	

S.No	Project Name		Length to Protection Work (m)	Quadrant Code	Geographical Coordinate		Remarks
14.				DQ4	27.512004°	94.965337°	
15.	Reach 2 Maijan		1200	DQ5	27.510346°	94.961676°	Tea Estate
16.				DQ6	27.508921°	94.955965°	
17.	Chaulkhow to Bogibeel		3690	DQ7	27.385092°	94.773117°	Scrub Land
18.				DQ8	27.350756°	94.767621°	
19.	Nagakhelia		600	DQ9	27.462278°	94.870629°	Agricultural Habitat
20.	Mohana Ghat		780	DQ10	27.469803°	94.881048°	Settlement
21.				DQ11	27.473260°	94.884537°	Settlement
22.	Porcupine DTP Dyke	Dibrugarh East	-	DQ12	27.504469°	94.947647°	Settlement
23.			-	DQ13	27.499259°	94.929915°	
24.	ADB T-II-D3		1000	DQ14	27.482639°	94.895912°	
25.				DQ15	27.479756°	94.892541°	Settlment
26.	Porcupine Bogi beel	Dibrugarh West	-	DQ16	27.410125°	94.804910°	Tea Estate
27.	Porcupine Mohpuwal More		-	DQ17	27.448295°	94.844924°	Agriculture

S.No	Project Name		Length to Protection Work (m)	Quadrant Code	Geographical Coordinate		Remarks
28.	Reach 1 Oakland	Dibrugarh	1300	DQ18	27.515137°	94.990465°	Tea Estate
29.	ADB T-I-Mothola		2400	DQ19	27.527611°	95.018743°	-
30.	ADB T-II-D1		1000	DQ20	27.535313°	95.052164°	Agricultural Area

Table 3.00: Identification of Tree Species Using Quadrant Analysis Methods

S. No	Species Name	Quadrants																		
		TQ 1	TQ 2	TQ 3	TQ 4	TQ 5	TQ 6	TQ 7	TQ 8	TQ 9	TQ10	DQ 1	DQ 2	DQ 3	DQ 4	DQ 5	DQ 6	DQ 7	DQ 8	DQ 9
1.	Semal (*Bombax ceiba*	2	1	-	1	-	-	-	1	-	1	-	-		1	1	--	4	1	1
2.	*Ficus Hispida,*	-	-	-	-	-	1	-	-	-	-	-	--	1	1	-	-	1	1	-
3.	*Mango*	-	-	-	-	-	1													
4.	Teak (*Tectona grandis*)	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-
5.	*Alstonia scholaris,*	-	-	-	1	-	-	-	-	-	1	-	-	1	1	-	-	1	-	-
6.	*Ficus oppositifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
7.	*Mimosops elengii*	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-
8.	Jack fruit (*Artocarpus heterophyllus*),	-	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-
9.	*Azadirachta indica*	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1
10.	Betel nut (*Areca catechu),*	3	-	-	11	8	-	-	-	-	1	-	-	2	-	-	-	3	-	-
11.	*Terminalia belerica,*	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
12.	Banana (*Musa sp.*	-	-	-	-	-	7	-	-	-	-	-	-	7	5	-	5	-	-	-
13.	*Date (Phonix sylvestris),*	-	-	-	-	-	-	-	-	-	-	-	-	-	--	-	1	-	-	--
14.	*Coconut (Cocos nucifera),*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-

S. No	Species Name	Quadrants																		
		TQ 1	TQ 2	TQ 3	TQ 4	TQ 5	TQ 6	TQ 7	TQ 8	TQ 9	TQ10	DQ 1	DQ 2	DQ 3	DQ 4	DQ 5	DQ 6	DQ 7	DQ 8	DQ 9
15.	Peepal (*Ficus religiosa)*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
16.	*Syzygium macrocarpa,*	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
17.	*Terminalia chebula,*	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-
18.	*Syzygium macrocarpa,*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-
19.	Ficus fistulosa	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	1	-	-	-
20.	Kadamb (Anthocephalus cadamba),	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-
21.	Arjun (terminalia arjuna),	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
22.	Dalbergia sp.	-	-	1	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	1
23.	Cluster Fig (Ficus glomerata)	-	1	-	-	1	-	1	-	1	-	-	-	-	-	-	1	-	-	-
24.	Ziziphus jujuba	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
25.	Plectomia assamica	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
26.	Albizza Sp.	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	1
27.	Plectomia bractealis	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
28.	Cassia sophera	-	-	-	-	1	-	1	-	1	-	-	-	-	1	1	-	-	-	1
29.	Derris robusta	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-

S. No	Species Name	Quadrants																		
		TQ 1	TQ 2	TQ 3	TQ 4	TQ 5	TQ 6	TQ 7	TQ 8	TQ 9	TQ10	DQ 1	DQ 2	DQ 3	DQ 4	DQ 5	DQ 6	DQ 7	DQ 8	DQ 9
30.	Artocarpus chaplasha	-	-	-	-	-	-	1	-	-	-	-	-	-	--	1	-	-	-	-
31.	Castanopsis indica	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
32.	*Erythrina Sp*.	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
33.	Ficus clavate	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	1
34.	Ficus fistulosa	-	-	-	-	1	-	1	-	1	-	-	-	-	-	1	-	-	--	
35.	Syzygium oblatum	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1

Table3.00: Identification of Tree Species Using Quadrant Analysis Methods

S. No	Species Name	Quadrants											Total No. Of Individual of Sp	No. of Qdt. Of Occurrence	No. of Qdt. Studied	Frequency (%)	Density(per m²)	Abundance
		DQ10	DQ11	DQ12	DQ13	DQ14	DQ15	DQ16	DQ17	DQ18	DQ19	DQ20						
1.	*Bombax ceiba*	1			1		2		1	1			20	15	20	75	0.01	1.3
2.	*Ficus Hispida,*		1				1			1			8	8	20	40	0.004	0.4
3.	*Mangifera indica*					1							2	2	20	10	0.001	1
4.	*Tectona grandis*			1					1			1	6	6	20	30	0.003	1
5.	*Alstonia scholaris,*		1			1						1	8	8	20	40	0.004	1
6.	*ficus oppositifolia*		1						1				3	3	20	15	0.0015	1
7.	*Mimosops elengii*	1							1				4	4	20	20	0.002	1
8.	*Artocarpus heterophyllus*	1		1								1	6	6	20	30	0.003	1
9.	*Azadirachta indica*				1		1						5	5	20	25	0.0025	1
10.	*Areca catechu*	2		4		2			3				39	10	20	50	0.02	3.9
11.	*Terminalia belerica,*		1					1	1			1	6	6	20	30	0.003	1
12.	*Banana (Musa sp.)*		31	7			6					4	72	8	20	40	0.036	9
13.	*Date (Phonix sylvestris),*			1			1		1				4	4	20	20	0.002	1
14.	*Coconut (Cocos nucifera),*			2		3	1		3			2	13	6	20	30	0.0065	2.1
15.	*Peepal (Ficus religiosa)*		1			1			1				4	4	20	20	0.002	1
16.	*Syzygium macrocarpa*									1			2	2	20	10	0.001	1
17.	*Terminalia chebula,*				1		1						4	4	20	20	0.002	1
18.	*Syzygium macrocarpa,*	1							1			1	5	5	20	25	0.0025	1
19.	*Ficus fistulosa*				1								5	5	20	25	0.0025	1
20.	*Kadamb (Anthocephalus cadamba),*	1	-	-	-	-	1	1	-	-	-	1	6	6	20	30	0.003	1
21.	*Arjun (terminalia arjuna),*	-	-	-	-	1	-	-	-	-	-	-	2	2	20	10	0.001	1
22.	*Dalbergia sp.*	-	1	-	-	-	-	-	-	-	1	-	8	8	20	40	0.004	1

S. No	Species Name	Quadrants											Total No. Of Individual of Sa	No. of Qdt. Of Occurrence	No. of Qdt. Studied	Frequency (%)	Density(per m²)	Abundance
		DQ10	DQ11	DQ12	DQ13	DQ14	DQ15	DQ16	DQ17	DQ18	DQ19	DQ20						
23.	*Cluster Fig (Ficus glomerata)*	1	-	1	-	-	1	-	-	-	1	-	9	9	20	45	0.005	1
24.	*Ziziphus jujube*	-	1	-	-	-	1	4	-	-	3	-	12	6	20	30	0.0035	2
25.	*Plectomia assamica*	1	-	-	-	-	-	1	-	1	-	1	5	5	20	25	0.0025	1
26.	*Albizzia sp.*	1	-	-	-	-	1	-	-	-	1	-	7	7	20	35	0.004	1
27.	*Plectomia bractealis*	-	-	-	-	1	-	-	-	1	-	-	3	3	20	15	0.0015	1
28.	*Cassia sophera*	-	-	-	1	-	-	-	-	1	-	-	8	8	20	40	0.004	1
29.	*Derris robusta*	-	-	-	-	-	-	1	-	-	-	-	4	4	20	20	0.002	1
30.	*Artocarpus chaplasha*	-	1	-	-	-	-	-	-	1	-	-	4	4	20	20	0.002	1
31.	*Erythrina Sp.*	1	-	-	-	-	-	1	-	-	-	-	5	5	20	25	0.0025	1
32.	*Castanopsis indica*	-	-	-	1	-	-	-	-	-	-	-	2	2	20	10	0.002	1
33.	*Ficus clavate*	-	1	-	-	-	1	1	-	1	-	-	7	7	20	35	0.004	1
34.	*Ficus fistulosa*	-	-	1	-	-	-	-	-	1	-	-	6	6	20	30	0.003	1
35.	*Syzygium oblatum*	1	-	-	-	-	1	1	-	1	1	-	8	8	20	40	0.004	1

Figure 3.00: Google Image Showing Quadrant Location Along Proposed Protection Work – Tinsukia

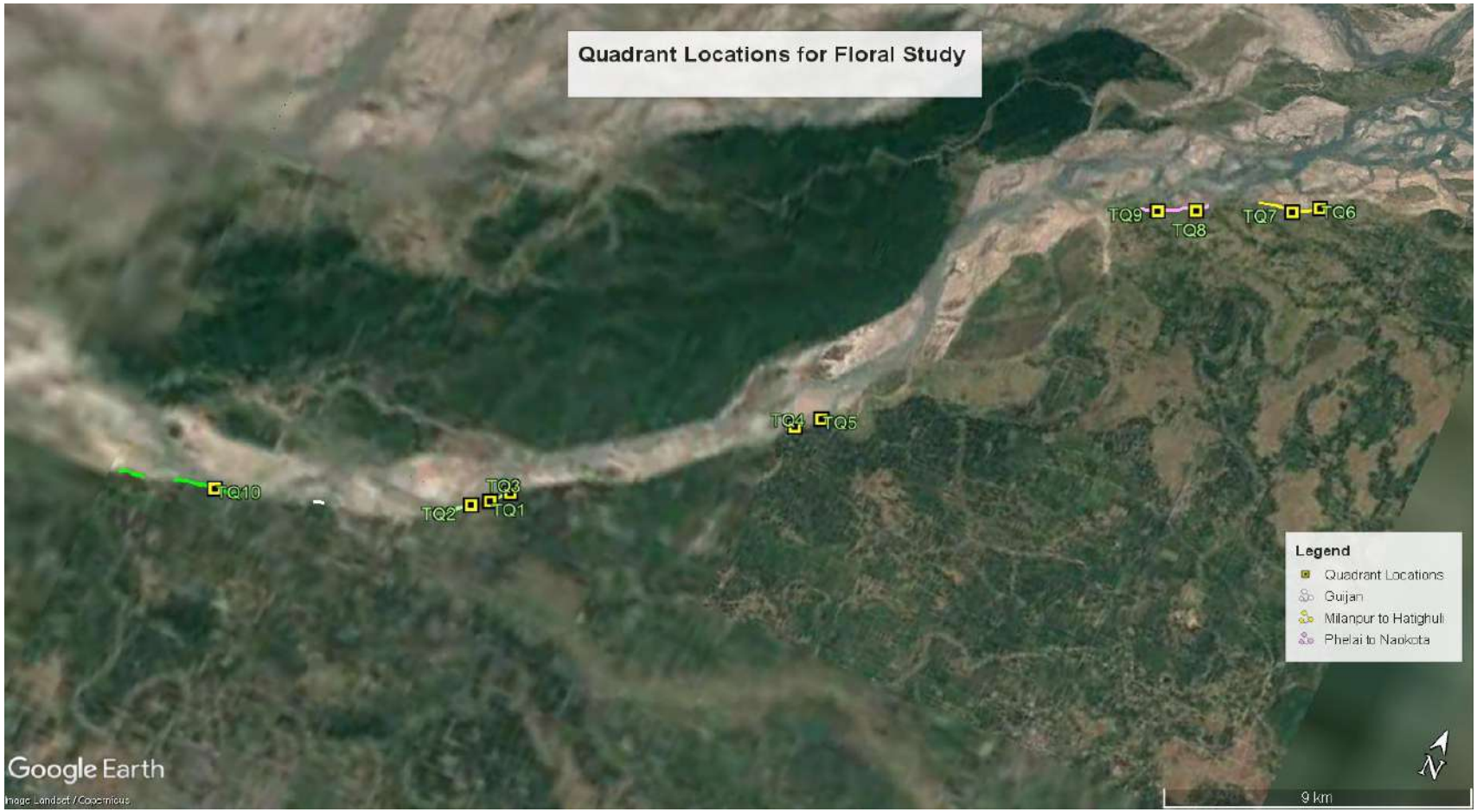
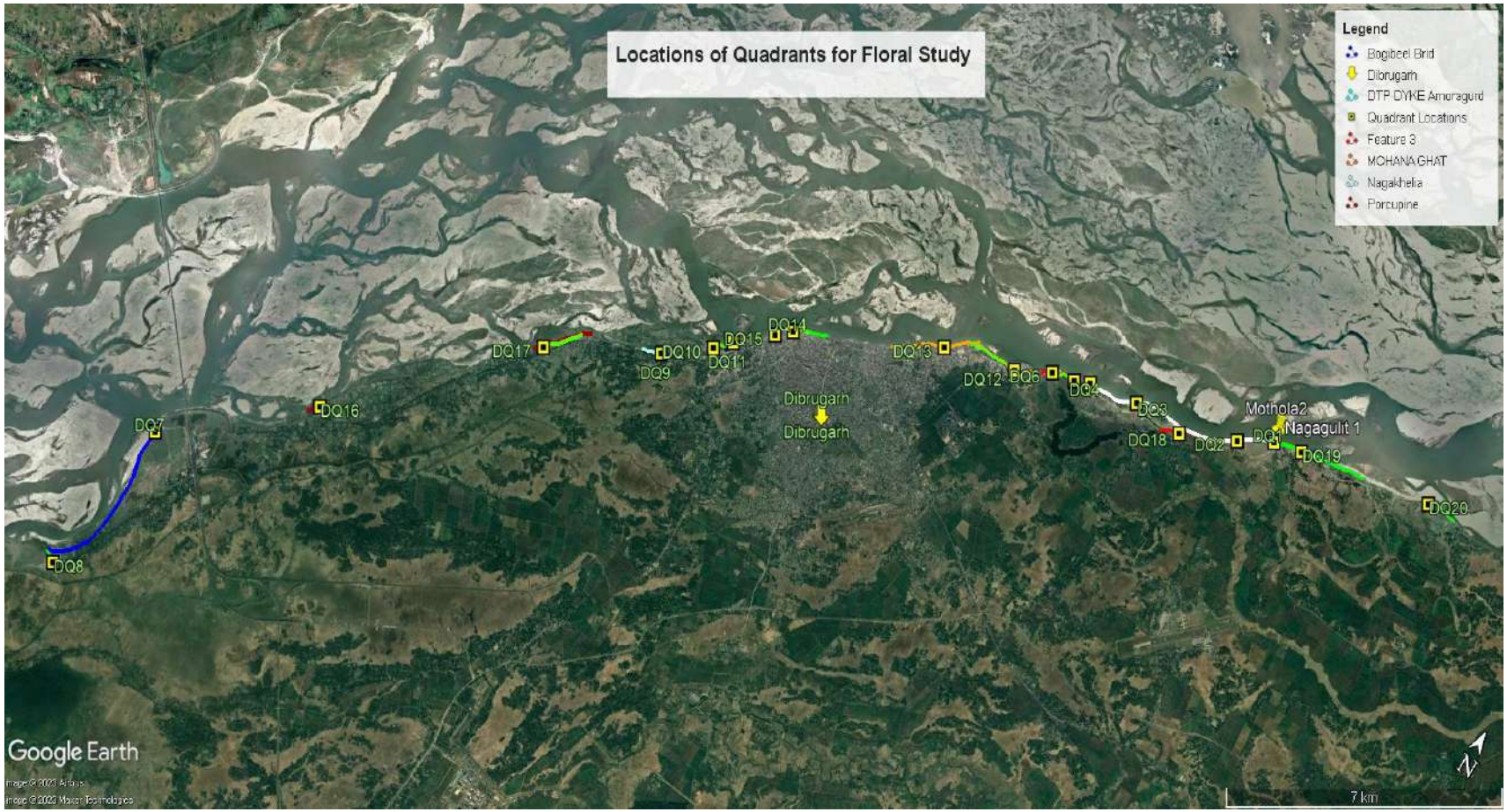


Figure 4.00: Google Image Showing Quadrant Location Along Proposed Protection Work – Dibrugarh



AQUATIC FLORA :

Brahmaputra river is famous for its riparian habitat. Which keeps on changing due to high current in watter and annual flooding during monsoon. There exists no well-established riparian habitat. This is due to large portion of the bank are cut annually. Walk through and transect methods were adopted to record the hydrophytes reported within the core zone. The sandbars formed in the Brahmaputra bank were also survey to study the establishment of grass land and for herbaceous habitats. The species reported during survey were elephant grass *(Pennisetum purpureum), Phragmites karkar, Ipometa aquatica, Ipomea carnea, Eichhornia crassipes, Sagittaria sagittifolia, Colocasia alocasia, etc.*

Sandbars and Sandy River beds vegetative Cover

Due to monsoon spell in the Uppar Assam Region, the level of Brahamaputra River and flow current of water has increased. At most of the site visited, no Sandbars or char land was noticed, except at location Milanpur to Hatighuli (27.761020°; 95.559537°). There were continuous rain prior to our visit schedule. Due to heavy rains entry on the sandbars and chars land were avoided.

Sandbar at Milanpur to Hatighuli is located within the ESA of Dibru-Saikhowa National Park. Entry restriction under Wildlife (Protection), Act 1972. Hence survey limited to 100 meters from riverbank. During survey grasses like *Parthenium hysterophorus (Congress grass), Cynodon dactylon, Eriachne aristidea, Aristida purpurea, indicus Panicum, khasianum Munro, Aristida fusca Isachne albeus, Panicum brevifolium*, etc. were noticed. in scatter form.

	
Sand Bars at Milanpur to Hatighuli 27.761020°; 95.559537°	*Eichhornia crassipes extensive growth in lotic water pond in river bed at Milanpur to Hatighuli - 27.759776°; 95.554074°*

MAIJAN BEEL:

This Maijan beel is located adjacent to the proposed embankment (Reach 2 Maijan) of length 1200. The project would involve development of earthen embankment to prevent the surrounding from flooding.

Maijan Beel adjacent to proposed embankment work - 27.508691°; 94.956285°

The water in this beel is feed from Brahamaputra river (Back water) when flooding occurs. The Maijan Beel towards project witnesses' growth of hydrophytes and shrubs. Small water ponds were noticed. Stream from the beel flows towards Brahmaputra River over which bridge exists. This beel is known for it ecological values. It harbours wide variety of plankton (Phyto and zooplanktons[80]). A total of 42 macrophytes have been recorded under 34 genera belonging to 28 families from the Maijan wetland, Assam during February 2013 to March 2014[81].

The primary survey hydrophytes growth followed by Lantana Camara shows dominance in distribution. Among hydrophytes reported within the Proposed Right of Way of embankment work were *Eichhornia crassipes, Pistia stratiotes, Ottelia alismoides, Lemna minor, Potamogeton crispus, Vallisneria spiralis, Hydrilla verticillata, Ipomoea aquatica, Azolla pinnata, Spirodela polyrhiza, Eleocharis plantaginea, and Sagittaria sagittifolia.*

Grasses like *Eupatorium adoratum, Achyranthes aspera, Cyperus esculentus, Phragmites karka, , Saccharum spontaneum and Imperata arundinacea* shows their presence. The proposed project location, Maijan Beel and surrounding features is shown in **Figure 5.00.**

[80] https://www.researchgate.net/publication/304180101_DiversityyoffPlanktonninnMaijan _Upper_Assam_Beel
[81] Diversity of macrophytes in Maijan wetland, Upper Assam, India., Abujam, S. S. ; Shah, R. K. ; Deori, D. J. ; Biswas, S. P.

Figure 5.00: Location Maijan Beel , Brahmaputra River, Proposed Maijan Embankment Work and it Is surrounding Features

Terrestrial Fauna

MAMMALIAN SPECIES:

During primary survey, no mammalian species were recorded/ sited within construction zone and within 1 km radius. Based on secondary information and interaction with locals, about 10 mammalian species reported during visits which falls under category EN (Elephant and Tiger), NT (Otter), VU (Sambar) as per IUCN Red data List. List of terrestrial wild animals reported from study area is given in **Table 10.00.**

Chinese Pangoline (CR), Wild Water Buffalo, Ganges River Dolphins, Hog Deer, Asian Elephants, Tiger, Fishing Cat, Asian Small Clawed Otter (EN), Bos Gauru, Sambar, Leopard has been listed VU under IUCN and reported in IBAT report for project area. The surrounding habitat within one km is suitable habitat for presence of this species (Ecologically Appropriate Area of Analysis). Though their presence are not reported by farmers in project influence area. Except elephants, tiger and Sambar other animal's presence were not reported by the locals during survey.

AVIFAUNA

Based on primary survey and secondary findings, 61 species of birds are reported. Five vulnerable (VU) species i.e *Ciconia episcopus, Ortygornis gularis, Halcyon smyrnensis and Ceryle rudis, Streptopelia turtur are noted.* One Near Threatened *(NT) i.e Ephippiorhynchus asiaticus* and remaining 54 species of birds are listed under Least Concern (LC) as per IUCN Red Data Book List publishes in 2022.

Two species i.e Woolly Necked stork and Black necked Stork is listed under Schedule -I and one bird like common Myna is listed under Schedule -V. The remaining 56 species of birds are listed under schedule -IV of the Wildlife (Protection), Act -1972.

Based on Habitat distribution about 15 bird's species are reported from marshy area. These birds are *Ephippiorhynchus asiaticus, Chrysocolaptes lucidus, Anastomus oscitans, Bubulcus ibis. Alcedo atthis, Ardeola grayii, Halcyon smyrnensis, Ceryle rudis, Merops orientalis, Plegadis falcinellus, Amaurornis phoenicurus, Porphyrio porphyrio, Gallinula chloropus, Actitis hypoleucos and Tringa nebularia.* The remaining birds are terrestrial and are reported from settlements, Orchids and agricultural, scrub land and grass land.

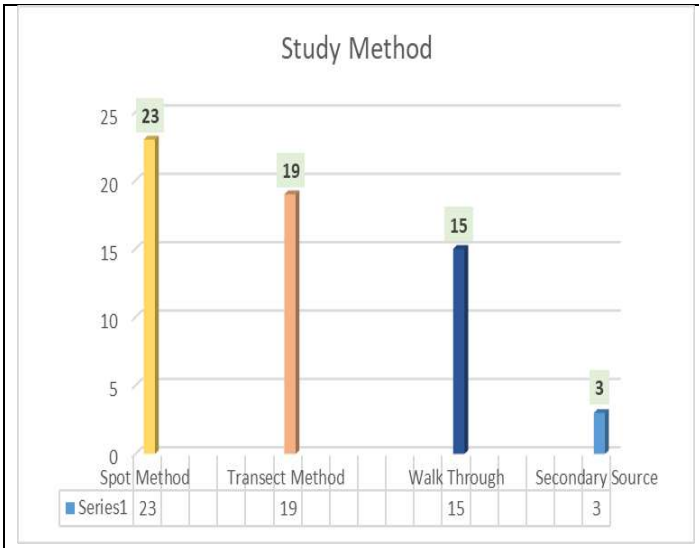


Figure 6.00: Survey Method adopted

Few glimpses of Birds reported in buffer zone

		
Pariah Kite	Pied Myna	Common Iora
		
Red Vented Bulbul	Common Hoopoe	Darter

To record the species distribution 19, transect survey method, 15 walk through survey methods and 23 spot methods were adopted. The details are discussed in **Figure 6.00**

Spot methods, line transect and walk through methods were adopted to carry out avifaunal study. The location of Transect were same as those for Flora study proposed, refer **Table 1.00.** The spot study locations for avifauna are same as proposed for floral Quadrant Locations. Based on random count methods, The total population avifauna reported are 781 within 1 km radius. These are not the actual population of avifauna in study area, but project population based on primary survey. The circle wise avifauna population density are given in **Figure 7.00.** Based on the log book, it has been reported that 261 numbers of birds are recorded by transect methods, 170 number of birds by walk through method and 350 numbers by spot methods. Three species are based on secondary information. The details of avifauna reported in the study area is given in **table 4:00.**

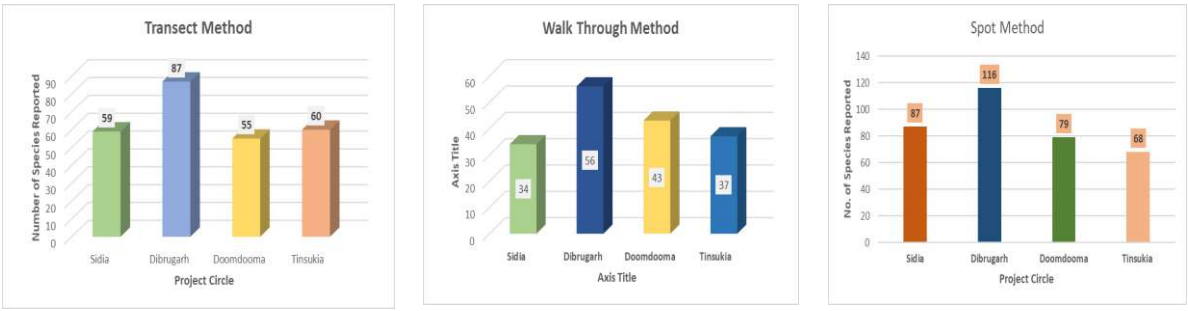


Figure 7.00: Avifauna Population Reported Circle wise

Based on IBAT Proximity Report (Assessment for Ecologically Appropriate Area of Analysis considering Dibru Saikhowa National Park ESZ and Boundary to be within 1 km radius from Tinsukia project locations) for distribution of Avifauna. Based on IBAT report and presence of Eco-Sensitive Zone, we can conclude that eight Critically Rare avifaunal species may be present. These species were Baer's Pochard, Masked Finfoot, White-bellied Heron, Yellow breasted Bunting, Bengal Florican, White Rumped Vulture, Red-headed Vulture and Slender billed Vulture. One species Ortygomis gularis was reported during primary survey.

Nine species Categorized as Endangered and 18 species Categorized as Vulnerable under IUCN may be present in study area,

Table 4:00: List of Birds Recorded in Sub Project Zone -A

S. No	Common Name	Scientific Name	Reported	Study Method	Sadia	Dibrugarh	Doomdooma	Tinsukia	Study area	Habitat	IUCN Red list – 2022-2	WPA-72
1	Black headed munia	*Lonchura malacca*	Secondary source	-	-	-	-	-	Buffer Zone	Orchids and Agricultural	LC	-
2	White Wagtail	*Motacilla alba*	Sighted	Spot Method	-	2	-	1	Buffer Zone	Riverbank	LC	Sch -IV
3	Jungle babbler	*Turdoides striata*	Sighted	Transect Method	4	7	2	7	Buffer Zonw	Orchids and Settlements	LC	Sch-IV
4	Red Jungle flow	*Gallus gallus*	Sighted	Transect Methods	-	3	-	1	Settlements	Habitation	LC	Sch- IV
5	Ruddy shelduck	*Tadorna ferruginea*	Sighted	Spot Method	-	7	4	-	Inner Buffer Zone	Sand island	LC	Sch-IV
6	Woolly Necked stork	Ciconia episcopus	Sighted	Transect Methods	-	8	6	3	Buffer zone	Marshy area	VU	Sch-I
7	Black necked Stork	Ephippiorhynchus asiaticus	Secondary Source	-	-	-	-	-	Buffer Zone	Marshy Area	NT	Sch-I
8	Woodpecker	*Chrysocolaptes lucidus*	Sighted	Walk Through Method	2	-	-	1	Impact Zone	Riparian	LC	Sch-IV
9	Swamp francolin	*Ortygornis gularis*	Secondary Source	-	-	-	-	-	Buffer Zone	-	VU	-
10	Blue Throated Barbet	*Megalaima asiatica*	Sighted	Spot Method	1	2	-	2	Buffer Zone	Orchids	LC	Sch-IV
11	Common Hoopoe	*Upupa epops*	Sighted	Transect Method	4	1	2	1	Buffer Zone	Riparian	LC	Sch-IV
12	Asian openbill	*Anastomus oscitans*	Sighted	Transect Method	4	-	7	2	Buffer Zone	Marshy Area	LC	Sch-IV
13	Cattle Egret	*Bubulcus ibis*	Sighted	Walk Through	3	10	7	5	Buffer Zone	Marshy Area	LC	Sch-IV
14	India roller	*Coracus benghalensis*	Sighted	Transect Method	2	1	1	2	Buffer Zone	Orchids	LC	Sch-IV
15	Common Kingfisher	*Alcedo atthis*	Sighted	Walk Through and transect	1	1	2	1	Inner Buffer Zone	Marshy Area	LC	Sch-IV
16	Pond Heron	*Ardeola grayii*	Sighted	Spot Through	8	4	7	10	Buffer Zone	Marshy Area	LC	Sch-IV
17	White Throated King fisher	*Halcyon smyrnensis*	Sighted	Spot Method	-	2	-	1	Buffer Zone	Marshy area	VU	Sch-IV
18	Pied Kingfisher	*Ceryle rudis*	Noise	Walk Through Method	-	1	1	1	Core Zone	Riparian	VU	Sch-IV
19	Green bee eater	*Merops orientalis*	Sighted	Walk through method	2	3	1	1	Inner Buffer Zone	Marshy Area	LC	Sch-IV
20	Pied cuckoo	*Clamator jacobinus*	Sighted	Spot Method	4	-	1	-	Buffer zone	Orchids	LC	Sch-IV
21	Indian cuckoo	*Cuculus Micropterus*	Noise	Transect	1	2	1	-	Inner buffer	Orchids	LC	Sch-IV
22	Glossy ibis	*Plegadis falcinellus*	Sighted	Transect Method	2	9	3	5	Buffer Zone	Marshy Area	LC	Sch-IV
23	Asian koel	*Eudynanmys scolopacea*	Noise	Spot Method	1	1	1	-	Buffer Zone	Orchids	NA	Sch-IV
24	Rose Ringed parakeet	*Psittacula krameria*	Sighted	Spot method	4	3	2	3	Buffer Zone	Orchids	LC	Sch-IV

S. No	Common Name	Scientific Name	Reported	Study Method	Sadia	Dibrugarh	Doomdooma	Tinsukia	Study area	Habitat	IUCN Red list – 2022-2	WPA-72
25	Asian Palm Swift	*Cypsiurus balasiensis*	Sighted	Spot methods	10	6	5	2	Core and Inner buffer zone	Open area	LC	Sch-IV
26	House swift	*Apus nipalensis*	Sighted	Spot Methods	5	-	1	1	Core and Inner buffer zone	Above water bodies	LC	Sch-IV
27	Spotted owlets	*Athene brama*	Sighted	Spot	1	1	-	-	Buffer Zone	Orchids	LC	Sch-IV
28	Laughing Dove	*Spilopelia senegalensis*	Sighted	Walk through	5	2	2	1	Core and Inner buffer zone	Riparian	LC	Sch-IV
29	Spotted dove	*Spilopelia chinensis*	Sighted	Transect	2	4	1	1	Inner and Outer buffer zone	Farm land and Orchids	LC	Sch-IV
30	Oriental turtle dove	*Streptopelia orientalis*	Sighted	Transect	1	-	-	1	Buffer Zone	Orchids	LC	Sch-IV
31	Eurasian collared dove	*Streptopelia decaocto*	Sighted	Spot method	1	2	1	2	cosmopolitan	-	LC	Sch-IV
32	White breasted waterhen	*Amaurornis phoenicurus*	Sighted	Transect	8	5	4	-	Buffer zone	Marshy	LC	Sch-IV
33	Purple swamphen	*Porphyrio porphyrio*	Sighted	Walk through	-	6	10	7	Buffer zone	Marshy	LC	Sch-IV
34	Common moorhen	*Gallinula chloropus*	Sighted	Spot method	4	3	2	1	Inner and outer buffer zone	Marshy	LC	Sch-IV
35	Common sandpiper	*Actitis hypoleucos*	Sighted	Walk through method	8	6	3	2	Inner and outer buffer zone	Riparian	LC	Sch-IV
36	Red wattled lapwing	*Vanellus indicus*	Noise	Spot method	1	2	1	1		agriculture	LC	Sch-IV
37	Common greenshank	*Tringa nebularia*	Sighted	Walk Through	4	2	8	10	Buffer Zone	Riparian and Marshy	LC	Sch-Iv
38	Pariah kite	*Milvus migrans*	Noise	transect	2	1	1	3	Outer buffer	orchids	LC	Sch-IV
39	Darter	*Anhinga melanogaster*	Sighted	Transect	1	6	2	-	Outer buffer	Marshy	LC	Sch-IV
40	Little cormorant	*Microcarbo niger*	Sighted	Spot methods		5			Outer buffer zone	Marshy	LC	Sch-IV
41	Indian cormorant	*Phalacrocorax fuscicollis*	Sighted	Spot Method	2	1	2	1	Buffer	Marshy	LC	Sch-IV
42	Great egret	*Ardea alba*	Sighted	Walk Through	-	4	2	2	Outer buffer	Agriculture	LC	Sch-IV
43	Indian pond heron	*Ardeola grayii*	Sighted	Walk through	2	5	-	1	Outer buffer	Marshy area	LC	Sch-IV
44	Long tailed shrike	*Lanius schach*	Sighted	Transect	-	2	-	-	Inner buffer	Riparian	LC	Sch-IV
45	House crow	*Corvus splendens*	Sighted	Spot and transect	10	22	9	17	Cosmopolitan	All	LC	Sch-IV
46	Jungle crow	*Corvus culminatus*	Sighted	Walk through	6	4	1	4	Inner buffer	Settlement	LC	Sch-IV
47	Black drongo	Dicrurus macrocercus	Sighted	Walk through		6			Inner and outer	Agriculture	LC	Sch-IV
48	Common woodshrike	Tephrodornis pondicerianus	Sighted	Spot method	-	-	5	-	Riparian	Agriculture	LC	Sch-IV
49	Oriental magpie robin	Copsychus saularis	Sighted	Walk through	1	1	2	`2	Inner and outer buffer zone	Agriculture	LC	Sch-IV
50	Brahminy starling	Sturnia pagodarum	Sighted	Transect	4	2	2	7	Inner Buffer	Riparian	LC	Sch-IV

S. No	Common Name	Scientific Name	Reported	Study Method	Sadia	Dibrugarh	Doomdooma	Tinsukia	Study area	Habitat	IUCN Red list – 2022-2	WPA-72
51	Indian pied Myna	Gracupica contra	Sighted	Transect method	12	18	10	16	Cosmopolitan	Riparian, orchid, agricultural	LC	Sch-IV
52	Common Myna	Acridotheres tristis	Sighted	Spot method	8	12	6	10	Cosmopolitan	-	LC	Sch-V
53	Red whiskered bulbul	Pycnonotus jocosus	Sighted	Spot and walk through	6	8	12	4	Inner and outer buffer	Riparian, orchid, agricultural	LC	Sch-IV
54	Red vented bulbul	Pycnonotus cafer	Sighted	Spot method	10	18	8	4	Inner and outer Buffer	Riparian, orchid, agricultural	LC	Sch-IV
55	Grey breasted prinia	Prinia hodgsonii	Sighted	Transect	4	8	6	10	Inner and outer Buffer	Agriculture	LC	Sch-IV
56	Plain prinia	Prinia inornata	Sighted	Walk Through	-	5	4	1	Inner and Outer	Agriculture	LC	Sch-IV
57	Reed warbler	Acrocephalus scirpaceus	Sighted	Transect	2	6	-	1	Outer Buffer	Agriculture	LC	Sch-IV
58	Striated babbler	Turdoides earlei	Sighted	Transect	6	4	7	-	Outer Buffer	Agriculture	LC	Sch-IV
59	House sparrow	Passer domesticus	Sighted	Spot and transect	11	13	12	8	Inner and Outer Buffer	Settlement and Orchids	LC	Sch-IV
60	Common Iora	Aegithina tiphia	Sighted	Spot Method	-	2	-	-	Outer Buffer Zone	Settlement	LC	
61	European Turtle-dove	Streptopelia turtur	Sighted	Walk Through Methods	1	-	-	-	Outer biffer Zone	Orchids	VU	-

LC – Least Concern; VU – vulnerable, NT- Near Threatened; WPA – Wildlife (Protection), Act – 1972.

Bufferflies:

Project area harbour's rich floral diversity. This result in large varieties of bufferflies. During primary survey bufferflies were reported from core zone and buffer zone. Spot methods, walk through were adopted to record the butterflies in study. About 22 species off butterflies were reported. 11 species of buffer fly are reported from core zone and 18 species are reported in buffer zone. The most commonly reported Bufferfly are small grass yellow, common grass yellow and lemon pansy. **Table 5.00** below gives the list of butterflies reported in study area

Bufferfly reported in core zone – Peacock Pansy

Table 5.00: List of butterflies reported during primary survey in subproject Zone -C

S. No	Common Name	Scientific Name	IUCN	IWPA-1972	Study area	
					Core Zone	Buffer Zone
1	Burara jaina	*Orange Awlet*	NA		-	+
2	Lime blue	*Chilades lajus*	LC		+	+
3	Bush Hopper	*Ampittia dioscorides*	NA		+	-
4	Lesser glass blue	*Chilades lajus*	LC		-	+
5	Common Palm Dart	*Telicota colon*			+	+
6	Lemon pansy	*Junonia lemonias*	LC		+	+
7	Grey pansy	*Junonia atlites*	LC		+	-
8	common grass yellow	*Eurema hecabe*	LC		+	+
9	Common Mormon	*Papilio polytesromulus*	DD		-	+
10	Lime Swallowtail	*Papilio demoleus*	DD		-	+
11	Common Brush Brown	*Mycalesis perseus*	LC	Sch-I	-	+
12	Common tiger	*Danaus genutia*		Sch-I	+	+
13	Plain tiger	*Danaus chrysippus*	LC		-	+
14	Peacock Pansy	*Junonia almana*		Sch-I	+	+
15	Common sergeant	*Athyma perius*	LC		+	+
16	Lime butterfly	*Papilio demoleus*	DD		-	+
17	Indian cabbage white	*Pieris canidia*	LC	Sch-I	-	+
18	Small grass yellow	*Eurema brigitta*	LC		+	+
19	Common Albatross	*Appias albina darada*	LC			
20	Lesser gull	*Cepora nadina*	DD		-	+

S. No	Common Name	Scientific Name	IUCN	IWPA-1972	Study area	
21	Indian Cabbage White	*Pieris canidia canidia*	LC			
22	Common grass Yellow	*Eurema hecabe*	LC		+	+

Source: Primary survey; Symbol + Present; - Absent

REPTILIAN SPECIES:

5 species of Reptiles are reported from the buffer zone. They are common Indian skink, house gecko, garden lizard, rat snake and cobra.

Based on IBAT report for Ecologically Appropriate Area of Analysis i.e both fresh water and Terrestrial habitat exists. It can be assumed that species like Black Softshell Turtle (*Nilssonia nigricans*) - CR, Assam Roofed Turtle (*Pangshura sylhetensis*) - CR, Spotted Pond Turtle - EN, Indian Softshell Turtle (*Nilssonia gangetica*) – EN and King Cobra – VU Category of IUCN Red Data Book.

Fishes

To record distribution of fish species in 1 km study area. All fishing point near settlements were surveyed. About 7 fishing point were visited. The details of these location are given **in table 6.00.** About 14 species of fishes were reported from the study area in Brahmaputra River. Based on primary survey, the species reported were *Labeo gonius*, *Bagarius bagarius*, *Cirrhinus mrigala, Cirrhinus reba, Labeo bata, Labeo calbasu, Labeo rohita, , Mystus. tengra, Channa marulius, Channa. punctata, Rita rita, etc,* . Species of fishes reported based on secondary source were *Mystus bleeker, , Wallago attu, Channa bleeheri* These are sold in local markets. Fish like *Wallago attu* and *Bagarius bagarius* has been listed under Vulnerable Category of IUCN Red Data Book.

Based on IBAT report, and interpretation of Ecologically Appropriate Area of Analysis (Aquatic Habitat). It can be expected that in addition to above mention fish, other species which may be present in study area were *Devario horai (EN), Lepidocephalichthys arunachalensis (VU), Amblyceps arunchalensis (VU), Aborichthys tikaderi (VU), Pseudecheneis sirenica (VU)* in Brahamaputra River. These fished are listed under IUCN Red Data List.

Table 6: Location of Village Fishing Point with their Coordinate

S. No	Name of Location	Location Code	Geographical Coordinate		Aquatic Habitat
			Latitude	Longitude	
1.	Milanpur to Hatighuli	F1	27.759336°	95.556725°	Riverine
2.	Gariating Gaon	F2	27.659107°	95.460046°	
3.	Rungagorah to Dinjan	F3	27.571886°	95.294892°	
4.	Nagaghulit Spur	F4	27.518096°	94.998183°	
5.	Bogibeel Brid	F5	27.354543°;	94.769172°	
6.	DTP DYKE Amoragurd	F6	27.479525°	94.892042°	
7.	ADB T -II-D3	F-7			

	
Species of Fish Caught in net at Nagaghulit Spur - 27.518096°; 94.998183°.	Fish Trap in Brahmaputra River at Bogibeel Brid - 27.354543°; 94.769172°
	
Bamboo made fishing net used at DTP DYKE Amoragurd - 27.479525°; 94.892042°	Fishing point at ADB T -II-D3 - 27.483764°; 94.897291°

AMPHIBIANS:

The species of amphibian reported form the study area were *Duttaphrynus melanostictus, Polypedates teraiensis, Philautu ssp., Hoplobatrachus tigerinus, Euphlyctis cyanophlyctis, Hylarana nigrovittata, etc.* None of the Amphibian species reported falls under IUCN RET list. The locations of amphibian sampling are similar to fish sampling **locations Table 7.00:**Gives the list of amphibian species and their presence in project study area

Table 7.00: List of Amphibian Species Reported in study area

S. No	Name of Amphibians	F1	F2	F3	F4	F5	F6	F7
1.	Common Toad	+	+	+	+	+	+	+
2.	Common Tree Frog	+	-	-	+	+	-	-
3.	Bush Frog	+	+	-	-	+	+	-
4.	Jerdon's Bull Frog	+	-	-	-	-	+	+
5.	Common Water Frog	+	+	+	+	+	+	+

6.	Indian Bull Frog	+	+	+	+	+	+	+
7.	Cope's Assam Frog	+	+	+	-	-	-	-

(+ Reported based on net catch and reported by fishermen; - Not Reported in study area)

AQUATIC MAMMALIAN SPECIES:

Brahmaputra river is famous for aquatic mammalian species i.e fresh water dolphins *(Platanista gangetica).* It is reported all over Brahmaputra River were depth of water and counter current for fish hunting exist.

During aquatic mammalian survey along the river bed specially where bank protection are proposed, consultation with locals, fishermen are undertaken. During primary survey the river course are far from the bank, except few. River beds are died and exposed. 12 sites in sub project (Zone -A) has been identified under bank protection work. Dolphin's distribution in project influence area (1km radius) is discussed in **Table 8.00.**

Table 8.00: Distribution of Dolphins in Study Area

S.No.	Project	LAC	Revenue Circle	Dolphins Distribution	
				Within 100	Beyond 100 to 1 km
1.	Chaulkhowa	Moran	Dibrugarh West	-	+
2.	Milanpur to Hatighuli	Doomdooma	Doomdooma	-	+
3.	Nagaglulit	lathowal	Dibrugarh East	-	-
4.	Maijan Reach. -2	lathowal	Dibrugarh East	-	+
5.	Nagakhelia	Dibrugarh	Dibrugarh East	-	-
6.	Baghjan to Notungaon	Chabua/ Doomdooma	Tinsukia	-	-
7.	Simalugurisara	Doomdooma	Doomdooma	+	+
8.	Mohanaghat	Dibrugarh	Dibrugarh East	-	-
9.	Amoragurd	Dibrugarh	Dibrugarh East	-	-
10.	ADB T-I-Mothala	Lahowal	Dibrugarh East	-	+
11.	ADB T-II, D-3	Dibrugarh	Dibrugarh East	-	-
12.	Gariating gaon	Doomdooma	Doomdooma	-	-

Source: LASA Primary Survey; Symbol: - Not Reported; + Reported; ©Reported during monsoon

Ecologically Sensitive Area/Wildlife Protected area/Forest Area

Ecologically Sensitive Area

No ecologically Sensitive area is located within 5 km radius of proposed project, which are declared sensitive area under the Environmental (Protection), Act 1986.

Forest Area: *No Notified Forest under The Indian Forest Act 1927; Forest (Conservation), Act 1980 and The Assam Forest Regulation Act 1891 were located within Project construction zone or in adjacent.*

Eco- Sensitive Zone

Wildlife Protected Area:

Biogeographically, the Dibru-Saikhowa National Park represents the "North Eastern India-Brahmaputra Valley Bio-geographical Province" (9A). Having rich flora and fauna being the transition zone of two major biodiversity hot spots, which supports diverse fauna well adopted to life in terrestrial, aquatic and arboreal ecosystems. This National Park supports astonishingly rich flora including 28 tree species, 26 species of shrubs, 2 species of parasitic plants, 17 species of grasses, 16 species of aquatic plants, 3 species of marshy plants, 4 species of climbers and scandens, 5 species of canes, 13 species of orchids, and 6 threatened medicinal plant species;

Dibru-Saikhowa National Park is a habitat for many animals and birds with a total of 36 species of mammals belonging to 10 orders and 19 families and 27 genera are recorded in the core, out of which 12 belonged to Schedule-I. Feral horses are one of the prime mammal species available in the park. The National Park supports 11 species of turtles, 9 species of lizard including two species of monitor Lizards, 18 species of amphibian, 104 species of fish, 23 different species of snakes and 104 species of butterflies besides having a huge number, about 500 species of avifauna. The area also attracts Migratory birds and is a feeding ground for a variety of aquatic and terrestrial birds;

The Gazette of India dated 28th January, 2020, through vide S.O460(E) declared Eco-sensitive zone (ESZ) boundary which extent from 0 (zero) kilometres to 8.7 kilometres around the boundary

of Dibru-Saikhowa National Park and the area of the Ecosensitive Zone is 658.251 square kilometres. (Zero extent of Eco-sensitive Zone was justified as “Existence of crude oil and natural gas in the immediate vicinity of the southern side of the National Park boundary”).

Based on final ESZ notification and project locations, 1 Km and 5 km radius maps were prepared highlight Protected Area and Eco – Sensitive Zone boundary. The detailed maps were given in Figure 8.00 and 9.00. The project locations with respect to National Park Boundary and ESZ Boundary is given in table 9.00.

