Ministry of Road Transport and Highways
National Highways and Infrastructure Development Corporation Limited

Japan International Cooperation Agency (JICA)

Preparatory Study for North-East Road Network Connectivity Improvement Project (Phase 2)

Draft Final Report
- Dhubri Bridge -

February 2018

PADECO Co., Ltd.

Nippon Engineering Consultants Co., Ltd.

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List of Abbreviations and Acronyms

AADT	Average Annual Daily Traffic
AC	Asphalt Concrete
ADB	Asian Development Bank
AH	Asian Highway
BOT	Build-Operate-Transfer
BRDB	Border Roads Development Board
BRO	Border Roads Organization
CAGR	Compound Annual Growth Rate
CBR	California Bearing Ratio
CC	Cement Concrete
CPCB	Central Pollution Control Board
CCEA	Cabinet Committee on Economic Affairs
CRF	Central Road Fund
CTCS	Classified Traffic Count Survey
DBFO	Design-Build-Finance-Operate
DBST	Double Bituminous Surface Treatment
DPR	Detailed Project Report
ESC	Environment and Social Consideration
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rates of Return
EMMP	Environmental Mitigation and Monitoring Plan
EMP	Environment Management Plan
EPC	Engineering-Procurement-Construction
F/S	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GOI	Government of India
GOJ	Government of Japan
GQ	Golden Quadrilateral
GSDP	Gross State Domestic Product
GS Road	General Staff Road (for defense requirements)
HDI	Human Development Index
HFL	High Flood Level
IEE	Initial Environmental Examination
IAHE	Indian Academy of Highway Engineers
ICB	International Competitive Bidding
INR	Indian Rupee
IRC	Indian Road Congress
IRI	International Roughness Index
IS	Indian Standard
ISC&EI	Inter State Connectivity and Economic Importance
IWAI	Inland Waterways Authority of India

IWT	Inland Water Transport
JICA	Japan International Cooperation Agency
KP	Kilo Post
LCV	Light Commercial Vehicle
MDONER	Ministry of Development of North-Eastern Region
MDR	Major District Road
MDB	Multilateral Development Bank
MEA	Ministry of External Affairs
MOEF	Ministry of Environment and Forests
MOEFCC	Ministry of Environment, Forests and Climate Change
MORTH	Ministry of Road Transport and Highways
NE	North-East
NEC	North-East Council
NER	North-Eastern Region
NH	National Highway(s)
NHAI	National Highways Authority of India
NHDP	National Highways Development Project
NHIDCL	National Highways and Infrastructure Development Corporation
NHIIP	National Highway Interconnectivity Improvement Programme
NITHE	National Institute for Training of Highway Engineers
NSDP	Net State Domestic Product
OD	Origin Destination
PAP	Project Affected Person
PCI	Per Capita Income
PCU	Passenger Car Units
PHF	Peak Hour Factor
PM	Penetration Macadam
PPP	Public-Private-Partnership
PWD	Public Works Department
RAP	Resettlement Action Plan
RO	Regional Office
R&IPDP	Resettlement and Indigenous People Development Plan
ROW	Right of Way
RSI	Roadside Interview
RSMP	Road Sector Modernization Program
SARDP-NE	Special Accelerated Road Development Programme for North-East
SBST	Single Bituminous Surface Treatment
SDP	State Domestic Production
SEIA	Summary Environmental Impact Assessment
SEZ	Special Economic Zone
SH	State Highway
SIA	Social Impact Assessment
SPCB	State Pollution Control Board
STR	Strategic Road
SVF	Seasonal Variation Factors

TA	Technical Assistance
TOR	Terms of Reference
TTC	Travel Time Cost
UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
V/C	Vehicle Capacity Ratio
VGF	Viability Gap Funding
VOC	Vehicle Operating Cost
WB	World Bank