Table 9.00: Details of Project with respect to Wildlife Boundary and ESA Area

S.No	Name of Project	Wildlife Boundary	Eco-Sensitive Zone	Comments is any
1.	Milanpur to Hatighuli	363 meters	Within	NoC required from SBWL/ NBWL
2.	Phelai to Naokota	937 meters	Within	
3.	Gariating Gaon	-	760 meter Outside	-
4.	Simaluguri Satra	-	Outside	NoC required from SBWL/ NBWL
5.	Baghjan to Notun Gaon	331 meters	Within	
6.	Guijan	1286 meters	Within	
7.	Rungagorah to Dinjan	466 meters	Within	

Figure 8.00: 1 Km Radius Map with Project Locations, Earmarking Dibru Saikhowa National Park and ESZ Area

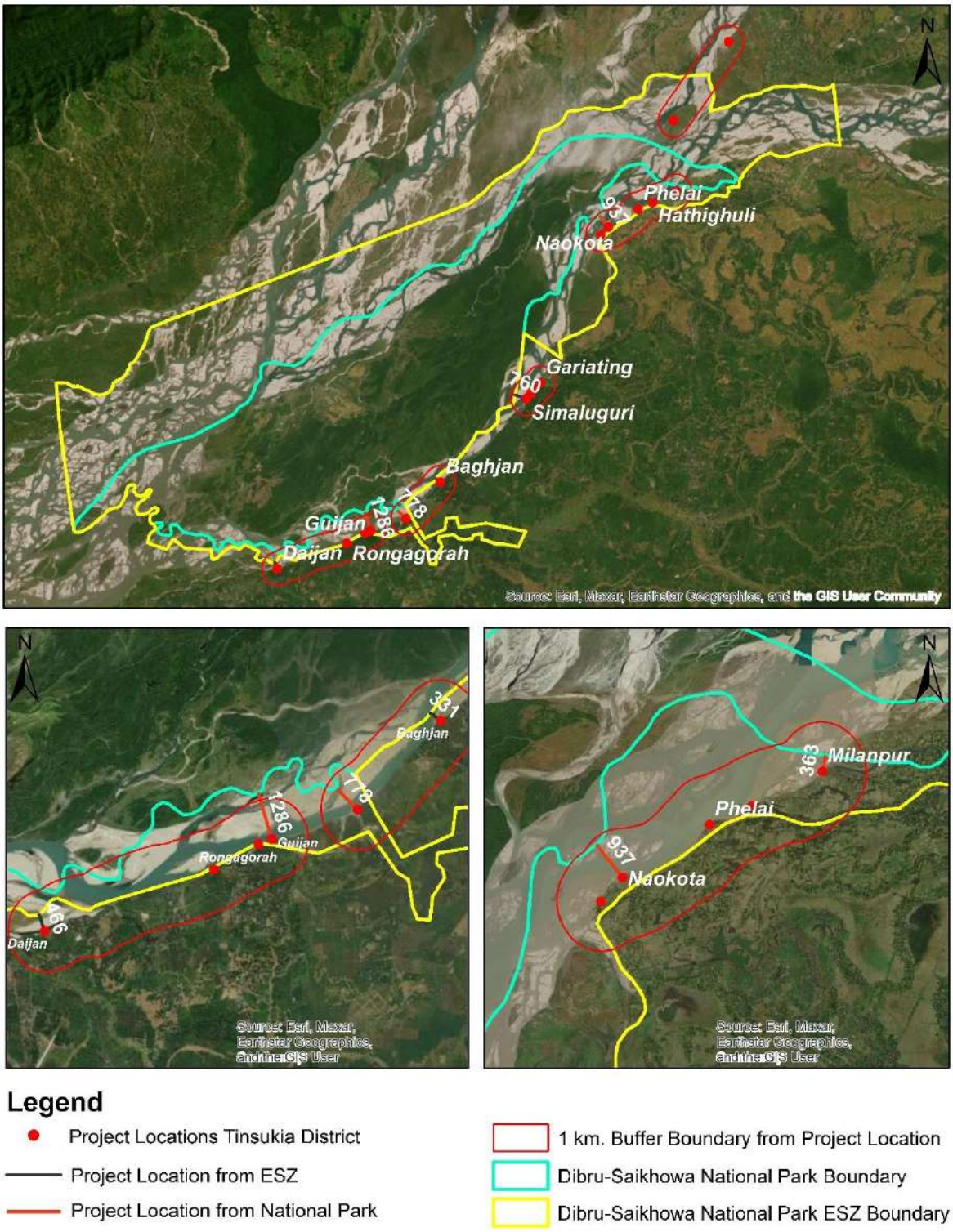


Figure 9.00: 5 km Radius Map with Project Locations and Dibru Saikhowa National Park Core and ESZ Area

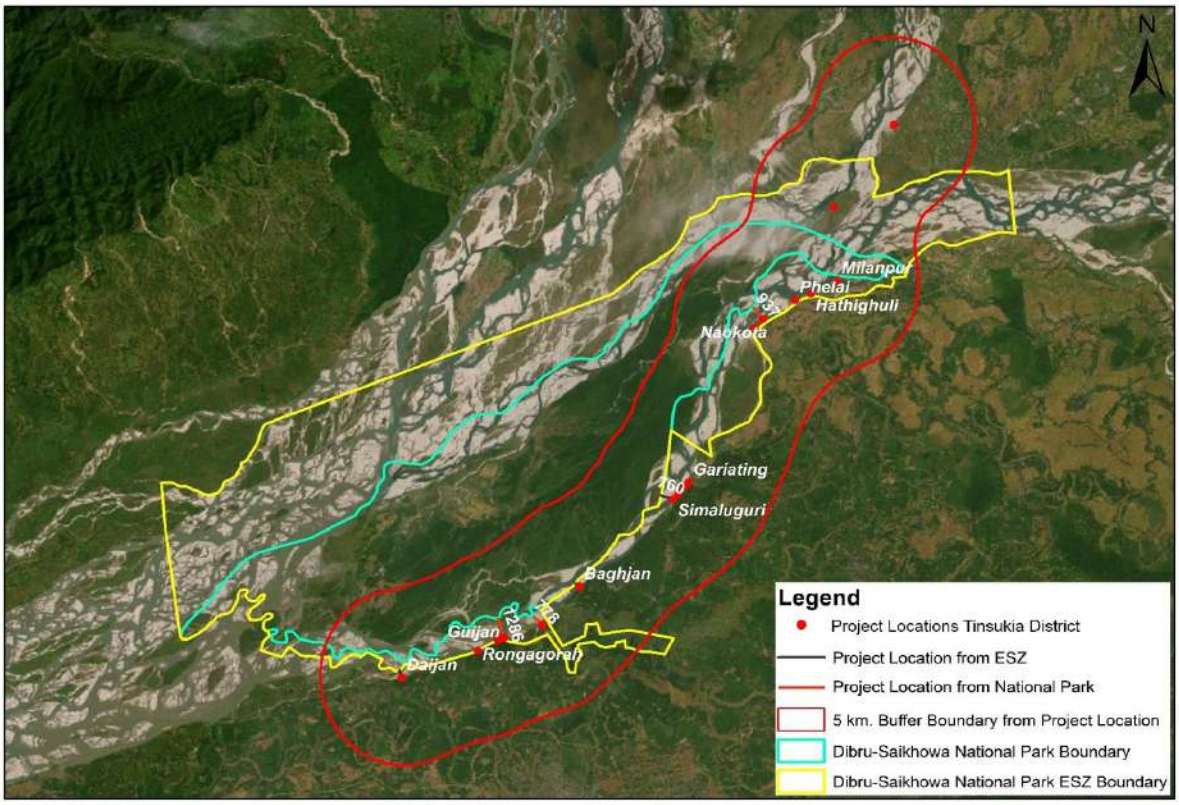


Table 10.00: List of Mammalian Species reported from Project Area (Zone-A)

S. No	Common Name	Scientific Name	LAC	Revenue Circle	Project	Reported	IUCN	WLPA-1972
1	Elephant	*Elephus maximus*	Moran	Dibrugarh West	Chaulkhowa	Secondary Source	EN	Sch-I
2			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
3	Royal Bengal Tiger	*Panthera tigris*	Moran	Dibrugarh West	Chaulkhowa	Secondary Source	EN	Sch-I
4	Rhesus Macaque	*Macaca mulata*	Moran	Dibrugarh West	Chaulkhowa	Secondary Source	LC	SCH-II
5			Chabua/ Doomdooma	Tinsukia	Baghjan to Notungaon	Secondary Source		
6			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
7	Jackal	*Canis aureus*	lathowal	Dibrugarh East	Nagaglulit	Secondary source	LC	Sch-II
8			lathowal	Dibrugarh East	Maijan Re. -2	Secondary source		
9			Chabua/ Doomdooma	Tinsukia	Baghjan to Notungaon	Secondary Source		
10			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
11	Wild Pig	*Sus scrofa*	lathowal	Dibrugarh East	Nagaglulit	Secondary sourec	LC	Sch-III
12			lathowal	Dibrugarh East	Maijan Re. -2	Secondary source		
13			Moran	Dibrugarh West	Chaulkhowa	Secondary Source		
14			Chabua/ Doomdooma	Tinsukia	Baghjan to Notungaon	Secondary Source		
15			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
16	Small Asian Mongoose	*Amblonyx cinereus*	lathowal	Dibrugarh East	Nagaglulit	Secondary sourec	DD	Sch-IV

S. No	Common Name	Scientific Name	LAC	Revenue Circle	Project	Reported	IUCN	WLPA-1972
17			lathowal	Dibrugarh East	Maijan Re. -2	Secondary source		
18			Moran	Dibrugarh West	Chaulkhowa	Secondary Source		
19			Dibrugarh	Dibrugarh East	Nagakhelia	Secondary Source		
20			Chabua/ Doomdooma	Tinsukia	Baghjan to Notungaon	Secondary Source		
21			Doomdooma	Doomdooma	Simalugurisara	Secondary Source		
22	Wild Buffalo	*Bubalus bubalis*	Moran	Dibrugarh West	Chaulkhowa	Secondary Source	LC	Sch-I
23			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
24	Otter	*Lutra lutra*	lathowal	Dibrugarh East	Maijan Re. -2	Secondary source	NT	Sch-III
25			Moran	Dibrugarh West	Chaulkhowa	Secondary Source		
26			Dibrugarh	Dibrugarh East	Mohanaghat	Secondary Source		
27			Dibrugarh	Dibrugarh East	Amoragurd	Secondary Source		
28			Lahowal	Dibrugarh East	ADB T-I-Mothala	Secondary Source		
29			Chabua/ Doomdooma	Tinsukia	Baghjan to Notungaon	Secondary Source		
30			Doomdooma	Doomdooma	Simalugurisara	Secondary Source		
31			Doomdooma	Doomdooma	Gariating gaon	Socondary Source		
32	Sambar	*Cervus unicolor*	lathowal	Dibrugarh East	Nagaglulit	Secondary source	VU	Sch-III
33			Moran	Dibrugarh West	Chaulkhowa	Secondary Source		

S. No	Common Name	Scientific Name	LAC	Revenue Circle	Project	Reported	IUCN	WLPA-1972
34			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
35	Jungle Cat	*Felis chaus*	lathowal	Dibrugarh East	Nagaglulit	Secondary sourec	LC	Sch-II
36			lathowal	Dibrugarh East	Maijan Re. -2	Secondary source		
37			Moran	Dibrugarh West	Chaulkhowa	Secondary Source		
38			Dibrugarh	Dibrugarh East	Nagakhelia	Secondary Source		
39			Chabua/ Doomdooma	Tinsukia	Baghjan to Notungaon	Secondary Source		
40			Doomdooma	Doomdooma	Milanpur to Hatighuli	Secondary Source		
41	House mouse	*Mus musculus*	lathowal	Dibrugarh East	Nagaglulit	Secondary source	LC	Sch-IV
42			Dibrugarh	Dibrugarh East	Amoragurd	Secondary Source		
43			Dibrugarh	Dibrugarh East	ADB T-II, D-3	Secondary Source		
44			Doomdooma	Doomdooma	Simalugurisara	Secondary Source		
45			Doomdooma	Doomdooma	Gariating gaon	Socondary Source		

Secondary Source: Consulted with Local and Forest Working Plan. (Not Sighted).

Appendix 8: Environmental Monitoring Records

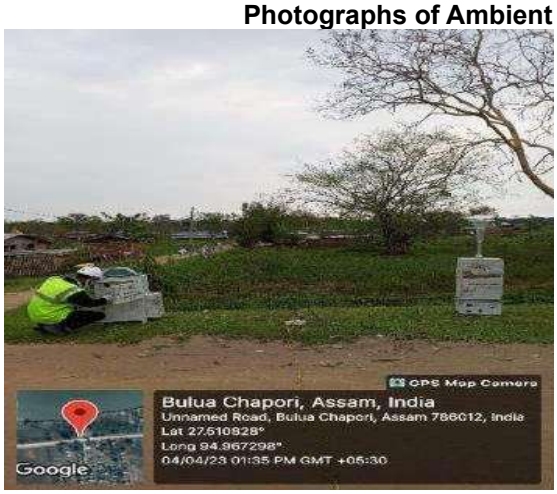
Photographs

Photographs of Ambient Noise Monitoring Result

Saiai Gaon, Dibrugarh

Kardoiguri No 1 Tinsukia

Photographs of Ambient Air Quality Monitoring Result



Mithila, Dibrugarh

Maijan Dibrugarh

Kardoiguri, Tensukia

Khamti Gaon, Tinsukia

Photographs of Surface water samplings

Maijan Village; Dibrugarh

Mothila 1st Part; Dibrugarh

Koilapothar Goan; Tinsukia

Photograph of Groundwater Monitoring

Maijan Bora Village; Dibrugarh

Photographs of Soil samplings

Gohaingaon, Tinsukia,

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CERTIFICATE OF ACCREDITATION

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in the field of

TESTING

Certificate Number: TC-6376

Issue Date: 09/06/2022 Valid Until: 08/06/2024

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.

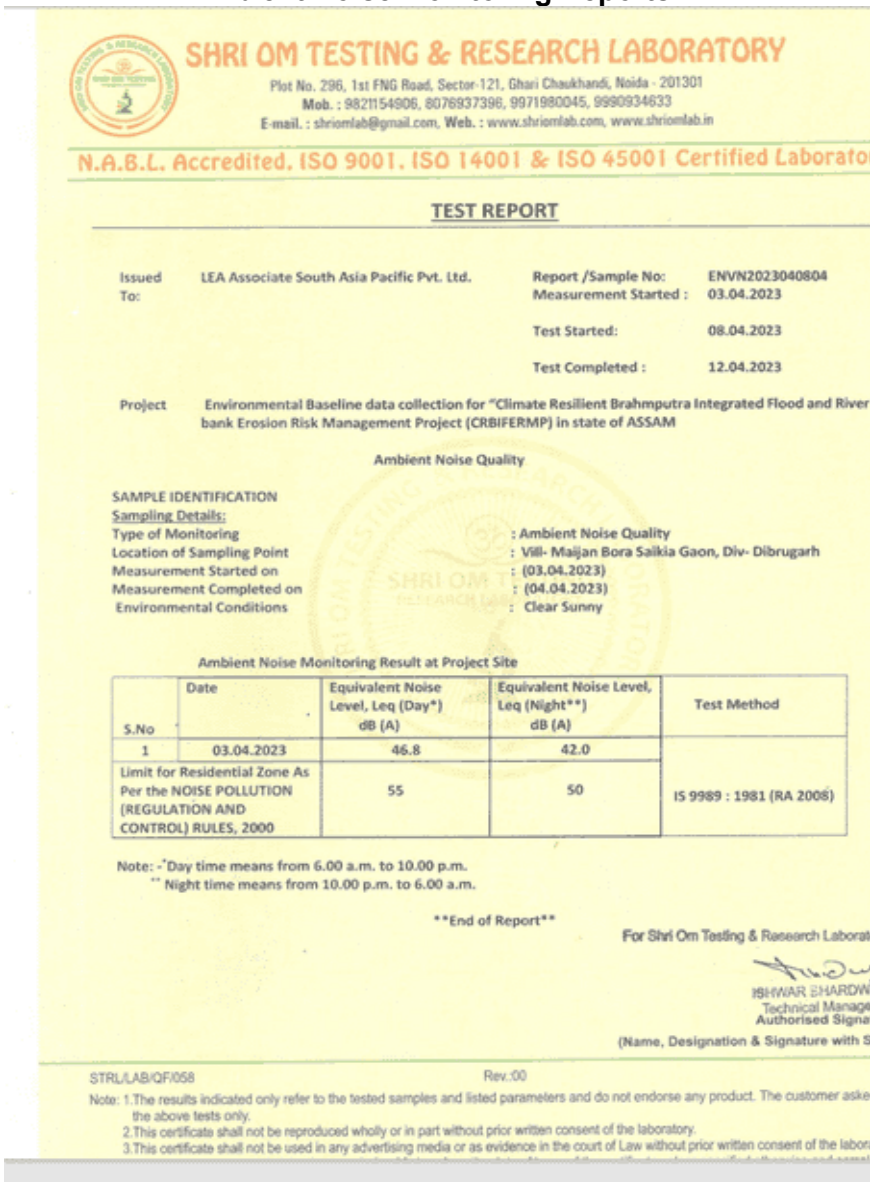
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Entity : SHRI OM TESTING & RESEARCH LABORATORY

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

Ambient Noise Monitoring Reports



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TEST REPORT

Issued To: LEA Associate South Asia Pacific Pvt. Ltd.

Report /Sample No: ENVN2023040804
Measurement Started : 03.04.2023
Test Started: 08.04.2023
Test Completed : 12.04.2023

Project: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM

Ambient Noise Quality

SAMPLE IDENTIFICATION
Sampling Details:
Type of Monitoring : Ambient Noise Quality
Location of Sampling Point : Vill- Maijan Bora Saikia Gaon, Div- Dibrugarh
Measurement Started on : (03.04.2023)
Measurement Completed on : (04.04.2023)
Environmental Conditions : Clear Sunny

Ambient Noise Monitoring Result at Project Site

S.No	Date	Equivalent Noise Level, Leq (Day*) dB (A)	Equivalent Noise Level, Leq (Night**) dB (A)	Test Method
1	03.04.2023	46.8	42.0	
Limit for Residential Zone As Per the NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000		55	50	IS 9989 : 1981 (RA 2008)

Note: -*Day time means from 6.00 a.m. to 10.00 p.m.
** Night time means from 10.00 p.m. to 6.00 a.m.

End of Report

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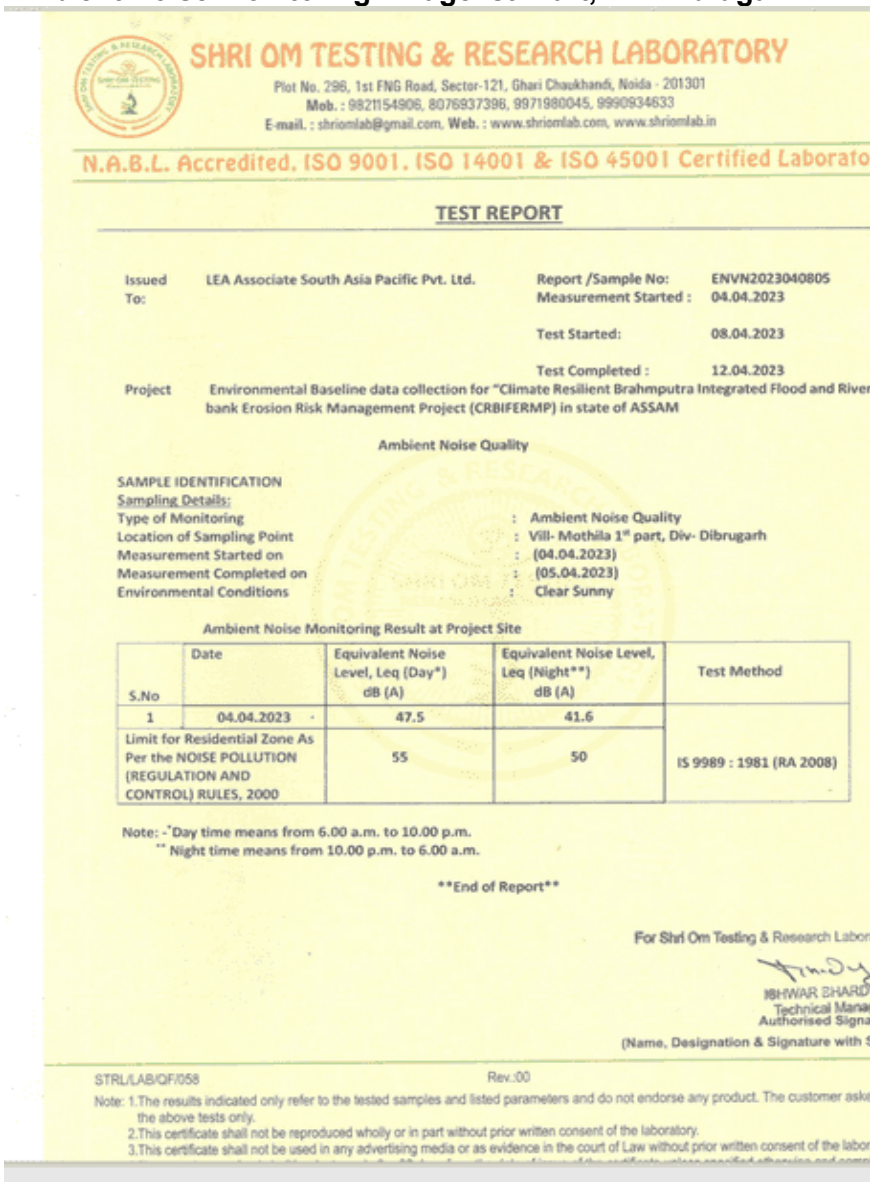
Ambient Noise monitoring Village Ist. Part, Div Dibrugarh



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TEST REPORT

Issued To: LEA Associate South Asia Pacific Pvt. Ltd.

Report /Sample No: ENVN2023040805
Measurement Started : 04.04.2023
Test Started: 08.04.2023
Test Completed : 12.04.2023

Project: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM

Ambient Noise Quality

SAMPLE IDENTIFICATION
Sampling Details:
Type of Monitoring : Ambient Noise Quality
Location of Sampling Point : Vill- Mothila 1st part, Div- Dibrugarh
Measurement Started on : (04.04.2023)
Measurement Completed on : (05.04.2023)
Environmental Conditions : Clear Sunny

Ambient Noise Monitoring Result at Project Site

S.No	Date	Equivalent Noise Level, Leq (Day*) dB (A)	Equivalent Noise Level, Leq (Night**) dB (A)	Test Method
1	04.04.2023	47.5	41.6	
Limit for Residential Zone As Per the NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000		55	50	IS 9989 : 1981 (RA 2008)

Note: -*Day time means from 6.00 a.m. to 10.00 p.m.
** Night time means from 10.00 p.m. to 6.00 a.m.

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TEST REPORT

Issued To: LEA Associate South Asia Pacific Pvt. Ltd.

Report /Sample No: ENVN2023040806
Measurement Started : 05.04.2023
Test Started: 08.04.2023
Test Completed : 12.04.2023

Project: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and R bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM

Ambient Noise Quality

SAMPLE IDENTIFICATION
Sampling Details:
Type of Monitoring : Ambient Noise Quality
Location of Sampling Point : Vill- 1 No Kardoiguri, Div- Tinsukia
Measurement Started on : (05.04.2023)
Measurement Completed on : (06.04.2023)
Environmental Conditions : Clear Sunny

Ambient Noise Monitoring Result at Project Site

S.No	Date	Equivalent Noise Level, Leq (Day*) dB (A)	Equivalent Noise Level, Leq (Night**) dB (A)	Test Method
1	05.04.2023	46.8	42.1	
Limit for Residential Zone As Per the NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000		55	50	IS 9989 : 1981 (RA 2008)

Note: -*Day time means from 6.00 a.m. to 10.00 p.m.
** Night time means from 10.00 p.m. to 6.00 a.m.

End of Report

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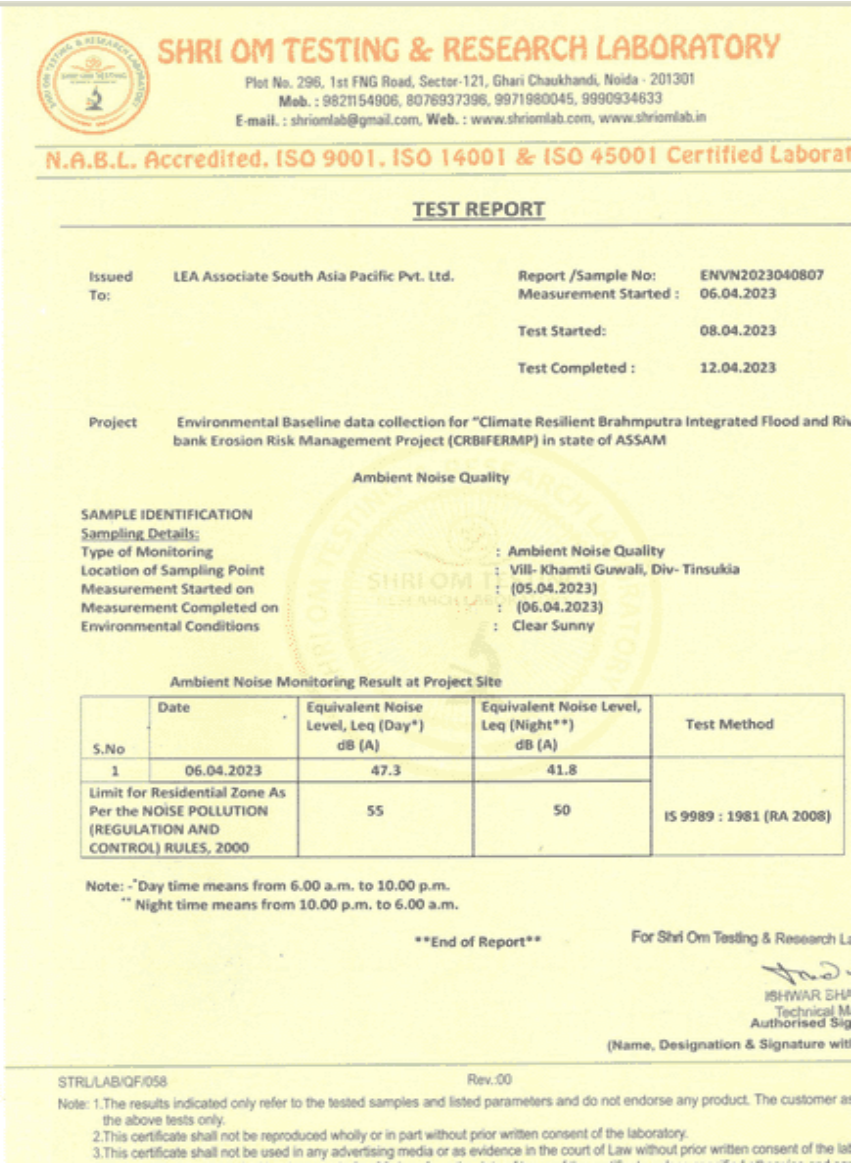
Ambient Noise monitoring Village Khamti Guwali, Div Tinsukia



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TEST REPORT

Issued To: LEA Associate South Asia Pacific Pvt. Ltd.

Report /Sample No: ENVN2023040807
Measurement Started : 06.04.2023
Test Started: 08.04.2023
Test Completed : 12.04.2023

Project: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and Riv bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM

Ambient Noise Quality

SAMPLE IDENTIFICATION
Sampling Details:
Type of Monitoring : Ambient Noise Quality
Location of Sampling Point : Vill- Khamti Guwali, Div- Tinsukia
Measurement Started on : (05.04.2023)
Measurement Completed on : (06.04.2023)
Environmental Conditions : Clear Sunny

Ambient Noise Monitoring Result at Project Site

S.No	Date	Equivalent Noise Level, Leq (Day*) dB (A)	Equivalent Noise Level, Leq (Night**) dB (A)	Test Method
1	06.04.2023	47.3	41.8	
Limit for Residential Zone As Per the NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000		55	50	IS 9989 : 1981 (RA 2008)

Note: -*Day time means from 6.00 a.m. to 10.00 p.m.
** Night time means from 10.00 p.m. to 6.00 a.m.

End of Report

For Shri Om Testing & Research La

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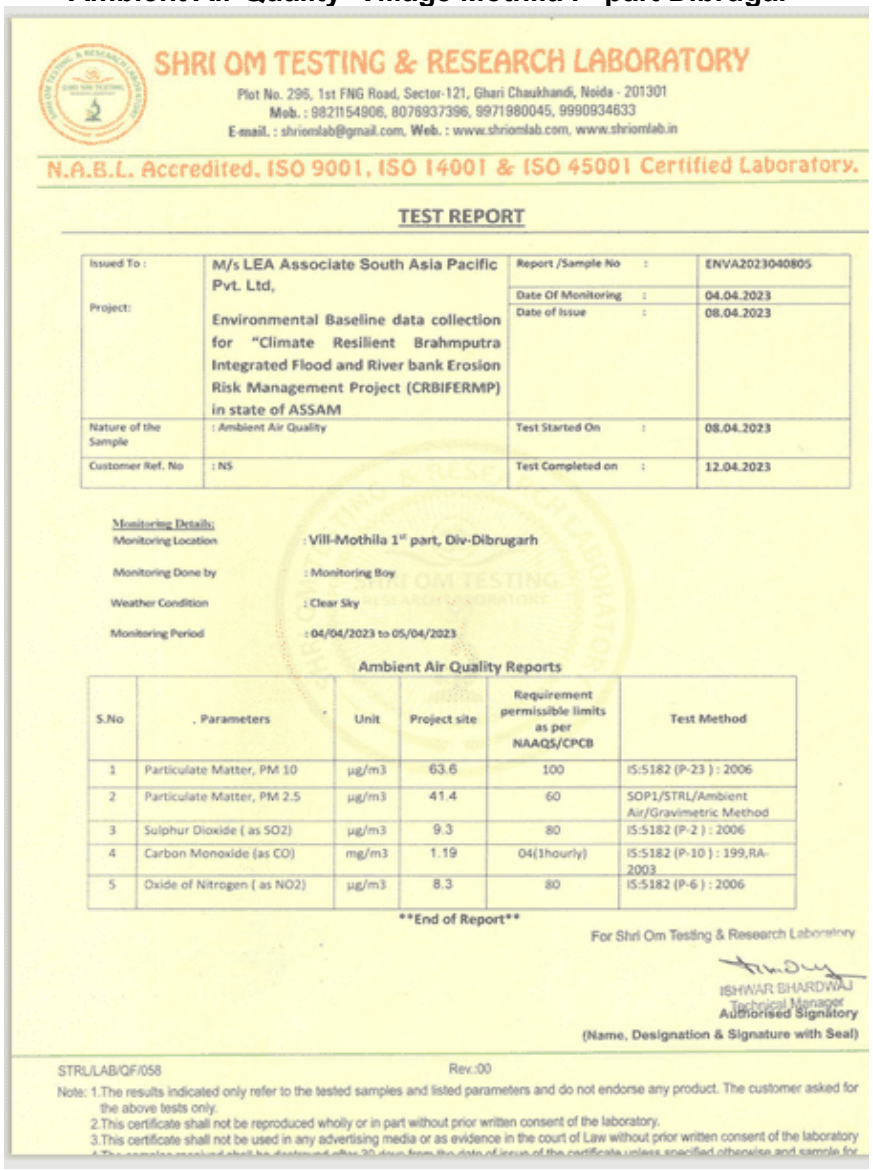
Ambient Air Quality Village Mothila I[st] part Dibrugar



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TEST REPORT

Issued To :	M/s LEA Associate South Asia Pacific Pvt. Ltd,	Report /Sample No :	ENVA2023040805
		Date Of Monitoring :	04.04.2023
Project:	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM	Date of Issue :	08.04.2023
Nature of the Sample	: Ambient Air Quality	Test Started On :	08.04.2023
Customer Ref. No	: NS	Test Completed on :	12.04.2023

Monitoring Details:
Monitoring Location : Vill-Mothila 1st part, Div-Dibrugarh
Monitoring Done by : Monitoring Boy
Weather Condition : Clear Sky
Monitoring Period : 04/04/2023 to 05/04/2023

Ambient Air Quality Reports

S.No	Parameters	Unit	Project site	Requirement permissible limits as per NAAQS/CPCB	Test Method
1	Particulate Matter, PM 10	µg/m3	63.6	100	IS:5182 (P-23) : 2006
2	Particulate Matter, PM 2.5	µg/m3	41.4	60	SOP1/STRL/Ambient Air/Gravimetric Method
3	Sulphur Dioxide (as SO2)	µg/m3	9.3	80	IS:5182 (P-2) : 2006
4	Carbon Monoxide (as CO)	mg/m3	1.19	04(1hourly)	IS:5182 (P-10) : 199,RA-2003
5	Oxide of Nitrogen (as NO2)	µg/m3	8.3	80	IS:5182 (P-6) : 2006

End of Report

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
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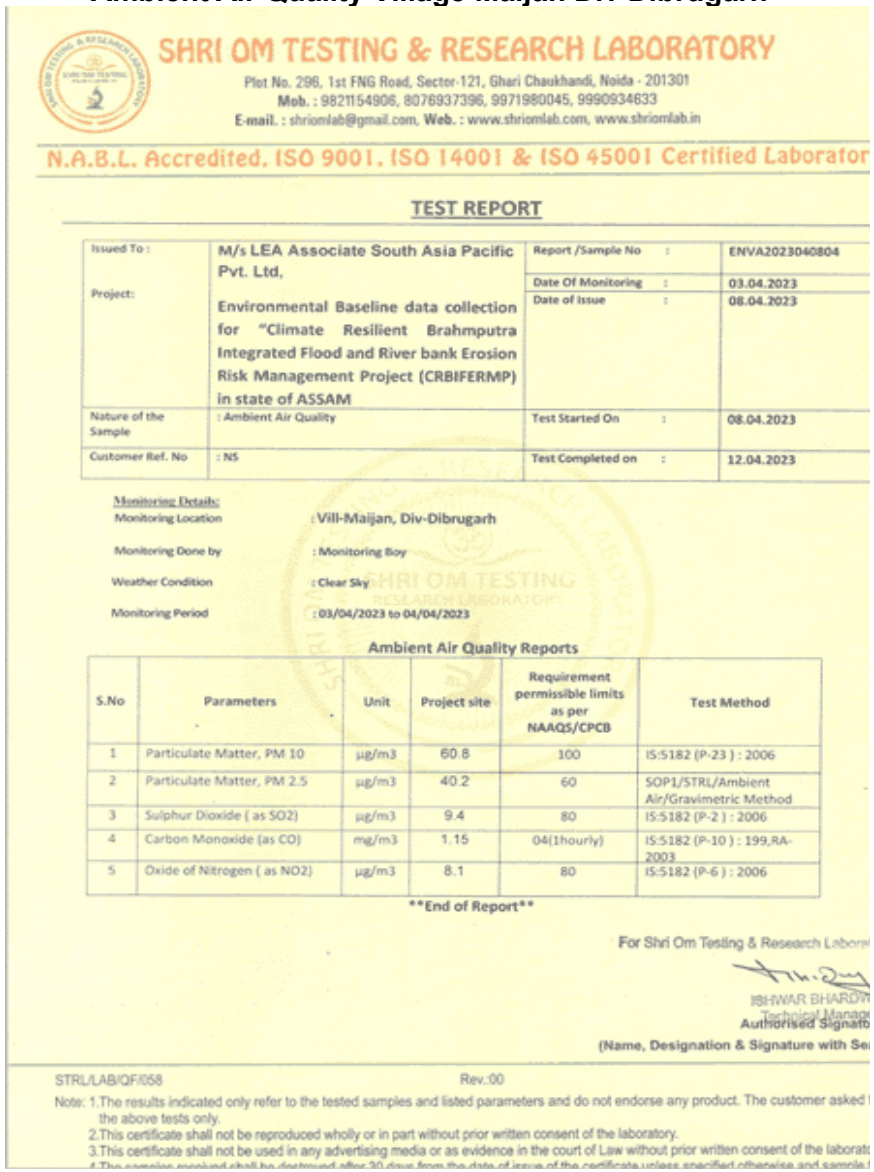
Ambient Air Quality Village Maijan Div Dibrugarh



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TEST REPORT

Issued To :	M/s LEA Associate South Asia Pacific Pvt. Ltd,	Report /Sample No :	ENVA2023040804
		Date Of Monitoring :	03.04.2023
Project:	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM	Date of Issue :	08.04.2023
Nature of the Sample	: Ambient Air Quality	Test Started On :	08.04.2023
Customer Ref. No	: NS	Test Completed on :	12.04.2023

Monitoring Details:
Monitoring Location : Vill-Maijan, Div-Dibrugarh
Monitoring Done by : Monitoring Boy
Weather Condition : Clear Sky
Monitoring Period : 03/04/2023 to 04/04/2023

Ambient Air Quality Reports

S.No	Parameters	Unit	Project site	Requirement permissible limits as per NAAQS/CPCB	Test Method
1	Particulate Matter, PM 10	µg/m3	60.8	100	IS:5182 (P-23) : 2006
2	Particulate Matter, PM 2.5	µg/m3	40.2	60	SOP1/STRL/Ambient Air/Gravimetric Method
3	Sulphur Dioxide (as SO2)	µg/m3	9.4	80	IS:5182 (P-2) : 2006
4	Carbon Monoxide (as CO)	mg/m3	1.15	04(1hourly)	IS:5182 (P-10) : 199,RA-2003
5	Oxide of Nitrogen (as NO2)	µg/m3	8.1	80	IS:5182 (P-6) : 2006

End of Report

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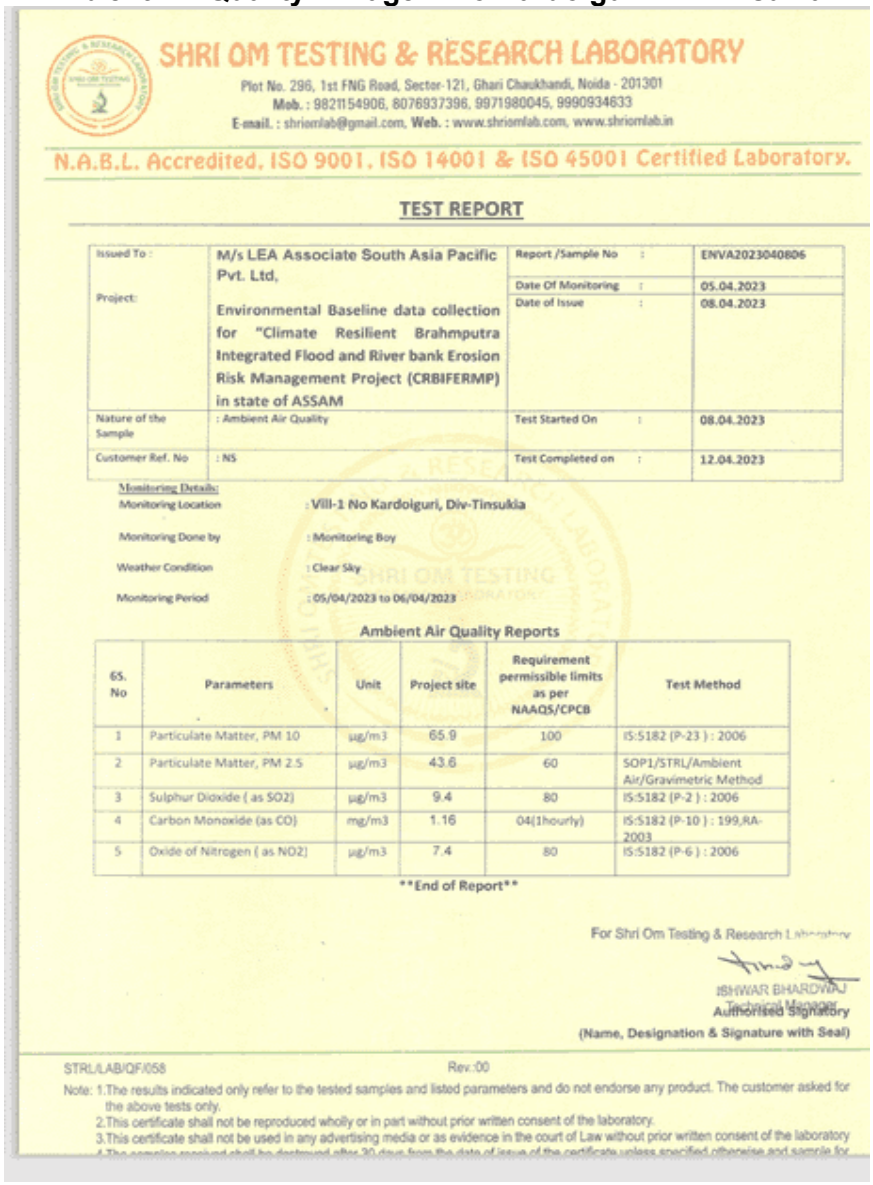
Ambient Air Quality Village 1 No Kardoiguri Div Tinsukia



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TEST REPORT

Issued To :	M/s LEA Associate South Asia Pacific Pvt. Ltd,	Report /Sample No :	ENVA2023040806
		Date Of Monitoring :	05.04.2023
Project:	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM	Date of Issue :	08.04.2023
Nature of the Sample	: Ambient Air Quality	Test Started On :	08.04.2023
Customer Ref. No	: NS	Test Completed on :	12.04.2023

Monitoring Details:
Monitoring Location : Vill-1 No Kardoiguri, Div-Tinsukia
Monitoring Done by : Monitoring Boy
Weather Condition : Clear Sky
Monitoring Period : 05/04/2023 to 06/04/2023

Ambient Air Quality Reports

65. No	Parameters	Unit	Project site	Requirement permissible limits as per NAAQS/CPCB	Test Method
1	Particulate Matter, PM 10	µg/m3	65.9	100	IS:5182 (P-23) : 2006
2	Particulate Matter, PM 2.5	µg/m3	43.6	60	SOP1/STRL/Ambient Air/Gravimetric Method
3	Sulphur Dioxide (as SO2)	µg/m3	9.4	80	IS:5182 (P-2) : 2006
4	Carbon Monoxide (as CO)	mg/m3	1.16	04(1hourly)	IS:5182 (P-10) : 199,RA-2003
5	Oxide of Nitrogen (as NO2)	µg/m3	7.4	80	IS:5182 (P-6) : 2006

End of Report

For Shri Om Testing & Research Laboratory

BHWAR BHARDWAJ
Technical Manager
Authorised Signatory
(Name, Designation & Signature with Seal)

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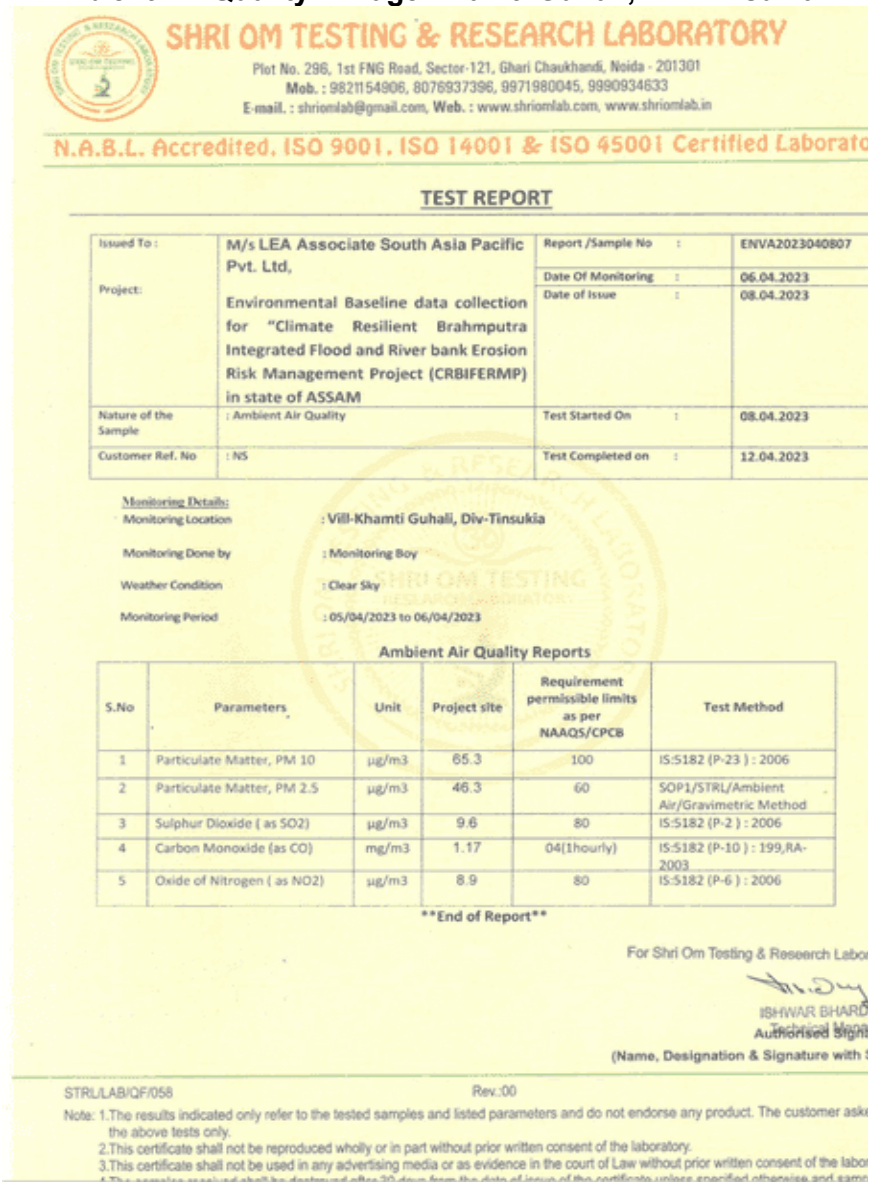
Ambient Air Quality Village Khamti Guhali, Div-Tinsukia



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TEST REPORT

Issued To :	M/s LEA Associate South Asia Pacific Pvt. Ltd,	Report /Sample No :	ENVA2023040807
		Date Of Monitoring :	06.04.2023
Project:	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP) in state of ASSAM	Date of Issue :	08.04.2023
Nature of the Sample	: Ambient Air Quality	Test Started On :	08.04.2023
Customer Ref. No	: NS	Test Completed on :	12.04.2023

Monitoring Details:
Monitoring Location : Vill-Khamti Guhali, Div-Tinsukia
Monitoring Done by : Monitoring Boy
Weather Condition : Clear Sky
Monitoring Period : 05/04/2023 to 06/04/2023

Ambient Air Quality Reports

S.No	Parameters	Unit	Project site	Requirement permissible limits as per NAAQS/CPCB	Test Method
1	Particulate Matter, PM 10	µg/m3	65.3	100	IS:5182 (P-23) : 2006
2	Particulate Matter, PM 2.5	µg/m3	46.3	60	SOP1/STRL/Ambient Air/Gravimetric Method
3	Sulphur Dioxide (as SO2)	µg/m3	9.6	80	IS:5182 (P-2) : 2006
4	Carbon Monoxide (as CO)	mg/m3	1.17	04(1hourly)	IS:5182 (P-10) : 199,RA-2003
5	Oxide of Nitrogen (as NO2)	µg/m3	8.9	80	IS:5182 (P-6) : 2006

End of Report

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Surface Water Test Report – Dibrugarh

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TEST REPORT

Issued To: LEA Associates South Asia Pecific Pvt. Ltd.,

Report/Sample No.: ENVSW2023041003
Date of Sampling : 03.04.2023
Date of Issue in lab : 10.04.2023

Project Name: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM

Nature of Sample : Surface Water
Customer Ref: No.: NS

Test Started : 10.04.2023
Test Completed : 17.04.2023

SAMPLING DETAILS:

Sampling Location : Vill-Maijan Bora, Saikia Gaon, Div-Dibrugarh
Sampling Done by : Lab Boy
Weather Condition : Clear Sky
Sample Packing & Marking : Plastic Bottle & Glass Bottle, PD/SW-11
Sampling Protocol : IS: 3025(P-1)-1987, Reef: 2003& IS: 1622-1981 (Reaff.2003)
Sample Quantity : 5 Lt+500 ml

Test Report

S. No.	Parameters	Unit	IS: 2296 -1992(Class C) Tolerance Limit	Results	Test method
1	pH	-	6.5 -8.5	7.05	IS: 3025(Pt-11)1983, RA. 2002
2	Temperature	° C	-	27.5	APHA 23rd Edn.2017-2550 B
3	DO	mg/l	Minimum -4	7.90	IS 3025(Part-38): 2006.
4	BOD	mg/l	30	3.60	IS 3025(Part-44):1993, RA 2009
5	Color	Hazen	300	5	IS: 3025 (Pt-4) 1983, RA 2017
6	Odour	-	-	Agreeable	IS: 3025(Pt-5)
7	TDS	mg/l	1500	312.2	IS 3025(Part-16): 1984, RA 2006
8	TSS	mg/l	-	24.0	IS 3025(Part-17)
9	TKN	mg/l		2.6	IS: 3025(Pt-34)1988, RA. 2003
10	Ammonical Nitrogen	mg/l		0.36	IS: 3025(Pt-34)1988, RA. 2003
11	Nitrate (as NO3)	mg/l	50	2.2	IS: 3025(Pt-34)1988, RA. 2003
12	Free Ammonia	mg/l		<0.1	IS: 3025(Pt-34)1988, RA. 2003
13	Chlorides (as Cl)	mg/l	600	14.7	IS 3025(Part-32): 1988
14	Sulphates (as SO4)	mg/l	400	15.1	IS 3025(Part-24):1986, RA 2003
15	Fluoride (as F)	mg/l	1.5	0.39	APHA 21st Ed., 4500(D)
16	Oil & Grease	mg/l	0.1	<0.1	IS 3025(Part-39):1991, RA 2009

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
(Name, Designation & Signature with Seal)

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TEST REPORT

Report/Sample No.: ENVSW2023041003

17	Phenolic Compound (as C6H5OH)	mg/l	0.005	<0.001	5530-B, C&E,APHA 23rd 2017
18.	Arsenic	mg/l	0.2	<0.1	3110- B, APHA 23nd Ed. 2017 (AAS)
19	Mercury (as Hg)	mg/l	-	<0.001	3110- B, APHA 23nd Ed.2017
20	Lead (as Pb)	mg/l	0.1	0.03	3110- B, APHA 23nd Ed. 2017 (AAS)
21	Cadmium (as Cd)	mg/l	0.01	0.004	3110- B, APHA 23nd Ed. 2017 (AAS)
22.	Chromium (as Cr+6)	mg/l	0.05	0.02	IS 3025(Part-52): 200
23.	Copper (as Cu)	mg/l	1.5	0.51	3110- B, APHA 23nd Ed. 2017 (AAS)
24.	Zinc (as Zn)	mg/l	15	0.42	3110- B, APHA 23nd Ed. 2017 (AAS)
25	Selenium (as Se)	mg/l	-	<0.1	IS: 3025 (P- 56)
26.	Anionic detergents (as MBAS)	mg/l	1.0	<0.1	Annexure K Of IS 13428
27.	Iron (as Fe)	mg/L	50	0.76	3500-Fe- B, APHA 23nd Ed. 2017
28.	Sulphide(as H_2S)	mg/l	-	0.54	IS-3025 (P-29)
29.	Phosphate (as PO4)	mg/l	-	7.60	APHA 22nd Edn.2012-4500-P C
30.	Cyanide (as CN)	mg/l	0.05	<0.1	4500-CN-B,C & E, APHA 23nd Ed.2017
31.	Manganese (as Mn)	mg/l	-	0.05	3110- B, APHA 23nd Ed.2017
32.	COD	mg/l	-	18.2	IS 3025(Part-58): 2006

Microbiological Parameters

33.	Total Coli form	MPN/100ml	5000	840	IS : 1622-1981

End of Report

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
(Name, Designation & Signature with Seal)

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TEST REPORT

Issued To: LEA Associates South Asia Pecific Pvt. Ltd.,

Report/Sample No.: ENVSW2023041004
Date of Sampling : 04.04.2023
Date of Issue in lab : 10.04.2023

Project Name: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM

Nature of Sample : Surface Water
Customer Ref: No.: NS

Test Started : 10.04.2023
Test Completed : 17.04.2023

SAMPLING DETAILS:

Sampling Location : Vill-Mothilla 1st part, Div-Dibrugarh
Sampling Done by : Lab Boy
Weather Condition : Clear Sky
Sample Packing & Marking : Plastic Bottle & Glass Bottle, PD/SW-12
Sampling Protocol : IS: 3025(P-1)-1987, Reef: 2003& IS: 1622-1981 (Reaff.2003)
Sample Quantity : 5 L+500 ml

Test Report

S. No.	Parameters	Unit	IS: 2296 -1992(Class C) Tolerance Limit	Results	Test method
1	pH	-	6.5-8.5	7.30	IS: 3025(Pt-11)1983, RA. 2002
2	Temperature	° C	-	27.8	APHA 23rd Edn.2017-2550 B
3	DO	mg/l	Minimum -4	8.10	IS 3025(Part-38): 2006.
4	BOD	mg/l	30	2.80	IS 3025(Part-44):1993, RA 2009
5	Color	Hazen	300	5	IS: 3025 (Pt-4) 1983, RA 2017
6	Odour	-	-	Agreeable	IS: 3025(Pt-5)
7	TDS	mg/l	1500	284.8	IS 3025(Part-16): 1984, RA 2006
8	TSS	mg/l	-	16.0	IS 3025(Part-17)
9	TKN	mg/l		3.2	IS: 3025(Pt-34)1988, RA. 2003
10	Ammonical Nitrogen	mg/l		0.43	IS: 3025(Pt-34)1988, RA. 2003
11	Nitrate (as NO3)	mg/l	50	2.8	IS: 3025(Pt-34)1988, RA. 2003
12	Free Ammonia	mg/l		<0.1	IS: 3025(Pt-34)1988, RA. 2003
13	Chlorides (as Cl)	mg/l	600	16.3	IS 3025(Part-32): 1988
14	Sulphates (as SO4)	mg/l	400	16.4	IS 3025(Part-24):1986, RA 2003
15	Fluoride (as F)	mg/l	1.5	0.47	APHA 21st Ed., 4500F(D)
16	Oil & Grease	mg/l	0.1	<0.1	IS 3025(Part-39):1991, RA 2009

For Shri Om Testing & Research Laboratory

ISHWAR DHARDWAJ
Technical Manager
Authorised Signatory
(Name, Designation & Signature with Seal)

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TEST REPORT

Report/Sample No.: ENVSW2023041004

17	Phenolic Compound (as C6H5OH)	mg/l	0.005	<0.001	5530-B, C&E,APHA 23nd 2017
18.	Arsenic	mg/l	0.2	<0.1	3110- B, APHA 23nd Ed. 2017 (AAS)
19	Mercury (as Hg)	mg/l	-	<0.001	3110- B, APHA 23nd Ed.2017
20	Lead (as Pb)	mg/l	0.1	0.05	3110- B, APHA 23nd Ed. 2017 (AAS)
21	Cadmium (as Cd)	mg/l	0.01	0.006	3110- B, APHA 23nd Ed. 2017 (AAS)
22.	Chromium (as Cr+6)	mg/l	0.05	0.03	IS 3025(Part-52): 200
23.	Copper (as Cu)	mg/l	1.5	0.61	3110- B, APHA 23nd Ed. 2017 (AAS)
24.	Zinc (as Zn)	mg/l	15	0.52	3110- B, APHA 23nd Ed. 2017 (AAS)
25	Selenium (as Se)	mg/l	-	<0.1	IS: 3025 (P- 56)
26.	Anionic detergents (as MBAS)	mg/l	1.0	<0.1	Annexure K Of IS 13428
27.	Iron (as Fe)	mg/l	50	0.64	3500-Fe- B, APHA 23nd Ed. 2017
28.	Sulphide(as H_2S)	mg/l	-	0.43	IS-3025 (P-29)
29.	Phosphate (as PO4)	mg/l	-	6.80	APHA 22nd Edn.2012-4500-P C
30.	Cyanide (as CN)	mg/l	0.05	<0.1	4500-CN-B,C & E, APHA 23nd Ed.2017
31.	Manganese (as Mn)	mg/l		0.04	3110- B, APHA 23nd Ed.2017
32.	COD	mg/l	-	17.6	IS 3025(Part-58): 2006

Microbiological Parameters

33.	Total Coli form	MPN/100ml	5000	840	IS : 1622-1981

End of Report

For Shri Om Testing & Research Laboratory

ISHWAR DHARDWAJ
Technical Manager
Authorised Signatory
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SHRI OM TESTING & RESEARCH LABORATORY

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E-mail. : shriomlab@gmail.com, Web. : www.shriomlab.com, www.shriomlab.in

N.A.B.L. Accredited, ISO 9001, ISO 14001 & ISO 45001 Certified Laboratory.

TEST REPORT

Issued To: LEA Associates South Asia Pecific Pvt. Ltd.,

Report/Sample No.: ENVSW2023041005
Date of Sampling : 05.04.2023
Date of Issue in lab : 10.04.2023

Project Name: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM

Nature of Sample : Surface Water
Customer Ref: No.: NS

Test Started : 10.04.2023
Test Completed : 17.04.2023

SAMPLING DETAILS:

Sampling Location : Vill-1 No. Gohaingaon, Div-Tinsukia
Sampling Done by : Lab Boy
Weather Condition : Clear Sky
Sample Packing & Marking : Plastic Bottle & Glass Bottle, PD/SW-13
Sampling Protocol : IS: 3025(P-1)-1987, Reef: 2003& IS: 1622-1981 (Reaff.2003)
Sample Quantity : 5 L+500 ml

Test Report

S. No.	Parameters	Unit	IS: 2296 -1992(Class C) Tolerance Limit	Results	Test method
1	pH	-	6.5 -8.5	7.20	IS: 3025(Pt-11)1983, RA. 2002
2	Temperature	° C	-	27.4	APHA 23rd Edn.2017-2550 B
3	D.O	mg/l	Minimum -4	8.20	IS 3025(Part-38): 2006.
4	BOD	mg/l	30	3.10	IS 3025(Part-44):1993, RA 2009
5	Color	Hazen	300	5	IS: 3025 (Pt-4) 1983, RA 2017
6	Odour	- -	-	Agreeable	IS: 3025(Pt-5)
7	TDS	mg/l	1500	324.6	IS 3025(Part-16): 1984, RA 2006
8	TSS	mg/l	-	22.0	IS 3025(Part-17)
9	TKN	mg/l		3.4	IS: 3025(Pt-34)1988, RA. 2003
10	Ammonical Nitrogen	mg/l		0.41	IS: 3025(Pt-34)1988, RA. 2003
11	Nitrate (as NO3)	mg/l	50	2.3	IS: 3025(Pt-34)1988, RA. 2003
12	Free Ammonia	mg/l		<0.1	IS: 3025(Pt-34)1988, RA. 2003
13	Chlorides (as Cl)	mg/l	600	18.1	IS 3025(Part-32): 1988
14	Sulphates (as SO4)	mg/l	400	13.5	IS 3025(Part-24):1986, RA 2003
15	Fluoride (as F)	mg/l	1.5	0.41	APHA 21st Ed., 4500F(D)
16	Oil & Grease	mg/l	0.1	<0.1	IS 3025(Part-39):1991, RA 2009
17	Phenolic Compound (as C6H5OH)	mg/l	0.005	<0.001	5530-B, C&E,APHA 23nd 2017

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager

Authorised Signatory
(Name, Designation & Signature with Seal)

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TEST REPORT

Report/Sample No.: ENVSW2023041005

18.	Arsenic	mg/l	0.2	<0.1	3110- B, APHA 23rd Ed. 2017 (AAS)
19	Mercury (as Hg)	mg/l	-	<0.001	3110- B, APHA 23nd Ed.2017
20	Lead (as Pb)	mg/l	0.1	0.03	3110- B, APHA 23nd Ed. 2017 (AAS)
21	Cadmium (as Cd)	mg/l	0.01	0.004	3110- B, APHA 23nd Ed. 2017 (AAS)
22.	Chromium (as Cr+6)	mg/l	0.05	0.02	IS 3025(Part-52): 200
23.	Copper (as Cu)	mg/l	1.5	0.41	3110- B, APHA 23nd Ed. 2017 (AAS)
24.	Zinc (as Zn)	mg/l	15	0.63	3110- B, APHA 23nd Ed. 2017 (AAS)
25	Selenium (as Se)	mg/l	-	<0.1	IS: 3025 (P- 56)
26.	Anionic detergents (as MBAS)	mg/l	1.0	<0.1	Annexure K OF IS 13428
27.	Iron (as Fe)	mg/l	50	0.71	3500-Fe- B, APHA 23nd Ed. 2017
28.	Sulphide(as H_2S)	mg/l		0.57	IS-3025 (P-29)
29.	Phosphate (as PO4)	mg/l	-	0.20	APHA 22nd Edn.2012-4500-P C
30.	Cyanide (as CN)	mg/l	0.05	<0.1	4500-CN-B,C & E, APHA 23nd Ed.2017
31.	Manganese (as Mn)	mg/l		0.03	3110- B, APHA 23nd Ed.2017
32.	COD	mg/l	-	21.3	IS 3025(Part-58): 2006
	Microbiological Parameters				
33.	Total Coli form	MPN/100ml	5000	460	IS : 1622-1981

End of Report

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager

Authorised Signatory
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TEST REPORT

Issued To: LEA Associates South Asia Pvt. Ltd.,

Report/Sample No.: ENVSW2023041006
Date of Sampling : 06.04.2023
Date of Issue in lab : 10.04.2023

Project Name: Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM

Nature of Sample : Surface Water
Customer Ref: No.: NS

Test Started : 10.04.2023
Test Completed : 17.04.2023

SAMPLING DETAILS:

Sampling Location : Vill-Khamti Gwali (Koilapothar Gaon), Div-Tinsukia
Sampling Done by : Lab Boy
Weather Condition : Clear Sky
Sample Packing & Marking : Plastic Bottle & Glass Bottle, PD/SW-14
Sampling Protocol : IS: 3025(P-1)-1987, Reaff: 2003& IS: 1622-1981 (Reaff.2003)
Sample Quantity : 5 L+500 ml

Test Report

S. No.	Parameters	Unit	IS: 2296 -1992(Class C) Tolerance Limit	Results	Test method
1	pH	-	6.5 -8.5	7.35	IS: 3025(Pt-11)1983, RA. 2002
2	Temperature	° C	-	27.8	APHA 23rd Edn.2017-2550 B
3	D.O	mg/l	Minimum -4	8.10	IS 3025(Part-38): 2006.
4	BOD	mg/l	30	2.80	IS 3025(Part-44):1993, RA 2009
5	Color	Hazen	300	5	IS: 3025 (Pt-4) 1983, RA 2017
6	Odour	-	-	Agreeable	IS: 3025(Pt-5)
7	TDS	mg/l	1500	336.2	IS 3025(Part-16): 1984, RA 2006
8	TSS	mg/l	-	26.0	IS 3025(Part-17)
9	TKN	mg/l		3.7	IS: 3025(Pt-34)1988, RA. 2003
10	Ammonical Nitrogen	mg/l		0.53	IS: 3025(Pt-34)1988, RA. 2003
11	Nitrate (as NO3)	mg/l	50	2.6	IS: 3025(Pt-34)1988, RA. 2003
12	Free Ammonia	mg/l		<0.1	IS: 3025(Pt-34)1988, RA. 2003
13	Chlorides (as Cl)	mg/l	600	14.6	IS 3025(Part-32): 1988
14	Sulphates (as SO4)	mg/l	400	11.3	IS 3025(Part-24):1986, RA 2003
15	Fluoride (as F)	mg/l	1.5	0.38	APHA 21st Ed., 4500F(D)
16	Oil & Grease	mg/l	0.1	<0.1	IS 3025(Part-39):1991, RA 2009

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory

(Name, Designation & Signature with Seal)

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TEST REPORT

Report/Sample No.: ENVSW2023041006

17	Phenolic Compound (as C6H5OH)	mg/l	0.005	<0.001	SS30-B, C&E,APHA 23nd 2017
18.	Arsenic	mg/l	0.2	<0.1	3110- B, APHA 23nd Ed. 2017 (AAS)
19	Mercury (as Hg)	mg/l	-	<0.001	3110- B, APHA 23nd Ed.2017
20	Lead (as Pb)	mg/l	0.1	0.02	3110- B, APHA 23nd Ed. 2017 (AAS)
21	Cadmium (as Cd)	mg/l	0.01	0.006	3110- B, APHA 23nd Ed. 2017 (AAS)
22.	Chromium (as Cr+6)	mg/l	0.05	0.03	IS 3025(Part-52): 200
23.	Copper (as Cu)	mg/l	1.5	0.68	3110- B, APHA 23nd Ed. 2017 (AAS)
24.	Zinc (as Zn)	mg/l	15	0.51	3110- B, APHA 23nd Ed. 2017 (AAS)
25	Selenium (as Se)	mg/l	-	<0.1	IS: 3025 (P- 56)
26.	Anionic detergents (as MBAS)	mg/l	1.0	<0.1	Annexure K Of IS 13428
27.	Iron (as Fe)	mg/l	50	0.42	3500-Fe- B, APHA 23nd Ed. 2017
28.	Sulphide(as H_2S)	mg/l	-	0.46	IS-3025 (P-29)
29.	Phosphate (as PO4)	mg/l	-	7.80	APHA 22nd Edn.2012-4500-P C
30.	Cyanide (as CN)	mg/l	0.05	<0.1	4500-CN-B,C & E, APHA 23nd Ed.2017
31.	Manganese (as Mn)	mg/l	-	0.05	3110- B, APHA 23nd Ed.2017
32.	COD	mg/l	-	17.2	IS 3025(Part-58): 2006
	Microbiological Parameters				
33.	Total Coli form	MPN/100ml	5000	780	IS : 1622-1981

End of Report

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory

(Name, Designation & Signature with Seal)

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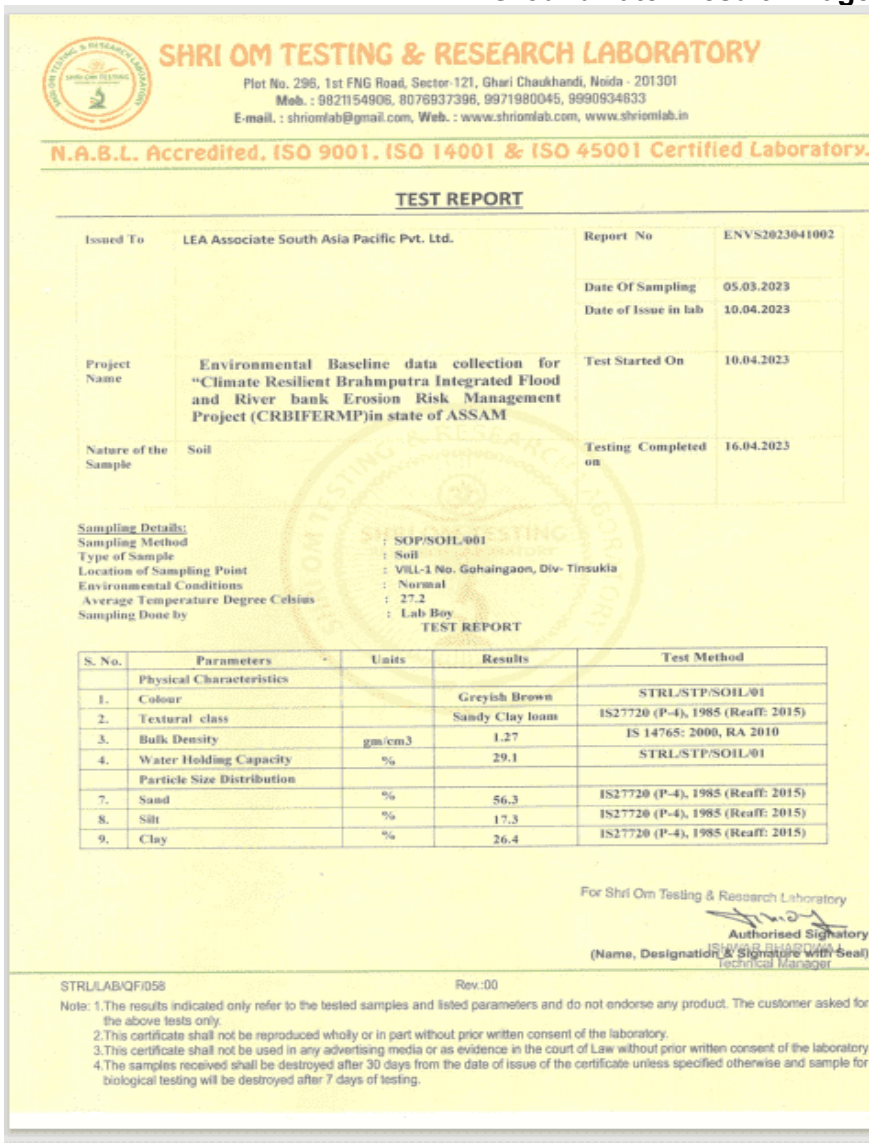
Groundwater Result Village 1 No Gohaingaon Tinsukia



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TEST REPORT

Issued To	LEA Associate South Asia Pacific Pvt. Ltd.	Report No	ENVS2023041002
		Date Of Sampling	05.03.2023
		Date of Issue in lab	10.04.2023
Project Name	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM	Test Started On	10.04.2023
Nature of the Sample	Soil	Testing Completed on	16.04.2023

Sampling Details:
Sampling Method : SOP/SOIL/001
Type of Sample : Soil
Location of Sampling Point : VILL-1 No. Gohaingaon, Div- Tinsukia
Environmental Conditions : Normal
Average Temperature Degree Celsius : 27.2
Sampling Done by : Lab Boy

TEST REPORT

S. No.	Parameters	Units	Results	Test Method
	Physical Characteristics			
1.	Colour		Greyish Brown	STRL/STP/SOIL/01
2.	Textural class		Sandy Clay loam	IS27720 (P-4), 1985 (Reaff: 2015)
3.	Bulk Density	gm/cm3	1.27	IS 14765: 2000, RA 2010
4.	Water Holding Capacity	%	29.1	STRL/STP/SOIL/01
	Particle Size Distribution			
7.	Sand	%	56.3	IS27720 (P-4), 1985 (Reaff: 2015)
8.	Silt	%	17.3	IS27720 (P-4), 1985 (Reaff: 2015)
9.	Clay	%	26.4	IS27720 (P-4), 1985 (Reaff: 2015)

For Shri Om Testing & Research Laboratory
Authorised Signatory
(Name, Designation & Signature with Seal)
ISHWAR BHARDWAJ
Technical Manager

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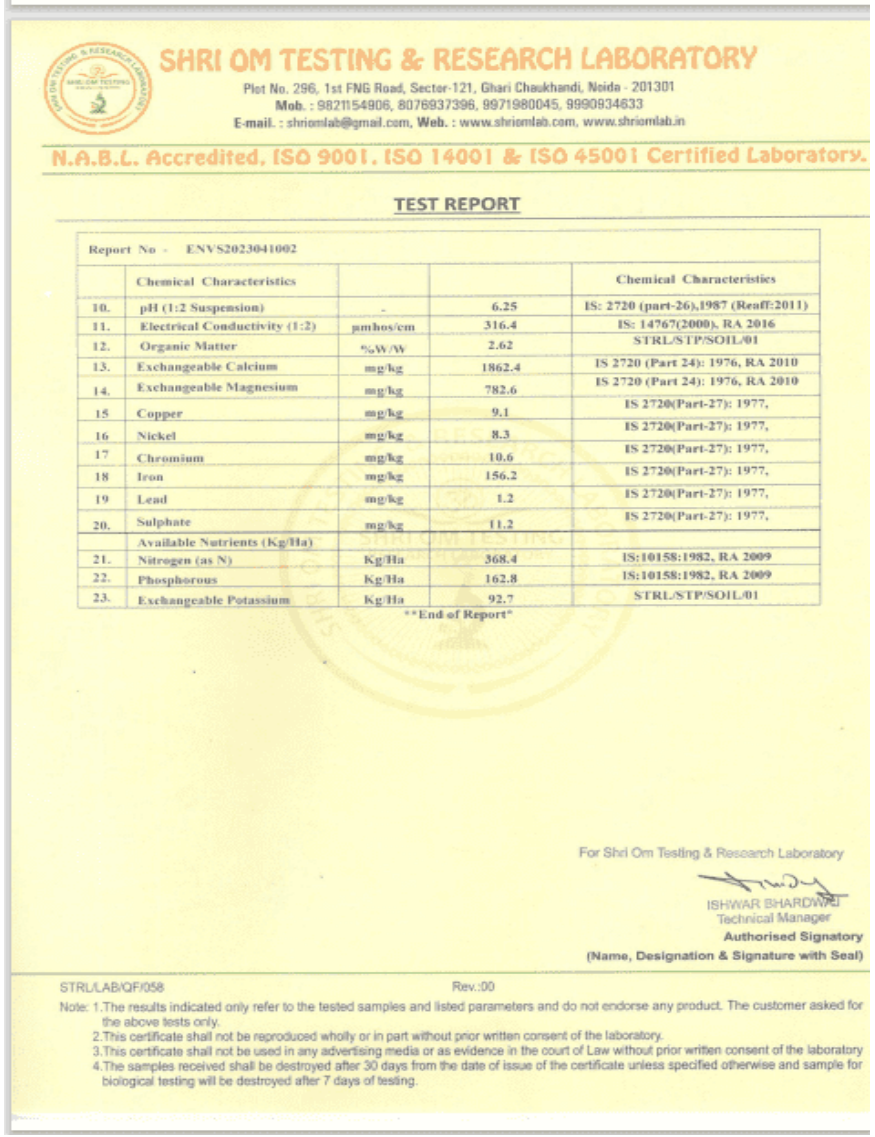

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TEST REPORT

Report No - ENVS2023041002

	Chemical Characteristics			Chemical Characteristics
10.	pH (1:2 Suspension)	-	6.25	IS: 2720 (part-26),1987 (Reaff:2011)
11.	Electrical Conductivity (1:2)	µmhos/cm	316.4	IS: 14767(2000), RA 2016
12.	Organic Matter	%W/W	2.62	STRL/STP/SOIL/01
13.	Exchangeable Calcium	mg/kg	1862.4	IS 2720 (Part 24): 1976, RA 2010
14.	Exchangeable Magnesium	mg/kg	782.6	IS 2720 (Part 24): 1976, RA 2010
15	Copper	mg/kg	9.1	IS 2720(Part-27): 1977,
16	Nickel	mg/kg	8.3	IS 2720(Part-27): 1977,
17	Chromium	mg/kg	10.6	IS 2720(Part-27): 1977,
18	Iron	mg/kg	156.2	IS 2720(Part-27): 1977,
19	Lead	mg/kg	1.2	IS 2720(Part-27): 1977,
20.	Sulphate	mg/kg	11.2	IS 2720(Part-27): 1977,
	Available Nutrients (Kg/Ha)			
21.	Nitrogen (as N)	Kg/Ha	368.4	IS:10158:1982, RA 2009
22.	Phosphorous	Kg/Ha	162.8	IS:10158:1982, RA 2009
23.	Exchangeable Potassium	Kg/Ha	92.7	STRL/STP/SOIL/01

End of Report

For Shri Om Testing & Research Laboratory
ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
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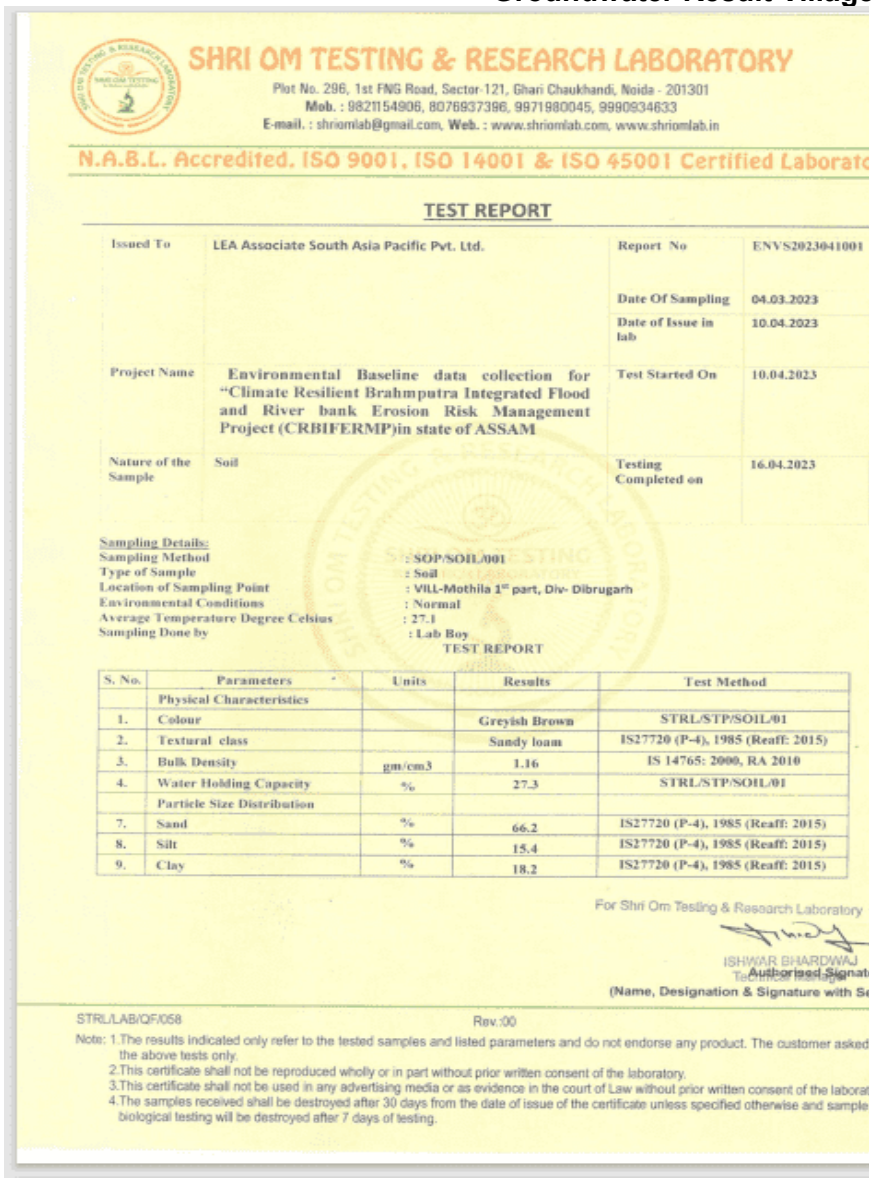
Groundwater Result Village Mothila 1st part, Dibrugarh



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TEST REPORT

Issued To	LEA Associate South Asia Pacific Pvt. Ltd.	Report No	ENVS2023041001
		Date Of Sampling	04.03.2023
		Date of Issue in lab	10.04.2023
Project Name	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM	Test Started On	10.04.2023
Nature of the Sample	Soil	Testing Completed on	16.04.2023

Sampling Details:
Sampling Method : SOP/SOIL/001
Type of Sample : Soil
Location of Sampling Point : VILL-Mothila 1st part, Div- Dibrugarh
Environmental Conditions : Normal
Average Temperature Degree Celsius : 27.1
Sampling Done by : Lab Boy

TEST REPORT

S. No.	Parameters	Units	Results	Test Method
	Physical Characteristics			
1.	Colour		Greyish Brown	STRL/STP/SOIL/01
2.	Textural class		Sandy loam	IS27720 (P-4), 1985 (Reaff: 2015)
3.	Bulk Density	gm/cm3	1.16	IS 14765: 2000, RA 2010
4.	Water Holding Capacity	%	27.3	STRL/STP/SOIL/01
	Particle Size Distribution			
7.	Sand	%	66.2	IS27720 (P-4), 1985 (Reaff: 2015)
8.	Silt	%	15.4	IS27720 (P-4), 1985 (Reaff: 2015)
9.	Clay	%	18.2	IS27720 (P-4), 1985 (Reaff: 2015)

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
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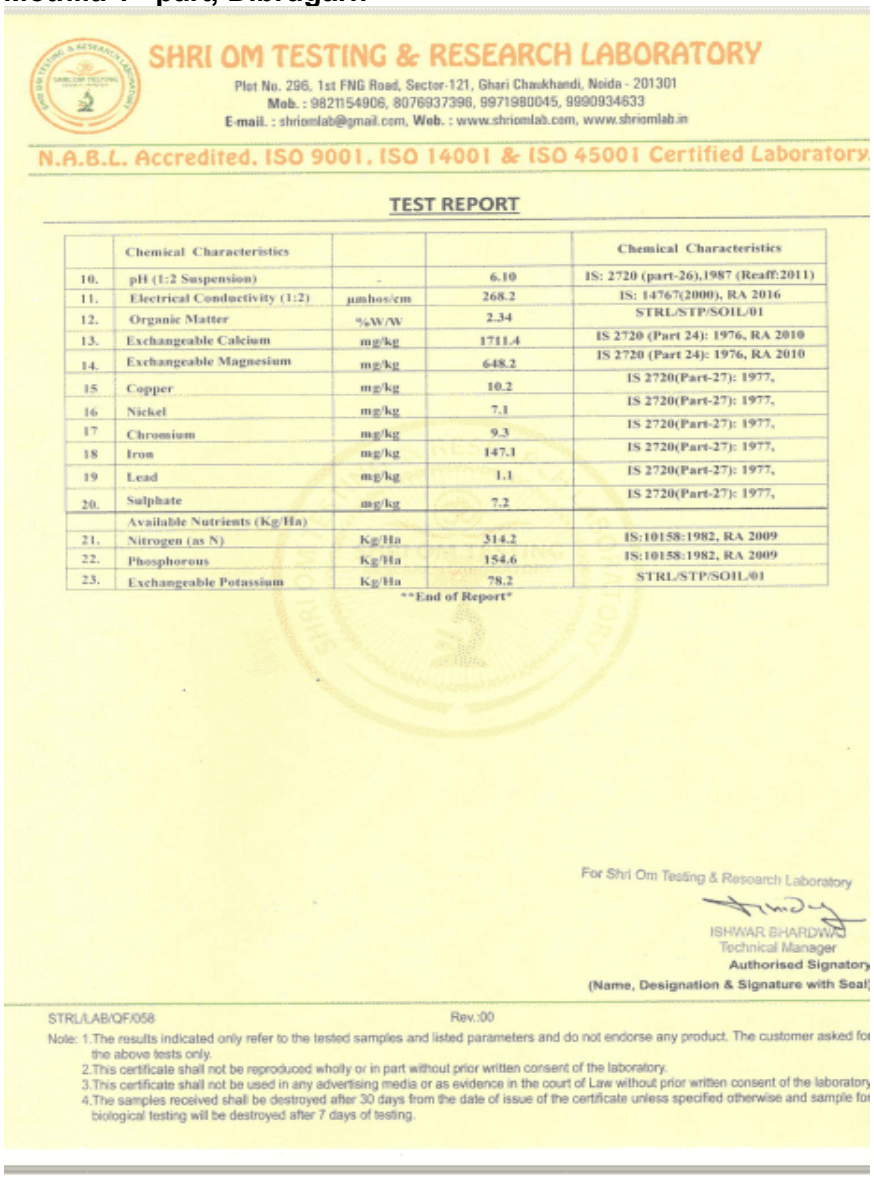

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TEST REPORT

	Chemical Characteristics			Chemical Characteristics
10.	pH (1:2 Suspension)	-	6.10	IS: 2720 (part-26),1987 (Reaff:2011)
11.	Electrical Conductivity (1:2)	µmhos/cm	268.2	IS: 14767(2000), RA 2016
12.	Organic Matter	%W/W	2.34	STRL/STP/SOIL/01
13.	Exchangeable Calcium	mg/kg	1711.4	IS 2720 (Part 24): 1976, RA 2010
14.	Exchangeable Magnesium	mg/kg	648.2	IS 2720 (Part 24): 1976, RA 2010
15	Copper	mg/kg	10.2	IS 2720(Part-27): 1977,
16	Nickel	mg/kg	7.1	IS 2720(Part-27): 1977,
17	Chromium	mg/kg	9.3	IS 2720(Part-27): 1977,
18	Iron	mg/kg	147.1	IS 2720(Part-27): 1977,
19	Lead	mg/kg	1.1	IS 2720(Part-27): 1977,
20.	Sulphate	mg/kg	7.2	IS 2720(Part-27): 1977,
	Available Nutrients (Kg/Ha)			
21.	Nitrogen (as N)	Kg/Ha	314.2	IS:10158:1982, RA 2009
22.	Phosphorous	Kg/Ha	154.6	IS:10158:1982, RA 2009
23.	Exchangeable Potassium	Kg/Ha	78.2	STRL/STP/SOIL/01

**End of Report*

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
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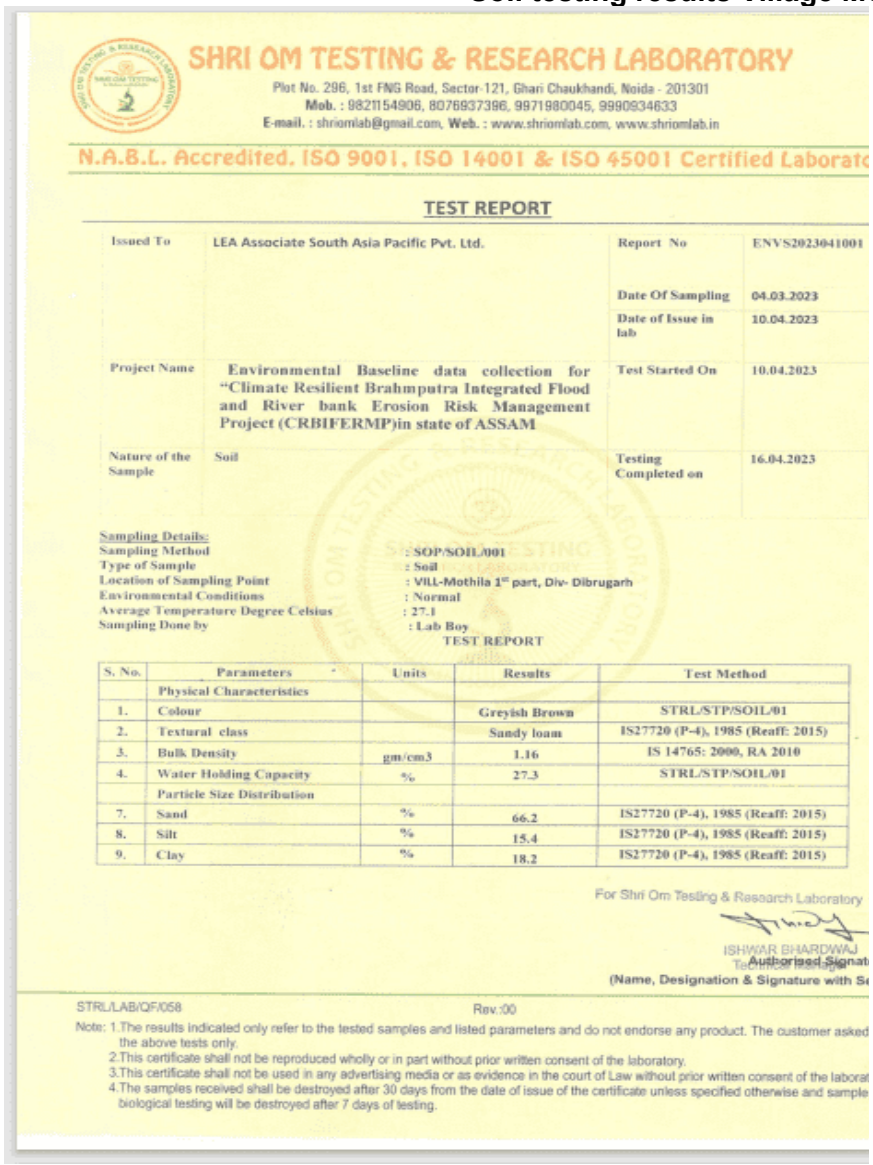
Soil testing results Village Mothila 1st part. Div Dibrugarh



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TEST REPORT

Issued To	LEA Associate South Asia Pacific Pvt. Ltd.	Report No	ENVS2023041001
		Date Of Sampling	04.03.2023
		Date of Issue in lab	10.04.2023
Project Name	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM	Test Started On	10.04.2023
Nature of the Sample	Soil	Testing Completed on	16.04.2023

Sampling Details:
Sampling Method : SOP/SOIL/001
Type of Sample : Soil
Location of Sampling Point : VILL-Mothila 1st part, Div- Dibrugarh
Environmental Conditions : Normal
Average Temperature Degree Celsius : 27.1
Sampling Done by : Lab Boy

TEST REPORT

S. No.	Parameters	Units	Results	Test Method
	Physical Characteristics			
1.	Colour		Greyish Brown	STRL/STP/SOIL/01
2.	Textural class		Sandy loam	IS27720 (P-4), 1985 (Reaff: 2015)
3.	Bulk Density	gm/cm3	1.16	IS 14765: 2000, RA 2010
4.	Water Holding Capacity	%	27.3	STRL/STP/SOIL/01
	Particle Size Distribution			
7.	Sand	%	66.2	IS27720 (P-4), 1985 (Reaff: 2015)
8.	Silt	%	15.4	IS27720 (P-4), 1985 (Reaff: 2015)
9.	Clay	%	18.2	IS27720 (P-4), 1985 (Reaff: 2015)

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signat
(Name, Designation & Signature with Se

STRL/LAB/QF/058 Rev.:00

Note: 1.The results indicated only refer to the tested samples and listed parameters and do not endorse any product. The customer asked
the above tests only.
2.This certificate shall not be reproduced wholly or in part without prior written consent of the laboratory.
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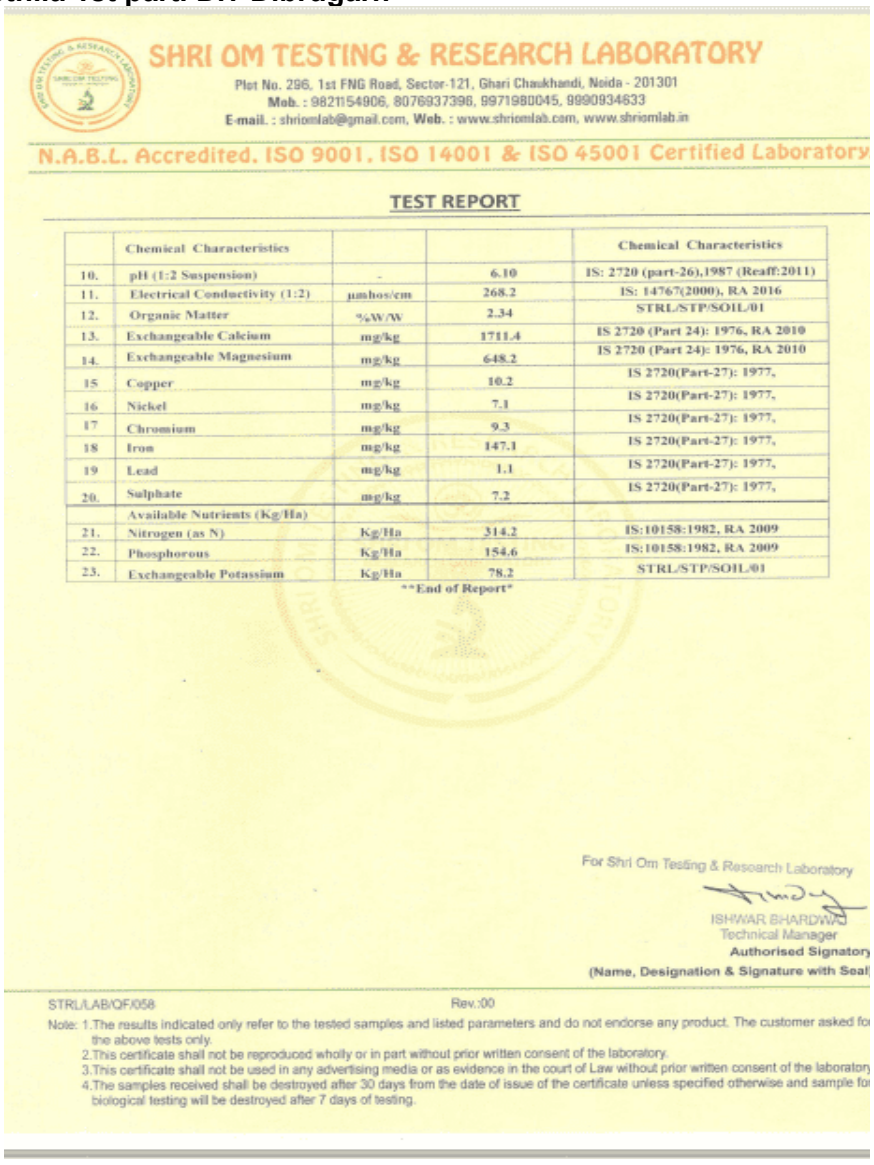
4.The samples received shall be destroyed after 30 days from the date of issue of the certificate unless specified otherwise and sample
biological testing will be destroyed after 7 days of testing.



SHRI OM TESTING & RESEARCH LABORATORY

Plot No. 296, 1st FNG Road, Sector-121, Ghari Chaukhandi, Noida - 201301
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TEST REPORT

	Chemical Characteristics			Chemical Characteristics
10.	pH (1:2 Suspension)	-	6.10	IS: 2720 (part-26),1987 (Reaff:2011)
11.	Electrical Conductivity (1:2)	µmhos/cm	268.2	IS: 14767(2000), RA 2016
12.	Organic Matter	%W/W	2.34	STRL/STP/SOIL/01
13.	Exchangeable Calcium	mg/kg	1711.4	IS 2720 (Part 24): 1976, RA 2010
14.	Exchangeable Magnesium	mg/kg	648.2	IS 2720 (Part 24): 1976, RA 2010
15	Copper	mg/kg	10.2	IS 2720(Part-27): 1977,
16	Nickel	mg/kg	7.1	IS 2720(Part-27): 1977,
17	Chromium	mg/kg	9.3	IS 2720(Part-27): 1977,
18	Iron	mg/kg	147.1	IS 2720(Part-27): 1977,
19	Lead	mg/kg	1.1	IS 2720(Part-27): 1977,
20.	Sulphate	mg/kg	7.2	IS 2720(Part-27): 1977,
	Available Nutrients (Kg/Ha)			
21.	Nitrogen (as N)	Kg/Ha	314.2	IS:10158:1982, RA 2009
22.	Phosphorous	Kg/Ha	154.6	IS:10158:1982, RA 2009
23.	Exchangeable Potassium	Kg/Ha	78.2	STRL/STP/SOIL/01

**End of Report*

For Shri Om Testing & Research Laboratory

ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
(Name, Designation & Signature with Seal

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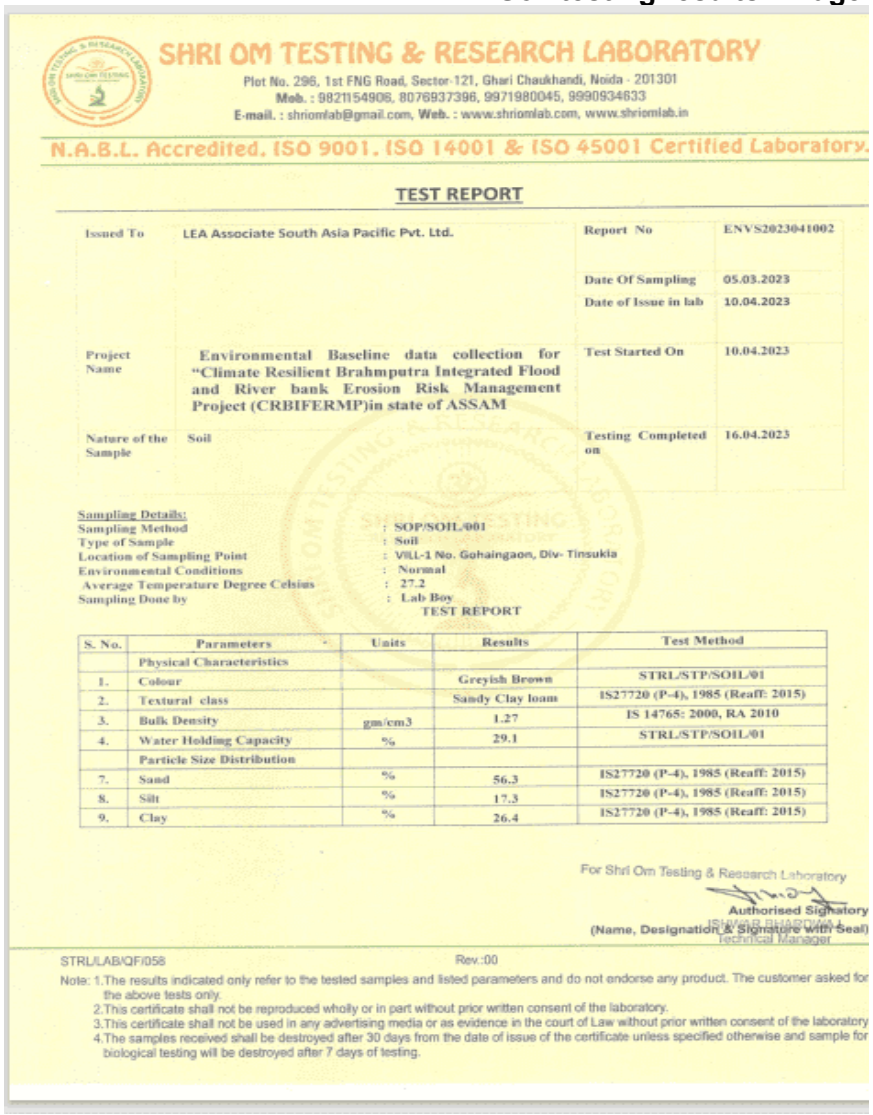
biological testing will be destroyed after 7 days of testing.

Soil testing results Village 1 No Gohaingaon Tinsukia



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TEST REPORT

Issued To	LEA Associate South Asia Pacific Pvt. Ltd.	Report No	ENVS2023041002
		Date Of Sampling	05.03.2023
		Date of Issue in lab	10.04.2023
Project Name	Environmental Baseline data collection for "Climate Resilient Brahmputra Integrated Flood and River bank Erosion Risk Management Project (CRBIFERMP)in state of ASSAM	Test Started On	10.04.2023
Nature of the Sample	Soil	Testing Completed on	16.04.2023

Sampling Details:
Sampling Method : SOP/SOIL/001
Type of Sample : Soil
Location of Sampling Point : VILL-1 No. Gohaingaon, Div- Tinsukia
Environmental Conditions : Normal
Average Temperature Degree Celsius : 27.2
Sampling Done by : Lab Boy

TEST REPORT

S. No.	Parameters	Units	Results	Test Method
	Physical Characteristics			
1.	Colour		Greyish Brown	STRL/STP/SOIL/01
2.	Textural class		Sandy Clay loam	IS27720 (P-4), 1985 (Reaff: 2015)
3.	Bulk Density	gm/cm3	1.27	IS 14765: 2000, RA 2010
4.	Water Holding Capacity	%	29.1	STRL/STP/SOIL/01
	Particle Size Distribution			
7.	Sand	%	56.3	IS27720 (P-4), 1985 (Reaff: 2015)
8.	Silt	%	17.3	IS27720 (P-4), 1985 (Reaff: 2015)
9.	Clay	%	26.4	IS27720 (P-4), 1985 (Reaff: 2015)

For Shri Om Testing & Research Laboratory
Authorised Signatory
(Name, Designation & Signature with Seal)
ISHWAR BHARDWAJ
Technical Manager

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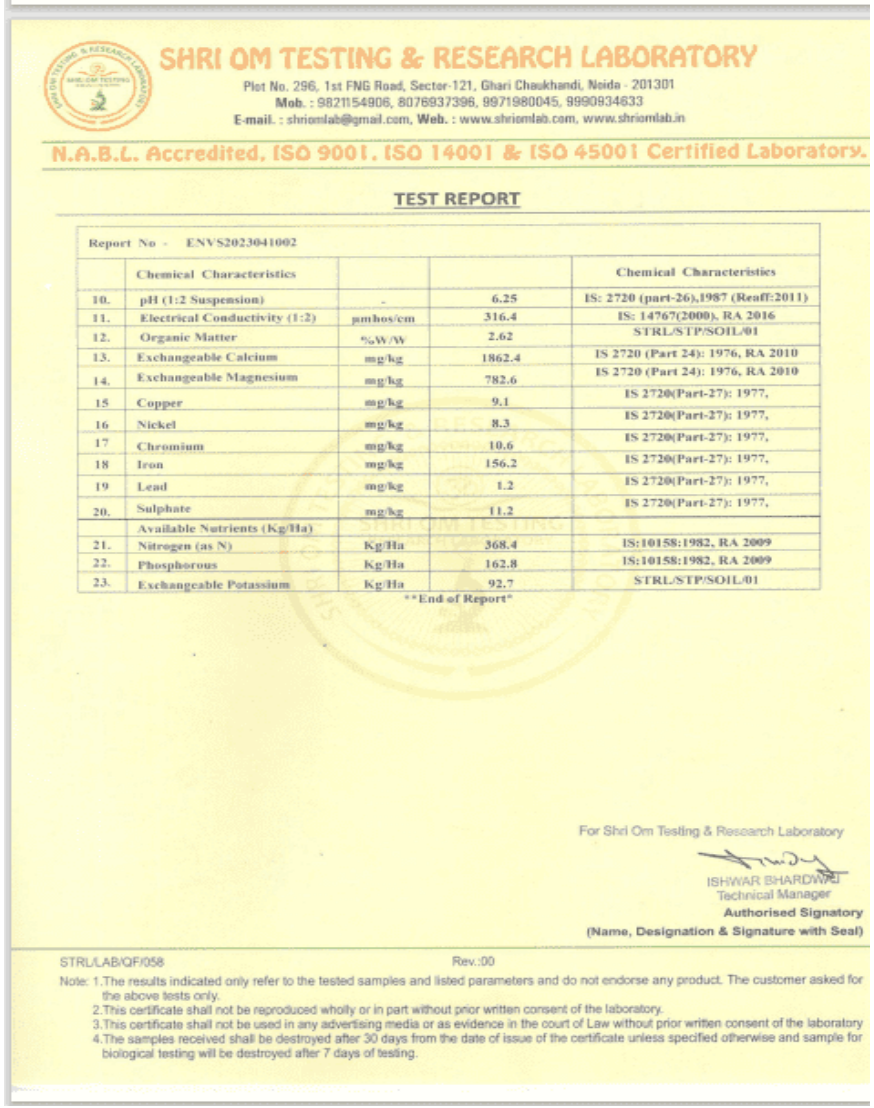

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TEST REPORT

Report No - ENVS2023041002

	Chemical Characteristics			Chemical Characteristics
10.	pH (1:2 Suspension)	-	6.25	IS: 2720 (part-26),1987 (Reaff:2011)
11.	Electrical Conductivity (1:2)	µmhos/cm	316.4	IS: 14767(2000), RA 2016
12.	Organic Matter	%W/W	2.62	STRL/STP/SOIL/01
13.	Exchangeable Calcium	mg/kg	1862.4	IS 2720 (Part 24): 1976, RA 2010
14.	Exchangeable Magnesium	mg/kg	782.6	IS 2720 (Part 24): 1976, RA 2010
15	Copper	mg/kg	9.1	IS 2720(Part-27): 1977,
16	Nickel	mg/kg	8.3	IS 2720(Part-27): 1977,
17	Chromium	mg/kg	10.6	IS 2720(Part-27): 1977,
18	Iron	mg/kg	156.2	IS 2720(Part-27): 1977,
19	Lead	mg/kg	1.2	IS 2720(Part-27): 1977,
20.	Sulphate	mg/kg	11.2	IS 2720(Part-27): 1977,
	Available Nutrients (Kg/Ha)			
21.	Nitrogen (as N)	Kg/Ha	368.4	IS:10158:1982, RA 2009
22.	Phosphorous	Kg/Ha	162.8	IS:10158:1982, RA 2009
23.	Exchangeable Potassium	Kg/Ha	92.7	STRL/STP/SOIL/01

End of Report

For Shri Om Testing & Research Laboratory
ISHWAR BHARDWAJ
Technical Manager
Authorised Signatory
(Name, Designation & Signature with Seal)

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Appendix 9: Summary of Stakeholder Consultations including Attendance Sheets

Sl. No.	Name of SubProject	Date	Place	Group Type	No of People	Female	Male	Topic of Discussion	Outcome
	Dibrugarh, Tinsukia - Subproject (Zone -A)	31St March 2023	Borasoikia Gaon, Dibrugarh	Active Women group and village representative.	19	18	1	Brief project description and proposed development Work. Safety issue Project Benefits Movement corridor of Wild Animals Presence of Dolphins Fishes caught Environmental issues due to protection work. i.e air, water, noise, etc. Source of raw material sand and borrow earth.	• Local People welcome the project after having detailed discussion on proposed development. • They requested us to expedite the work on priority. It will safeguard they village and livelihood. • No wild animals' movement has been reported. • Dolphins are reported only during flooding time, when the depth of water increase. No dolphins reported post monsoon seasons. The main Course of River is far from the Bank. • The compensation for structure low within 30 meters protection work. It was intimated to them that social teams will visit the affected village and will discuss on compensation. • Source of raw material will be Sand and will be source from Brahmaputra River. • Only JCB will be used for leveling and curve improvement off riverbank. • All will have PUC Certificate.

Sl. No.	Name of SubProject	Date	Place	Group Type	No of People	Female	Male	Topic of Discussion	Outcome
									• Only day time work • No source of pollution – • Monsoon and flood season will be avoided for proposed construction work.
		31st March 2023	Maijan Village, Dibrugarh	Consultation at Direct Affected Village	33	18	15	Brief project description and proposed development Work. Safety issue Project Benefits Movement corridor of Wild Animals Presence of Dolphins Fishes caught Environmental issues due to protection work. i.e air, water, noise, etc. Source of raw material sand and borrow earth.	• About 50% of the village resident were present during the meetings • They welcome the project and raise question why the work is getting delayed. • The are willing to give the land, but compensation against structure and land loss should be given. • Non-revenue land. No revenue record for this village exists. • It was intimated to them that there would be detailed social consultation and structure lost will be documented. • No movement corridor for terrestrial animals noted. • Dolphins are noticed only during flooding time. The main river course is far away from the Bank. Except monsoon, this portion remains day. • High bank cutting is reported during flooding time.
	Dibrugarh, Tinsukia -	03rd April	Khamti Guwali,	Local Community,	61	53	8	○ Brief introduction	○ They welcome the project. They express that the work is

Sl. No.	Name of SubProject	Date	Place	Group Type	No of People	Female	Male	Topic of Discussion	Outcome
	subproject (Zone -A)	2023	Tinsukia	Project affected people				about the Project. ○ Possible environmental Impact due to the project ○ Wild Animal Movement	necessary. They request to start the work urgently as they have lost their land and house every year because of erosion. ○ They are ready to give their land for the project with compensation from the government. ○ According to the participants there is no wild animal movement in the area. ○ The people of the village are primarily engaged in fishing, daily wage labor and small-scale business. They so not have agricultural land for cultivation.
		12th April 2023	Dighal Tarang	Local Community	13	1	12	○ Brief introduction about the Project. ○ Possible environmental Impact due to the project ○ Wild Animal Movement ○ Forest Area Nearby ○ Dolphins sighted	○ They welcome the project. They express that the work is necessary. ○ They request to start the work urgently as they have lost their land and house every year because of erosion. ○ They are ready to give their land for the project with compensation from the government. ○ According to the participants there is no wild animal movement in the area. ○ The people of the village are primarily engaged in fishing,
			Dighal Tarang	Adult Women	13	13	-		
			Kardoiguri-1	Adult Women	13	13	-		
			Kardoiguri-3	Young People, Female	10	10	-		
			Kardoigui-3	Young People, Male	13	13	13		
			Khamti Gohali	Young People, Female	12	-	-		
			Khamti Gohali	Young People, Male	13	12			

Sl. No.	Name of SubProject	Date	Place	Group Type	No of People	Female	Male	Topic of Discussion	Outcome
									daily wage labor and small-scale business. They so not have agricultural land for cultivation. o Movement of elephants has been reported in past near Milanpur to Hatighuli Section. o Wildlife Sanctuary is nearby. o Dolphins are noticed during monsoon season Gariating gaon and Dinjan Area.

PUBLIC CONSULTATION PHOTOGRAPHS

Photo: Public Consultation with Female help group at Borasoikia Gaon, Dibrugarh

Photo: Public Consultation at Maijan Dibrugarh – Direct Affect Project Area

Photo: Public Consultation at Khamti Gwali, Tinsukia

Village Dighaltarang (Local Community)

Village Dighal Tarang (Adult Women)

Village Kardoiguri -3 (Young People, Female)

Village Kardoiguri -3 (Young People- Male)

Village Khamti Gohali (Young People- Female)

Village Khamti Gohali (Young People, Male)

INSTITUTIONAL CONSULTATION PHOTOGRAPHS

Consultation with Mr. Biren Baishya, GIS Expert, Assam State Disaster Management Authority.

Consultation with Dr. Kuladip Sarma (assistant professor) Depertment of Zoology, Gauhati University.

Consultation with Dr. Niraj Agarwala (Assistant Professor) Department of Botany Gauhati University

Consultation with Sri Sandeep Kumar, IFS (Principal Chief Conservator of Forest (Biodiversity), Assam)

Consultation with Division Forest Officer (IFS) Doomdooma Tinsukia

Consultation with ACF Dibrugarh

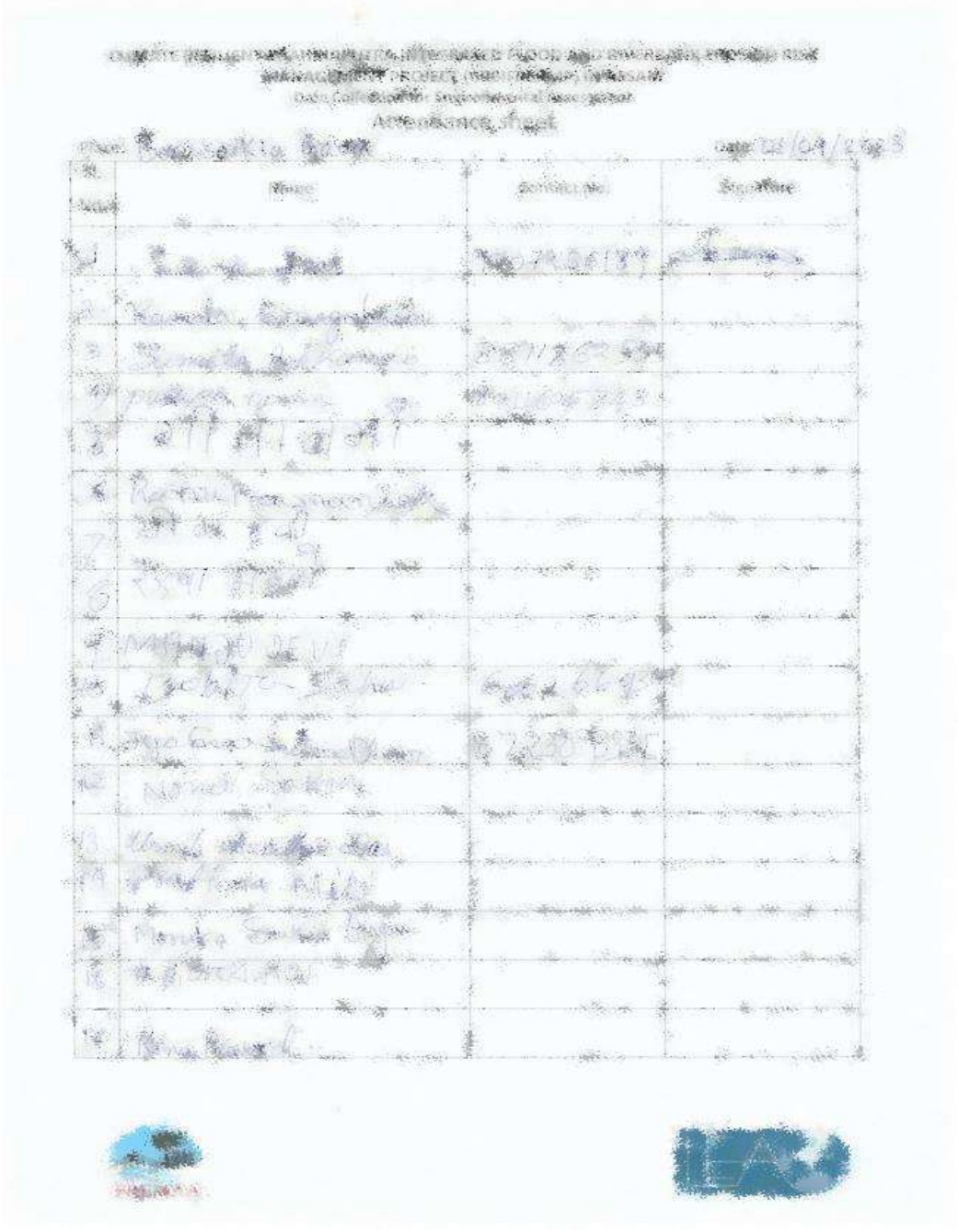
M. D Adhikary, Sr. Env. Scientist, Head Water Section, Pollution Control Board Assam.

Shri Ajim Ahmed, Pest Surveillance Officer, Department Of Agriculture and Horticulture, Directorate Of Agriculture, Government Of Assam

Shri Apurba Kumar Das, Joint Director of Fisheries, FFDA, Directorate of Fisheries,

ATTENDANCE SHEETS OF PUBLIC CONSULTATION
DIBRUGARH SUBPROJECT (ZONE-A)
(photographs' resolution are reduced to hide perosnnal details of participants)

Place: Borasoikia Gaon, Dibrugarh District **Date: 01-04-2023**



Attendance Sheet

Sl. No.	Name	Barangay No.	Signature
1			
2			
3			
4			
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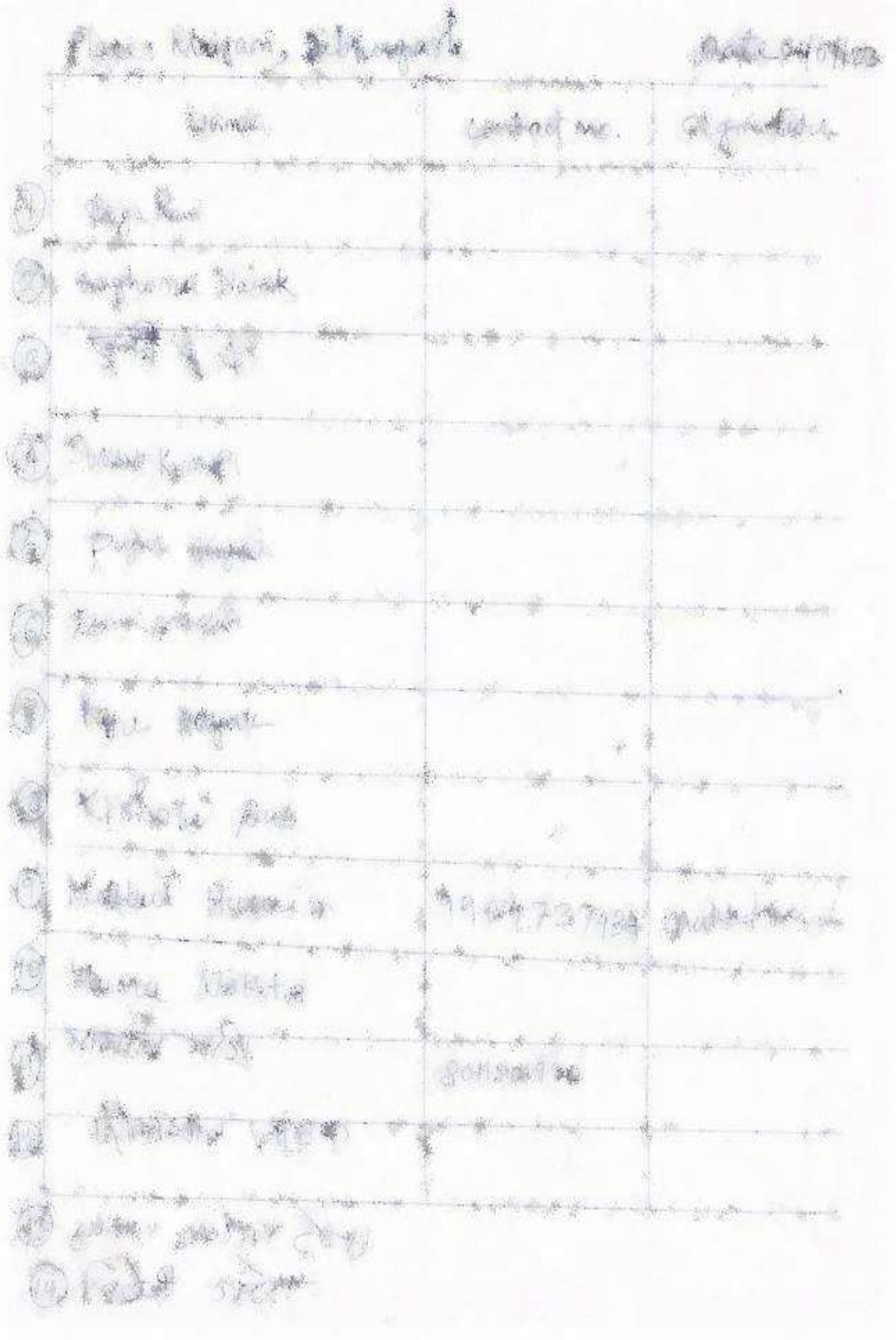
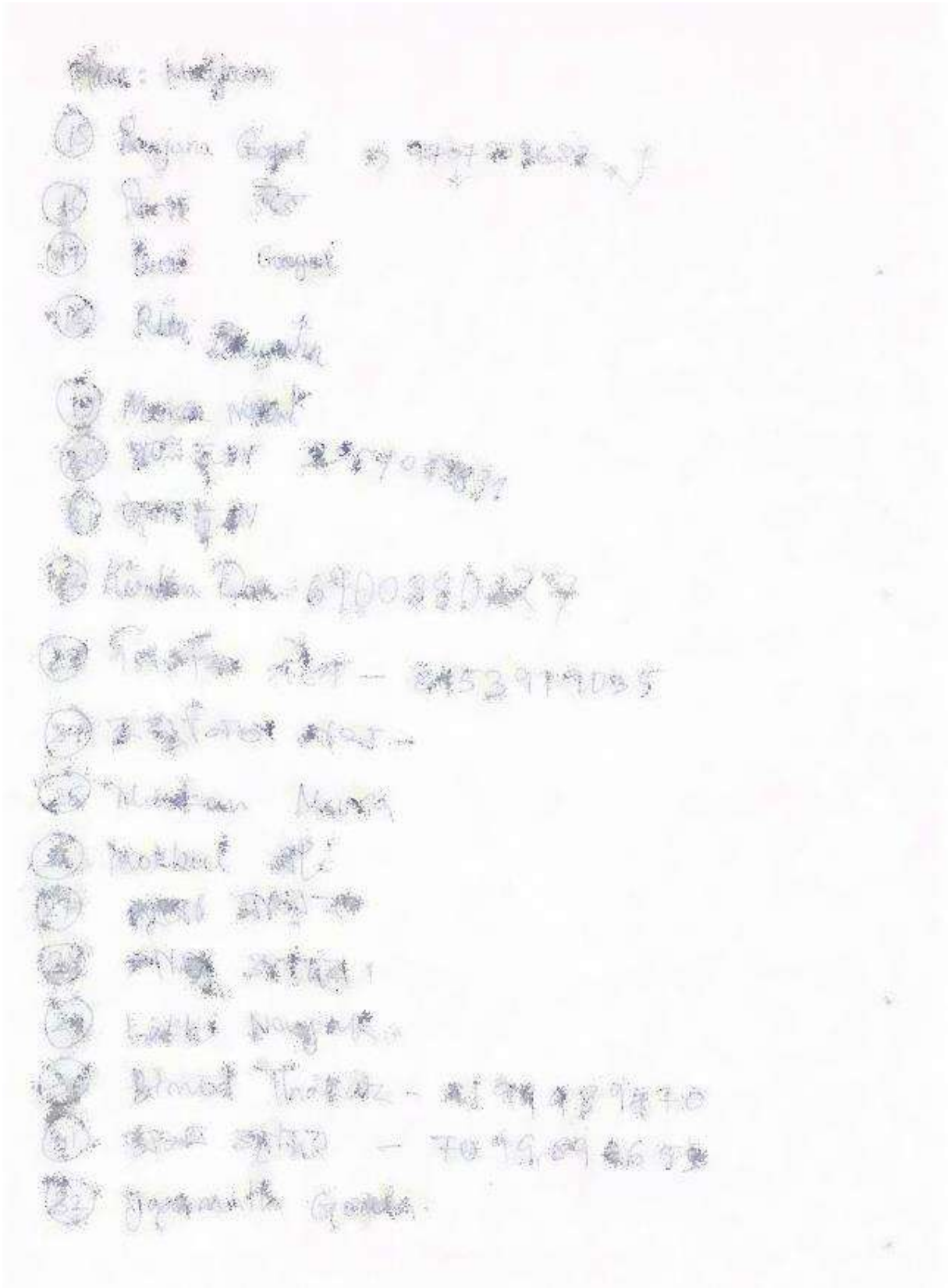
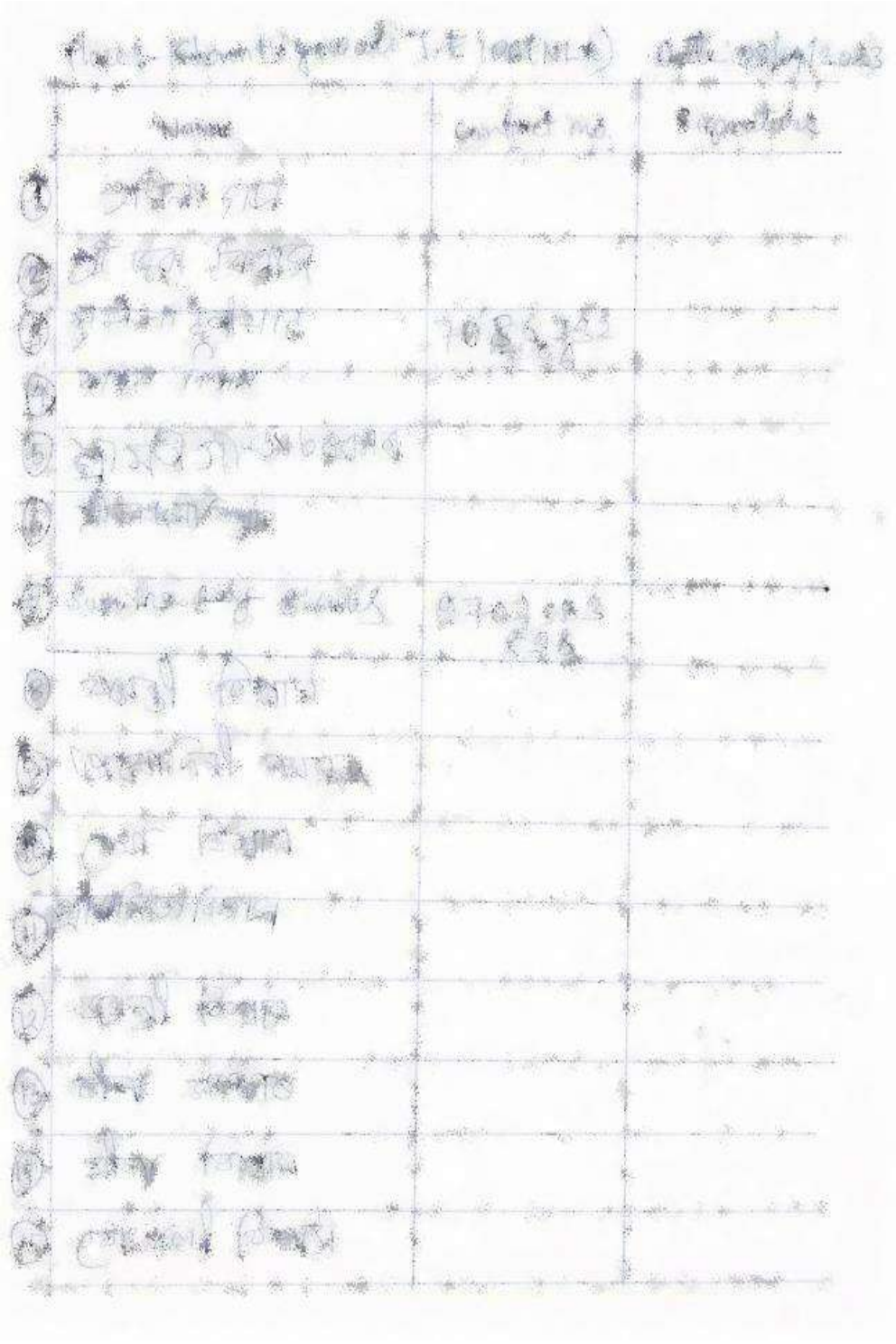
25			

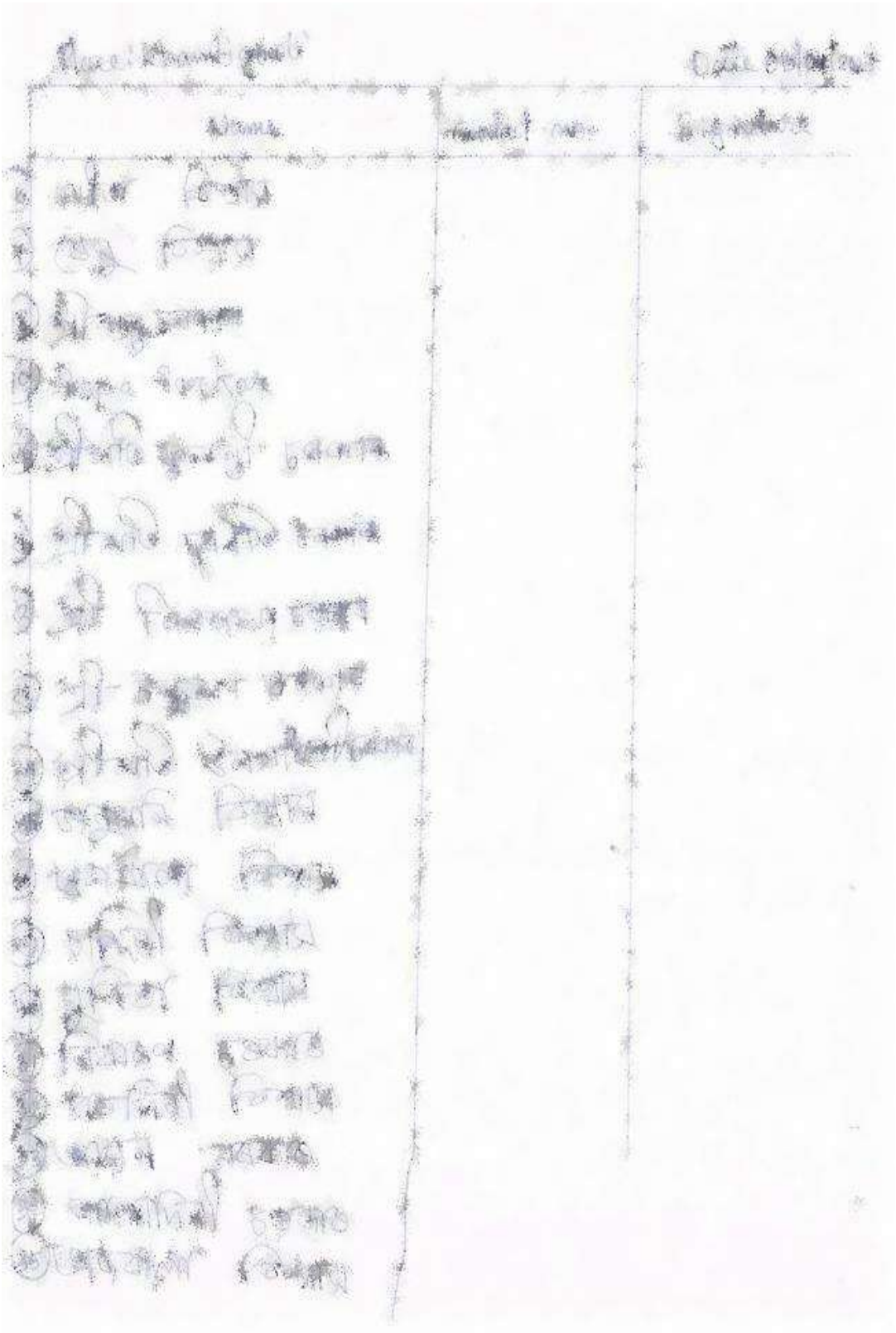
Place: Maijan, Dibrugarh District **Date: 01-04-2023**

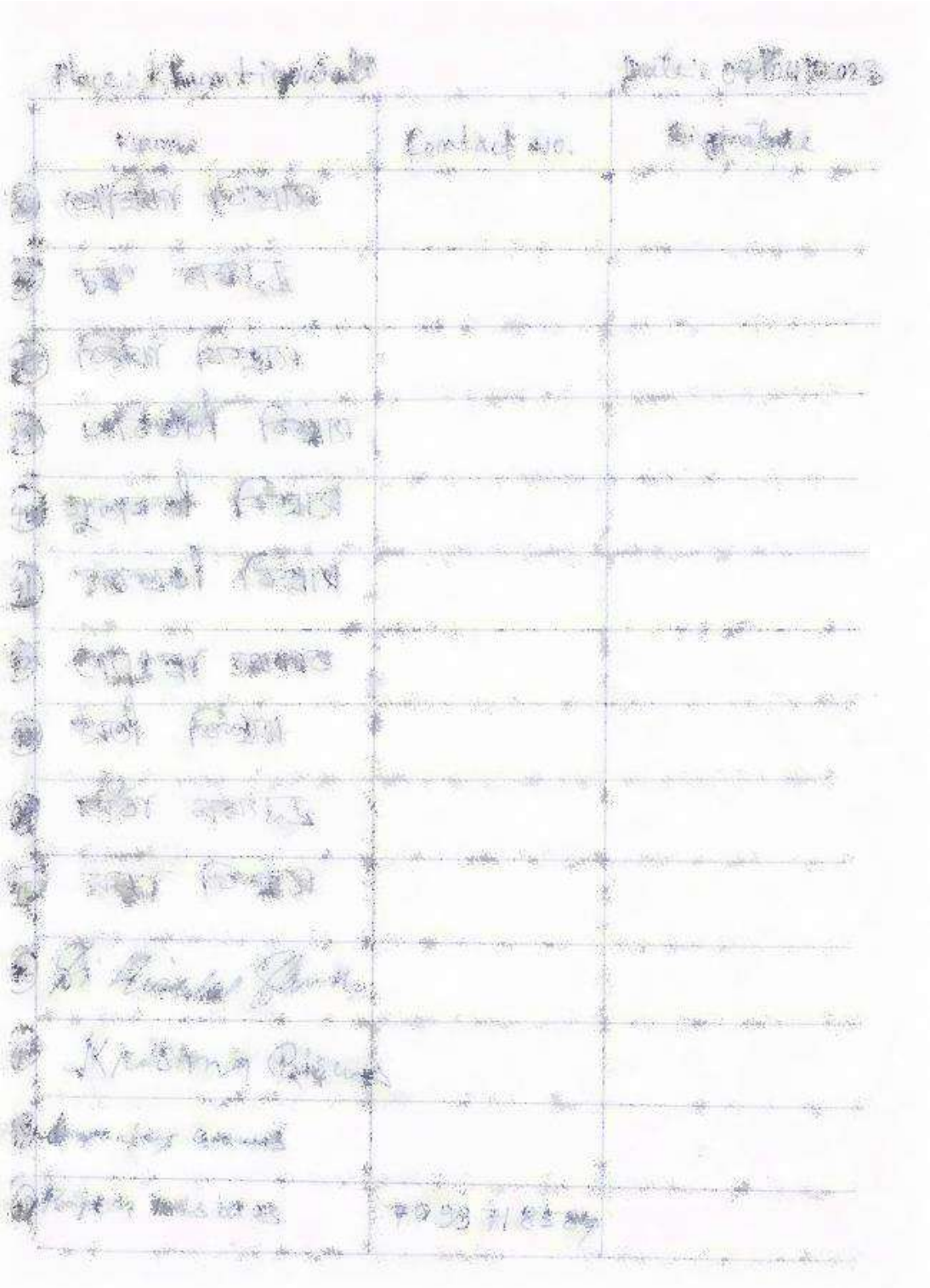


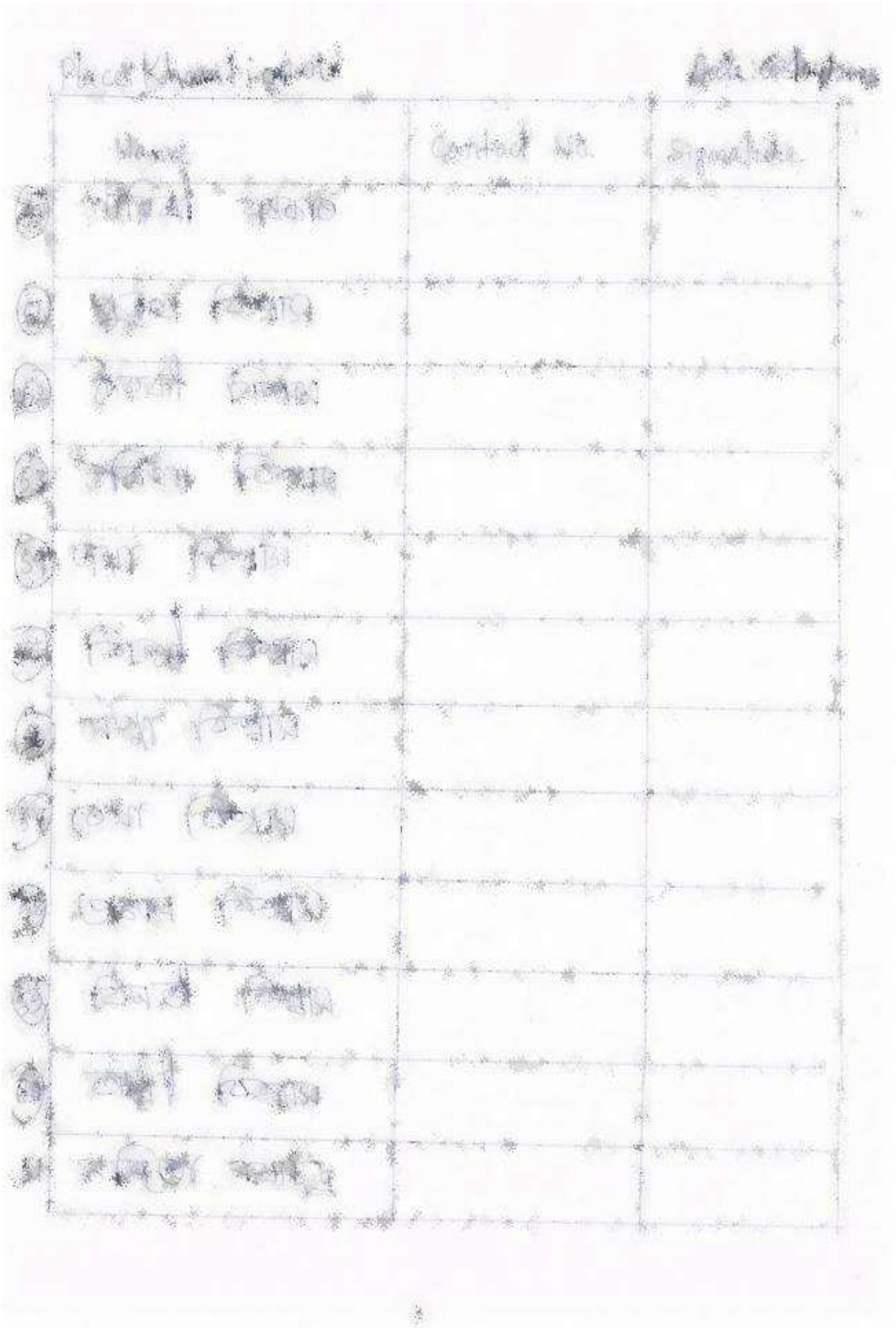


Place: Khamtigowali, Tinsukia District **Date: 03-04-2023**



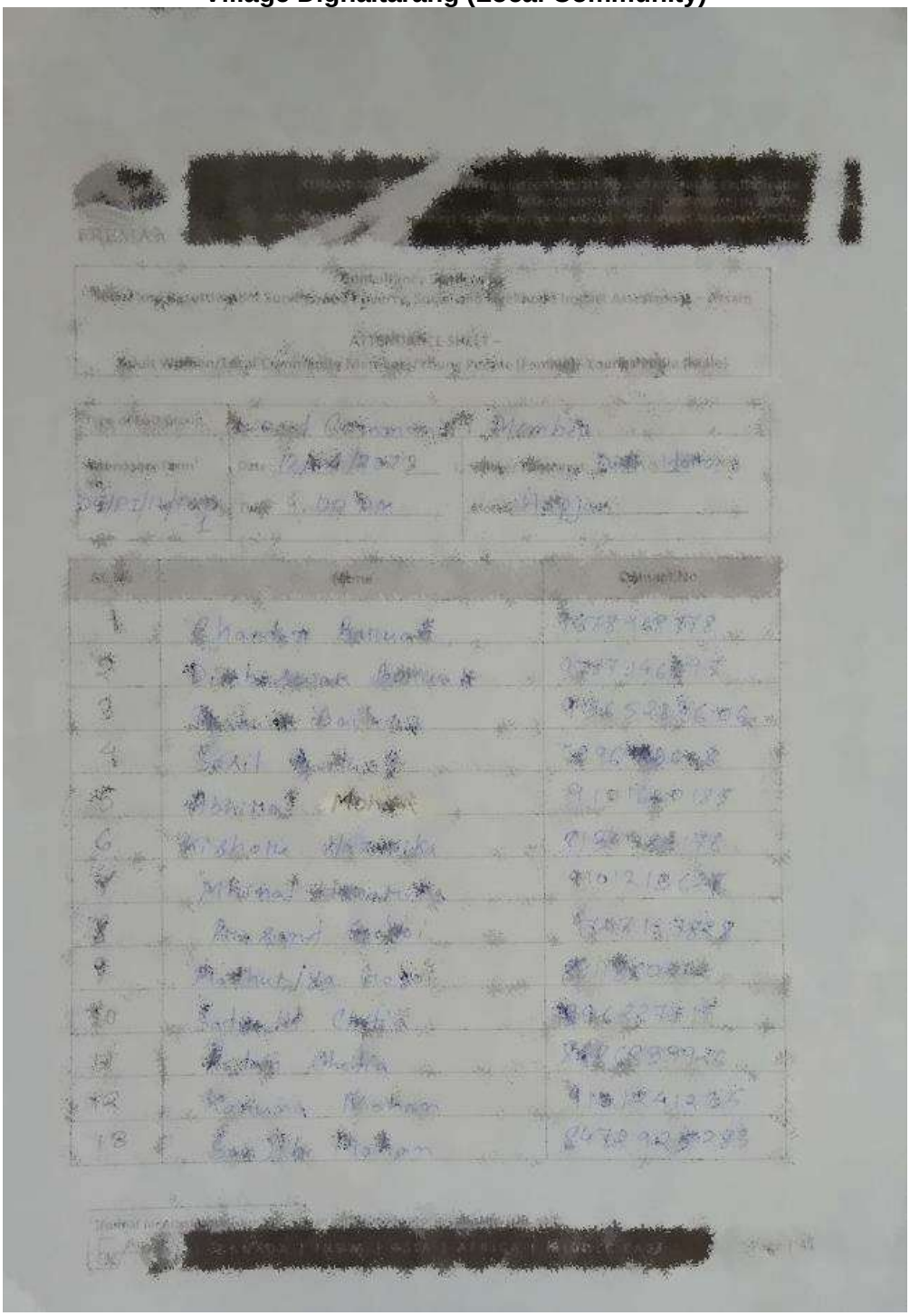




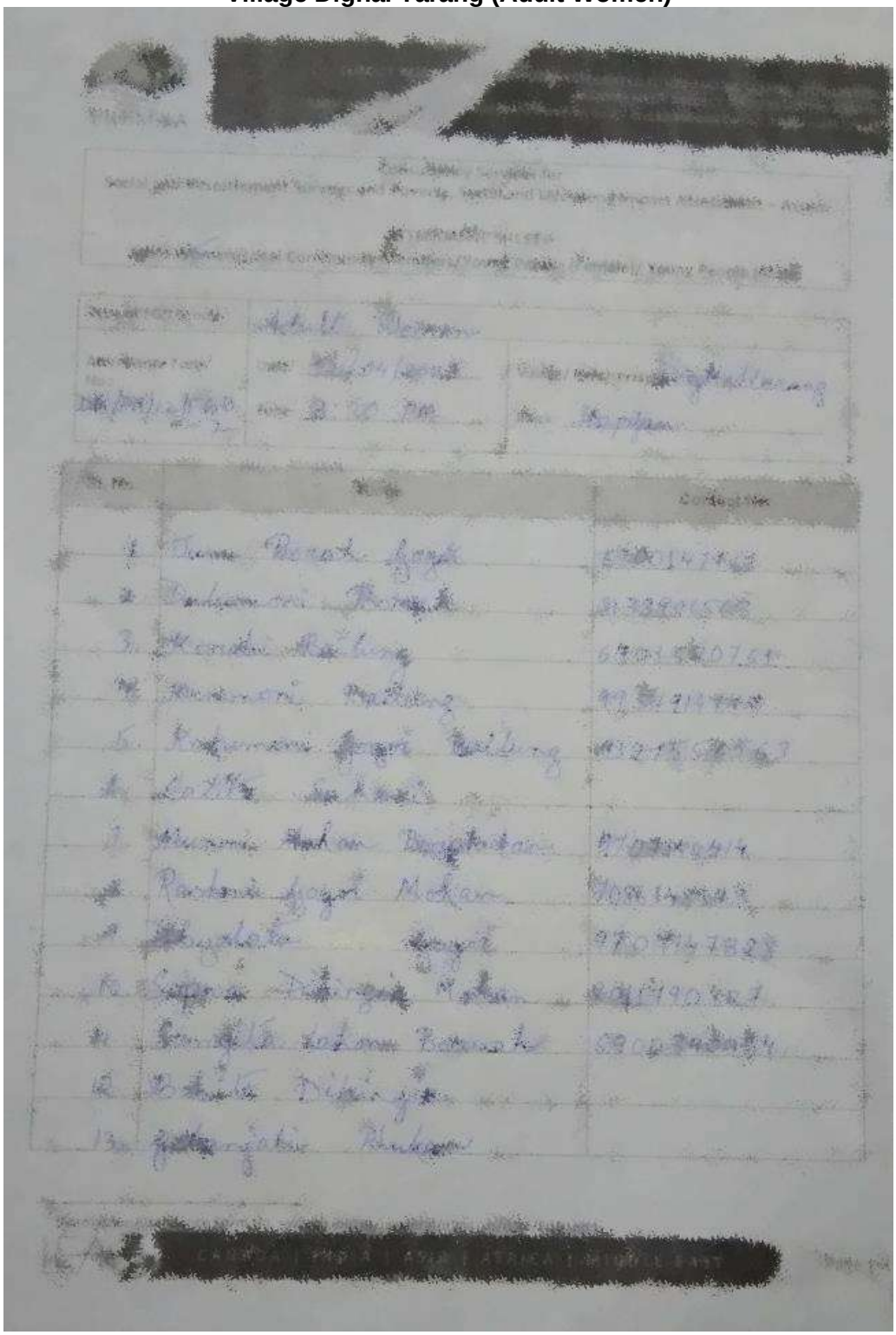


Subproject Zone -A; Dibrugarh, Tinsukia

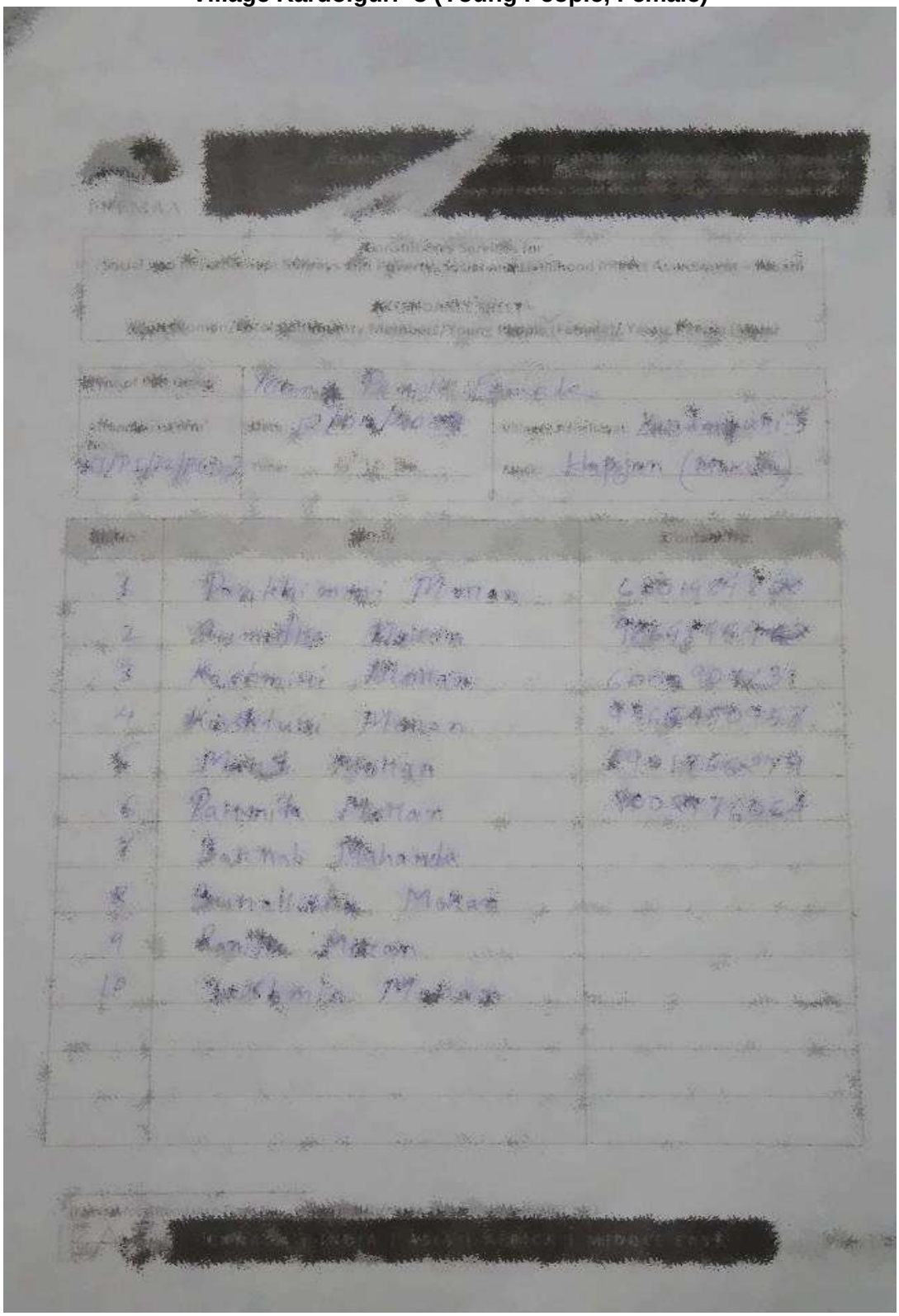
Village Dighaltarang (Local Community)



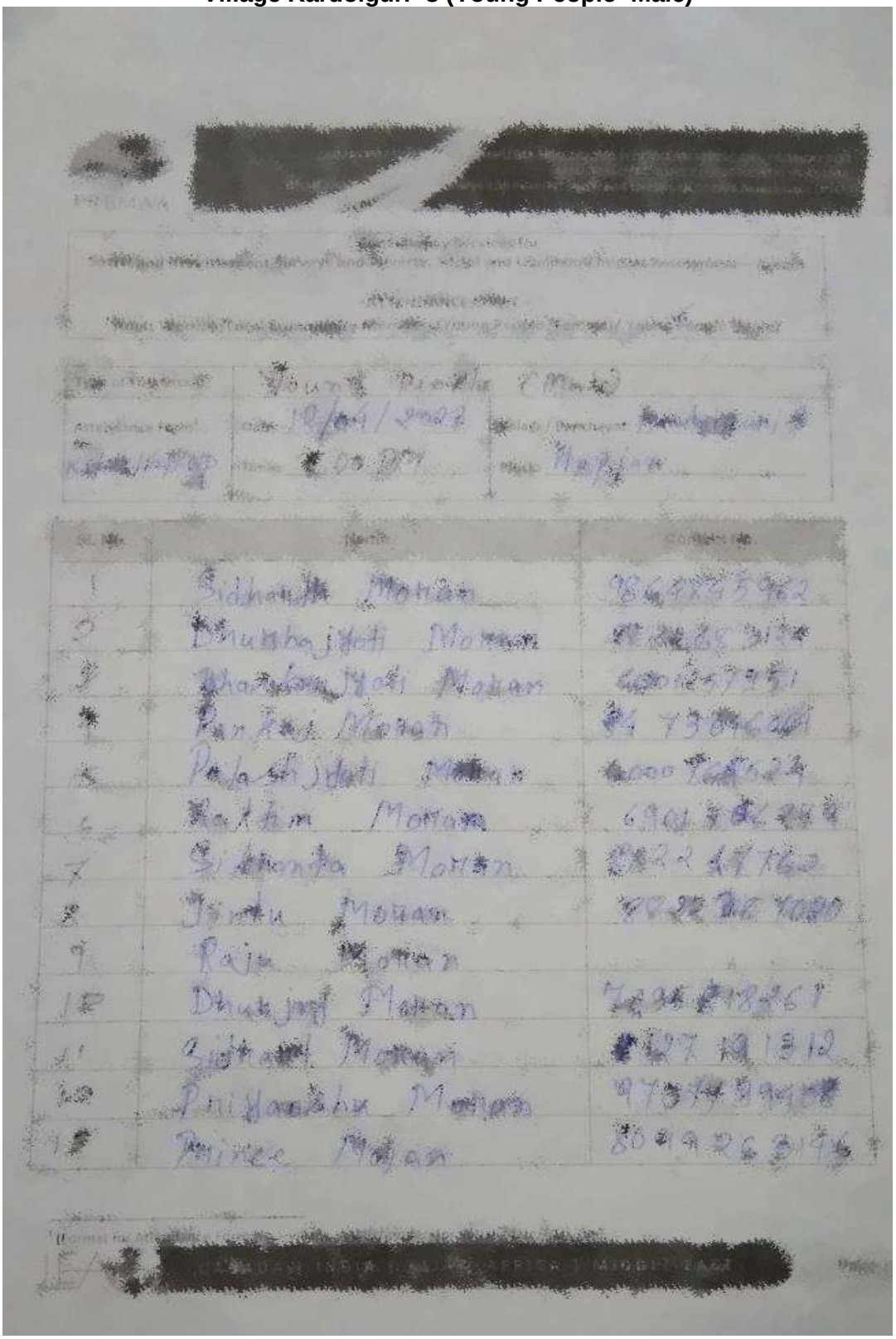
Village Dighal Tarang (Adult Women)



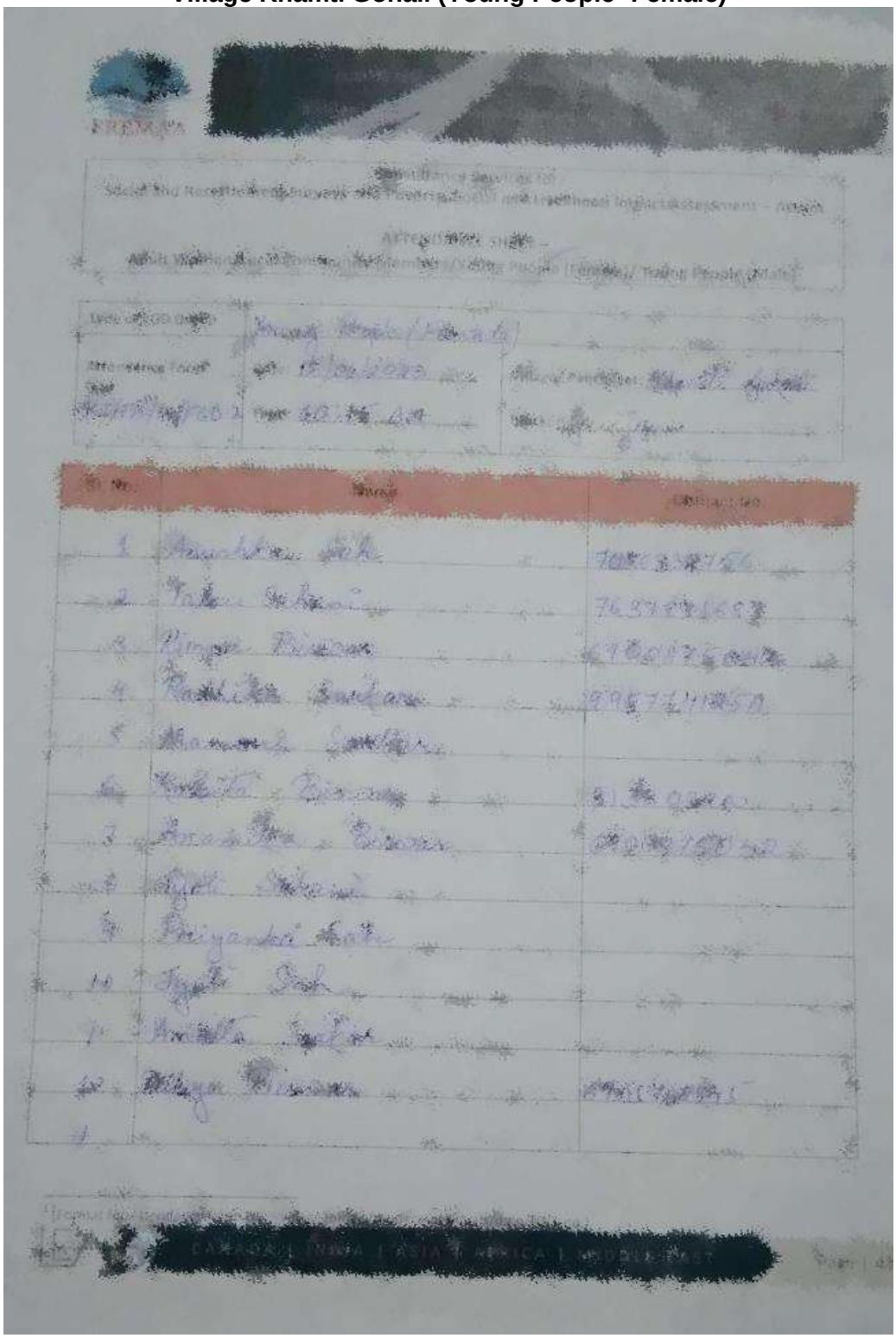
Village Kardoiguri-1 (Adult Women)
Village Kardoiguri -3 (Young People, Female)



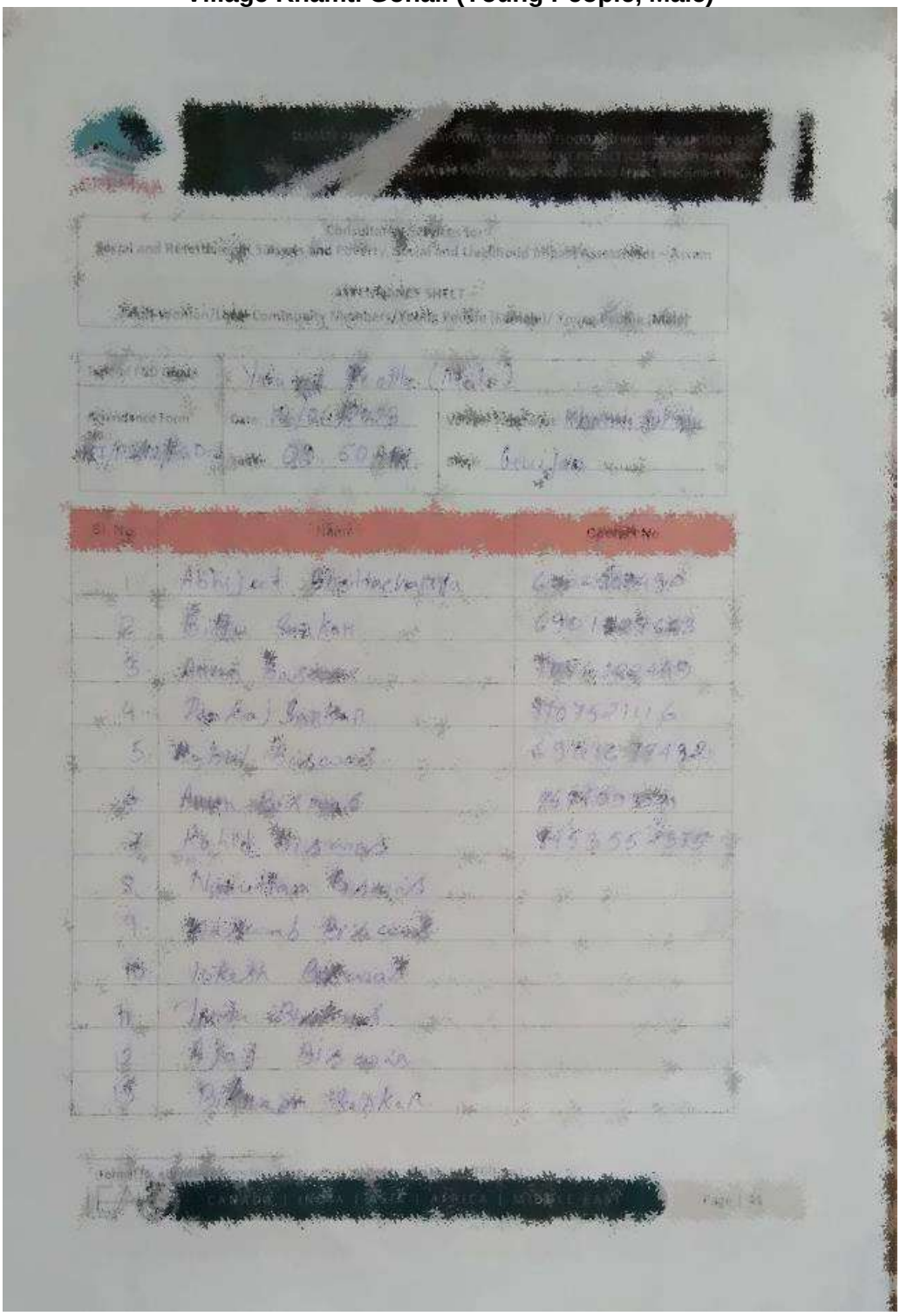
Village Kardoiguri -3 (Young People- Male)



Village Khamti Gohali (Young People- Female)



Village Khamti Gohali (Young People, Male)



Appendix 10: EMR Template

I. INTRODUCTION

- Overall project description and objectives
- Environmental category as per ADB Safeguard Policy Statement, 2009
- Environmental category of each subproject as per national laws and regulations
- Project Safeguards Team

Name	Designation / Office	Email Address	Contact Number
1. PMU			
2. PIUs			
3. Consultants			

- Overall project and sub-project progress and status
- Description of subprojects (package-wise) and status of implementation (preliminary, detailed design, on-going construction, completed, and/or O&M stage)

Package Number	Components/ List of Works	Status of Implementation (Preliminary Design / Detailed Design / On-going Construction/Completed / O&M)[a]	Contract Status (specify if under bidding or contract awarded)	If On-going Construction	
				%Physical Progress	Expected Completion Date

a- If on-going construction, include %physical progress and expected date of completion.

II. COMPLIANCE STATUS WITH NATIONAL, STATE OR LOCAL STATUTORY ENVIRONMENTAL REQUIREMENTS

Package No.	Subproject Name	Environmental Requirements[a]	Status of Compliance[b]	Validity if obtained[c]	Action Required	Specific Conditions that will require environmental monitoring as per Environment Clearance, Consent / Permit to Established[d]

a- All statutory clearance/s, no-objection certificates, permit/s, etc. should be obtained prior to award of contract/s. Attach as appendix all clearance obtained during the reporting period.

b- Specify status of compliance (e.g. nvironmental clearance? Permit/consent to establish? Forest clearance? etc.)

c- Specify if obtained, submitted and awaiting approval, application not yet submitted.

d- Example: Environmental Clearance requires ambient air quality monitoring, Forest Clearance/Tree-cutting Permit requires 2 trees for every tree, etc.

III. COMPLIANCE STATUS WITH ENVIRONMENTAL LOAN COVENANTS

No. (List schedule and paragraph number of Loan Agreement)	Covenant	Status of Compliance	Action Required

IV. COMPLIANCE STATUS WITH THE ENVIRONMENTAL MANAGEMENT PLAN (REFER TO EMP TABLES IN APPROVED IEE/s)

- Confirm if IEE/s require contractors to submit site-specific EMP/construction EMPs. If not, describe the methodology of monitoring each package under implementation.
- Identify the role/s of Safeguards Team including schedule of on-site verification of reports submitted by consultants and contractors.
- For each package, provide name/s and contact details of contractor/s' nodal person/s for environmental safeguards.
- Include as appendix all supporting documents including **signed** monthly environmental site inspection reports prepared by consultants and/or contractors.
- With reference to approved EMP/site-specific EMP/construction EMP, complete the table below

Package-wise Implementation Status

Package Number	Component	Design Status (Preliminary Design Stage/ Detailed Design Completed)	Final IEE based on Detailed Design				Site-specific EMP (or Construction EMP) Approved by Project Director? (Yes/No)	Remarks
			Not yet due (detailed design not yet completed)	Submitted to ADB (Provide Date of Submission)	Disclose d on project website (Provide Link)	Final IEE provided to Contractor/ s (Yes/No)		

- Provide the monitoring results as per the parameters outlined in the approved EMP (or site- specific EMP/construction EMP when applicable).
- In addition to the table on EMP implementation, the main text of the report should discuss in details the following items(but not limited to):
    a. Confirm if any dust was noted to escape the site boundaries and identify dust suppression techniques followed for site/s.
    b. Identify muddy water was escaping site boundaries or muddy tracks were seen on adjacent roads.
    c. Identify type of erosion and sediment control measures installed on site/s, condition of erosion and sediment control measures including if these were intact following heavy rain;
    d. Identify designated areas for concrete works, chemical storage, construction materials, and refuelling. Attach photographs of each area.
    e. Confirm spill kits on site and site procedure for handling emergencies.
    f. Identify any chemical stored on site and provide information on storage condition. Attach photograph.
    g. Describe management of stockpiles (construction materials, excavated soils, spoils, etc.).

Provide photographs.

h. Describe management of solid and liquid wastes on-site (quantity generated, transport, storage and disposal). Provide photographs.

i. Provide information on barricades, signages, and on-site boards. Provide photographs.

j. Provide information on checking if there are any activities being under taken out of working hours and how that is being managed.

Overall Compliance with CEMP/EMP

No.	Sub-Project Name	EMP/ CEMP Part of Contract Documents (Y/N)	CEMP/ EMP Being Implemented (Y/N)	Status of Implementation (Excellent/ Satisfactory/ Partially Satisfactory/ Below Satisfactory)	Action Proposed and Additional Measures Required

V. APPROACH AND METHODOLOGY FOR ENVIRONMENTAL MONITORING OF THE PROJECT

- Brief description on the approach and methodology used for environmental monitoring of each subproject

VI. MONITORING OF ENVIRONMENTAL IMPACTS ON PROJECT SURROUNDINGS (ambient air, water quality and noise levels)

- Brief discussion on the basis for monitoring
- Indicate type and location of environmental parameters to be monitored
- Indicate the method of monitoring and equipment to be used
- Provide monitoring results and an analysis of results in relation to baseline data and statutory requirements

As a minimum the results should be presented as per the tables below.

Air Quality Results

Site No.	Date of Testing	Site Location	Parameters (Government Standards)		
			PM10 $\mu g/m_3$	SO2 $\mu g/m_3$	NO2 $\mu g/m_3$

Water Quality Results

Site No.	Date of Sampling	Site Location	Parameters (Government Standards)					
			pH	Conductivity µS/cm	BOD mg/L	TSS mg/L	TN mg/L	TP mg/L

Noise Quality Results

Site No.	Date of Testing	Site Location	LA_{eq} (dBA) (Government Standard)	
			Day Time	Night Time

*Note: add more tables to show results of other monitoring activigties.

Summary of Environmental Monitoring Activities (for the Reporting Period)[a]

Impacts (List from IEE)	Mitigation Measures (List from IEE)	Parameters Monitored (As a minimum those identified in the IEE should be monitored)	Method of Monitoring	Location of Monitoring	Date of Monitoring Conducted	Name of Person Who Conducted the Monitoring
Design Phase						
Pre-Construction Phase						
Construction Phase						
Operational Phase						

[a] Attach Laboratory Results and Sampling Map/Locations

VII. GRIEVANCE REDRESS MECHANISM

Provide information on establishment of grievance redress mechanism and capacity of grievance redress committee to address project-related issues/complaints. Include as appendix Notification of the GRM (town-wise if applicable).

Complaints Received during the Reporting Period. Provide information on number, nature, and resolution of complaints received during reporting period. Attach records as per GRM in the approved IEE. Identify safeguards team member/s involved in the GRM process. Attach minutes of meetings (ensure English translation is provided).

VIII. SUMMARY OF KEY ISSUES AND REMEDIAL ACTIONS

- Summary of follow up time-bound actions to be taken within a set timeframe.

APPENDIXES

- Photos
- Summary of consultations
- Copies of environmental clearances and permits
- Sample of environmental site inspection report
- Other

Appendix 11: Contractor's Monthly Environmental Monitoring Report Format

Project Name:

EPC Contract Agreement No:

{Project Name, Contract Package / Lot}

Reporting Period {Month Year}

Submission Date: {Day Month Year}

Executing Agency:

Submitted by: Contractor's Name

Red text serves as guide for report preparation, please delete it when the report is finalized}

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXURES

ABBREVIATIONS

Abbreviations	Full Form	Abbreviations	Full Form

1. Introduction

{Please provide a brief in 2-3 paragraphs.}

{Succinctly convey the details of the contract package, details of construction camps and other temporary facilities}

{Highlight any unanticipated impacts in relation to change in the project scope, locations or alignments of components no matter how minor the contractor considers they may be, construction methods, and/or implementation schedule during the reporting period, if none confirm this.}

{Describe the implementation stage reached (design, pre-construction, construction, commissioning) and the % progress, main project activities and milestones achieved during the reporting period. Report on updates to IEE/EMP that were required during the reporting period, status of delivery of documents, permissions received, required amendments, consultation and disclosure undertaken etc.}

{Include table and/or organogram of environmental safeguards staffing at contractors/subcontractors and relationships between subcontractors, etc. Highlight any changes in the project organization and environmental safeguards staffing during the reporting period, if none confirm this}

Table X-1: Details of Contract

Sl. No.	Contract	Details of Work	District	Contract Amount	Appointed Date	Expected Date of Completion
1						

Source: Contract Agreement

Figure X-1: Location Map

Table X-2: Proposed Interventions / Summary of Construction Work Package X

Particulars	Details	Progress Status
		-
		-
		-
		-
		-
		-

Source:

2. Project Progress

The contract for was signed on xxx & the xx% physical progress achieved. Details of current progress of works are presented in table below:

Table X-3: Progress of Work Up to Month Year

Sl. No.	Description	Contract Package xxxx
1	**Financial progress**	
a	Mobilization Advance	Rs. xxx Crores up to date payment Certified

Sl. No.	Description	Contract Package xxxx
b	Mobilization Advance Recovery	Up to date recovered till end of xxx is xxx, as it is a stage payment of xx%
c	Stage Payment	Up to date Amount certified up to xxx is Rs. xxx Crores out of xxx Crores (xxx %)
2	**Pre-Construction Activities**	
a	Tree Cutting (if required)	
b	Electric Pole Erection / Shifting (if involved)	
c	Applicable Insurances	• Submitted by as per provision of contract • Employee Compensation Insurance valid till xxx • Contractor's All Risk Insurance Policy (CAR) valid till xxx • Professional Indemnity Insurance policy valid till xxx
3	**Design Review**	
a	Plan & Profile drawings for xxx	• Submitted by vide letter no. xxx dated xxx • Finalized for: xxx • Approved vide letter no. xxx dated xxx
b	Plan & Profile drawings for xxx	• Submitted by vide letter no. xxx dated xxx • Finalized for: xxx • Approved vide letter no. xxx dated xxx
c	Plan & Profile drawings for xxx	• Submitted by vide letter no. xxx dated xxx • Finalized for: xxx • Approved vide letter no. xxx dated xxx
5	**EMP**	• Site specific EMP submitted vide letter no. xxx dated xxx • Approved vide letter no. xxx dated xxx
6	**QAP & Work Programme**	• QAP submitted by vide letter no. xxx dated xxx • Reviewed and approved vide letter no. xxx dated xxx
7	**Plant Status**	
a	xxx Plant (Hot mix, batching, crusher etc.)	• Intimation of plant submitted vide letter no. xxx dated xxx • Installation and calibration completed and production started on xxx
b	xxx Plant (Hot mix, batching, crusher etc.)	• Intimation of plant submitted vide letter no. xxx dated xxx • Installation and calibration completed and production started on xxx
8	**Civil work**	
A	**Survey Work**	
a	NGL	• xxx % completed
b	OGL	• xxx % completed
c	TBM Fixing	• xxx % completed
9	**Milestone I**	• Milestone date is to be achieved on xxx • xxx Works xxx% Completed
10	**Milestone II**	• Milestone date is to be achieved on xxx • xxx Works xxx % Completed
11	**Milestone III**	• Milestone date is to be achieved on xxx • xxx % Completed
12	**Milestone IV**	• Milestone date is to be achieved on xxx

Sl. No.	Description	Contract Package xxxx
13	**Milestone xxx**	• Milestone date is to be achieved on xxx
14	**Physical Progress (%)**	• xxx %

Source:

3. Site Visits & Review Meetings by Client

{Please provide a brief in one – two paragraphs}

4. EHS Setup / Organization Chart

{Please provide a brief in one – two paragraphs}

Figure X-2: Organization Chart of EHS Team

Table X-4: Environmental, Health & Safety Staff

Name	Designation	Location	Mobile	Email address	Mobilization Date	Demobilization Date	Total Days Absent in last month	Total present (Months)

5. Compliance on Environment, Health & Safety Safeguards

5.1 Camp Details

{xxx camps, xxx separate labor / operator's camps besides xxx temporary labor camps for the project have been established. The details of the plants in the camps are given below:}

Table X-5: Details of Camps Established as on Month & Year

Sl. No.	Camp No.	Camp Location	Plants	Unit	Capacity	Clearance	Remarks
1							
2							

Source:

Table X-6: Details of Labor Camps Established as on Month Year

Sl. No.	Camp No.	Camp Location	Occupant (No.)	Grade	Facilities
1					• Toilets: XX No. • Lodging: XX No. • Kitchen XX No.

Sl. No.	Camp No.	Camp Location	Occupant (No.)	Grade	Facilities
2					• Toilets: XX No. • Lodging: XX No. • Kitchen XX No.
3					• Toilets: XX No. • Lodging: XX No. • Kitchen XX No.
4					• Toilets: XX No. • Lodging: XX No. • Kitchen XX No.
5					• Toilets: XX No. • Lodging: XX No. • Kitc`hen XX No.

Source:

5.2 Compliance to Environmental Management Plan

{With reference to the EMP of the project, include a table following sample table below with the compliance status during the reporting period, with sufficient details (evidence) to show how compliance was achieved, or corrective action to be taken if there was non-compliance including timeline and budget}

{Flag if previous environmental monitoring report(s) included corrective action plan, if it did details of that corrective action plan should be incorporated into the EMP table and compliance status reported}

{Provide explanations of any instances where performance standards were temporarily exceeded during the reporting period, along with details of any response taken to rectify the exceedance once identified, even if at the end of the reporting period the project is deemed as being compliant}

{Copies of clearances, CEMP, construction method statements, and other documentation produced in accordance with EMP during the reporting period should be included as an appendix}

Table X-7: Status of EMP as of Month Year

Item #	**Requirement**	**Prior Corrective Action** **Compliance Status** {complied; partially complied; not complied; still ongoing or n/a at current stage of the project}	**Remarks** {provide sufficient details (evidence) to show how compliance was achieved; or explain the corrective action to be taken if there was noncompliance including timeline and budget}

5.3 Status of National / State/ Local Statutory Environmental Requirements

{Status of compliance and further action to ensure ongoing compliance; if there is partial or no compliance recommendations for corrective action are required. Provide explanations of any instances where the requirements of regulations or agreements were breached along with details of responses taken to rectify the breach once identified. Include all the applicable National Regulations and International Agreements

following the sample table below attaching copy of the consents/license in the period they were obtained}

Table X-8: Status of Legal Compliance as of Month Year

Sl. No.	Activities	Statutory Authority	Status (Yes, No or Partial only)		Expiry Date	Remarks
			Applied	Obtained		
1	Camp Layout Plan	Engineer			-	
2	NOC letter	District Commissioner			-	
3	Storage, Handling, and Transport of Hazardous Materials	State Pollution Control Board				Consent No. xxx dated xxx
4	Labor License	Labor Commissioner				Consent No. xxx dated xxx
5	Withdrawal of Ground Water for Construction	Ground Water Board				Consent No. xxx dated xxx
6	Registration of Vehicles & PUC	Motor Vehicle Department				-
7	Debris Disposal Sites	Gram Panchayat				Consent No. xxx dated xxx
8	Any other clearances / permits / NOCs					

Source: EPC Contractor

5.4 Spoil Disposal Sites & Utilization of Construction Wastes

{Please provide a brief in 2-3 paragraphs. Provide not more than 4 photographs showing before & after scenario}

Figure X-3: Some Photographs of Spoil Disposal Sites

5.5 Environmental Supervision and Monitoring Results

{With reference to the contract budget earmarked for EMP (if any) summarize details of budget allocated and the current spend profile}

Table X-9: Status of Budget allocated for EMP and spent as of Month Year

Activity	Allocated Budget (INR)	Budget Spent (INR	% Spent	Remarks
Total				

5.6 Environmental Pollution Monitoring

{Please provide a brief in one – two paragraphs. Provide not more than 1 photograph at each site for each activity}

{Environmental monitoring results – summarize in a table the reporting period's quantitative monitoring

activities and data obtained in accordance with the Environmental Monitoring Plan (EMoP) of the project. Provide explanations of any instances where performance standards were exceeded along with details of responses taken to rectify the exceedance once identified. Attach survey reports}

Typically, this section will include the results of:

- Flora and fauna surveys
- Air quality surveys
- Noise and vibration surveys
- Water quality surveys

{Indicate monitoring locations using a map or plan with grid coordinates, dates, times, duration of samples as applicable, weather conditions as applicable, parameters measured, equipment used, standards, tests, and limits used etc.}

{Corrective actions with timeline and budget are required to ensure any exceedances will be prevented in the future}

{Calibration and QA certifications of monitoring equipment and laboratories analyzing samples should be included as an appendix}

Figure X-4: Photographs Environmental Monitoring

Table X-10: Ambient Air Quality Monitoring Results

Name of sampling site	Geo-Coordinates	Parameters					
		PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO	Lead
Location xx							
Location xx							
Location xx							
Location xx							
Stack emission of DG Location xx (xx KVA)							
Stack emission of DG Location xx (xx KVA)							
National Ambient Air Quality Standards[82]		**100**	**60**	**80**	**80**	**4**	**1**
Emission Limits for Diesel generator set up to 800 kW[83]		**0.2**		**-**	**4**	**3.5**	**-**

Source:

Table X-11: Ambient Noise Quality Monitoring Results

Name of sampling site	Geo Coordinates	Parameters		National Standards		Remarks
		Leq (Day)	Leq (Night)	Day time	Night time	
Location xx						

[82] National Ambient Air Quality Standards, Notification dated 16th November 2009
[83] Environment (Protection) (Third Amendment) Rules, 2013 dated 11th December 2013, G.S.R. 771(E)

Name of sampling site	Geo Coordinates	Parameters		National Standards		Remarks
		Leq (Day)	Leq (Night)	Day time	Night time	
Location xx						
Location xx						
Location xx						
DG at Location xx						
DG at Location xx						

Source:

Table X-12: Drinking Water Quality Monitoring Results

Parameters	Location					National Standards (IS 10500:2012)	
	Location xx	Location xx	Location xx	Location xx	Location xx	Acceptable Limit	Permissible Limit
Color						5 max.	15 max.
Odor						Agreeable	Agreeable
Turbidity						1 max.	5 max.
pH						6.5 – 8.5	No Relaxation
Total Dissolved Solids						500 max.	2000 max.
Total Hardness ($CaCO_3$)						200 max.	600 max.
Total Alkalinity ($CaCO_3$)						200 max.	600 max.
Chloride (Cl)						250 max.	1000 max.
Fluoride (F)						1.0 max.	1.5 max.
Sulphate (SO_4)						200 max.	400 max.
Nitrate (NO_3)						45 max.	No Relaxation
Iron (Fe)						0.3 max.	No Relaxation
Lead (Pb)						0.01 max.	No Relaxation
Zinc (Zn)						5 max.	15 max.
Total Chromium (Cr)						0.05 max.	No Relaxation
Copper (Cu)						0.05 max.	1.5 max.
Calcium (Ca)						75 max.	200 max.
Magnesium (Mg)						30 max.	100 max.
Manganese (Mn)						0.1 max.	0.3 max.
Total Arsenic (As)						0.01 max.	0.05 max.
Total Coliform						Should be	No

Parameters	Location					National Standards (IS 10500:2012)	
	Location xx	Location xx	Location xx	Location xx	Location xx	Acceptable Limit	Permissible Limit
						absent	Relaxation
E. Coli						Should be absent	No Relaxation

Source:

5.7 Supply & Status of PPE

The details of the PPEs are given in table below:

Table X-13: Status of PPEs on Month Year

Sl. No	PPE	Opening Stock	Distributed	Closing Stock	Ordered
	Helmets – Laborers (Yellow)				
	Helmets – Supervisors (color)				
	Helmets – Engineers (color)				
	Helmets – EHS (Green)				
	Helmets – Visitors (color)				
	Helmets – Others (color)				
	Gloves				
	Masks				
	Goggles				
	Safety Shoes				
	Gum boots				
	Safety Tackles				
	Safety Jacket – Laborers (color)				
	Safety Jacket - Engineers (color)				
	Safety Jacket – Others (color)				
	Others, please specify				

Source:

5.8 Medical Facilities

Please provide details of the medical facilities including first aid and hospitals in one – two paragraphs.

Table X-14: Details of First Aid / Medical Room on Month Year

Sl. No	Camp	Size (m^2)	No. of First Aider	No. of Beds	Capacity to Treat (No. of Laborers that can be treated)	Compliant with Labor laws
						Yes/No

Table X-15: Details of First Aider as on Month Year

Sl. No	Camp	Name	Qualification	Years of Experience	Deployment Date	Employment Status

Table X-16: Details of Hospitals & Doctors tied up with as on Month Year

Sl. No	Name	Location	Distance from Site	MoU Number	Date of MoU	Facilities offered	Expiry Date

Table X-17: Details of First Aid Boxes in Project Site as on Month Year

Sl. No	Location	Size of Box	Date of last Inspection	Inspected by (Name & Designation)	Status of Inspection

Table X-18: Details of Ambulances in Project Site as on Month Year

Sl. No	Location	Vehicle Type	Vehicle Number	Date of last Inspection	Inspected by (Name & Designation)	Status of Inspection	Fitness Certificate Status

Figure X-5: Photographs of Medical Facilities in camp sites

Not more than 6 photographs

Figure X-6: Photographs of Ambulances in Camp Sites

Not more than 4 photographs

5.9 EHS Trainings

Please provide a table/para showing the details of the trainings that are to be conducted as per EPC contract. Details shall include name of training and frequency. The list of attendees to be provided in the annex.

The following programs were conducted during the reporting period:

Table X-19: Training Programs Conducted during Reporting Period

Sl. No	Date	Program Name	Type of Program	Location	No. of Attendees	Faculty/Trainer

Figure X-7: Some Photographs of EHS Training Programs

5.10 AIDS & COVID 19 Awareness Camps

The following programs on COVID, 19 HIV/AIDS were conducted during the reporting period:

Table X-20: AIDS & COVID 19 Awareness Programs Conducted during Reporting Period

Sl. No	Date	Program Name	Type of Program	Location	No. of Attendees	Faculty/Trainer

Figure X-8: Some Photographs of Awareness Programs

5.11 COVID 19 Response & Mitigation (if Relevant during reporting period)

Single Paragraph on steps taken, Any Cases of COVID amongst workers etc.

6. Compliance on Labor

The details on the compliance of labor are given in sections below

6.1 Labor Details

Table X-21: Labor Details as on Month Year

Sl. No	Type	Number			Camp Location	Employment Type		
		Local	Outsider	Total		Casual	Outsourced	Permanent
	Unskilled							
	Semi-skilled							
	Skilled							
	Total							

6.2 Accident Record

{If there was any near-miss or accident, illness, or other occupational or community health and safety related incident during the reporting period (or a previously reported incident with ongoing rectification) report following the sample table below. Include as appendices work safety checklists, incident reports, and other relevant supporting documents. If no incidents, please confirm}

- Total Man hours preceding month: xx
- Total Man hours in reporting month: xx
- Total Man hours in project till the end of present month: xx
- Total Safe Man hours preceding month: xx
- Total Safe Man hours in reporting month: xx
- Total Safe Man hours in project till the end of present month: xx
- No. of accidents in reporting month: xx
- Total Accidents in project: xx
- No. of incidents in reporting month: xx
- Total Accidents in project: xx
- Total near misses in reporting month: xx
- Total near misses in Project: xx
- Any other points: xx

Table X-22: Safety Details on Month Year

Frequency Rate	Severity Rate	Risk Index	Risk Index Factor	Accident Rate	Incident Potential Rate	Frequency of First Aid Case

Table X-23: Accident Details as on Month Year

First Aid Cases	Accidents	Fatality	Incidents	Near Miss	Dangerous Occurrenc	Unsafe Acts Observed	Complian ce %	Man-hours worked	Man- day lost	Safe Man hours

Table X-24: Safety Details on Month Year

Frequency Rate	Severity Rate	Risk Index	Risk Index Factor	Accident Rate	Incident Potential Rate	Frequency of First Aid Case

Table X-25: Accident Details as on Month Year

First Aid Cases	Accidents	Fatality	Incidents	Near Miss	Dangerous Occurrenc	Unsafe Acts Observed	Complian ce %	Man-hours worked	Man- day lost	Safe Man hours

7. Meaningful Consultation

{Meaningful consultation – report on any ongoing consultation undertaken, and main issues raised by consultees; detailed consultation records should be included as an appendix. If no ongoing consultation, please confirm}

Table X-26: Consultations in Month Year

Date	Format/Venue	Participants (Occupation, M/F)	Main Issues Raised

8. Grievance Redressal

{If there was any grievance or complaint, regardless informal or minor, during the reporting period (or previously reported complaint with ongoing rectification) provide the corrective action taken following the sample table below. Detailed grievance records and response reports should be included as an appendix}

{A paragraph on:

- Procedure for redressal
- No. of grievances received and type
- Status of grievances}

Table X-27: Grievances details as on Month Year

Grievances Received		Grievances Status of last Month		Total till Date Grievances Status	
Last Month	Total till Date	Open	Closed	Open	Closed

Table X-28: Status of Grievances on Month Year

Complainant/s or Affected Persons	Location/s and Date/s of Complaint	Description of Grievance/Complaint	Timeline*	Time-bound Corrective Action

* To be solved within 2 weeks

9. Follow up Actions & Conclusions

{Summarize the contract's environmental performance during the reporting period based on the previous sections and, if any non-compliance identified, provide detailed recommendations including responsibilities, timeliness and budget for the preparation and completion of corrective action}

{If non-compliance is major or not readily addressed then a separate corrective action plan may need to be prepared. For minor and readily addressed non-compliances the corrective action plan can be incorporated into this final section of the environmental monitoring report following the sample table below}

Table X-29: Follow up actions as on Month Year

Non-compliance	Corrective Action to be Taken	Responsibility	Timeline	Budget

APPENDICES

Photographs {Include relevant photographs of the project site and project area of influence taken during the reporting period to provide evidence of compliance and/or non-compliance. For each photo, provide a caption with description of what it illustrates, accurate location, and date taken}

Supporting Documents {E.g.,

- Maps and plans
- Checklists and reports
- Permits/Clearances/NOCs obtained in Last Month and documentation
- Training records
- Detailed monitoring data, laboratory results etc.
- Calibration and QA certificates
- Consultation records
- Meeting agendas and attendance records
- Grievance records
- Environment, health and safety reports
- EHS Correspondences in Last Month

Appendix 12: Sample Chance find Protocol

Introduction

Tthere are possibility of any chance finds (artefacts) recovery during excavations. Contractors working must take additional care not to destroy or damage historic features during excavations. There may be many buried historic features in heritage towns such as – idols, toys, wells, ancient drains, remains of buildings, other walls, grain pits, etc. Every care must be made not to destroy these during excavations.

Excavator drivers need to be instructed to be aware of hitting buried features and that they must be investigated before continuing work. When features are encountered during mechanical excavation, work should stop and the PIU/Consultants engineers must be informed immediately so that they can be inspected at the first opportunity.

When historic features such as walls, brick constructions and other features are encountered during excavation the excavation must be stopped immediately and the PIU/Consultants must be informed immediately.

Contractors' instruction*:* As soon as contractor recovers any chance find during any excavation works for pipe laying, they should immediately inform PIU/Consultant present in town about the chance find recovery. Immediately stop the excavation activity near point of recovery. After PIU/consultants engineers come at site, contractor should follow cleaning and photography in supervision of PIU/Consultant engineers.

Cleaning - When a feature/chance find is discovered it must be defined by careful cleaning. Roots must be removed and dirt must be carefully cleaned away. The section or trench base should also be cleaned back for a little distance around the feature.

Record photography – When the feature is clean good photography should be taken – vertical and face-on shots and a few general shots of the feature, also showing its position in relation to surrounding features, buildings, etc. The photographed should be catalogued (date, location, direction of shot)

Drawn record - When features/chance finds are revealed a drawn record should also be made.

a. General location record – measuring its position and orientation within the protected site / in relation to surrounding structures
b. Record drawings – detail drawings made in plan and section/profile. The extent (edges) of the feature should be drawn and the level of the existing ground surface and the top and base of the feature should be recorded. These levels should be marked on the drawings. The drawings should include detail of the construction of the feature. Perspective sketches could also be made if necessary. Explanatory notes can also be put on the drawings.

Reporting finds - When finds are made these should be reported to PIU/Consultants.

Photographs and record drawings should be sent.

Discovery of historic objects - When clearance and excavation takes place artifacts and historic objects are sometimes found. These should be recovered and kept in a safe place. The place of discovery should be recorded, and each find given a number and tag tied to the find with the same number on it. A list of the finds should be kept (with the find No. And place of discovery and date of discovery recorded).

PIU/Consultants responsibility- PIU/Consultants should inform in written to the State Archaeological Department at the earliest with photographs and request to Archaeology Department to visit the site and hand over the chance finds to them.

Appendix 13: Environment and Social Risk Analysis.

The process of environmental and social Impact Assessment was accomplished through the review of available documents viz. Detailed Project Reports (DPR), literatures available related project site, site selections etc. Detailed Site visits and field surveys were carried out engaging key experts. The expert during visit interacted with key stakeholders and consultations with host communities.

The finding of site was used to identify and assess the anticipated environmental and social impacts associated with the proposed project,

Environmental risk is a function 1- Magnitude of potential consequences (i.e., levels of magnitudes) and likelihood of these consequences to occur (i.e., levels of probability of occurrence). To quantify the environmental risks, the formula is:

Likelihood x Consequence

First, ratings have been assigned for different levels of likelihood and consequence to determine the level of environmental risks. Each risk has been given as ratings for likelihood and consequence. Examples of ratings are presented below, however they can be modified by the executive agency as appropriate.

Table X-30: Likelihood or level of probability

Likelihood		Rating
Likely	Potential to occur more than twice during construction and/or operations	3
Unlikely	May occur once or twice during construction and/or operations	2
Rare	Highly unlikely to occur during construction and/or operations	1

Table X-31: Consequence or level of magnitude

Consequences	Consequence or levels of magnitude Consequence	Rating
Major	Significant damage or impact on the natural environment or communities.	3
Moderate	Limited adverse impact on natural environment or communities	2
Minor	No or minimal adverse impact on natural environment or communities.	1

When all environmental risks are assigned with likelihood and consequence ratings, then the formula is to be applied and results stated. The E&S ratings show the quantifiable environmental risks. These risks are then to be classified based on the levels of risk. The table below shows the categories of environmental risk based on the formula above.

Table X-32: Quantifiable Environmental risk matrix

Likelihood	Likely	3	3	6	9
	Unlikely	2	2	4	6
	Rare	1	1	2	3
Higher 6 and above			1	2	3
Medium 3-5			Minor	Moderate	major
Low 0-2			consequences		

Definition of Environmental Risk level pertains to High, medium and moderate has been presented below:

Table 1-5: Definition of Environmental Risk level

High	Significant damage or impact on natural environment or communities For example: • Major loss of soil, water resources & water quality due to storm water runoff • Significant pollution of soil &water resources including major contamination from hazardous materials • Significant effects on eco systems with isolated deaths of non- vulnerable fauna • Major nuisance or annoyance to communities • Major damage to archaeological or historical sites.
Medium	Limited adverse impact on the natural environment or communities. For example; • Localized short-term notice able changes in storm water quality • Localized &contained pollution of soil resources Short-term minor changes in ecosystem (no death of fauna) • Isolated or partial damage to archaeological or historical sites
Low	No or minimal adverse impact on natural environment or communities. For example; • No measurable or noticeable change in storm water runoff and quality remains within tolerable limits • Undetectable effects on soil resources from material storage Minimal effects on modified habitat • No or only isolated few complaints from the community • No or minimal damage to archaeological or historical site

Based on the above criteria, the level of risk and their respective rating has been estimated. The level of risk on ambient air, water, soil, noise, land is anticipated as moderate level and specific and confined during construction stage. The risk would mainly be due to construction stage,

though the construction activity area majorly manual in nature. The embankment protection at reach is stacking of sandbags/ geo bags with no machinery interference. Excavator/ Digger machines shall be used for the preparation of site would be major construction equipment in the project. The carriage of material is majorly through boat/ local vendors, vehicles. Based on the Table 1-5 criteria following table shows the analysis of level of environmental risk and rating.

Table 1-6: Computation of Environmental risk

Environmental Risks	Likelihood	Consequence	Rating
Air & Noise Environment			
Increase of dust generation at construction sites	1	1	2
Disruption of livelihood activities along affected reaches	2	2	4
Effect on Air quality due to construction and operation phases- emission	1	1	1
Effect on Noise & vibrations during construction activity	2	1	2
Impact on land			
Acquisition of private land on some patches	2	2	4
Land Use Change due to Project Activities and, material Sourcing	1	1	1
Borrow Areas	2	2	4
Soil Compaction and Contamination	1	1	1
Wastes from construction activity	1	1	2
Impact on Water			
Effects on River Morphology - Upstream and Downstream Effect	2	2	4
Impact on Silt Deposition and Bed Level Change	1	1	2
Impact on surface/ river water quality	2	2	4
Effect on Drainage System	2	1	2
Effect on Wetlands/ Beels	1	1	2
Accidental spillage of fuel and hazardous chemicals	1	1	1

Environmental Risks	Likelihood	Consequence	Rating
Ecology & biodiversity			
Damage on wildlife habitats due to removal of natural riverbanks	2	2	4
Effect on ecology and habitat on long run	1	1	1
Effect on fishing activity /productivity	1	1	2
Tree Felling	2	2	4
Ground Clearance (Bushes)	2	1	2
Impact on Wildlife Corridor & Schedules -I Species	1	1	2
Impact on Aquatic Habitat	2	1	3
Community /occupational health and safety			
Occupational health and hazard to worker/Labour camp	1	1	2
Impact on flood and local community	1	1	1
Socio Economic impact / sourcing of labour-construction & operation stage	2	1	2
Socio Economic impact on livelihood and agriculture on flood plains in long run	1	1	1

Impact during Design Stage/Construction stage & operation stages

Type of activity involve are river bank protection work with geo bag apron, pro siltation measures by PSC porcupine in the projects (are basically using apron of size 42m width and 1.00m thickness (type c) for entire stretch having spurs and bridge effect and of size 33 m width and 1.00 m thickness for normal size, Establishment of geo bags at revetment at reach, tabular geo bang mattresses, toe key of PVC coated wire netting cage of 1.5m X1.5mX0.45min two layers filled with silt filled geo bags). It also involves embankment work crest 7.5m width with ground level width 30.45 meters. The height of embankment has been kept at 4.6340 meters. These activities will involve procurement of sandbags, geo bags, carraige of material like porcupine, PVC coated cage, and silt. Majorly the stacking of geo bags and porcupines and wire net shall be done by manual labours no equipment, machinery will be involved in the project activity. Thus, contamination due to carriage of material, leakage of chemical, exposure to machineries is insignificant in the project area.

Outer Buffer Zone: area delignated between 500 meters to 1000 meters (1 km area).

The risk associated to the project interventions has been analysed based on the following stage of the project activity:

- During Designing & construction phase which would be temporary and short term.
- During the operation phase which would have long term effects

Impact on Land

- The project activity involves, rehabilitation and strengthening of the existing embankments, Riverbank protection works, Flood embankment, rehabilitation of existing embankment against flood on various locations, apron work at Dibrugarh (19370 m)-Tinsukia (13200 m) and embankment work at Maijan reach-2 and Oakland Dyke. During site visit it was observed that major land use along the project sites at Tinsukia District are under Tea plantation. In Dibrugarh district the land use varies along with the project sites. The project sites near the Dibrugrah town, comprises of settlement area; Chaulkhowa At D/S Of Bogibeel Bridge and Nagakhelia is under vegetation cover, U/S Of Bogibeel and At Mohpuwalmora is majorly under agricultural land and RoW of embankment work at Maijan reach 2 and Oakland Dyke sites are under Tea plantation. The extent of project' ROW is 25-30.45m. The change in land use is assessed as under low impact category. The changes in the land would be temporary and confined to the project site and its inner 500 m buffer zones. The effective mitigation measures throughout the construction and operation phase will significantly reduce the negative impact.
- **Temporary Change in land use:** Based on satellite imagery and GIS interpretations/ land use analysis of the project, the project area at Dibrugrah district 28% land use under vegetation cover, 29% under river sand & followed by 13% water body, and 11% agricultural land within 1 km buffer area of the project. In Tinsukia district 26% of land use under vegetation cover, 29% river sand followed by 13% water body and 11% agricultural land. (Refer- Land Use (Technical note) Table: 2 Land use area within 1 km Buffer Zone on either side of the Project locations of Tinsukia District & Table: 4 Land use area within 1 km Buffer Zone on either side of the Project locations of Dibrugarh District.).

  The total area affected by the project in Tinsukia District is 33 Ha. which would be used for river protection work and for embankment. It is about 0.058% of the Total Area under 5 km study area (56486.46 Ha) and 0.48% of the total area within 1 km study area (Total area 6822.23Ha).

  The Total area affected in Dibrugarh protection work is 0.1036% (Landuse Change) within 5 km study area and 0.65% land-use change which I km study area. The total change in landuse is less than 1% of the total study area. In the last 40 years, about 7000 ha of land has been eroded rendering hundreds of families homeless and converting productive land into unusable sand chor[84]. Therefore 175 ha of productive land is washed off into river annually in Tinsukia district. Same rate of cutting and erosion prevails for Dibrugarh.

[84] Source DPR for river protection work, Chapter4, section 4.1.

Risk Of Non-Compliances for Regulatory Provisions- since the project location is located within the Eco - Sensitive Zone, so prior NoC from NBWL/ SBWL under The Wildlife (Protection), Act -1972 is required. The list of Project falling within Eco-Sensitive Zone of Dibru-Saikhowa National Park is given in table below

Details of Project with respect to Wildlife Boundary and ESA Area

Name of Project	Wildlife Boundary	Eco-Sensitive Zone	Comments is any
Milanpur to Hatighuli	363 meters	Within	NoC required from SBWL/ NBWL
Phelai to Naokota	937 meters	Within	
Gariating Gaon	-	760 meter Outside	-
Simaluguri Satra	-	Outside	NoC required from SBWL/ NBWL
Baghjan to Notun Gaon	331 meters	Within	
Guijan	1286 meters	Within	
Rungagorah to Dinjan	466 meters	Within	

Habitat Fragmentation during Construction Phase : project is planned over existing devastated flood plain of the river Brahmaputra which is vulnerable to flood in every year. Due to the project activities in the reach, no habitat fragmentation or degradation is anticipated. No embankment protection work is falling within natural protected area, spawning ground. Based on final ESZ notification[85], Dibrigarh Tinsukia project site 'Milanpur to Hatighuli '(nearest point) is about 363 meters towards South. However, installation of drainage sluices will improve the aquatic biodiversity's ability. It will improve recolonise by hydrophytes in Maijan Beel by maintaining water level in beels, post monsoon season. .

Animal Distribution/Migratory Route: Dolphin is sensitive to polluted water and any obstruction of the channels at this stage may disturb the breeding activities (June to August).

[85] Biogeographically, the Dibru-Saikhowa National Park represents the "North EasternIndia-Brahmaputra Valley Bio-geographical Province" (9A), having rich in flora and fauna being the transitionzone of two major biodiversity hot spots, which supports diverse fauna well adopted to life in terrestrial, aquaticand arboreal ecosystems.

Table 1-8: Dolphin's distribution in project influence area (1km radius)

Project	LAC	Revenue Circle	Dolphins Distribution	
			Within 100	Beyond 100 to 1 km
Chaulkhowa	Moran	Dibrugarh West	-	+
Milanpur to Hatighuli	Doomdooma	Doomdooma	-	+
Nagaglulit	lathowal	Dibrugarh East	-	-
Maijan Re. -2	lathowal	Dibrugarh East	-	+
Nagakhelia	Dibrugarh	Dibrugarh East	-	-
Baghjan to Notungaon	Chabua/ Doomdooma	Tinsukia	-	-
Simalugurisara	Doomdooma	Doomdooma	+	+
Mohanaghat	Dibrugarh	Dibrugarh East	-	-
Amoragurd	Dibrugarh	Dibrugarh East	-	-
ADB T-I-Mothala	Lahowal	Dibrugarh East	-	+
ADB T-II, D-3	Dibrugarh	Dibrugarh East	-	-
Gariating gaon	Doomdooma	Doomdooma	-	-

Symbol: - Not Reported; + Reported; ©Reported during monsoon

Endangered Species: Based on secondary information and interaction with locals, about 10 mammalian species reported which falls under category EN (Elephant & Tiger), NT (Otter), VU (Sambar) as per IUCN Red data List.

Other species like Chinese Pangoline (CR), Wild Water Buffalo, Ganges River Dolphins, Hog Deer, Asian Elephants, Tiger, Fishing Cat, Asian Small Clawed Otter (EN), Bos Gauru, Sambar, Leopard has been listed VU under IUCN and reported in IBAT report for project area. These species needs attention. Wildlife Management plan need to be prepared and get is approved by the wildlife department.

Migratory Routes: In Brahmaputra, the migratory fish species like Hilsa (Tenualosa ilisha[86]) and Anguilla[87] (eel fish) which migrate through the main channel of the river i.e., through the deeper zones of the river to sea. Therefore, project will not have any impact on the migratory

[86] *MIGRATORY BEHAVIOR OF HILSA, TENUALOSA ILISHA IN THE TRIBUTARIES OF BRAHMAPUTRA RIVER SYSTEM, ASSAM,* INDIA, INTERNATIONALJOURNALOF MULTIDISCIPLINARYEDUCATIONALRESEARCH

[87] *Breeds in sea. After the larva stages the adult fishes migrates to the freshwater bodies and spend their life in paddyfields, lakes and lagoons.*

route of these fishes. Other fish species like Crossocheilius, Tor also show local migratory behaviours. Their migration is from upper to lower reaches of the river and only during breeding season (Monsoon). The construction of the embankment protection measures will not have any effect on the migratory routes.

Impact on Spawning and Breeding Grounds: There are few fish breeding areas and spawning grounds along the entire stretch of each subproject zone has been reported. All fish species do not appear to breed in the same location. Breeding grounds differ by geography and fish kind. Most riverine fish species, including Baralius, Salmostoma, Danio, Gara, and others, have been found to prefer the shallow parts of rivers for breeding and spawning. For reproducing, Channa, Labeo, and similar fish prefer beel to other fish species like minnows. Seasons during which fish spawn also differ from fish to fish. But for over 80% of fish species, the typical season runs from April through August

Impact from carriage of Borrow E**arth:** Substantial quantity of the earth will be required for construction of the river embankment of crest width of the embankment of 7.5 m and a side slope 2H:1V and 3H:1V at the river side which is designed for 100-year flood return period. The quantity of borrow earth required for Oakland Dyke is 1,16,830 cum and for Maijan -2 Embankment is 99,297 88cum. This is huge amount. It is proposed that the demand for earth will be fulfilled by excavating borrow pits in the vicinity of the river embankment.

The unintended selection of borrow areas and no rehabilitation/ closing of borrow areas may lead to loss of productive use of the land in the project vicinity. The transportation of borrow earth may also cause air pollution, if transported in uncovered trucks. The contractor needs to obtain borrow earth from the approved vendor. FREEMA should see that the borrow earth supplier has Environmental Clearance for extraction of borrow earth and has approved mining plan for operation and closure prepared from register RQP (Mine) and get is approved from district mining officer. The mining closure plan need to comply with MoEF&CC guidelines for minor minerals.

Loss of topsoil: Top 25 cm of the new borrow area and proposed ROW of Embankment need to be removed and preserve. These top soils are rich productive soil and need preservation. During mining closure. It can be spread in borrow area and plantation done accordingly. It can be also given to the nearby farm and Tea Estate for restoration of damaged lands.

Soil erosion: potential of an area depends on its topography, geological structure, rainfall, soil type, and land use/ land cover. In the project reach, the topography of the terrain comprises of alluvial floodplain though out the project region and buffer zone. There is a general lowering of the gradient of the area from southeast to the northwest. From the highlands in the south-eastern side covering foothills of the Due to the relatively steeper slopes and friable rocks structure, the soils in the upland areas are easily erodible and during heavy rainfall, the rivers in the valley part of the basin show more of a depositional character due to their greatly reduced slope, transport of higher sediment load from upstream areas and congestion of drainage. During construction stage, soil cutting, embankment protection work will create soil erosion if the compaction not done properly. The agricultural activity along the river bank and encroachment also causes soil erosion.

[88] Source DRP for Zone -A

The river protection work should be done during lean period. Mostly from October to February, when water flows in main stream away from the river bank. This is finding is based on primary survey. This will minimize cutting and erosion and increase in water turbidity of Brahmaputra River.

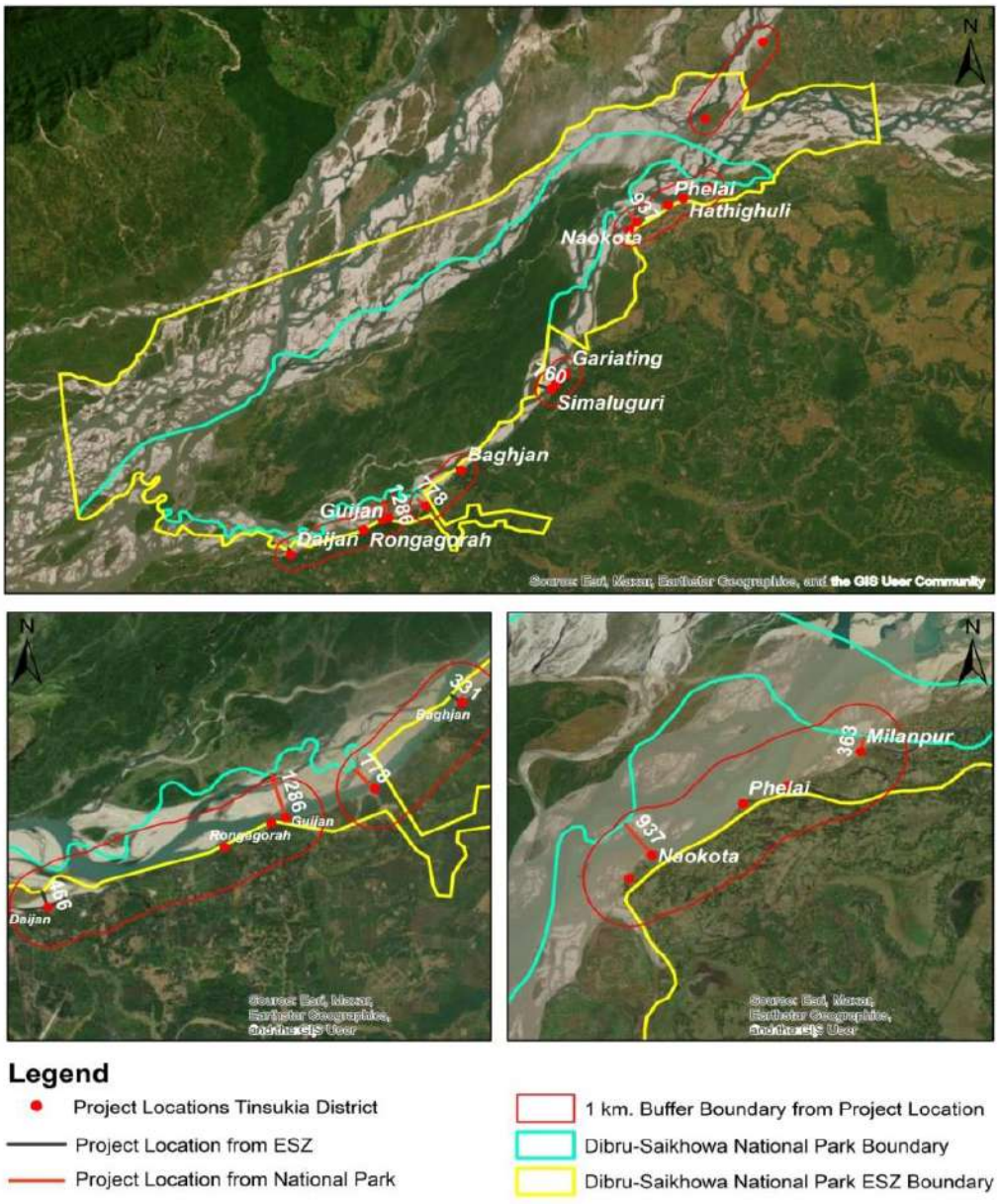


Figure 1: map showing location of project with ESZ at Tinsukia district.

Figure 2: Tea Garden and Tree cover area at u/s of Guijan ongoing works

Disruption in the access to the embankment construction site is mostly through the single lane rural roads (paved and unpaved both). These roads would require strengthening to sustain the heavy trucking load. Carriage of material may disrupt the existing condition of the roads. Peak hours of the day should be avoided for transportation of borrow earth.

Contamination of soil: Soil around construction site, haulage road, construction camp, and workshop, may be compacted and contaminated due to transportation of material machine and vehicle. Since about 30 to 40% of land in the closed vicinity of river embankment is under vegetation cover and tea garden the contamination may negatively impact the vegetation cover and tea garden, soil fertility.

Location of the project: The project location such as Milanpur, Phelai, Naokota, Guijan at Tinsukia district are located inside to the Dibru- Shikowa National Park ESZ boundary. Prior approval before start of protection work need to be obtained from SBWL/ NBWL. NoC condition need to be implemented. The Wildlife Department needs to be engaged during river protection work in ESZ.

Trimmed Earth from River Bank: about 77545.35 Cum trimmed earth (which is 60% of total) will be shifted in Tinsukia and 151201.50 cum[89] (60% of trimmed earth) will be shifted in Dibrugarh

[89] DPR for Sub project Zone -A

Sub Project. The locations for dumping of trimmed earth from river bank need to be identified prior to start of work. It should not be stocked on river bed.

Disposal of Excavated Material during construction: The proposed project will have construction involved and as such if the management and disposal of excavated material is not properly done, it will impose a problem to local people and residents. It will also result in water pollution and degradation of adjacent agricultural land. Because the project site is located in the Eco Sensitive Zone, disposal of construction should be managed. A waste disposal plan should be prepared with locations identified for disposal. No waste should be stock on river bed or in vicinity agricultural land. Reusing of Geo bags and its disposal during rehabilitation work will be an issue if not managed properly. However, Geobags are made up of biodegradable material and PVC coated. This would be a temporary impact if haphazard dumping of used and teared geobag done at the site and suitable mitigation measure is not adopted. It should not be dumped on river bed or allowed to be washed off in Brahmaputra River.

The location where adaptation work has been proposed, i.e ADB T-II-D1, ADB T-I-Mothala and ADB T-II-D3 (All in Dibrugarh), proper management of RCC Block need to be adopted. It should be either re-used at existing adaptation work sites or used at other suitable locations. It should not be dumped on river bed. It should by no mean crushed and reused for adaptation work. Will have sieve impact on water quality.

- These impacts will be minor and limited to the construction phase only. No major impact on soil quality is anticipated.

Surface Water Pollution: Surface Water pollution is expected if not managed properly during bank protection and adoption work. During trimming work, care should be taken that, soil does not reach the flowing water. if required, temporary cofferdam should be installed and undertaken soil work. The extraction of sand from river bed for geo-bag filling should be from sand bars where there is no water flow. If not taken care suspended silt in water flow will increase. Monsson season should be avoided. The boat which are driven by diesel engine should be not spill fuel in water. The old engines in boats, where water from the river are taken in the diesel engine for cooling were common source of river water pollution. There should be checking mechanism adopted by FREEMA, in selecting boats for bank protection work. The old boat should be avoided. Over loading on boats should be avoided.

At embankment site like Maijan -2 where Maijan beel is in adjacent. The contract should carry out embankment work in non-monsoon season. Provision of silt traps should be available. Unexpected rain in Assam state is very common. Embankment soil should be stabilized regularly. Maijan Beel receive water from Brahmaputra River as back flow water through connecting stream. No burrow soil should be dumped in this stream. Siltation and runoff during rain would result in increase in suspended particles. This would affect primary productivity of Maijan Beel. During Monsson spawning of fishes take place. The schedule of embankment work should be planned in manner that it is over before arrival of monsoon. The slopes of embankments should be

stabilized adopting bioengineering measures. Grassing, seeding and mulching are biological measures. Geo membrane may be installed to prevent embankment from cutting.

- The soil used in embankment should be tested for pollutants like heavy metals. Polluted soil if reaches Maijan Beels with storm water. Will affect water quality. This would affect beel productivity.
- The project's construction is anticipated to take 3 years to complete. The majority of the workers would be locals or from the immediate area. About 50 fifty unskilled and semi-skilled labours will be engaged (day labour). No labour camps. The contractor will provide drinking water and 15 LPCD for flushing (MoEF construction manual). No labour should be allowed to do open defecate on river. This would result in increase in total coliform and faecal coliform in river water. There should be provision of mobile toilets at all construction sites. Makeshift rest area should be provided at each bank protection and embankment area. No material storage camps labours camps, borrow earth be allowed within 500 meters from riverbed and 1 km from the forest and Eco-sensitive Zone. If labour camp is required for skilled labours rented houses can be used. There should be provision of septic tanks and soke pits in all labour camps. There should be 1 toilet among 15 female and 1 toilet for 10 males. If construction camps are provided for skilled labour, I individual would require 6m^2. Therefore, labours camps should be designed accordingly.

Impact on River Bed due to Sand Extraction: The sand extracted from the river bed for Geo bags filling need to have approval from regional office of mines. The WRD should get mining plan prepared and get it approved through RQPs and mining office. The extraction of sand should not be near to river bank. This would lead to damage in bank by cutting of underline sand. No excess sand should be extracted. The extent of extraction should be as per the approved mining plan.

Tree Felling: The tree falling within 25 meter of bank protection work may involve cutting and removal. Before start of felling, tree numeration with species name, girth size should be prepared. Approval needs to be taken from regulatory agency. Young trees can be replanted at identified site. Compensatory plantation in ratio of 1:10 needs to be carried out. Plantation should be species wise. For an individual species cut, ten time the same species need to be planted**.**

Ground Clearance: project would involve clearance of ground covers, which are mostly shrubs, followed by herbs and grasses. The shrubs reported are invasive weeds like lantana (dominant species). Ground clearance would lead to expose of underneath soil to rain and winds. This would result in water pollution during rains and high winds. The planning should be in manner that working zone should be cleared of bushes and shrubs.

Geo bags application completely cover the benthic zone of the river bank slope that might impact on benthic habitats. However, based on earlier research the anticipated impacts on benthic zone are local, short term, and reversible. The high siltation rate over geobag within a year restores the benthic habitat. During installation, the fish habitat might be disturbed and some damage to benthonic and planktonic community. In addition, the covering of river bed with geobag in limnetic zone may have some effects on small fish species by limiting their feeding opportunity. Study on

work of similar nature found that the regeneration of algae and benthos community over the geobags were found, that indicates the restoration of food sources for fish. The covering of the river bed (limonitic zone) by geo bag may affect the bottom fishes. After placing of geo-bags, the fishes those live in holes may migrate. [90]

During post construction phase, encroachment near embankment for habitation, cultivation, cattle grazing, etc may affect embankment stability. Since the villagers residing along the river bank are majorly flood impacted victims, after flood protection work, their activity may get boost and gradually if proper maintenance or awareness drive with local villagers not taken, will result in degradation of embankments.

Many a times, villagers/local residents also cut the embankment or revetment to create approach to river side for their movement for toileting, cattle grazing, fish farming, navigation approach, agricultural activities etc.

Additional to this, borrow pits if not rehabilitated properly may create an unsafe landscape in the project influence area. This would result in accidental hazards. Proper borrow pit closure needs to be implemented meeting the guidelines of MoEF&CC.

Reduction in soil erosion: Rehabilitation of existing cut embankment and geo work will reduce the further embankment cutting and soil runoff. This will stabilize the river banks and indirectly elevate the socio-economic productivity of the region.

The proposed project will have net benefits in terms of soil erosion and in preventing progression of agriculture productive land loss. Soil erosion may still occur, and early detection and remedial measures shall be taken for safety of the embankment.

Impact on rive morphology: Since the proposed flood protection measures along the Brahmaputra are mostly focused on strengthening existing embankments, their effect is considered to be negligible. The current bank line will be confirmed and stabilised by the proposed bank protection measures, while the pro-siltation actions will have no appreciable impact on overall bed levels. In conclusion, it is anticipated that the proposed improvements won't have any negative consequences on the river's dynamic shape.

External Impacts on Flood and Drainage: The envisaged construction will improve protection from widespread flooding for flood-prone communities behind embankments. The proposed anti-erosion and pro-siltation measures will not have substantial impact on river morphology, flood behaviour, or general cross-sectional sediment behaviour. Embankments are only going to be

[90] Md. Sarfaraz Wahed, Md. Shibly Sadik* And Syeda Mohsina Muhit, Environmental Impacts of Using Sand Filled Geo-Bag Technology Under Water in River Erosion Protection of Major Rivers In Bangladesh, International Conference On Environmental Technology And Construction Engineering For Sustainable Development Icetcesd-2011, March 10-12, 2011, Sust, Sylhet, Bangladesh.

moved 25–30 m from where they are now, thus neither the storage of the floodplain nor the conveyance of the cross-section will alter much.

Changes in Water Levels: The conveyance capacity of the Brahmaputra will remain unchanged by the proposed works on the southern bank. Accordingly, the proposed works will have no noticeable effect on river water levels. The risk of abrupt, catastrophic flooding will be reduced. It will also result in more predictable and stable water levels on the flood plains (particularly from temporary local inundation throughout the flood season).

Impact on Silt Deposition and Bed Level Change: the Brahmaputra River carries the second-highest amount of silt in the world. The significant sediment content is predominantly mobilised during the heavy flood season flows, which frequently results in dramatic changes to the platform (river appearance on maps). While the finer silts and clay make up the floodplains, the coarser sediments, such as sand and more upstream gravel, generally create the riverbed. They are transported through the channels to the sea without being settled and make up the wash load in the river. The finer sediments don't settle until after flooding and in places where there is no discernible flow. Embankments protection work will not have impact on silt deposition and bed level changes work in long run.

Effect on Subproject Drainage System: The embankment acts as a barrier for the drainage of accumulating countryside water into the Brahmaputra during the wet season. The proposed works will have no additional adverse impacts on drainage.

Impact on climate

The planned project is not expected to have a direct effect on the climate of the research region. Climate change can have a significant impact on the planned project because of what it means for inland/freshwater wetlands, water supplies, and water availability. India's Initial National Communication (Natcom 1) Project investigated the effects of climate change on the nation's water supplies. The study found that the effects of climate change on inland wetlands would be complicated and dependent on a number of factors, such as temperature rise, rate of evaporation, changes in catchment precipitation, changes in nutrient cycling, and responses of various aquatic species. Despite the fact that tropical lakes are less susceptible to the effects of climate changes. Marshes and swamps with shallow water would be significantly more sensitive to rising temperatures and less precipitation. The Brahmaputra basin may experience more flooding as a result of this. Since there are conflicting opinions regarding the aforementioned findings, they cannot currently be taken into account for any design changes until more detailed and reliable information regarding the impact of climate change on river hydrology in this area is available.

Air & Noise environment – Construction Phase

The ambient air quality of the area is good. The level of PM 10, PM2.5, NOx, SO2, CO, is much lower at the locations monitored (at Dibrugarh, Tinsukia) than the prescribed National Ambient Air Quality Standards for rural areas (Refer Environmental Monitoring data report). The monitoring result for Particulate Matter of size 10µ (PM10) level at zone A, is within the National

Ambient Air Quality Standard (100 µg/m³). The highest value of PM 10 µg/m³ is reported 65.9 µg/m³ sub project Zone-A (Village 1 no. Kardoiguri, Tinsukia District). This is due to industrial area nearby. While various construction activities will increase the ambient air quality, but the level is likely to remain within the prescribed standards.

There will be two main types of air emissions throughout the construction phase i.e., mobile sources and stationary sources. Vehicular emissions and fugitive dust come from mobile sources like haulage of construction material on paved /unpaved roads, the stationary sources include excavation and grading equipment, and other equipment if in use. In addition to this, dust emissions from storage and handling of borrow earth and sand materials will account for air pollution in the form of particulate matter. The anticipated impact during construction phase is localized, except the transport of borrow earth to embankment site. Th transport vehicles used should have PUC certificate and should be covered.

As per baseline monitoring record of the project locations in each zone, it is perceived that ambient noise level of the project region is well below the permissible limit. During construction phase, noise will be generated from various activities such as site clearing, excavation, erection, finishing etc. The general noise levels during construction phase are due to working of heavy earth moving equipment and machineries. This result in background noise level upto 100 dB(A) or more. As per the proposed plan, manual labour was likely to be preferred with limited use of machinery. Only excavator / grader will be used which will have some noise level (at 85 dBA).

In addition to the aforementioned, there will be a considerable increase in vehicle traffic for the transportation of supplies. The increase in vehicle movement will be significantly increased for transported of borrow and trimmed earth.

The primary impact of noise level would be mainly on workers operating high noise generating machines, if appropriate control measures are not adopted. Schools and educational institutes, temples may suffer temporarily due to the elevated noise levels. Increase of noise level at night may produce disturbances, causing sleeplessness in people in the vicinity of the site in case construction activity is extended into the night hours. However, these impacts are of temporary in nature, lasting only during the construction period. The sensitive receptors identified at project locations are:

Table 1-7: Sensitive receptors pertains to Noise.

Name of project area	No of sensitive location within 100 m vicinity
Dibrugarh	24
Tinsukia	10

Operation stage

Noise Impact

During operation stage, no major noise generating activity will be happened at the project area only the prime source of noise pollution during operation phase will be the vehicular movement for embankment protection maintenance purpose which will be periodically.

Impacts on Wildlife Habitat. No direct impact is anticipated during operation stage except accidental damages. Inappropriate opening of the sluice gate may have substantial damage to the ecosystem.

Socio Economic

Design and Construction Phase

Impacts

A number of reasons might cause social conflict during the planning and implementation stages of riverbank protection work. Some of the most common causes of conflict are:

Stakeholders may feel excluded or neglected if they are not kept informed of project intentions and progress. This might result in animosity and mistrust, which can lead to conflict. Concerns about the project's impact on the environment and its residents may cause conflict between various interest groups. The project may necessitate the purchase of land or the utilisation of already existent government land. Conflicts between landowners, contractor, and other parties with stake in the property may result as a result. Projects may be delayed or scaled back due to funding issues. This can cause frustration and conflict between stakeholders who have different priorities for the project. Construction work can be hazardous and safety concerns can lead to tension among employees, project managers, and local residents.

During the construction phase of the project, there may be establishment of construction camps that will add to the population of the project locations. Migrant workers will have the potential impacts of conflicting culture and lifestyle. They also compete with local labourers over job opportunities, and potential health issues such as HIV/AIDS. This shall also exert pressure on the natural resources in the project area. However, this will only be a temporary phase lasting only during the construction period.

Establishments

Design and Construction Phase

Impacts

About 100 to 150 number of houses and establishments are located close to the proposed riverbank protection and embankment work, which will be affected and need to be shift during

construction phase. (Survey pertains to Actual No. of affected HH is under process with Executive agency**)**

During construction phase, here are some of the common factors that can lead to establishment's loss: (i) Construction activities may obstruct or restrict access to a business, education, health facility resulting in a decline in customer numbers, affect the education and health of the locality. (ii) Construction activities can generate considerable amounts of noise and dust, which can be unpleasant for nearby educational, health and businesses establishment. Customers may be less likely to visit a business that is affected by noise and dust. (iii) Construction work could lead to changes in traffic patterns, which may impact the movement of the local community and local businesses. This may result in revenue loss for businesses. (iv) Construction activities can cause unintentional harm to surrounding structures, including businesses. This damage could require repairs, leading to a decline of income for the business as a whole. (v) In some cases, construction activities may require the temporary closure of an educational and business for a period of time. This can lead to a significant loss of revenue and affect the education of the students.

Various Educational, business structure is located near to the riverbank protection and embankment work.

Archaeological Sites to be Impacted

No archaeological sites will be impacted due to the proposed construction of riverbank protection and embankment work in Dibrugrah and Tinsukia Districts. The list of Archaeological Sites and Monuments in Dibrugrah and Tinsukia district along with nearest distance from the proposed project locations area presented in below Table.

Name	Distance from Project Location
Raidongia Doul, Kalakhowa, Dibrugarh	9 km From Chaulkhowa
Moiramora Doul, Khamtighat, Dibrugarh	Beyond 10 km Mohpuwalmora
Bezor Doul, Dimou, Dibrugarh[91]	Beyond 10 km From Chaulkhowa
The gun of Emperor Sher Shah, Sadiya, Tinsukia	Beyond 10 km from project site.
The two swivel guns belonging to the Mughal Nawwara, Tinsukia[92]	Beyond 10 km from project site.

91 https://archaeology.assam.gov.in/information-services/detail/list-of-protected-archaeological-sites-and-monuments
92 https://asi.nic.in/alphabetical-list-of-monuments-assam/

Places of Common & Cultural Priority Resource and Tourism to be impactedPlaces of cultural Priority and tourism may be impacted in a number of ways throughout the planning and construction phases of the projects. The following are a few typical impacts:

Access to tourist and cultural places may be restricted or blocked by construction works, which will inconvenience and interrupt tourists. Religious rituals may be interrupted if places of cultural Priority are affected by construction. Construction activities can produce high levels of noise and dust, which can be disruptive to nearby places of pilgrimage and tourism. This can lead to a decrease in the number of visitors to these sites. The list of establishment, Common & Cultural Priority Resource and Tourism places within 1 km buffer from the project locations which may be affected during the construction phase are listed in the Table 1-11.

Table 1-11: Name of Establishments, Common & Cultural Priority Resource within 1 km buffer from the project locations.

Name of Establishments, Common & Cultural Priority Resource	Type of Establishment	Distance from proposed Project locations.
Wakhabi L.P. School	Educational	35 m from U/S OF BOGIBEEL RoW
Aithan dighalia L.P.chool	Educational	400 m from MOHPUWALMORA RoW
Tingkhong matikota shiv mandir	Religious	250 m from MOHPUWALMORA RoW
Tingkhong mohpuali mora shiv mandir	Religious	120 m from NAGAKHELIA RoW
Brahmaputra valley cadets academy	Educational	50 m from NAGAKHELIA RoW
Naga khelia gaon lower primary school	Educational	200 m from NAGAKHELIA RoW
B.N.P. H.S. School	Educational	200 m from ADB_T-II-D3 RoW
Dibrugarh state hospital (civil hospital)	Hospital	800 m from DTP DYKE (DIBRUGARH TOWN AREA) RoW
Graham bazar girls' high school	Educational	450 m from DTP DYKE (DIBRUGARH TOWN AREA) RoW
Astha hospital	Hospital	400 m from DTP DYKE (DIBRUGARH TOWN AREA) RoW
S.I.P.E law college	Educational	200 m from DTP DYKE (DIBRUGARH TOWN AREA RoW
Chandmari masjid	Religious	50 m from DTP DYKE (DIBRUGARH TOWN AREA RoW
Swastha Hospital	Educational	500 m from DTP DYKE (DIBRUGARH TOWN AREA RoW
Naliapool jama masjid	Religious	650 m from DTP DYKE (DIBRUGARH TOWN AREA RoW
J.J. Memorial hospital	Hospital	500 m from DTP DYKE (DIBRUGARH TOWN AREA RoW
Dr. Radhakrishnan school of arts, commerce & science	Educational	500 m from DTP DYKE(AMORAGURI) RoW

Name of Establishments, Common & Cultural Priority Resource	Type of Establishment	Distance from proposed Project locations.
Dr. Damani's nursing	Hospital	450 m DTP DYKE (DIBRUGARH TOWN AREA) RoW
Jagannath mandir, dibrugarh	Educational	180m DTP DYKE (DIBRUGARH TOWN AREA) RoW
Aditya hospital and diagnostic	Hospital	800 m DTP DYKE (DIBRUGARH TOWN AREA) RoW
Maijan te L.P. school	Educational	300 m NAGAGHULI TO 7400 FT SPUR RoW
Assamness Evening Hotspot	Tourist Place	REACH 2 MAIJAN RoW
Simaluguri satra		40 m from riverbak SIMALUGURI SARA
Dinjan hindi english L.P. School	Educational	900 M RONGAGORAH TO DINJAN RoW
Dinjan assamese high school	Educational	900 m RONGAGORAH TO DINJAN RoW
Divine mercy catholic church, nowkata	Religious	50 m from NAOKATA AREA RoW
Hatighuli high school	Educational	450 m from MILANPUR TO HATIGHULI RoW
Na bormura shiv madir, 2 no na bormura	Religious	600 m from MILANPUR TO HATIGHULI RoW
Kerani L.P. school	Educational	350 m from SIMALUGURI SARA
Rani Ghat Picnic Spot	Tourist Place	RoW from RONGAGORAH TO DINJAN RoW
Rongagorah tea Industry	Industry	Within RONGAGORAH TO DINJAN ROW
Guijan Picnic Spot	Tourist Place	50 m from U/S OF GUIJAN ONGOING WORKS RoW
Baghjan Assamness Hotspot	Tourist Place	Within BAGHJAN TO NOTUN GAON RoW
Kolapani Tourist Hotspot Assamness	Tourist Place	Within BAGHJAN TO NOTUN GAON RoW
Dibrugrah Town	Commercial	Within 100 m from the project sites near Dibrugrah Town.

Water Supply and Sanitation

Design and Construction Phase

Impacts

In DIbrugrah and Tinsukia district out of the total 7,028 & 3213rural habitation, 5,513 & 1,846 habitation area fully covered with Drinking Water Supply and 1,270 & 8,67 habitations are partially

covered [93] Under jal jeevan Mission- Har Ghar Jal 1,19,907 (43.87%) & 1,14,264 (44.86%) rural household connected with tap water out of 2,73,293 & 2,54,686 HH in rural Dibrugrah and Tinsukia.[94] Apart from the water supply from government department riverine population also dependent on ground water and river water for their daily need.

Ground water of the Dibrugrah & Tinsukia district is colorless, odor-less and free from turbidity and suitable for both domestic and irrigation purposes. Fe content in most part of the Dibrugrah district is below 5 ppm in ground water. But, in and around Tengakhat area, Dibrugrah and in some places of Tinsukia concentration of iron is found more than permissible limit for drinking purpose and requires treatment before being used for drinking purposes.

Accidents and Safety

Design and Construction Phase

Impacts

The worker working during the construction face would be subjected to injuries and health hazard if precaution at workplace is not taken. Riverbank protection work can involve various safety issues, both for the workers carrying out the work and for the general public. Here are some potential safety issues to consider.

Slips, trips, and falls: Workers may be at risk of slips, trips, and falls, particularly when working on sloping riverbanks, elevated work platforms.

Machinery accidents: Riverbank protection work often involves the use of heavy machinery, such as excavators, which can pose a risk of accidents if not operated safely.

Workers and members of the public may be at risk of drowning if they fall into the river during the construction phase.

Construction vehicles and equipment may cause traffic congestion and accidents if not properly managed, particularly if the riverbank is located close to a road or other busy area.

Navigation

Design and Construction Phase

Impacts

Navigation can be impacted during the construction phase of the project. Here are some of the potential impacts:

Restricted access: During the construction phase, access to the river may be restricted, making it difficult or impossible for boats to navigate through the area.

[93] Public Health Engineering Department (PHED), Government of Assam

[94] https://ejalshakti.gov.in/jjmreport/JJMVillage.aspx

Altered river flow: Changes in the flow of the river resulting from the construction of protective structures can also impact navigation.

Increased sedimentation: Construction activities can cause sediment to be stirred up and deposited in the river, potentially affecting the depth and width of the channel.

Hazardous conditions: During construction, hazardous conditions may be present in the river, such as debris or submerged equipment, which can pose a risk to navigation.

People use this river section as a means of transportation to travel from one riverbank location to another and for fishing. For these movements, they use small motorboats, temporary fish landings, or boat ghats. Thera are small ghat use by the local people for transportation of goods and people from one place to another, which may be affected during the construction phase.

Conclusion:

In view of above, it is culminated that the project interventions such as rehabilitation of embankment, flood protection measure on reach etc. may cause minor to moderate impact during construction phase and which will be confined to the particular project locations. All the identified environment and social risk are temporary in nature no permanent impact as such noticed.

The project will have positive benefit on the locals in terms of flood protection measure stabilization on their day-to-day activity and uplifting of their socio economics situations, which will go very good positive impact on the long time.

Based on the rating analysis criteria done for the project location, it is considered that the majorly the project activities are of minor in nature, except few which are rated moderate. Which will be mitigated through effective environment plan. A good design of embankment measure, Geo bags measure in rehabilitation of existing eroded embankment has considered high flood level; low flood level of the project area, the riverbed level will definitely create positive interventions in terms of flood protection.

During community consultation and the Focus group discussion, it was notice that project due to recurrent flooding in that project region has devastated lot of economic property and their reducing socio economics conditions. The project will definitely increase the productivity of the region and reduce the Havoc of flood.

Due to the project, no negative cumulative impact as such has been observed. The major E&S impact which is already explained. They are temporary in nature. Cumulative positive impact can be considered like social upbringing and stabilization of the locality, improvement of ecological habitations of that region.

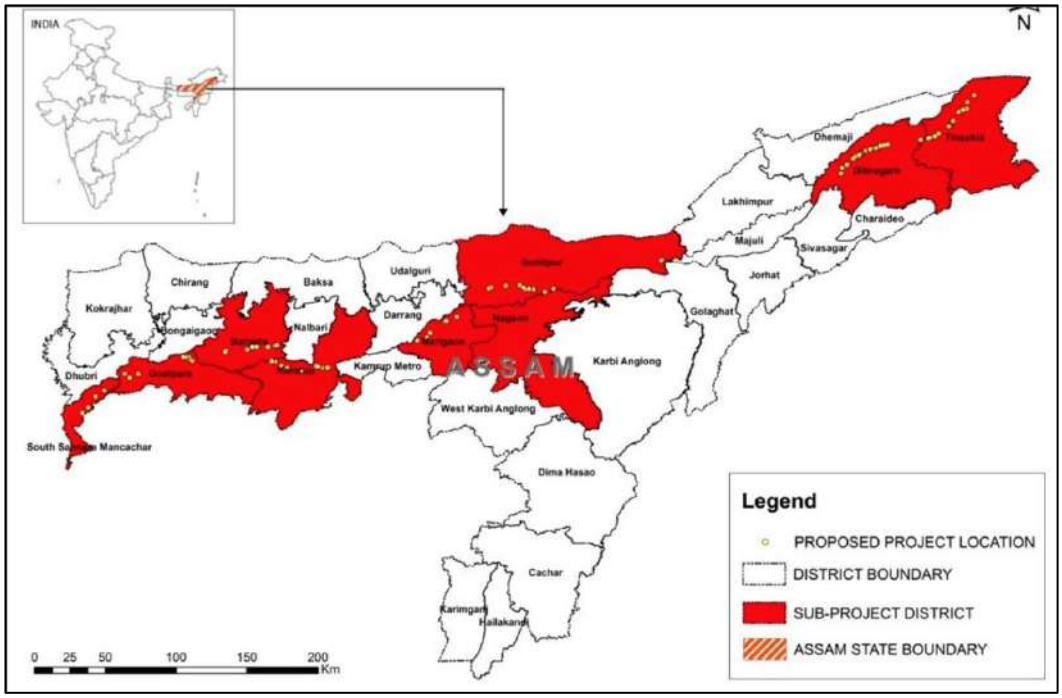
Using of locally available construction material like soil, locally made Geo bags will also increase the overall sustainability of the project, the project activity will majorly involve manual method of stacking Geo bags, stitching and establishing erosion protection measures along the river will not lead to contamination in soil water and air of the project area.

Appendix 2: Cumulative Impacts of the Project

Scope of Works

1. All the project components are along banks of the Brahmaputra River. The works are spread across 5 districts – Goalpara (Goalpara Subproject), Kamrup Rural (Palasbari–Gumi (PGP)/Guwahati West Subproject), Morigaon (Morigaon Subproject), Dibrugarh and Tinsukia (Dibrugarh Subproject). Golapara Subproject is located at the western-most among the target areas, while Dibrugarh Subproject is at the extreme eastern part. PGP and Morigaon is in the middle. See below map to see locations. There is around 500 kilometers distance between the Goalpara and Dibrugrah subprojects, where proposed structural flood protection measures will be implemented at strategic sites and local levels.

Figure 1. Locations of the subprojects along the Brahmaputra River



2. The proposed activities in Goalpara involve construction of apron, bank protection/anti-erosion (AE) and embankment works in between Baladmari Char to Pahartali area (2.35 km), Goalpara town protection tie bund/spur to Natunbasti (3 km), end of Goalpara town protection tie bund to HurkakuchI near Karbala area (2.8 km) and Chunari to Jaleswar area (6 km), construction of 3 new sluice gates and launching of porcupine screens at 6 locations for a length of 4.5 km.

3. In PGP/Guwahati West, there will be construction of apron, bank protection/AE at 8 locations for a total length of 11.54 km, adaptation works/emergency contingency works for total of 8.75 km and launching of 8 porcupine screens in 3 layers covering 2.7 km. Additionally, construction of pumphouse is also proposed at Kalbhog sluice gate in Palasbari, which includes installation of 4 numbers of pump sets, construction of pumphouse and staff quarter.

4. Construction activities in Morigaon subproject will include construction of apron, bank protection/AE works in between Mikirgaon - Kathani - Tengaguri area (7.5 km), Kupatimari - Balidunga area (1.9 km), Upstream of Panchali Spur (0.25 km), Down strean of Panchali Spur to

Baralimari (2 km) and Gagolmari - Garubandha (4 km), embankment upgrading works, and launching of 7 porcupine screens in 3 layers for 1 km.

5. For Dibrugarh Subproject, activities involve construction of apron, bank protection/AE for a total length of 26.26 km, adaptation works/emergency contingency works for total of 4.65 km is proposed to be undertaken at 4 locations and launching of 173 porcupine screens in 3 layers in 7 locations. Additionally, construction of 1.2 km (new) close gap in embankment at Maijan Beel in Dibrugarh is also proposed besides A RCC triple shutter sluice gate in Maijan Beel embankment with regulator and fish pass. Adaption works of 4.65 km at 3 locations of Dibrugarh with geo-bags is also proposed.

Protected Areas

6. There are no notified eco-sensitive zone (ESZ) or protected areas (PA) in the Goalpara and PGP subproject areas. Thus, no concerns with the protected areas are foreseen.

7. In Morigaon subproject, the nearest PA is Pobitora Wildlife Sanctuary (WLS) which is around 3.22 km from the subproject intervention areas. The subproject sites are also 12.83 km from the ESZ of Amchang WLS and within 5-10 km of Orang NP, which is on the northern bank of the Brahmaputra River. The ESZ of Pobitora WLS and Orang NP are yet to be notified and thus a 10 km radius from the boundary of the PAs shall be taken as ESZ.

8. In Dibrugarh subproject, there are 2 notified protected areas (Dibru - Saikhowa NP within 1 km of the project intervention areas and Bherjan – Borajan - Podumoni WLS within 5 km of the project intervention areas. The ESZ of Dibru - Saikhowa NP has been notified and all the proposed bank protection sites are adjacent to or within the notified area of the ESZ. The ESZ of Bherjan - Borajan - Podumoni WLS is notified as well.

Cumulative Impacts during Construction and Operation Phases

Soil Environment

9. Soil erosion potential of an area depends on its topography, geological structure, rainfall, soil type and land use/land cover. In Goalpara subproject reach, the topography of the terrain covering the alluvial plain is nearly flat with a gentle gradient towards south-west. There is a presence of occasional hillocks like near the Goalpara town where the AE stretch of Baladmari ends. The soils in the subproject area are easily eroded during heavy rainfall.

10. In PGP subproject area, the topography of the terrain covering the alluvial plain is mostly flat plain except a few forested hills with elevation between 40 to 50 meters. The area also includes a large number of riverine tracts and sandy river island in the Brahmaputra River.

11. In Morigaon subproject reach, the topography of the terrain covering the alluvial plain is nearly flat with a gentle gradient. The soils in the subproject area are easily eroded during heavy rainfall.

12. In Dibrugarh subproject area, the topography of the terrain covering the alluvial plain is mostly flat plain except a few forested hills with elevation between 40 to 50 meters. The area also includes a large number of riverine tracts and sandy river island in the Brahmaputra River.

13. Possibility of occurrence of gully and rill erosion is expected in the uncovered side slopes of embankments and other freshly cut or deposited areas in all the 4 subprojects.

14. During operation phase, all the 4 subprojects will have net benefits in terms of reducing soil erosion and preventing progression of land loss. It is estimated that 10,300 Ha. of land shall

benefit in Goalpara, while in PGP 75,558.4 ha of land shall be benefited from the subproject interventions. In Morigaon subproject, it is estimated that 40,178 Ha of land shall be benefited while approximately, 26819 hectares and 40000 hectares of valuable land in Dibrugarh and Tinsukia districts respectively will be benefited in Dibrugarh subproject

External Impacts on Flood and Drainage

15. The proposed anti-erosion, pro-siltation works, and flood protection works will not significantly change flood behavior, gross cross-section-wide sediment behavior of river morphology, however, the impacts of the floods will be addressed considerably at the local level. In Goalpara Subproject, the new embankment shall have a length of 2.075 km and is an extension of the existing embankment near the Goalpara town. The embankment varies from a distance of 600m to 1km from the river front and shall protect the Goalpara Town that gets inundated and eroded during the monsoon season. In Morigaon Subproject, the upgradation of the embankment for a length of 1.15km shall protect the project area from getting inundated and eroded during the monsoon season. In Dibrugarh Subproject, the new embankment near Maijan Beel in Dibrugarh shall have a length of 1.2km and is an extension of the existing embankment near the Dibrugarh Town. The proposed bank protection measures will stabilize the banks and no discernible change in downstream flood levels is envisaged due to the embankments in the subprojects. Sluice gate with regulator and fish passes in Maijan Beel embankment and in Goalpara shall help to mitigate drainage congestion within the proposed flood protected areas.

Changes in Water Levels

16. The conveyance capacity of the Brahmaputra River at all subproject areas is enormous and will remain unchanged by the proposed works. Accordingly, the proposed works will have no discernable effect on river water levels. Changes in channel conveyance brought about by the natural processes of riverbank erosion, accretion and channel avulsion will play a much greater role in any future change in water levels. An improved embankment network will reduce the risk of sudden devastating flooding and as such provide more predictable and stable water levels on the flood plains, especially from temporary local inundation during the flood season.

17. During operations, changes in cross-section will be monitored at regular intervals to detect any changes and initiate corrective measures. The project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies. Under the project, the numerical hydraulic model of the subproject area will be used to identify low lying areas with a potential risk of deep inundation when major floods occur.

Effect on Flow Velocity/Discharge Intensities

18. The proposed interventions are not expected to have any significant effect on the overall velocity profile of the river. Works are limited to the bank or near shore areas of the river and a combination of largely passive river training and flow regulating measures will be taken up to provide an optimum flow velocity in the section. Recognizing instability and unpredictability of the Brahmaputra River, clearly two different scales need to be distinguished for studying effects of flow velocity and discharge changes: (i) the total river cross section, many kilometers in width, and (ii) the cross section of the near bank channel, typically below one kilometer in width.

19. Limited interventions along the bank do not change the cross section average flow velocities in alluvial rivers. Areas of faster flow are compensated through areas of slower flow and lower discharges, which on average even out. The average flow velocity and discharge is affected

by different river stages with increasing discharges resulting in increasing flow velocities. The lack of systematic measurements limits the present ability of quantifying this satisfactorily.

20. The magnitude and variation of discharge in the Brahmaputra River undergoes drastic changes on seasonal as well as annual basis due to the unique hydro-meteorological and geophysical characteristics of its basin. The potential increase of these natural perturbations in the river hydrograph in the wake of unfolding climate change scenario appears to be more significant compared to any minor change that may be introduced as a result of the proposed activities on or near the riverbank. The river being very wide with appreciable channel roughness due the presence of multitudes of sandbars and bed forms, transmission of any minor disturbance in the flow close to the bank to areas midstream or across the channel to the other bank appears quite unlikely. Only major proactive river training interventions like spurs protruding into the river may have direct impact on the flow pattern and channel configuration affecting it significantly.

21. Flow velocity changes along the bankline will be systematically monitored as part of the near-bank surveys. This includes establishing systematic records of discharges and flow velocities during the hydrological cycle. It is expected that this monitoring will contribute to a better understanding and a gradual optimization of the layout of structural flood and erosion countermeasures.

Impact on Silt Deposition and Bed Level Change

22. The Brahmaputra River carries the second highest sediment load of all major rivers in the world. The high amount of sediment is largely mobilized during the high flood season flows and often leads to dramatic changes of the platform (river appearance on maps). While the riverbed is largely formed by the coarser sediments especially sand and more upstream gravel, the floodplains are built from finer silts and clay. The latter constitute the wash load in the river, which means they are transported within the channels to the sea without settlement. Only after inundation and in areas without noticeable flow do the finer sediments settle.

23. Problematic at this moment are breaches in the embankments, which result in high velocities in the breach area allowing the flowing water to transport coarser, infertile sand through the breached section. This sand gets deposited downstream where the area widens, and the flow velocities drop. The resulting sand carpets are disastrous for the overwhelmingly small and marginal farmers as they render the fertile floodplain land unusable and can only be removed at great cost

24. The bank stabilization and retirement of the embankment system in the subproject area will reduce the risk of embankment breaches with associated deposition of infertile land in the breach. This will help in supporting agriculture and livelihood of the dominant small and marginal farmers.

Effect on Project Drainage System

25. The proposed works will have no additional adverse impacts on drainage. In fact, the installation of sluice gate on Kalbogh channel at Palasbari under previous ADB project AIFRERMIP has helped in resolving drainage problem and resultant inundation during heavy rainfall in the subproject area. The construction of pumphouse and installation of the pumps under

this subproject will further enhance the capacity to dispose the excess water.

Effect on Wetlands/Beels within the Project

26. In Goalpara subproject, Hasila Beel is the only wetland which has direct connection with the Brahmaputra River and a sluice gate shall be provided at the mouth where it meets the proposed embankment. In PGP, Deepor Beel is the only wetland which has direct connection with the Brahmaputra River and a sluice gate has been provided under previous ADB project AIFRERMIP at the mouth where it meets the embankment at Kalbhog in Palasbari. There is no wetland which has direct connection with the Brahmaputra River along the Morigaon Subproject area. In Dibrugarh subproject, Maijan Beel is the only wetland which has direct connection with the Brahmaputra River along the Dibrugarh reach. A RCC triple shuttle sluice gate with regulator and fish passes is proposed to be provided under the project at the mouth where it meets the proposed embankment at Maijaan in Dibrugarh. The proposed embankments will not impede the functioning of the beels, as it is not impeding the connection between the beels and the Brahmaputra River. The other wetlands in the subproject areas are Urpad Beel (Goalpara subproject), Sonai beel which is a cluster of natural lakes namely Nandini, Mer, Sonai, Raumari, Dobarani, and Patiabandha beel (Morigaon subproject) and Maguri-Motapung Beel (Dibrugarh subproject). These are quite far away from the project interventions and are connected to the Brahmaputra River either upstream or downstream of the project interventions and shall thus not be affected by the proposed project activities.

Water Quality

27. The major source of surface water pollution during project construction phase will be sewage and wastewater generated from labor camps as well as workshop areas.The project implementation period is estimated for a period of 6 years. The contractor will establish a labor camp and it is expected that 100 – 200 laborers shall stay in each construction/labor camps. It can be safely assumed that about 80% of the water supplied will be generated as sewage. Labour camps may pollute land and other nearby water bodies if discharged untreated, especially during the low flow season.

Animal Distribution/Migratory Route

28. Winter migratory birds are reported at Urpad beel (also a KBA is within 10km of Goalpara town) in Goalpara subproject, while these are are reported at Deepor Beel (PGP subproject) and at Maijan Beel in Dibrugarh District which is within the vicinity of the subproject area. Winter migratory birds are also reported in Maguri-Motapung Beel in Tinsukia District but the beel is at sufficient distance from the proposed subproject area. Winter migratory birds may also use the riverine charland/islands/sand bars and some impacts may be envisaged like poaching by construction laborers.

29. Ganges River Dolphins and other aquatic animals use the river for movement from one stretch to other. The Ganges River Dolphins is reportedly found mainly in the main channel of the Brahmaputra River. No impacts are envisaged, even if the Ganges River Dolphins enter the secondary channels close to the riverbanks. The only impacts that are probable are that of accidental hitting by the barges that shall carry materials for the project and dolphins being stuck in the shallow waters. No or minimal impacts on the movement and migration routes of the aquatic

animals and avifauna are envisaged.

Effect on Fishing Activities/Productivity

30. There are no major fish landing sites in the project areas hence fishing activities and productivity will not be disturbed during the project implementation period. The construction work will not affect the fish activity in the river as they move with the river current. The construction activity may increase the turbidity on the bank temporarily, however the impact is temporary and site-specific.

Project Benefits

31. After implementation of the project, large areas in all the 4 subprojects will be protected and will give benefit to the people for cultivation etc. Many school buildings, government institutions, rural hospitals, public utility buildings, industrial setups will be safe from the grip of erosion of Brahmaputra River. Hence, it will be great help for maintaining socio-economic development of the people for a vast area. Furthermore, the most important communication to the local people will also be in future after implementation of the project.

32. All the project areas are thickly populated and the proposed project will have net benefits in terms of soil erosion and preventing progression of land loss. Besides, a number of government and private buildings, educational institutions, public utilities, vast agricultural land etc. in the vulnerable section are also to be benefited from the implementation of this project.

33. It is estimated that 10,300 Ha. as well as approx. 3,00,000 numbers of population will be benefited from the subproject interventions in Goalpara subproject area. A vast area comprising of thickly populated, Goalpara Town, Baladmari Pt-I, Pt-II, Pt-III, Pt-IV, Goaltuli, Bhati Para, Natunbasti and Karbala areas under the Goalpara Township reach and Chunari, Sonalurtol, Baniapara, Modhupur, Natin Thonga, Takimari, Pub-Kathuri, Pachim-Kathuri, Chilarvita, Tarangapur, Tulsibari, Moamari, Jaleswar Beel, Jaleswar Bazar and Satvendi villages under Chunari to Jaleswar reach shall be protected from the annual erosion caused by the Brahmaputra River.

34. In PGP subproject, a vast area comprising of thickly populated areas of Palasbari, Mirza, Bijoynagar, Bhagawatipara, Gumi, Tapapathar, Jorsimula, Achalpaara, Boraakhat, Panikhaity, Lotordia N.C. etc., besides several small villages but also several industrial setups in the Palasbari area shall be protected. Approximately 75,558.4 hectares of valuable land as well as 5,00,000 numbers of population will be benefited from the project, as per estimates of WRD.

35. The proposed project interventions in Morigaon subproject will also protect a vast area comprising of thickly populated settlements of Pambori, Kathani, Bagalipara, Mohmari Pathar, Tengaguri Kachari Gaon, Borhollow kanda, 2 No Borkur, Balidunga, Kupatimari, Bhuragaon Rev.Town, Dighaliati, Baramari Pam, Baramari Gaon, Pabakhati, Garubandha etc. Approximately 40,178 Ha of valuable land as well as 2,00,000 numbers of population will be benefited from the project.

36. In Dibrugarh subproject area, approximately, 26819 hectares and 40000 hectares of valuable land in Dibrugarh and Tinsukia respectively will be benefited from this project. The project will benefit a population of 1800000 in Dibrugarh and 300000 in Tinsukia between Nagaghuli to Chaulkhowa and Tinsukia between Milanpur to Dinjan areas.

37. The project is likely to bring positive impact to wetlands, pond fisheries and agricultural

productivity due to protection from flood and reduced sedimentation. The introduction of NbS (as pilot) shall be beneficial in strengthening the flood protection works and embankment besides rejuvenating some wetlands along the Brahmaputra basis.

38. The project activities shall have an incremental impact on the local socio-economics by: (a) reducing impact of annual floods, (b) increase source of livelihood in agriculture, fisheries, etc. thus aiding poverty reduction, (c) creating employment opportunities in this project and else, (d) women involvement and empowerment and (e) reducing the negative impacts of climate change. The project shall have overall positive impact on the life of the inhabitants in the subproject area.

Appendix 15: Critical Habitat Assessment

INDIA: CLIMATE RESILIENT BRAHMAPUTRA INTEGRATED FLOOD AND RIVERBANK EROSION RISK MANAGEMENT PROJECT IN ASSAM

I. Introduction

Critical habitat assessment (CHA) was carried out as part the initial environmental examination of the India: Climate Resilient Brahmaputra Integrated Flood and Riverbank Erosion Risk Management Project (CRBIFRERMP) in Assam. Critical habitat refers to areas of high biodiversity value in which development would be particularly sensitive and require special attention. The purpose of a critical habitat assessment is to identify areas of high biodiversity value that meet certain criteria set in ADB Safeguard Policy Statement (SPS) 2009. Critical habitat and underlying criteria and corresponding thresholds are suggested by the International Finance Corporation (IFC) in its Performance Standard 6 (PS6) on Biodiversity Conservation and Sustainable Management of Living Resources (IFC, 2012a/2019)[95].

Critical habitat is fundamentally based on the following six criteria:

a. habitat required for the survival of critically endangered or endangered species
b. areas having special significance for endemic or restricted-range species
c. sites that are critical for the survival of migratory species and areas supporting globally significant concentrations or numbers of individuals of congregatory species
d. areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services
e. areas having biodiversity of significant social, economic, or cultural importance to local communities
f. areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.

Objectives of CHA

This report specifically prepared to fulfil the following objectives:

- Identify wildlife species potentially triggering the definition of CH
- To assess the potential impact of the proposed project activities on critical habitats and/or priority species
- To prepare biodiversity action plan to ensure that the proposed project achieve a no net loss in biodiversity.

In accordance with the environment safeguard requirement of ADB SPS 2009, the project should

[95] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps6

be able to demonstrate that no project activity will be implemented in areas of critical habitat unless the following requirements are met:

- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.
- The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
- Any lesser impacts are mitigated[96].

Steps taken for the CHA

Considering proposed project components and to fulfil the compliance to ADB SPS 2009 requirement, following steps were adopted for the preparation of CHA of CRBIFRERMP:

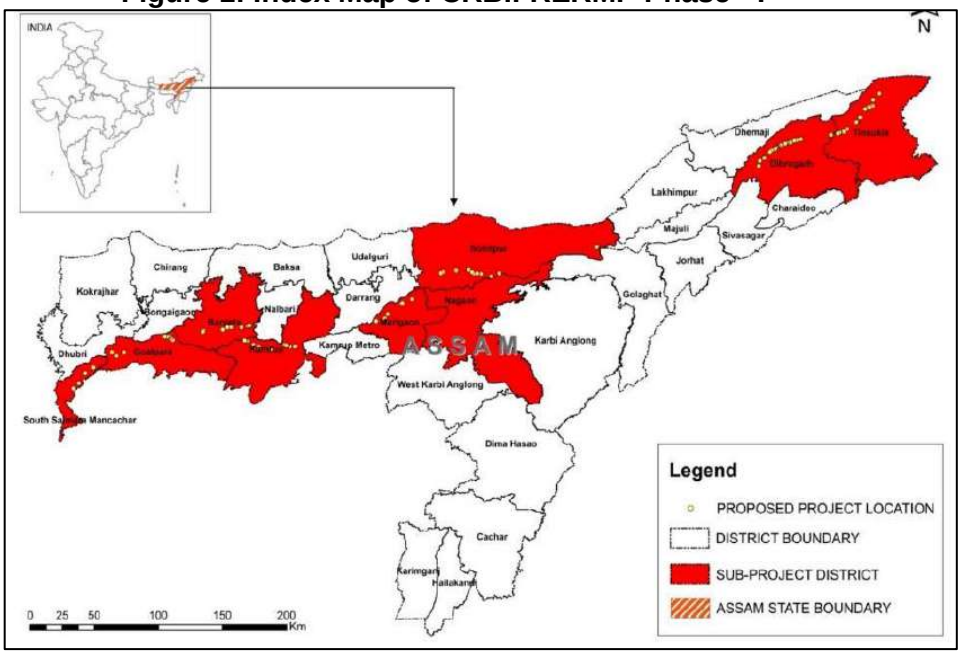
1. Understanding of subproject and scope of works
2. Identification of critical species and habitats
3. Critical habitat assessment
4. Impact assessment
5. Biodiversity Action Plan (BAP)

[96] Mitigation measures will be designed to achieve at least no net loss of biodiversity. These may include a combination of actions, such as post-project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity.

II. Scope of CRBIFRERMP

Under CRBIFRERMP four high-priority subprojects characterized by a high risk of riverbank erosion, and valuable assets under threat have been selected. The location of the subproject locations are (i) Dibrugarh, (ii) Morigaon, (iii) Palasbari-Gumi/Guwahati West, and (iv) Goalpara are shown in Figure 1.

Figure 1: Index Map of CRBIFRERMP Phase - I



Source: FREMAA and WRD

Dibrugarh Subproject

The proposed Dibrugarh subproject is partly located in Dibrugarh District and partly in Tinsukia District. The subproject areas of Dibrugarh are located from Nagaghuli to Chaulkhowa on the south bank of Brahmaputra (see Appendix 1a). The subproject covers Dibrugarh Town area and its adjoining areas up to Oakland at upstream to Bogibeel areas at downstream. The areas of Tinsukia proposed under this subproject are located in the district of Tinsukia on the south bank of Brahmaputra. The project covers South Bank of Brahmaputra from Saikhowaghat - Milanpur area at upstream to Dinjan army camp areas at downstream.

Project involves; (i) construction of bank revetment and apron works with geo-bag for a total length of 21.26 km of which 11.86 km is in Dibrugarh and 9.4 km is in Tinsukia, (ii) adaption works for 4.65 km in Dibrugarh, (iii) pro-siltation measures by providing 173 numbers of P.S.C porcupine screen over 3 layers are proposed of which 72 screens at 5 locations in Dibrugarh and 101 screens at 2 locations in Tinsukia. Further, construction of a 1.2 km (new) close gap in embankment is proposed at Maijan Beel in Dibrugarh which includes a RCC triple shutter sluice gate with fish passes. The project also proposes revival of Maijan beel with nature-based solutions (NbS).

Morigaon Subproject

The subproject area falls in Morigaon District of Assam. The subproject sites are situated between Mikirgaon in Laharighat revenue circle and Garubandha area in Mayong revenue circle. The subproject sites are under Laharighat, Bhuragaon and Mayong Revenue Circles respectively in Morigaon District of Assam. It covers thickly populated settlements of Pambori, Kathani, Bagalipara, Mohmari Pathar, Tengaguri Kachari Gaon, Borhollow kanda, 2 No Borkur, Balidunga, Kupatimari, Bhuragaon Rev.Town, Dighaliati, Baramari Pam, Baramari Gaon, Pabakhati, Garubandha etc. See Appendix 1b for reference.

There are four project components under the subproject: (i) construction of riverbank revetment and apron works with geo-bags at 5 locations for a total of 15.65 km (Mikirgaon - Kathani - Tengaguri area for 7.5 km, Kupatimari - Balidunga area for 1.9 km, Upstream of Panchali Spur for 0.25 km, Down strean of Panchali Spur to Baralimari for 2 km and Gagolmari to Garubandha for 4 km), (ii) upgrading embankment works for 1.15 km (iii) adaption works/emergency contingency for 0.25 km and (iv) 7 porcupine screens over 3 layers of pre-stressed concrete covering 1 km.

Palasbari-Gumi/Guwahati West Subproject

Subproject area in Kamrup District of Assam. The subproject sites are situated between Palasbari to Lotordia N.C area on the south bank of the mighty Brahmaputra River. This is under Palasbari Revenue Circle, Goroimari Revenue Circle and Chamaria Revenue Circles in Kamrup District, Assam. The subproject area covers very thickly populated villages of Kalitapara, Guimara Simina, Makadhuj, Futuri, Gumi, Borkhat, Panikhaity, Lotordia N.C. etc areas.

This subproject is continuation of flood protection works along the Brahmaputra River in Palasbari and Gumi areas. There are four project components under Palasbari reach: (i) bank protection works at Dakhala (Kalipatara) area for a reach of 0.8 km; (ii) bank protection works at Guimara for a reach of 0.2 km; (iii) bank protection works at Simina area for a reach of 0.64 km; and (iv) bank protection works in between Makadhuj spur and land spur no 1 at Futuri for a reach of 1.45 km. There are four components under Gumi reach: (i) bank protection works at Gumi area for a reach of 0.85 km; (ii) bank protection works at Borakhat area over a reach length of 3.9 km; (iii) bank protection works at Panikhaity area over a reach length of 1.1 km; and (iv) bank protection works at Lotordia N.C area for a reach length of 2.6 km. (Appendix 1c)

Goalpara Subproject

The project area falls in Goalpara District of Assam. The subproject sites are situated between Baladmari Char to Pahartali area, Goalpara Town protection tie bund/spur Natunbasti near and Chunari to Jaleswar area. The first two locations are in the vicinity of Goalpara Town, on the south bank of the Brahmaputra River under Matia, Balijana & Lakhipur Revenue Circles respectively in Goalpara District of Assam.

There are four project components under the subproject: (i) new embankment from end of Goalpara town protection tie bund to Hurkakuchi near Karbala area for 2.08 km (ii) construction of riverbank revetment works and apron works with geo-bags at 3 locations for a total of 11.35 km (Baladmari char to Pahartali area for 2.35 km, Goalpara town protection tie bund – Notunbasti

for 3 km & Chunari to Jaleswar area for 6 km) (iii) adaption works/emergency contingency for 0.25 km and (iv) 6 porcupine screens over 3 layers of pre-stressed concrete covering 4.5 km.

Figure 2: Use of Geo textile bags for anti-erosion works

Source: ADB TA Consultant

Figure 3: Presence of old Porcupine screens in Project Area[97]

Project Benefits

After implementation of the project, large area will be protected for erosion and floods and will give benefit to the people for cultivation etc. Many school buildings, Government institutions, rural hospitals, public utility buildings, industrial setups will be safe from the grip of erosion of Brahmaputra River. Hence, it will be great help for maintaining socio-economic development of the people for a vast area. Furthermore, the most important communication to the local people will also be in future after implementation of the project. Summary of the scope of works under the project is shown in Appendix 2.

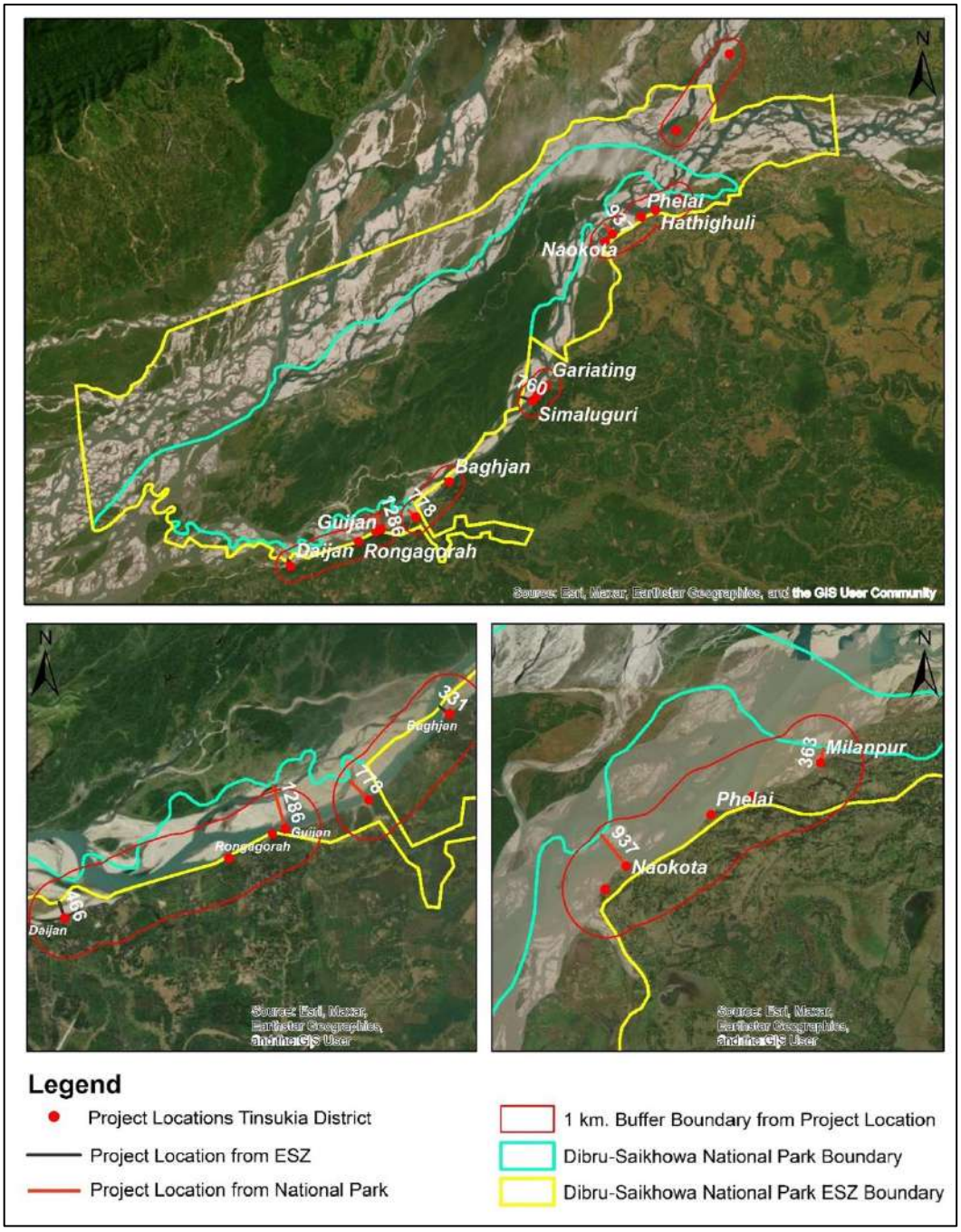
[97] Existing works by WRD in Dibrugarh subproject area (Tinsukia District) and in Baladmari char to Pahartali & Chunari to Jaleswar areas of Goalpara subproject area

III. Biodiversity Baseline in Subproject Areas

Biodiversity in Dibrugarh Subproject

A 1 km radius map were prepared to highlight protected area and eco – sensitive zone boundary of Dibru-Saikhowa. The detailed map is given in Figure below.

Figure 4: 1 km radius map of Dibrugarh Subproject Locations earmarking Dibru-Saikhowa National Park



Existing landscape in Dibrugarh Subproject

The subproject area is dominated by tea gardens, followed by settlement and less proportion of agriculture area. Few patches of land with no local use were also noticed, particularly in Bogibeel and ADB's trance I and II areas. Plantations are mainly human induced.

Mammalian Species in Dibrugarh Subproject

Based on secondary information, about 11 mammalian species falls under critically endangered (CR), endangered (EN), and vulnerable (VU) as per International Union for Conservation of Nature (IUCN) Red data List. Due to Dibru-Saikhowa National Park at the opposite bank of Brahmaputra River, there are reported presence of Chinese Pangoline (*Manis pentadactyla*, CR), Wild Water Buffalo (*Bubalus arnee*, CR), Ganges River Dolphins (*Platanista gangetica*, EN), Indian Hog Deer (*Axis porcinus*, EN) Asian Elephants (*Elephas maximus*, EN), Tiger (*Panthera tigris*, EN), Fishing Cat (Prionailurus viverrinus, VU), Asian Small-Clawed Otter (*Aonyx cinereus*, VU), Gaur (*Bos Gaurus*, VU), Sambar (*Rusa unicolor*, VU), and Leopard (*Panthera pardus*, VU). During primary survey at the proposed subproject area, no mammalian species were recorded/sited within construction zone and within 1 km radius.

Brahmaputra river is famous for Ganges River Dolphins *(Platanista gangetica).* During aquatic mammalian survey along the river bed specially where bank protection are proposed, consultation with locals, fishermen are undertaken. During primary survey the river course are far from the bank, except few. There are 12 sites in the Dibrugarh subproject were identified under bank protection works. Dolphin's distribution in the study area (1km radius) is summarized below.

Table 1: Distribution of Dolphins in Dibrugarh Subproject Area

Project	LAC	Revenue Circle	Dolphins Distribution	
			Within 100	Beyond 100 to 1 km
Chaulkhowa	Moran	Dibrugarh West	-	+
Milanpur to Hatighuli	Doomdooma	Doomdooma	-	+
Nagaglulit	lathowal	Dibrugarh East	-	-
Maijan Reach. -2	lathowal	Dibrugarh East	-	+
Nagakhelia	Dibrugarh	Dibrugarh East	-	-
Baghjan to Notungaon	Chabua/ Doomdooma	Tinsukia	-	-
Simalugurisara	Doomdooma	Doomdooma	+	+
Mohanaghat	Dibrugarh	Dibrugarh East	-	-
Amoragurd	Dibrugarh	Dibrugarh East	-	-
ADB T-I-Mothala	Lahowal	Dibrugarh East	-	+
ADB T-II, D-3	Dibrugarh	Dibrugarh East	-	-
Gariating gaon	Doomdooma	Doomdooma	-	-

Source: LASA Primary Survey; Symbol: - Not Reported; + Reported; ©Reported during monsoon

Avifauna Species in Dibrugarh Subproject

Based on primary survey and secondary findings, 61 species of birds are reported. Two vulnerable (VU) species, particularly *Ortygornis gularis* and *Streptopelia turtur* are noted.

Table 2: Vulnerable species of birds noted from site survey

Common Name	Scientific Name	Reported	Study Method	Sadia	Dibrugarh	Doomdooma	Tinsukia	Study area	Habitat
Swamp francolin	*Ortygornis gularis*	Secondary Source	-	-	-	-	-	Buffer Zone	-
European Turtle-dove	Streptopelia turtur	Sighted	Walk Through Methods	1	-	-	-	Outer buffer Zone	Orchids

Reptilian Species in Dibrugarh Subproject

Based on Integrated Biodiversity Assessment Tool (IBAT) report, there are species like Black Softshell Turtle (*Nilssonia nigricans*, CR), Assam Roofed Turtle (*Pangshura sylhetensis*, CR), Spotted Pond Turtle (*Geoclemys hamiltonii*, EN), Indian Softshell Turtle (*Nilssonia gangetica*, EN) and King Cobra (*Ophiophagus hannah,* VU) Category of IUCN Red Data Book. However, only 5 species of reptiles are reported from the buffer zone. These are common Indian Skink, house gecko, garden lizard, rat snake and cobra.

Fish Species in in Dibrugarh Subproject

To record the distribution of fish species in 1 km study area. All fishing point near settlements were surveyed. Based on primary survey from the study area in Brahmaputra River, species found were *Labeo gonius*, *Bagarius bagarius*, *Cirrhinus mrigala, Cirrhinus reba, Labeo bata, Labeo calbasu, Labeo rohita, Mystus tengra, Channa marulius, Channa punctata,* and *Rita rita*. Species of fish reported based on secondary source were *Mystus bleeker, , Wallago attu, Channa bleeheri* These are sold in local markets. Fish like *Wallago attu* and *Bagarius bagarius* has been listed under VU Category of IUCN Red Data Book.

Biodiversity in Morigaon Subproject

Landscape characteristic in Morigaon Subproject Area

The subproject sites fall in lower assam division, which is characterized by moist deciduous forests. These forests are further described as Sal Forests and Mixed Deciduous Forests. Based on land-use distribution map, the project sites falls within agriculture land-use (dominant) distribution followed by settlement area. From edge of river towards land, agriculture production is the main source income of the locals. During primary survey growth of paddy, chillis, mustards, maize, brinjal, cabbage, capsicum, gourd, better gourd, sweet potato, tomato, potatoes, etc are recorded from the subproject sites. Further, it was noted that the surface are barren except at few locations where agriculture practice are noticed.

Terrestrial Mammalian Diversity in Morigaon Subproject

The project area does not harbour rich mammalian habits. The subproject within 1 km study area has dominant agrarian habitats and no forest, wildlife national park, sanctuary nor protected area. This has also been confirmed by forest department.

Based on interaction with farmers and locals, the species reported in the study area are Jungle cat (*Felis chaus*), Asian Elephant *(Elephas maximus*), Leopard cat (*Felis bengalensis*), Wild pig (*Sus scrofa*), Small Indian civet (*Viverricula Indica*), Indian Fox (*Vulpes bangalensis*), Rhesus macaque (*Macaca mulatta*), Mangoose *(Herpestes javanicus)* and Indian barking deer *(Munitiacus muntjac).* All the species are categorized under least concern, except Asian Elephant which is declared endangered as per IUCN Red Data Book. Elephants are reported occasionally in study area in search of food, but no notified corridor reported.

Aquatic Mammalian Diversity in Morigaon Subproject

Based on primary survey and secondary information, aquatic mammalian species reported within 1 km radius are Smooth Indian Otter *(Lutra perspicillata)* is listed as Vulnerable (VU) and Ganges River Dolphin *(Platanista gangetica)* listed endangered under IUCN Red Data Book.

Distributions of Dolphins in project area is highlighted in table below. The finding is mainly based on the secondary survey through interaction with locals and fishermen. In most of the subproject site, river dolphins are not reported due to shallow depth. During monsoon when Brahmaputra River gets flooded, dolphins are reported in some sections. The details of sighting/ reporting is given in table below:

Table 3: Distribution of Ganges River Dolphins in Study Area Sub Project Zone -B

Project	LAC	District	Dolphins Distribution	
			Within 100	Beyond 100 to 1 km
Silghat	Kaliobar	Nagaon	+	Sighted
Gagalmari – Garubandha	Jagiroad (Mayong)	Morigain	-	+
Baralmari	Laharighat	Morigaon	-	-
Mikirgaon	Laharighat	Morigaon	-	©
Paken	Gohpur	Bisanath	-	-
Kalibari	Tezpur	Sonitpur	-	©
Zahaz Ghat	Tezpur	Sonitpur	-	+
Berachburi	Tezpur	Sonitpur	-	©
Jarani	Tezpur	Sonitpur	-	-
Bharasingri	Tezpur	Sonitur	-	@

Symbol: - Not Reported; + Reported; ©Reported during monsoon

Avifauna Diversity in Morigaon Subproject

The total population avifauna reported are 282 species within 1 km radius according to reports. Based on primary survey and secondary sources about 27 bird's species of avifauna are recorded from the subproject area. The 25 bird species falls as least concern, and Turtle Dove *(Streptopelia turtur)* is VU and Greater Adjutant *(Leptoptilos dubius*) is EN as per IUCN Red List.

Reptiles in Morigaon Subproject

Local farmers, people residing near banks and forest department were consulted to establish information of reptilian species and habitats in the Morigaon Subproject area. Based on interactions, 8 reptilian species were noted from during survey. These species were rat snake, cobra, common green whip snake, monitor lizard, gecko, Oriented Garden Lizard and Buff Striped Keelback. They were encounter by the farmers in agriculture fields, densely grown shrubs area and enters the houses during flooding. The reptiles reported in the study area are classified Least Concern by IUCN Red Data Book, except for the cobra (*Ophiophagus hanna* VU).

Fish Species in Morigaon Subproject

Fishermen and local fish market people were consulted to collect fish distribution in the Morigaon Subproject area. During surveys, fishing activity were also visited to interact with local fishermen and record fish catch. Based on the overall survey about 15 species of fishes were recorded from the study area from Brahmaputra River, marshy area and ponds. The species reported were Dwarf Tengra *(Mystus*), *Cirrhinus mrigala, Cirrhinus reba, Labeo bata, Labeo calbasu, Labeo rohita, Mystus bleeker, Mystus. tengra, L. calbasu, L. gonius, Rita rita, Channa*

bleeheri, Channa marulius, Channa. punctata, etc. These are sold in local markets. None of the fish species reported falls under IUCN RED list.

Biodiversity in Palasbari-Gumi/ West Guwahati Subproject

Landscape characteristic in Palasbari-Gumi/ West Guwahati Subproject

The subproject sites are mostly dominated by agricultural land. About 70 to 75 % of project area is under agriculture practices. During primary survey, growth of vegetables followed by maize were common. Based on primary survey and interaction with farmers, one crop are harvested annuals. The common vegetable reported in core zone are potato, sweet potatoes, cabbage, cauliflowers, brinjal, tomatoes, mustards, spinaches, Dhania, Gourd, better Gourd, mustard, etc. Under crop, maize are common cash crops. Trees species falling within proposed bank protection works have sparce distribution of trees. This is due to annual flooding of the area resulting in loss of trees.

Brahmaputra river is famous for its riparian habitat. Which keeps on changing due to high current in watter and annual flooding during monsoon. There exists no well-established riparian habitat. This is due to large portion of the bank are cut annually. During primary survey, the locals fears that the existing portion where we are doing survey may not exists due to cutting and erosions of banks. Walk through and transect methods were adopted to record the hydrophytes reported within the core zone. The sandbars formed in the Brahmaputra bank were also survey to study the establishment of grass land and for herbaceous habitats. The species reported during survey were elephant grass *(Pennisetum purpureum), Phragmites karkar, Ipometa aquatica, Ipomea carnea, Eichhornia crassipes, Sagittaria sagittifolia, Colocasia alocasia, etc.*

Terrestrial Fauna in Palasbari-Gumi/ West Guwahati Subproject

The project area does not harbour rich mammalian habits. This is mainly due to human induced agrarian habitat. There are no forest, wildlife national park, sanctuary nor protected area within 1 km radius. Based on interaction with farmers and locals, the species reported in the study area are Jungle cat (*Felis chaus*), Wild pig (*Sus scrofa*), Small Indian civet (*Viverricula Indica*), Indian Fox (*Vulpes bangalensis*), Rhesus macaque (*Macaca mulatta*), Mangoose (*Herpestes javanicus*), etc. All the species reported from the study area are categorized as Least Concern as per IUCN Red Data Book.

Avifauna Diversity in Palasbari-Gumi/ West Guwahati Subproject

Assam is one of the “endemic bird areas” in the world. With 950 bird species, the State is home to 53.5% of the bird species found in the Indian Sub-Continent. To establish the presence of birds in the subproject areas. Various survey methods like spot count, walk through, transect

and call detection methods were adopted. Based on the survey (i.e primary and secondary source), about 27 species of birds are reported. All remaining of these bird species fall as least concern according to IUCN Red List.

Reptilian Species in Palasbari-Gumi/ West Guwahati Subproject

Reptilian species like lizards and snakes are reported in agricultural field. During flooding, they enters the settlements area and houses. Snake bite is uncommon. The reptilian species reported are common Indian skink, house gecko, garden lizard, rat snake, cobra and common krait. Among the reptiles King Cobra (*Ophiophagus Hannah) is classified as* VU in the IUCN Red List.

Fishes Species in Palasbari-Gumi/ West Guwahati Subproject

All fishing point near settlements were surveyed to record distribution of fish species in 1 km study area. There were 11 species of fishes were reported from the study area in Brahmaputra River. Based on primary survey, the species reported were *Cirrhinus mrigala, Cirrhinus reba, Labeo bata, Labeo calbasu, Labeo rohita, Mystus tengra, Channa marulius* and *Channa punctata*. Species of fishes reported based on secondary source were *Mystus bleeker, Wallago attu, and Channa bleeheri*. Fish like *Wallago attu* has been listed under vulnerable Category of IUCN Red Data Book.

Aquatic Mammalian Species in Palasbari-Gumi/ West Guwahati Subproject

Brahmaputra river is famous for aquatic mammalian species i.e fresh water dolphins *(Platanista gangetica).* It is reported all over Brahmaputra River were depth of water and counter current for fish hunting exist. This dolphin species is categorized as EN as per IUCN Red Data Book.

Consultation with locals and fishermen were undertaken during aquatic mammalian survey along proposed bank protection. During primary survey, the river course are far from the bank and dried and exposed. At few sites, water course in form of small channels with depth less than meter were noticed. Not suitable for dolphin's habitat. However, locals also confirm that during monsoon, dolphins are observed towards the main flow of the river and don't approach the river banks.

Table 4: Ganges River Dolphin distribution in project influence area (1km radius)

Name of Project	LAC	Stretch (m)	Dolphins Distribution	
			Within 100	Beyond 100 to 1 km
Gumi	Goroimari	850	-	+
Borakhat	Goroimari	3900	-	-
Panikhaity	Chamaria	1100	-	+
Lotordia NC	Chamaria	2600	©	+

Name of Project	LAC	Stretch (m)	Dolphins Distribution	
			Within 100	Beyond 100 to 1 km
Dakhala	Palashbari	800	©	+
Guimara	Palashbari	200	-	+
Simina	Palashbari	640	©	+
Makadhu spur	Palashbari	1450	©	+

Symbol: - Not Reported; + Reported; ©Reported during monsoon

Biodiversity in Goalpara Subproject

Landscape characteristic in Goalpra Subproject Area

Based on land-use distribution, the Goalpara Subproject sites are falling within agriculture land-use and settlement area. These settlements are surround by orchids, tree plantation on bunds and within agriculture lands. After floods recedes post monsoon, cultivation of vegetable (winter season) are being undertaken such as french beans, tomotoes, potatoes, cabbage, cauliflower, beet root, spinaches, spring onion, etc. During primary survey, growth of paddy, chilis, mustards, maize, brinjal, etc were noted. These vegetables are sold to local vendors, which are later source to main nearby town.

Terrestrial Mammalian Diversity in Goalpara Subproject

The subproject area does not harbour abundant mammalian habitats. Based on interaction with farmers and locals, the species reported in the study area are Jungle cat (*Felis chaus*), Wild pig (*Sus scrofa*), Small Indian civet (*Viverricula Indica*), Indian Fox (*Vulpes bengalensis*), Rhesus macaque (*Macaca mulatta*), Mangoose *(Herpestes javanicus)* and Indian barking deer *(Munitiacus muntjak).*

Aquatic Mammalian Diversity in Goalpara Subproject

The aquatic mammalian species reported within 1 km radius are Smooth Indian Otter *(Lutra perspicillata)* is listed as Vulnerable (VU) and Ganges River Dolphin *(Platanista gangetica)* listed endangered under International Union for Conservation of Nature (IUCN) Red Data Book. Distributions of Dolphins in project area is highlighted in table below. The finding is mainly based on the secondary survey through interaction with locals and fishermen.

Table 5. Distribution of Ganges River Dolphins in Goalpara study area

Project	LAC	Dolphins Distribution	
		Within 100	Beyond 100 to 1 km
Baladmari to Pahartali	Goalpara East	©	©
Chenimari	Chenga	-	@
Natunbasti	Goalpara East	-	+
Chunari to Joleshwar	Goalpara West and Joleswar	©	©
Goalpara Town	Goalpara East	-	+
Sluice 1	Goalpara East	-	-
Sluice 2	Goalpara East	-	-
Sluice 3	Jaleswar	-	-
Jadavpur to Dongra	Baghbar	+	+
Nosheet to Baghbar	Baghbar	@	+
Sunderpara to Sujyomoni	South Salmara	@	+
Monich to Katdanga	South Salmara	@	+

Symbol: - Not Reported; + Reported; ©Reported during monsoon

Based on Assam Inland Water Transport Project, Dolphin Study Report (AIWTDS) 2019. The Dolphins population in the project area based on AIWTDs report is given in table below.

Table 6: Ganges River Dolphin's population in the subproject area (AIWTDS Report)

Location Name	No.of Dolphins Sighted
Fakirganj to South Salmara	12
Dhubri to Jaleswar	2
Dhubri to Ghat up & down	7
Total Population	21

Source: AIWTDS Report

Avifauna Diversity in Goalpara Subproject

There are 45 species of birds from Assam, which are listed in the Indian Red Data Book. Based on primary survey and secondary source in the project area about 24 bird's species are reported from the study area. All species falls under Least Concern (LC) as per IUCN Red Data Book – 2022-2.

Reptiles Diversity in Goalpara Subproject

No reptilian species were noticed during primary survey. Based on secondary information and

interaction with local farmers, the species reported area rat snake, cobra, Common Green whip snake, Monitor Lizard, Gecko Oriented Garden Lizard and Buff striped Keelback. They are mostly reported from the field and densely grown shrubs. All the reptiles reported in the study area are rated Least Concern by IUCN Red Data Book. Among the reptiles King Cobra (*Ophiophagus Hannah) is classified as* VU in the IUCN Red List.

Fish Species in Goalpara Subproject

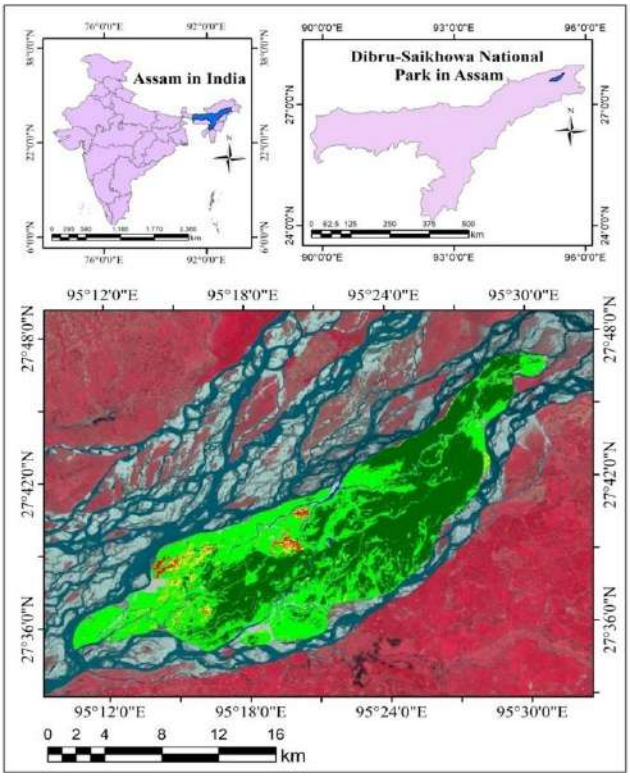
11 species reported from the study area in Brahmaputra River and from marshy area are Cirrhinus mrigala, Cirrhinus reba, Labeo bata, Labeo calbasu, Labeo rohita, Mystus bleeker, Mystus. tengra, Wallago attu, Channa bleeheri, Channa marulius, Channa. punctata, etc. These are sold in local markets. Fish like Wallago attu has been listed under vulnerable Category of IUCN Red Data Book.

IV. Protected Areas

Dibru-Saikhowa National Park represents the “North Eastern India-Brahmaputra Valley Bio-geographical Province”. Having rich flora and fauna being the transition zone of two major biodiversity hot spots, which supports diverse fauna well adopted to life in terrestrial, aquatic and arboreal ecosystems. This National Park supports astonishingly rich flora including 28 tree species, 26 species of shrubs, 2 species of parasitic plants, 17 species of grasses, 16 species of aquatic plants, 3 species of marshy plants, 4 species of climbers and scandens, 5 species of canes, 13 species of orchids, and 6 threatened medicinal plant species.

Dibru-Saikhowa National Park is a habitat for many animals and birds with a total of 36 species of mammals belonging to 10 orders and 19 families and 27 genera are recorded in the core, out of which 12 belonged to Schedule-I. Feral horses are one of the prime mammal species available in the park. The National Park supports 11 species of turtles, 9 species of lizard including two species of monitor Lizards, 18 species of amphibian, 104 species of fish, 23 different species of snakes and 104 species of butterflies besides having a huge number, about 500 species of avifauna. The area also attracts Migratory birds and is a feeding ground for a variety of aquatic and terrestrial birds.

Figure 5. Dibru-Saikhowa National Park’s location in India and State of Assam[98]



[98] Source: Shah, R.K., Shah, R.K. Forest Cover Change Detection Using Remote Sensing and GIS in Dibru-Saikhowa National Park, Assam: A Spatio-Temporal Study. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.* (2023). https://doi.org/10.1007/s40011-023-01449-4

V. Critical Habitat (CH) Assessment

CH Assessment is a process to identify areas with high biodiversity value, which are considered particularly sensitive to impacts and where special attention must be given. The CH Assessment process commences with initial biodiversity screening to identify potential CH trigger habitats or species present within 1 km of the study area (area of analysis or AoA). If such triggers are present the following process should then be followed:

1. Define the AoA area of analysis to be used for the assessment. The extent of this area will depend on the biodiversity features of interest and the ecological functions required to maintain them.

2. Determine trigger species and habitats for which the analysis is to be undertaken. Undertake desktop review of available data to understand the biodiversity within the landscape.

3. Confirm biodiversity triggers likely to meet critical habitat criteria to each biodiversity feature (see detailed information on trigger thresholds below).

4. Determine critical habitat based on assessment of all collected data.

Critical habitat is a subset of both natural and modified habitat that deserves particular attention due to high biodiversity value, which includes at least one or more criterion. The critical habitat definition of ADB SPS 2009 uses the different criteria defined in the IFC's Guidance Note 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources (updated on 2019). There is no one criterion more important than any other for critical habitat designations or for determining compliance with SPS 2009. These values are referred to as "critical habitat criteria", where each is described in the subsequent paragraphs and assessment of each species considered in the assessment.

Criterion 1. The first criterion is the presence of areas required for the survival of critically endangered or endangered species. The details to allow accurate assessment is as follows:

a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥0.5% of the global population AND ≥ 5 reproductive units GN16 of a CR or EN species)
b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a)
c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species

Table 7: Criterion 1.a or areas that support globally important concentrations of an IUCN Red-listed EN or CR species

Common Name/ Scientific Name/ IUCN RED List category	Subprojects	Comments/ Analysis	Critical Habitat Likelihood
Chinese Pangoline (*Manis pentadactyla*) CR	Dibrugarh	Species is recorded at the Dibru-Saikhowa National Park located in Dibrugarh and Tinsukia Districts, which in the opposite bank of the subproject. See Chapter IV (Protected Area) for details of distance.	Unlikely
Wild Water Buffalo (*Bubalus arnee)* CR	Dibrugarh	Dibru-Saikhowa National Park, which is a complex of wetlands, grasslands, littoral swamps and semi-evergreen forests, an ideal habitat of the species. However, no data to support Criterion 1a.	Unlikely
Ganges River Dolphins (*Platanista gangetica*) EN	All subprojects	There are approximately 2,500-3,000 Ganges River dolphins left living in the wild.[99] No actual number of individuals recorded during surveys; however local people accounted sightings of this species at main channel of Bhramaputra River.	Possible
Indian Hog Deer (*Axis porcinus*) EN	Dibrugarh	Dibru-Saikhowa National Park, which is a complex of wetlands, grasslands, littoral swamps and semi-evergreen forests, an ideal habitat of the species. However, no data to support Criterion 1a.	Unlikely
Asian Elephants (*Elephas maximus*) EN	Dibrugarh Morigaon	Population of this species has become separated from the South Bank due to expansion of Guwahati City, clearing of forest for jhum and increased human habitation along National Highway. By district, this population occurs in Golaghat, Karbi Anglong, Nagaon, North Cachar Hills, Morigaon and Kamrup in Assam.[100]	Unlikely
Tiger (*Panthera tigris*) EN	Dibrugarh	This species is found in Dibru-Saikhowa National Park and not along subpprject sites.	Unlikely

[99] https://wwfint.awsassets.panda.org/downloads/ganges_river_dolphin_2019.pdf
[100] https://www.academia.edu/102148937/Status_and_conservation_of_the_Asian_Elephant_Elephas_maximus_in_north_eastern_India

Common Name/ Scientific Name/ IUCN RED List category	Subprojects	Comments/ Analysis	Critical Habitat Likelihood
Greater Adjutant (*Leptoptilos dubius*) EN	Morigaon Palasbari-Gumi	Kamrup District in Assam is known to be a stronghold for the species, with almost 75% of its population in Assam found in this district. However, no data to support Criterion 1a.	Unlikely

Table 8: Criterion 1.b or Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species

Common Name/ Scientific Name/ IUCN RED List category	Subprojects	Comments/ Analysis	Critical Habitat Likelihood
Fishing Cat (*Prionailurus viverrinus*)	Dibrugarh	The Fishing Cat is widely distributed in South and Southeast Asia from Pakistan in the west to Cambodia in the east, and from the Himalayan foothills in the north to Sri Lanka and peninsular Thailand in the south.[101] Potential impact of subproject will not contribute to loss of this species and result in the change of the IUCN Red List status to EN or CR.	Unlikely
Asian Small-Clawed Otter (*Aonyx cinereus*)	All subprojects	It has a broad distribution range, extending from India in South Asia eastwards through Southeast Asia, including Lao PDR, Malaysia, Myanmar, Cambodia, Bangladesh and Indonesia to Palawan, Philippines (Mason & Macdonald 1986; Wozencraft 1993; Hussain 2000; Hussain et al. 2011). In India it occurs in West Bengal, Assam, and Himachal Pradesh, and in southern Indian hill ranges of Coorg.[102] Potential impact of subproject will not contribute to loss of this species and result in the change of the IUCN Red List status to EN or CR.	Unlikely
Gaur (*Bos Gaurus*)	Dibrugarh	Occurs in most of the larger protected areas such as Kaziranga National Park, Manas National Park, Nameri National Park, Dibru-Saikhowa Wildlife Sanctuary and Garampani Wildlife Sanctuary. No subproject site is proposed within its habitat.	Unlikely
Sambar (*Rusa unicolor*)	Dibrugarh	This species occurs is Dibru-Saikhowa Wildlife Sanctuary. No subproject site is proposed within its habitat.	Unlikely
Leopard (*Panthera*	Dibrugarh	This species occurs is Dibru-Saikhowa Wildlife	Unlikely

[101] https://www.iucnredlist.org/species/18150/221434864#population
[102] https://cites.org/sites/default/files/eng/cop/18/prop/020119_d/E-CoP18-Prop_draft-Aonyx-cinereus.pdf

pardus)		Sanctuary. No subproject site is proposed within its habitat.	
Swamp Francolin (*Ortygornis gularis*)	Dibrugarh	Native to the foothills of the Himalayas in Northern India and Nepal.[103] Potential impact of subproject will not contribute to loss of this species and result in the change of the IUCN Red List status to EN or CR.	Unlikely
Helicopter Catfish (*Wallago attu*)	Dibrugarh Goalpara Palasbari-Gumi	This freshwater species is widespread, occurring all across India, Pakistan, Sri Lanka, Nepal, Bangladesh, Myanmar, Laos, Thailand, Vietnam, Cambodia and Java in Indonesia. Its extent of occurrence is estimated at 10,446,620 sq. km.[104]	Unlikely
Bagar Fish (*Bagarius bagarius*)	Dibrugarh	This species is widespread throughout South and Southeast Asia. Potential impact of subproject will not contribute to loss of this species and result in the change of the IUCN Red List status to EN or CR.	

There is no species identified as under Criterion 1c. Please see table below.

Table 9: Criterion 1c or areas containing important concentrations of a nationally or regionally listed EN or CR species

Common Name/ Scientific Name/ IUCN RED List category	Comments/ Analysis	CH Likelihood
Chinese Pangoline (*Manis pentadactyla*) CR	This species occurs in the Himalayan foothills of Nepal, southern Bhutan, north and northeastern India, northeast, northwest and southeastern Bangladesh, northern and western Myanmar, to northern and Annamite regions of Lao PDR and northern Viet Nam, and part of northwestern Thailand.[105]	Unlikely
Wild Water Buffalo (*Bubalus arnee)* CR	Wild water buffalos occur in India, Nepal, Bhutan, Thailand, and Cambodia, with an unconfirmed population in Myanmar. They have been extirpated in Pakistan, Bangladesh, Laos, and Vietnam. They are associated with wet grasslands, swamps and densely vegetated river valleys. In India, they are largely restricted to in and around Kaziranga, Manas and Dibru-Saikhowa National Parks, Laokhowa Wildlife Sanctuary and Bura Chapori Wildlife Sanctuary and in a few scattered pockets in Assam; and in and around D'Ering Memorial Wildlife Sanctuary.[106]	Unlikely

[103] BirdLife International (2016). "*Francolinus gularis*". *IUCN Red List of Threatened Species*. **2016**: e.T22678733A92785771.
[104] https://www.iucnredlist.org/species/pdf/174784999
[105] https://www.iucnredlist.org/species/12764/168392151#geographic-range
[106] https://www.thainationalparks.com/species/wild-water-buffalo

Common Name/ Scientific Name/ IUCN RED List category	Comments/ Analysis	CH Likelihood
Ganges River Dolphins (*Platanista gangetica*) EN	This species is found in the muddy river waters of India, Nepal, Bhutan, and Bangledesh in the Ganges, Brahmaputra, Meghna, Karnapuli and Hoogli river systems. This freshwater species may migrate to tidal waters during the rainy season, and during the dry season they migrate away from areas where temperatures and/or salinity rise significantly.[107]	Unlikely
Indian Hog Deer (*Axis porcinus*) EN	Historically occurred from Pakistan, throughout northern and northeastern India, including the Himalayan foothill zone, east across non-Sundaic Southeast Asia and, southern Yunnan province[108]	Unlikely
Asian Elephants (*Elephas maximus*) EN	The species occurs in Bangladesh, Bhutan, India, Nepal, and Sri Lanka in South Asia and Cambodia, Indonesia (Kalimantan and Sumatra) Lao PDR, Malaysia (Peninsular Malaysia and Sabah), Myanmar, Thailand, and Viet Nam in South-east Asia. Feral populations occur on some of the Andaman Islands (India).[109]	Unlikely
Tiger (*Panthera tigris*) EN	Inhabits parts of India, but it is possible to find some populations in Nepal, Bhutan, and Bangladesh.[110]	Unlikely
Greater Adjutant *(Leptoptilos dubius*) EN	The total population is estimated to number 800-1,200 mature individuals, roughly equivalent to 1,200-1,800 individuals in total. This is based on estimates of 650-800 birds in Assam, India, plus 150-200 birds in Cambodia, as well as at least 156 birds in Bihar state, India, which may have dispersed from the Assam population.[111]	Unlikely

Criterion 2. This includes restricted-range species or endemic plants and animals, which have limited extent of occurrence (EOO). As an example, terrestrial vertebrates and plants having EOO of less than 50,000 square kilometers (km^2) are involved in this criterion. The threshold for Criterion 2 is the following:

Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.

There is no species identified as under Criterion 2. The existing species of plants and animals found within the AOO are widely spread throughout the region and globe.

[107] https://www.marinebio.org/species/south-asian-river-dolphins/platanista-gangetica/
[108] https://www.iucnredlist.org/species/41784/22157664#geographic-range
[109] https://www.iucnredlist.org/species/7140/45818198#geographic-range
[110] https://www.tigers-world.com/tiger-habitat/
[111] http://datazone.birdlife.org/species/factsheet/greater-adjutant-leptoptilos-dubius/details

Criterion 3. Habitats or sites that are critical for the survival of migratory[112] and congregatory species[113]. Thresholds for Criterion 3 are the following:

a) ≥ 1% of the global population of a migratory or congregatory species at any point of the species' lifecycle.
b) *Areas that predictably support ≥10% of the global population of a species during periods of environmental stress.*

Along the 4 subproject areas, there is no migratory route of terrestrial wildlife species nor wildlife corridor. Thus, criterion 3 is not true for any terrestrial mammals.

Ganges River Dolphins and other aquatic animals use the river for movement from one stretch to other. The river dolphins are reportedly found mainly in the main channel of the Brahmaputra River. The migratory fish species like Hilsa (*Tenualosa ilisha*)[114] and Anguilla (*Anguila bengalensis*)[115] migrate through the main channel of the river i.e., through the deeper zones of the river. There is no data on the global population for the Ganges River Dolphins, Hilsa and Anguila. Hence, criterion 3 will not be able to be concluded for aquatic species.

The entire State of Assam falls within the Central Asian flyway and East Asian – Australian flyways. There are many migratory bird species that migrates through the subproject areas, and use riverine charland, islands or sand bars. Various types of water birds like Greylag Goose, Ruddy Shelduck, Geese and Swans, Cranes and Rails, Storks, Ibises and Spoonbills, Flamingoes, Gulb, Terns, Skimmers, Pelicans, Pintail Duck, and Indian Spot-Billed duck are seen visiting the river banks of Brahmaputra.[116] However, there is no data that could support the number of individual migratory bird species and their respective global population. Hence, criterion 3 will not be able to be concluded for aquatic species.

Criterion 4. Areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services. According to IFC Guidance Note 6, the structural attributes of a region, such as its topography, geology, soil, temperature, and vegetation, and combinations of these variables, can influence the evolutionary processes that give rise to regional configurations of species and ecological properties. These are areas with distinct landscape features associated with particular evolutionary processes or populations of species, which are especially distinct and have special conservation concern due to the species' distinct evolutionary history.

There is no unique assemblages of species associated with key evolutionary processes or provide key ecosystem services in the proposed subproject areas, thus do not qualify as critical habitat under this criterion.

Criterion 5. areas having biodiversity of significant social, economic, or cultural importance to local communities.

[112] Migratory species is defined as any wildlife of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem).
[113] Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis.
[114] Anadromous: migration of fish from sea to fresh water for breeding.
[115] Catadromous: fish that lives in fresh water and breeds in sea.
[116] Migratory birds in wetlands of Assam - Sentinelassam

The rivers and wetlands serve as fishing grounds and irrigation sources, ensuring food security and agricultural productivity. In view of their importance to local communities, it would appear that only the fishing grounds should be classified as a priority economic importance. Locals were found to be fishing on the bank of the river with bamboo poles and nets and also using boats to lay nets across the smaller channels.

Criterion 6. Areas either legally protected or officially proposed for protection.

In Dibrugarh Subproject, no demarcation or any indication of boundary of Dibru-Saikhowa National Park exists. However, all the bank protection sites for Dibrugarh Subproject are adjacent to or within the eco-sensitive zone. Please see location of Dibrugarh Subproject River bank works in the table below.

Table 10: Location of Dibrugarh Subproject with respect to Wildlife Boundary and ESA

Locations of subproject sites	Wildlife Boundary	Eco-Sensitive Zone
Milanpur to Hatighuli	363 meters	Within
Phelai to Naokota	937 meters	Within
Gariating Gaon	-	760 meter Outside
Simaluguri Satra	-	Outside
Baghjan to Notun Gaon	331 meters	Within
Guijan	1286 meters	Within
Rungagorah to Dinjan	466 meters	Within

Table 11: Summary of CH Assessment

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Applicable Subproject/s
Areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species	Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units).	There are presence in the AOA. Possible critical habitat for 1 species (Ganges River Dolphin - EN).	All subprojects
	Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a).	No	None
	As appropriate, areas containing important	No	None

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Applicable Subproject/s
	concentrations of a nationally or regionally listed EN or CR species		
Areas having special significance for endemic or restricted-range species	Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.	No	None
Sites that are critical for the survival of migratory species	Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.	No sufficient data hence inconclusive	None
Areas supporting globally significant concentrations or numbers of individuals of congregatory species	Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.	No sufficient data hence inconclusive	None
Areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services		No	None
Areas having biodiversity of significant social, economic, or cultural importance to local communities		Yes, due to fishing activities for local people	All Subprojects
Areas either legally protected or officially proposed	Such as areas that meet the criteria of the World Conservation Union classification, the Ramsar	Possible critical habitat due to proximity to Dibru-Saikhowa National Park	Dibrugarh

Critical Habitat Trigger	Thresholds Adopted	Trigger Present	Applicable Subproject/s
for protection.	List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.		

VI. Impact Assessment

The purpose of this chapter is to determine the subproject-related risks on biodiversity and critical habitat feature. Where there are likely potential impacts, mitigation measures are proposed to maintain the high biodiversity value in the project influence and/or affected areas. Further, to support the conditions necessary to maintain viable populations of species and other priority natural features.

SPS 2009 has provided the following requirements and for the proposed project to meet the necessary conditions, which are:

(i) There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.
(ii) The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
(iii) Any lesser impacts are mitigated[117]

The proposed project will focus on appropriate mitigation and offset actions, to ensure net gain to biodiversity and critical habitat. Through application of the mitigation hierarchy and the implementation of the actions given in the biodiversity action plan (BAP), it will be considered that no measurable adverse or significant residual impacts as a result of flood protection works.

Potential Impacts

Damage to wetlands or beels. Hasila Beel is the only wetland which has direct connection with the Brahmaputra River in Goalpara Subproject. Deepor Beel is the only wetland which has direct connection with the Brahmaputra River in Palasbari-Gumi Subproject. In Dibrugarh subproject, Maijan Beel is the only wetland which has direct connection with the Brahmaputra River. The other wetlands in the subproject areas are Urpad Beel (Goalpara Dubproject), Sonai beel which is a cluster of natural lakes namely Nandini, Mer, Sonai, Raumari, Dobarani, and Patiabandha beel (Morigaon subproject) and Maguri-Motapung Beel (Dibrugarh subproject). These are quite far away from the subproject interventions and are connected to the Brahmaputra River either upstream or downstream of the project interventions and shall thus not be affected by the proposed project activities.

[117] Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity.

Soil erosion. Potential of an area to soil erosion depends on its topography, geological structure, rainfall, soil type and land use/land cover. In the subproject area, the topography of the terrain covering the alluvial plain is mostly flat plain except a few forested hills with elevation between 40 to 50 meters. The area also includes a large number of riverine tracts and sandy river island in the Brahmaputra River. Possibility of occurrence of gully and rill erosion is expected in the uncovered side slopes of embankments and other freshly cut or deposited areas. This is a problem that contractors may face when cutting the banks into desired slopes and subject to runoff from general rain. Quarrying of nearby sand bars to fulfill the requirement of construction materials and fill-up geo-bags may lead to erosion as well. During construction stage, soil cutting, embankment protection work will create soil erosion if the compaction not done properly.

Water Quality. Major source of surface water pollution during project construction phase will be sewage and wastewater generated from labor camps. For labourers, the contractor will establish a labour camp and produce sewage that may pollute land and other nearby water bodies if discharged untreated. The boat which are driven by diesel engine should be not spill fuel in water. The old engines in boats, where water from the river are taken in the diesel engine for cooling were common source of river water pollution.

Air Quality. During the construction phase, there will be two main sources of air emissions, i.e., mobile sources and stationary sources. Mobile sources are mostly vehicles involved in construction activities, whereas emissions from stationary sources include construction equipment and machinery, batching plants, diesel generator sets, excavation/grading activities etc. In addition to these, fugitive emissions will also form a major proportion of air pollution in the form of particulate matter from storage and handling of construction material.

Noise. During construction phase, noise will be generated from various activities such as clearing and grubbing, excavation, earthworks, borrow works, etc. There will be significant increase in vehicular movement for transportation of construction material. An increase in noise level is expected. However, the increase in noise levels will be localized, temporary in nature and mostly will be during daytime only.

Disturbance to Vegetation. There would be no major impact on terrestrial flora except cutting of trees during project intervention in the subproject area. There is no diversion of forest land. There is 1 notified protected area (Dibru - Saikhowa NP) within 1 km of the project intervention areas in Dibrugarh District and Tinsukia District. The present vegetation is primarily planted by the locals such as Semal (*Bombax ceiba*), Teak (*Tectona grandis*), Jackfruit (Artocarpus heterophyllus), Betel nut (Areca catechu), Date (*Phonix sylvestris*), Banana (*Musa sp*.), Coconut (*Cocos nucifera*), Peepal (*Ficus religiosa*), Cluster Fig (*Ficus glomerata*), Kadamb (*Anthocephalus cadamba*), Arjun (*terminalia arjuna*), *ziziphus mauritiana*, Mango (Mangifera indica), various species of bamboo (*Bambusa balcooa, Bambusa tulda, Melocanna hamiltonii*, *Dendrocalamus giganteus*) *Plectomia assamica, Plectomia bractealis, Cassia sophera* etc.

Disruption of migratory animals. There may be migratory route of mammalian wildlife species in the project stretch and thus some impacts are envisaged like man animal conflict (distruction of standing crops, hutments etc.,). Winter migratory birds may also use the riverine charland, islands, sand bars and some impacts may be envisaged like poaching by construction laborers. Ganges

River Dolphins and other aquatic animals use the river for movement from one stretch to other. The Ganges River Dolphins are reportedly found mainly in the main channel of the Brahmaputra River and the proposed anti-erosion and flood protection works shall be limited within 30m of the riverbanks. The migratory fish species like Hilsa (*Tenualosa ilisha*) and Anguilla (*Anguila bengalensis*) migrate through the main channel of the river i.e., through the deeper zones of the river.

Decline of population of Ganges River Dolphins and other species (EN, CR and VU). Ganges River Dolphin sightings are reportedly found mainly in the main channel of the Brahmaputra River and the proposed anti-erosion and flood protection works shall be limited within 30m of the riverbanks. It may be likely that these dolphins may occasionally near riverbanks during the lean season. The only impacts that are probable are that of accidental hitting by the barges to carry materials and being stuck in the shallow waters. Dolphin is sensitive to polluted water and any obstruction of the channels at this stage may disturb the breeding activities (June to August). Other wildlife may also at risk due to potential damage to their natural habitats and pollution from construction activities.

Disruption of breeding and spawning section of the river. Breeding grounds varies from species as well as location. It has been reported in the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP) that most of the riverine smaller fish species, prefer the shallow courses of river for breeding and spawning. Some fish species refer wetlands and beels for breeding. Fish spawning seasons also vary from fish to fish. However, most normal seasons for almost 80% of fish species starts from April and ends in August (i.e., during pre-monsoon and monsoon seasons). Increase in siltation due to construction activity in the subproject area particularly during the breeding season, may disturb the breeding activities.

Reduction on local fishing activities. Locals were found to be fishing on the bank of the river with bamboo poles and nets and also using boats to lay nets across the smaller channels. Temporary flushing of the fish species towards the deeper part of the river may happen during the anti-erosion and flood protection works. The construction activities may increase the turbidity on the bank temporarily.

Risk Analysis

Environmental risk is a function magnitude of potential consequences (i.e., levels of magnitudes) and likelihood of these consequences to occur (i.e., levels of probability of occurrence). To quantify the environmental risks, the formula is:

Likelihood x Consequence

To perform the risk analysis, ratings were assigned for different levels of likelihood and consequence to determine the level of environmental risks. The ratings are presented below:

Table 12: Likelihood or level of probability

Likelihood	Definition	Rating
Likely	Potential to occur more than twice during construction and/or operations	3
Unlikely	May occur once or twice during construction and/or operations	2
Rare	Highly unlikely to occur during construction and/or operations	1

Table 13: Consequence or level of magnitude

Consequences	Definition	Rating
Major	Significant damage or impact on the natural environment or communities.	3
Moderate	Limited adverse impact on natural environment or communities	2
Minor	No or minimal adverse impact on natural environment or communities.	1

When all environmental risks are assigned with likelihood and consequence ratings, then the formula is to be applied and results stated. These risks are then to be classified based on the levels of risk. The table below shows the categories of environmental risk based on the formula (i.e., Likelihood x Consequence).

Table 14: Quantifiable Environmental risk matrix

Likelihood	Likely	3	3	6	9
	Unlikely	2	2	4	6
	Rare	1	1	2	3
High 6 and above			1	2	3
Medium 3-5			Minor	Moderate	major
Low 0-2			consequences		

The computation of level risk for the identified potential impacts are shown below. All environmental risks that have medium (3-5) and high ratings (6 and above) will have corresponding mitigation measures. To manage the potential impacts, biodiversity action plan will

be prepared and form part of the environmental management plan (EMP) of each subproject's initial environmental examination (IEE).

Table 15: Computation of Environmental risk

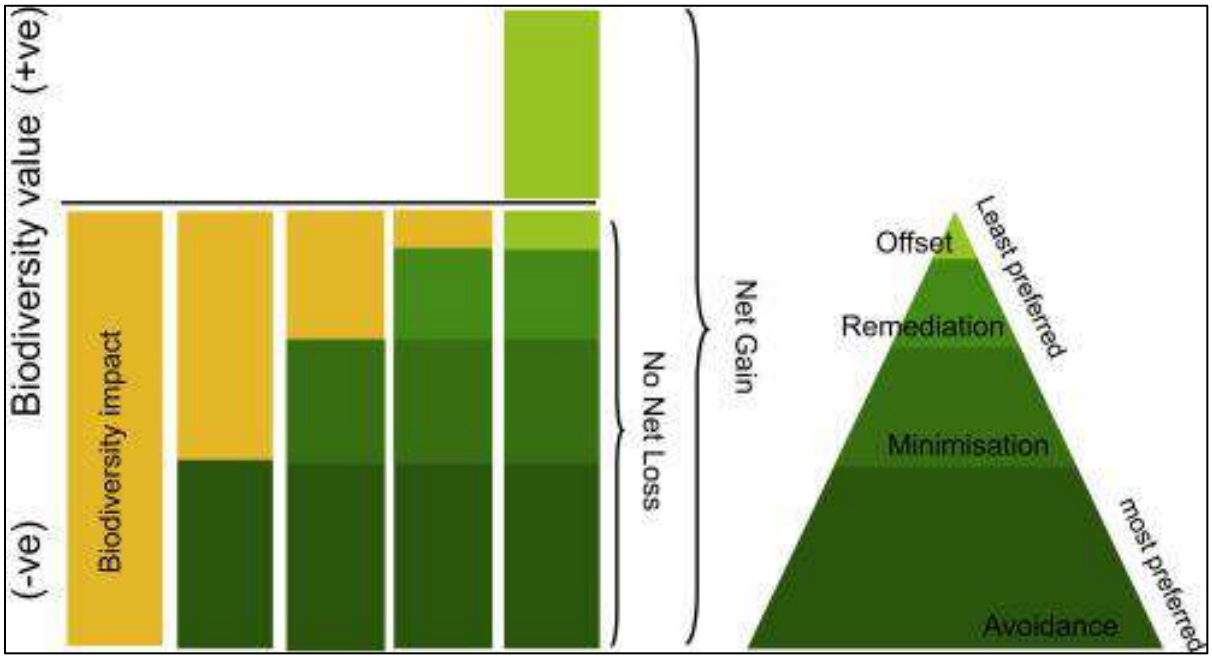
Environmental Risks	Likelihood	Consequence	Environmental Risk Level
Damage to wetlands or beels	1	1	1
Increase in soil erosion	3	2	6
Water quality decline	3	2	6
Air quality decline	3	2	6
Noise level increase	3	2	6
Disturbance to land vegetation	2	1	2
Disruption of migratory animals	2	2	4
Decline of population of Ganges River Dolphins and other species (EN, CR and VU)	2	2	4
Disruption of breeding and spawning section of the river	2	2	4
Reduction on local fishing activities	2	2	4

VII. Biodiversity Action Plan (BAP)

This section presents the Biodiversity Action Plan (BAP), which outlines the mitigation actions and monitoring activities to ensure that the proposed subprojects has no long-term net loss in biodiversity.

Conservation actions were developed for concerns on biodiversity features as result of the proposed subproject implementation and ensure the application of the mitigation hierarchy (i.e., avoid, minimize, mitigate/remediation and compensate/offset. The concept of the mitigation hierarchy is outlined below. This will allow for the careful management of risk and the best possible outcomes for the subproject without compromising the health, function and integrity of the ecological system and biodiversity features.

Figure 6: Diagram showing concept of mitigation hierarchy to achieve no net loss[118]



The actions to conserve habitats and wildlife population along the subproject areas aimed of achieving 'no net loss' to biodiversity in accordance with ADB's safeguards requirements. The requirements need evidence that the mitigation hierarchy will be applied, that avoidance is prioritized, and that offsets are only applied as a last resort where residual impacts are un-avoidable. This biodiversity action plan will be integrated with the EMPs for each subproject.

[118] Figure is sourced from "Net Gain: Seeking Better Outcomes for Local People when Mitigating Biodiversity Loss from Development. One Earth,Volume 1, Issue 2. 195-20" by Jones, J. P. G. and et. al. (2019).

Table 16. Biodiversity Action Plan (BAP)

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
Construction of embankments and sluice gates Operation of labour camps	Water resources	Water quality decline due to contamination of water flowing in wetlands or beels and Brahmaputra River.	*Avoidance:* - No borrow soil should be dumped in streams. - No labour should be allowed to do open defecate on river. This would result in increase in total coliform and faecal coliform in wetlands or beels. - No material storage camps labours camps, borrow earth be allowed within 500 meters from riverbed and 1 km from the forest and Eco-sensitive Zone. *Minimization:* - Carry out construction works in non-monsoon season. - During Monsoon spawning of fishes take place. The schedule of embankment work should be planned in manner that it is over before arrival of monsoon. - As barge to carry construction materials, old boats should not be utilized and over loading the capacity is not allowed.	Contractor	PISC, PIU and PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			Remediation: - Provision of silt traps should be available. - Embankment soil should be stabilized regularly. - The slopes of embankments should be stabilized adopting bioengineering measures. - Grassing, seeding and mulching are biological measures to stabilize river banks. - The soil used in embankment should be tested for pollutants like heavy metals. - There should be provision of mobile toilets at all construction site. - Modern flood embankments will be built and/or rehabilitated and will have openings (ie: sluice gates with fish passes) to enable river-floodplain interconnectivity and enhance biodiversity		
Sourcing of materials for filling-up geo-bags Earthworks and slope stabilization along river banks Construction of embankments and sluice gates	Soil stability	Increase in soil erosion results from construction works that disrupts bank slopes, sandbars and existing embankments	*Avoidance:* - Construction shall be scheduled during non-monsoon season. *Minimization:* - Obtain materials from aggregate and sand quarries/crusher sites which has necessary permissions from the Department of Mines and Geology, Prior EC from SEIAA/MoEF&CC and CTO from PCBA	Contractor	PISC, PIU and PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			Remediation: - Afforestation shall be undertaken with community participation. - Soil erosion shall be visually checked on potential erosion zones during construction phase. - The slopes of embankments should be stabilized adopting bioengineering measures. - Grassing, seeding and mulching are biological measures to stabilize river banks. - Exposed surface shall be resurfaced and stabilized as soon as possible and covered by straw or mulch to avoid soil loss in the intervening period.		
Construction of embankment, anti-erosion works and activities within construction camps	Ambient air quality	Air quality decline results from implementation of subprojects and related construction works.	*Avoidance:* - Batching plants shall be located away from high biodiversity areas and be fitted with the air pollution control devices. - No sand mining or any form construction works will be done in Dibru-Saikhowa Wildlife Sanctuary. *Minimization:* - The emission shall meet Pollution Control Board standards. - The batching plants must be sited at least 1 km in the downwind direction from wildlife habitats with high biodiversity value. - All slopes and embankments will be turfed as per best engineering practices to help minimize the dust generation during operation.	Contractor	PISC, PIU and PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			Remediation: - Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing road. - Water may be sprayed on earthworks, on a regular basis. During and after compaction of the sub-grade, water will be sprayed at regular intervals to prevent dust generation. - Regular maintenance of machinery and equipment will be carried out - Ambient air quality monitoring shall be carried out during construction and the first year of operation phase as per the Environmental Monitoring Plan (EMoP) - Plantation along the embankment shall be maintained.		
Construction of embankment, anti-erosion works and activities within construction camps	Acoustic environment	Noise level increase results from implementation of subprojects and related construction works.	*Avoidance:* - Stationary equipment shall be placed along low biodiversity value areas. - No sand mining or any form construction works will be done in Dibru-Saikhowa Wildlife Sanctuary. *Minimization:* - use of appropriate temporary noise barriers especially near noise sensitive receptors identified near the construction zone - Construction activities shall be prohibited between 9.00 pm and 6.00 am near high biodiversity value areas throughout the	Contractor	PISC, PIU and PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			subproject stretch *Remediation:* - Construction equipment and machinery shall be fitted with silencers and regularly maintained - Regular noise monitoring measurements shall be carried out as per the EMoP during the construction period and 1st year of the operation period		
Construction of embankment, anti-erosion works and activities within construction camps	Biodiversity values	Disruption of migratory animals in the Brahmaputra River. Decline of population of Ganges River Dolphins and other species (EN, CR and VU). Disruption of breeding and spawning section of the river.	*Avoidance:* - The construction activity in the riverbed shall be prohibited during the breeding period of April to August. - Poaching, hunting and fishing by the construction workers shall be strictly prohibited. *Minimization:* - Channels are not permanently obstructed during the construction period in any way nearby the work zone. - If Ganges River Dolphins are sighted near to the riverbanks during the construction period, works shall be temporarily suspended till it move out into the main channel. The same action will be taken for terrestrial and aquatic mammals. - No work will start until clearance from wildlife authority is achieved.	Contractor FREMAA to get clearance	PISC, PIU and PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			All conditions in the clearance should be strictly followed. *Remediation:* - Capacity building and workshops for the laborers shall be conducted about biodiversity and managing risks to wildlife. - In case of accidental trappings due to construction works, wildlife department shall be immediately contacted for necessary actions. - Biodiversity and ecology assessment including surveys/census of IUCN Red listed species shall be carried out during the first monsoon season in the construction period and winter season in the operations for all the 4 subprojects.		
Construction of embankment and anti-erosion works	Areas having biodiversity of significant social, economic, or cultural importance to local communities	Reduction on local fishing activities	*Avoidance:* - Construction shall be scheduled during non-monsoon season. *Minimization:* - Passage of local people to the river will not be blocked and ensure access to the temporary ghats. *Remediation:* - Any local facilities affected shall be restored or maintained for undisturbed movement of the fisherman. - During the construction, provide a clear signages to guide which areas	Contractor	PISC, PIU and PMU

Construction/ Subproject activity	Environmental Aspect	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Responsible for Supervision
			that local fishing boat should not pass. - During construction phase, contractors will provide alternate landing sites (ghats) with berthing facilities, access, and other common infrastructure - Regular consultation with local people in view of construction works. - In places the riverbank protection will provide steps to facilitate landing of local boats in support of trade and river crossings		

Offsetting

Nature-based solutions (NbS) such as bioengineering techniques through planting of reeds will be pilot tested along embankment slopes. This will reduce maintenance requirements of the infrastructures and provide local stakeholders with income generating activities opportunities. Assam Agroforestry Development Board (AADB) will develop, implement, improve, guide, and supervise pilot NbS including relevant research and dissemination of research results. The pilots will provide employment opportunities for riverine rural poor and as the pilots can be upscaled to broader implementation, more employment opportunities will be created in the next phases. The purposes of the AADB pilots are to prevent erosion of the slopes of embankments, to plan and promote wetland revival and biodiversity, and to promote siltation on possibly reclaimed land.

For the NbS for embankments and riverbanks, the slopes shall be stabilized by using vetiver, khas and other deep-rooted grasses in different type of embankments. AADB shall also plan and execute business models for sustainable harvesting of these grasses through local communities as part of livelihood improvements for people vulnerable to flooding and riverbank erosion.

AADB also plans to undertake wetland conservation for watershed conservation and livelihood support. Identification of suitable vegetation for selected wetland conservation, wherein multiple-use of wetlands shall be promoted and invasive species like water hyacinth (*Pontederia crassipes)* etc. shall be removed.

VIII. Conclusion

The purpose of a critical habitat assessment is to identify areas of high biodiversity value that meet criteria set in ADB SPS 2009 and corresponding thresholds by IFC in Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Resources (IFC, 2012a/2019). Based on the assessment, all the subprojects trigger Criterion 5, where the areas have biodiversity of significant social, economic, or cultural importance to local communities. Brahmaputra River and wetlands serve as fishing grounds to ensure food security. Fishing grounds should be classified as a priority economic importance. Locals were found to be fishing on the bank of the river with bamboo poles and nets and using boats to lay nets across the smaller channels.

The Ganges River Dolphin (EN) is noted from interviews with local people. In all subproject areas, there are sightings of this species and records from Assam Inland Water Transport Project, Dolphin Study Report (or AIWTDS) within the area of occurrence (1km radius from each subproject sites). However, there were no findings of Ganges River Dolphins in all proposed subproject areas during actual biodiversity survey. Available data is not sufficient to conclude dolphins would trigger critical habitat.

Dibru-Saikhowa National Park is the nearest protected area, particularly for works under Dibrugarh Subproject. There are no proposed works inside the boundaries of the national park. To manage potential impacts, biodiversity action plan includes prohibitions and mitigation measures that will be implemented during construction period.

Below are the SPS 2009 requirements for critical habitat, and compliance of the proposed project to meet these necessary conditions.

(i) There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.

Compliance: Structural works of the project would create temporary disturbances to fishing activities of local people. However, this are only temporary and specific to the sites of construction works. Without the implementation of subprojects, target areas will be continuously affected by floods and severe soil erosion that would put the socio-economic conditions and life at an increasing risk and could potentially worsen the living environment due to future extreme weather events. For the Ganges River Dolphins (EN), this species is not likely to meet the thresholds of the critical habitat (Criterion 1a and 1c). Secondary data shows presence of this species within the area of analysis of the proposed protection works during monsoon period. Primary data collected for the project did not show any presence of the species during the dry season (data collected during March-April 2023). There may be potential impact to this species due to transport of materials for the works through barges. However, construction works will be done during dry season when dolphins are in the deep channels and not nearby river banks.

(ii) The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned

such that the persistence of a viable and representative host ecosystem be compromised.

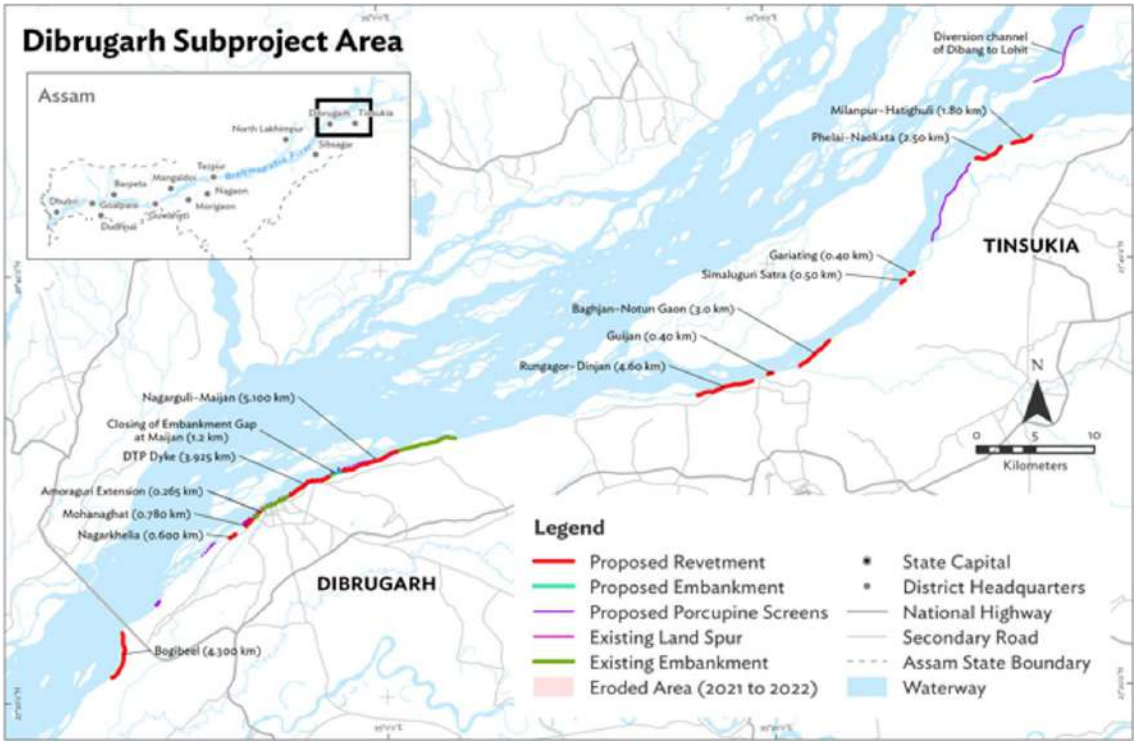
Compliance: There are EN and CR species in Dibru-Saikhowa NP, however no proposed works will be implemented inside the protected area. The subprojects will not lead to the reduction of Ganges River Dolphin's (EN) population and loss of its habitat because this species can be sighted within 100 m or more from the river bank during monsoon season when there is no construction works. To have measures safeguarding wildlife and their habitats, BAP will be part of contractors' commitment to mitigate the potential impacts from civil works.

(iii) Any lesser impacts are mitigated (Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity)

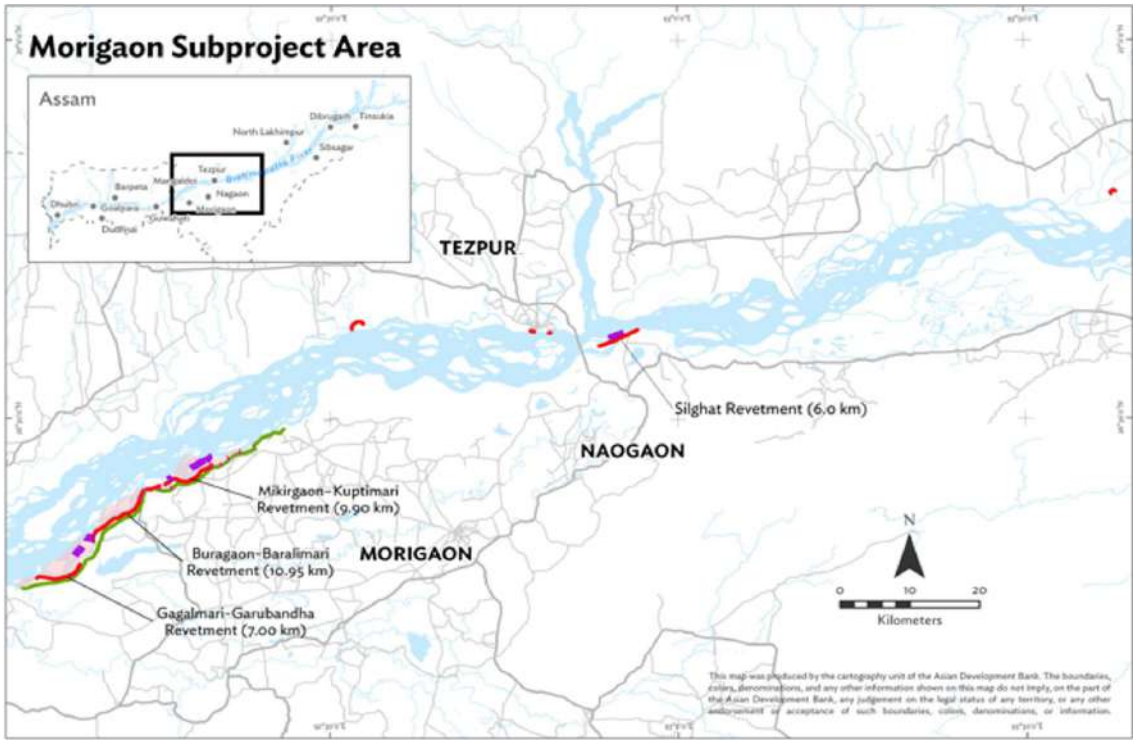
Compliance: The project will implement NbS. As a form of offsetting and to achieve no net loss, it will be beneficial in strengthening the flood protection works and embankment, and rejuvenating target wetlands along the Brahmaputra River.

Appendix 1. Map showing locations of the 4 subprojects

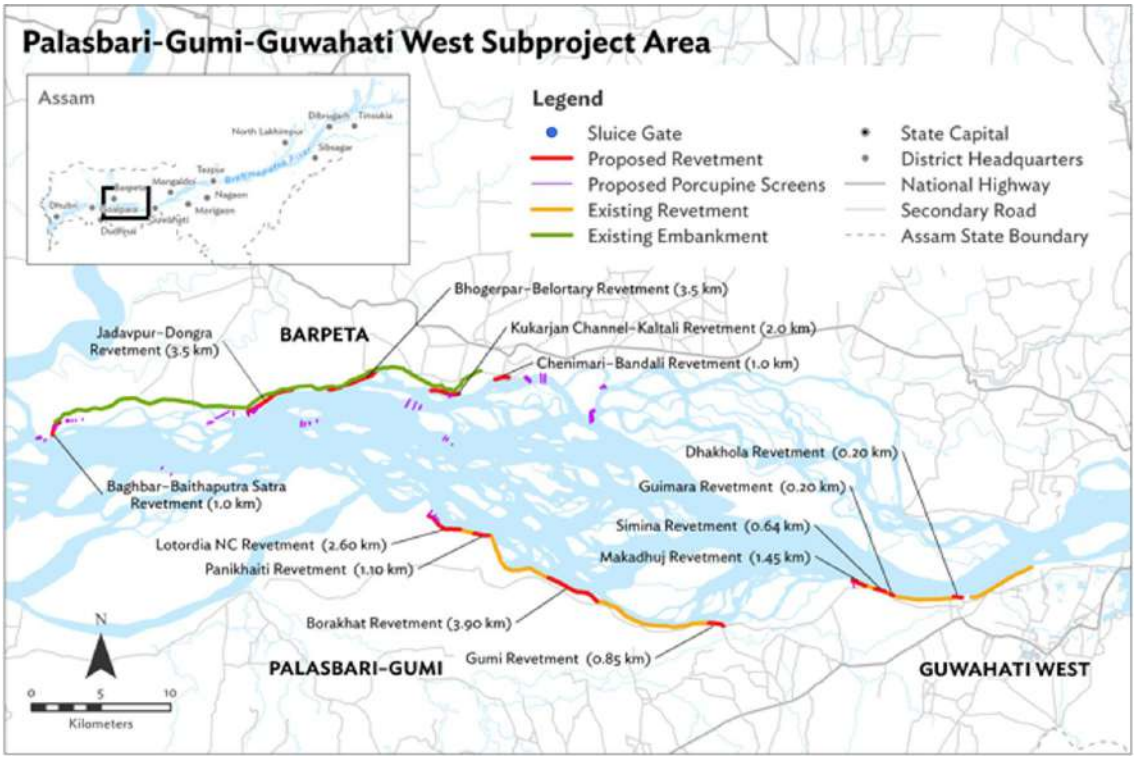
Appendix 1a.



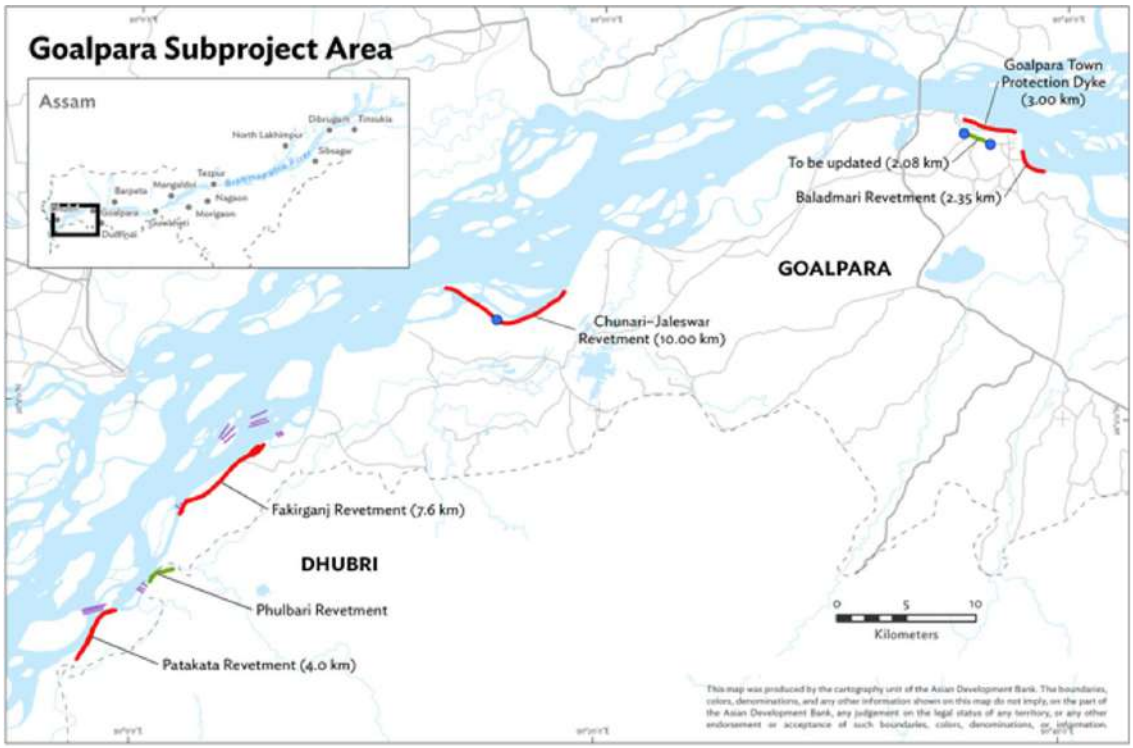
Appendix 1b.



Appendix 1c.



Appendix 1d.



Appendix 2. Summary of structural works in 4 subprojects

Subproject	New Embankments (km)		Upgrading Embankments (km)		Riverbank Revetments (km)		Adaption Works/Emergency contingency (km)		Porcupine screen (no.)	Porcupine screen (km)	Regulator (no.)		Fish pass (no.)	Other works
Dibrugarh (including Tinsukia district)	Close gap in embankment at Maijan Beel	1.20	0		Nagaghuli to Kachari Line	0.90	Kasuoni	1.00	173	24.1	RCC triple shutter sluice gate in Maijan Beel embankment	1	1	Revive of Maijan beel with nature based solutions
					Filunuguri to 7400 ft Spur	1.70	Mothola	2.40						
					DTP Dyke (Dibrugarh Town Area)	3.93	DTP dyke	1.00						
					DTP Dyke (Amoraguri)	0.27	Emergency	0.25						
					Mohanaghat	0.78								
					Nagakhelia	0.60								
					Chaulkhowa at D/S of Bogibeel Bridge	3.69								
					Milanpur to Hatighuli	1.50								
					Pheliai to Naokota	2.00								
					Gariating Gaon	0.40								
					Simaluguri Satra	0.40								
					Bahjan to Notun Gaon	2.10								
					upstream Guijan	0.30								
					Rungagorah to Dinjan	2.70								
Subproject Total	1.20		0		21.26		4.65		173	24.1	1		1	
Morigaon	0		Shifting/widening existing embankment at Kuptimari	0.70	Mikirgaon-Kathani-Tengaguri area	7.50	Emergency	0.25	7	1.0	0		0	
					Kuptimari-Balidunga area	1.90								
					Upstream of Panchali spur	0.25								
			Chutiagaon spur recoupment	0.45	Downstream of Panchali spur to Baralimari	2.00								
					Gagalmari-Garubandha area	4.00								
Subproject Total	0		1.15		15.65		0.25		7	1.0	0		0	

Subproject	New Embankments (km)		Upgrading Embankments (km)	Riverbank Revetments (km)		Adaption Works/Emergency contingency (km)		Porcupine screen (no.)	Porcupine screen (km)	Regulator (no.)		Fish pass (no.)	Other works
PGP/Guwahati West	0		0	Kalitapara	0.80	Palashbari	3.50	8	2.7	0		0	Pump house at Palishbari Hostel for trainees next to Assam Water Center in Guwahati
				Futuri	1.45	Guwahati West	5.00						
				Simina	0.64								
				Guimara	0.20								
				Gumi	0.85	Emergency	0.25						
				Borakhat	3.90								
				Panikhaity	1.10								
				Lotordia	2.60								
Subproject Total	0		0	11.54		8.75		8	2.70	0		0	
Goalpara	Embankment Goalpara town	2.08	0	Goalpara Town Two stretches, 2.35 km - Baladmari 3.00 km - Goalpara (geobags with PCC blocks)	5.35	Emergency	0.25	6	4.50	Goalpara town (1 shutter sluice and 4 shutters sluice)	2	0	
				Chinair to Jaleswar	6.00					Chunari (4 shutters)	1	0	
Subproject Total	2.08		0	11.35		0.25		6	4.50	3		0	
Project Total	3.28		1.15	59.80		13.90		194	32.30	4		1	As above

Appendix 16. Lessons Learned from Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP)

Introduction: Out of India's total land area of 329 million hectares (ha), more than 40 million ha are prone to floods. Flooding is a recurrent hazard and has been increasingly severe in recent years. Riverbank erosion is one of the most prominent causes of disasters in Assam due to highly dynamic morphology of the Brahmaputra River and its tributaries. About 40% of the state (i.e., about 9.4% of the national flood prone area) is inundated on average annually during the monsoon by the Brahmaputra River and its tributaries, resulting in damages and loss of assets and crops.

The Assam government's development plans reflect the critical need for effective, sustainable flood risk management since most urban and agriculture areas are prone to floods and have suffered devastation from flooding for years. As part of the boarded plan to address and manage the flood hazard in the state of Assam, the multitranche financing facility (MFF) between the Government of India and the Asian Development Bank (ADB) for the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program (AIFRERMIP) was approved by ADB in 2010 with two tranches.[119]

The program used a phased approach and focused on three selected and appraised subprojects—Palasbari–Gumi, Kaziranga, and Dibrugarh—that have flood embankment systems protecting critical urban and productive rural areas along the Brahmaputra River, and capacity- building initiatives.[120] The program introduced international best practices of riverbank protection technologies and community participation. A major initiative was state-level institutional capacity strengthening for flood and erosion risk management. Resilience against the possible impacts of climate change which may increase the frequency and magnitude of flood disasters was to be strengthened through the investment program, thereby contributing to the efforts of climate change adaptation.

Project 1 (Tranche I) became effective on 4 August 2011 and was completed on 31 July 2017. Project 1 successfully executed immediately required protection works in the three subproject areas, and laid the foundations for institutional strengthening for flood and riverbank erosion risk management (FRERM) and community participation. Project 2 (Tranche II) was approved by ADB on 30 November 2018 with completion date of 18th October 2020. Project 2 aimed to complete the remaining protection works in the same three subproject areas, and continue institutional strengthening activities, to accomplish the appraised investments with necessary refinement.

The MFF and projects 1 and 2 are rated *likely sustainable*. The design and technology adopted in the subprojects are innovative and appropriate given (i) the huge advantages of non-structural and innovative structural solutions and technology (geotextile bags, pro-siltation, and heightened embankments), which have addressed climate resilience and morphological changes; and (ii) the involvement of communities in flood management and their provision with better opportunities for income generation and tourism[121]. The project was nonrevenue-generating and so the financial internal rate of return was not calculated. Instead, financial sustainability was assessed based on

[119] ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility to India for the Assam Integrated Flood and Riverbank Erosion Risk Management Investment* Program. Manila.
[120] Built during 1950–1960, the area's flood embankments are among the most critical reaches of the Brahmaputra River, spanning 90 kilometers (km). They are at risk of being breached because of river erosion and overtopping during extreme floods.
[121] Besides tourism, livelihood activities were weaving and spinning, agro-diversification, and vegetable production.

guidelines of the ADB.[122] The analysis shows that the program is likely to be financially sustainable since, historically, WRD has received on average 85% of the operation and maintenance (O&M) budget from the Assam government, and the agency has been utilizing on average 94% of its budget in the last few years.

Environmental Safeguards ADB approved environment category of project 1 was A, per ADB's Environment Policy 2002; and category B for project 2, per ADB's Safeguard Policy Statement (SPS) 2009. The environmental impact assessment (EIA) report was prepared in June 2009 and disclosed on the ADB website. The EIA was carried out in the three subproject areas covered by Projects 1 and 2. While no significant negative environmental impacts were anticipated, ADB classified project 1 as environmental category A in consideration of the diverse riverine environment. An environmental assessment and review framework (EARF) was prepared and disclosed on ADB website to guide the subprojects selection, screening and categorization, environmental assessment, preparation, and implementation of the safeguards plans and documentation. Three initial environmental examination (IEE) reports were prepared for subprojects under project 2 from March to August 2018 and disclosed on ADB website. The EARF was also updated and disclosed to reflect the requirements for small community works proposed under project 2. An addendum to the IEE report—covering the Health and Safety Plan (in response to the coronavirus disease COVID-19 pandemic)—was prepared and disclosed on ADB website in June 2020 under project 2.

Positive environmental impacts included preservation of flora and fauna from the impacts of river erosion and flooding, including wetlands, pond fisheries, and agricultural lands. Interventions near Kaziranga helped preserve wildlife habitat by preventing the impacts of sudden flooding (from embankment breach). Based on environmental monitoring reports, no damage was occured to the endangered species (i.e. Ganges River Dolphins) and to Kaziranga National Park. The anticipated impacts on hydrology and morphology were also deemed insignificant. This is because the program supported the proper functioning of the existing flood embankment systems, and riverbank protection works were carried out taking an adaptive approach, i.e., providing protection along the naturally developed bank lines where and when necessary. Nevertheless, close monitoring was undertaken to detect any unforeseen impacts and that mitigation measures were provided. Possible negative impacts included those associated with construction, which were temporary, site-specific, and reversible and could be mitigated through prescribed mitigation measures under the environmental monitoring and management plan that was operationalized under the projects, with the necessary capacity building of the executing agency.

Statutory environmental compliance The regulatory permissions required under the then prevailing environmental and labor-related laws of India at the national, state, and local levels were reported to have been obtained—with significant delays for both projects 1 and 2. Given the nature of activities undertaken under both projects, regulatory compliances were commonly required. During project 1, the regulatory permission to undertake works in the Kaziranga National Park area was significantly delayed. As a result, the works proposed in this protected area were shifted to project 2 for implementation. The level of regulatory compliance during project 1 was observed to be limited. During the initial stages of project 2 implementation, regulatory compliance continued to be limited and needed persistent efforts to obtain them. The state's Forest Department had imposed penal sanctions for the regulatory lapses for which the civil works contractors paid fines imposed by the regulatory agency. The applicable forest and tree-cutting permissions were obtained. Initially, during project 2 implementation, regulatory shortcomings were observed: the earth used were obtained from borrow areas, construction materials were procured from quarries and mines, construction water was sourced from wells and bore wells, and construction plants were utilized for

[122] ADB. 2019. Financial Analysis and Evaluation: Technical Guidance Note. Manila.

the projects. With sustained follow-ups, these shortcomings were addressed to achieve regulatory compliance. Labor licenses, as required under the labor laws of India, were also obtained and renewed with some lapses during project 2 implementation. With regular follow-up, it was ensured that the project personnel were adequately insured by the contractors and their subcontractors during the implementation of the projects. By the project closure, all regulatory permissions were reported to have been obtained and were valid.

Institutional arrangements. During the implementation of project 1, the project management unit (PMU) designated one of its contractual staff as the environmental officer with the additional responsibility of managing the tasks related to environmental safeguards. The PMU-designated environmental officer did not possess the requisite academic background or professional experience in the subject area. This officer participated in ADB-organized capacity- building programs on safeguards for enhanced understanding. The same environmental officer continued to provide inputs for project 2. The executive officer of the PMU was ably supported by the environmental expert engaged within the consultancy firm. The civil works contractors designated their existing site engineers and/or engaged environment, health, and safety officers to implement the environmental management and monitoring plans. During project 2, the executive officer of the PMU held regular review meetings for environmental safeguards with the staff from the consulting firm and the contractors, which was helpful in identifying the areas requiring attention. Overall, the institutional arrangements during implementation were assessed to be just adequate. Towards the closure of the MFF program, the PMU was staffed with two full-time environmental practitioners on a long-term contractual basis who both have the requisite academic training and professional experience.

Implementation of environmental management, monitoring, and reporting. The civil works contracts included the environmental management and monitoring plans (EMMP). The consultant's and contractors' staff were provided training by the environmental expert from the consulting firm to understand the requirements in the EMMPs. The overall implementation of the EMMPs could have been better if the corrective actions were systematically executed. The concern areas—such as safety measures at the sites, the provision of basic amenities to laborers, housekeeping practices, and others—continued throughout the implementation of both projects 1 and 2. This is due to the adequate institutional set up to manage environmental safeguards. The testing of parameters for ambient air quality and noise levels was very limited during the initial stage of the project, which improved with regular follow-ups by the PMU and by the project management consultant. The environmental performance of the MFF improved over the period with increased monitoring and coordination by ADB with the project staff. During project 2 implementation, time-bound corrective action plans to address shortcomings were prepared but implemented with some delays. Semi-annual environmental monitoring reports (EMR) since project commencement to its operation period were submitted with some delays. The testing of parameters for ambient air quality, water qualities, and noise levels and the submission of semi-annual EMRs improved over the period with regular guidance from ADB. A total of 20 EMRs (during July 2014 to September 2022), capturing the implementation of environmental safeguards during construction and operation stages, were prepared. The EMRs captured the status of regulatory compliances, the implementation of EMMPs, and the public consultations held during the implementation of the program, and these were disclosed on ADB website.

Public consultation and grievance management system The project staff from the PMU, project implementing units (PIUs), consultants, and contractors conducted consultations with the local residents and other government agencies including regulatory agencies regarding project-related activities. The project staff increased the frequency of informal consultations with the locals to disseminate project benefits, identify issues, and address problems encountered by the public during implementation. Copies of environmental planning documents were made available at site

offices. The grievance redress committees were established at PMU and PIU levels and continued to be functional till closure of the project. The routine grievances registered at site offices on environmental aspects were mainly on issues such as dust, removal of debris, and borrowing earth from authorized areas. The project staff responded to these grievances within a reasonable time and obtained feedback from the complainants about their resolution prior to closing the grievance log.

The project engaged women in FRERM decision-making by increasing their participation in public consultations and representation in community-based village DMCs. Project 2 included lessons learned on gender in the draft FRERM plan document, which emphasized building the gender-mainstreaming capacities of FREMAA staff. The institutional environment and gender-mainstreaming capacity building will have long-term impact. The enabling factors will contribute to the likely sustainability of GAP achievements.

Conclusion The environmental implementation performance of the program was initially lacking due to limited institutional arrangements under the project, however, it improved over the period with increased monitoring and coordination by ADB with the project staff during project 2 implementation. Better environmental performance could have been achieved by deploying appropriate safeguards experts at the PMU and among contractors. To improve the environmental performance of the project, the envisaged institutional arrangements for environmental safeguards should be fully functional from commencement to closure of the project. The PMU and PIUs were unfamiliar with ADB's procedures and policies on environmental safeguards during the initial stages of the project and needed regular handholding by ADB through training at frequent intervals during the implementation of the project.

Appendix 17. No Objection Letter from Office of the Principal Chief Conservator of Forest (Wildlife) and Chief Wildlife Warden for construction activities within the ESZ of Dibru - Saikhowa NP.

ES

Assam Water Centre
15 JUL 2023
GUWAHATI-29

GOVERNMENT OF ASSAM
OFFICE OF THE PRINCIPAL CHIEF CONSERVATOR OF FORESTS (WILDLIFE) AND
CHIEF WILDLIFE WARDEN, ASSAM::PANJABARI::GUWAHATI-37
Email ID: pccf.wl.assam@gmail.com

No. WL/FG.31/Water Resource/2023, Date: 14.07.2023

To,

The Additional Chief Engineer,
EAP Wing, Water Resource Department,
AWC, Basistha, Guwahati-29.

Sub: Permission for execution of river protection works under ADB funded Climate Resilient Brahmaputra Integrated Flood and River Bank Erosion Risk Management Project (CRBIFRERMP) in Assam near Protected Area – regarding.

Ref: 1. CEO, FREMAA's letter No. FREMAA (P)/PROJ/17/2022/4418 dated 30.06.2023.
2. Your letter No. WR/ACE/EAP/ADB/2/2022-23/82, dated 14.07.2023.

Sir,

With reference to the subject and letters cited above it is to inform you that, as per the O.M. dated 17th May, 2022 issued by the MoEF & CC, Govt. of India vide letter No. FC-11/119/2020/FC and in view of your letter dated 14.07.2023 mentioned under ref. 2 conveying that porcupine screen will be excluded from the river work near Protected Areas under the ADB funded CRBIFRERMP, no objection is hereby conveyed to implement the ADB funded Climate Resilient Brahmaputra Integrated Flood and River Bank Erosion Risk Management Project in the Eco Sensitive Zone of Dibru Saikhowa National Park, Orang National Park and Pobitora Wildlife Sanctuary subject to fulfilment of the following conditions:

1. No porcupine screens shall be installed.
2. No adverse impact shall be caused to Gangentic River Dolphin and other riparian wildlife including their habitat during project implementation.

This is for favour of kind information and necessary action.

Yours faithfully,

(Sandeep Kumar, IFS)
Principal Chief Conservator of Forests, Wildlife
& Chief Wildlife Warden, Assam.

Copy for information & necessary action to:

1. Divisional Forest Officer, Tinsukia Wildlife Division, Tinsukia.
2. Divisional Forest Officer, Guwahati Wildlife Division, Guwahati.
3. Divisional Forest Officer, Nagaon Wildlife Division, Nagaon.
4. Divisional Forest Officer, Mangaldoi Wildlife Division, Mangaldoi.
5. Divisional Forest Officer, Nagaon Division, Nagaon.

Principal Chief Conservator of Forests, Wildlife
& Chief Wildlife Warden, Assam.

Contd..2

2208354
17/7/23

Copy for information to:

1. Additional Chief Secretary to the Govt. of Assam, Environment & Forest Department, Dispur, Guwahati-06.
2. Additional Chief Secretary to the Govt. of Assam, Water Resource Department, Dispur, Guwahati-06.
3. Principal Chief Conservator of Forests & Head of Forest Force, Assam, Panjabari, Guwahati-37.
4. Additional Principal Chief Conservator of Forests, Upper Assam Zone, Jorhat.
5. Chief Executive Officer, FREMAA, Basistha, Guwahati-29.
6. Conservator of Forests, Northern Assam Circle, Tezpur.

Principal Chief Conservator of Forests, Wildlife
& Chief Wildlife Warden, Assam.

Photo Documentation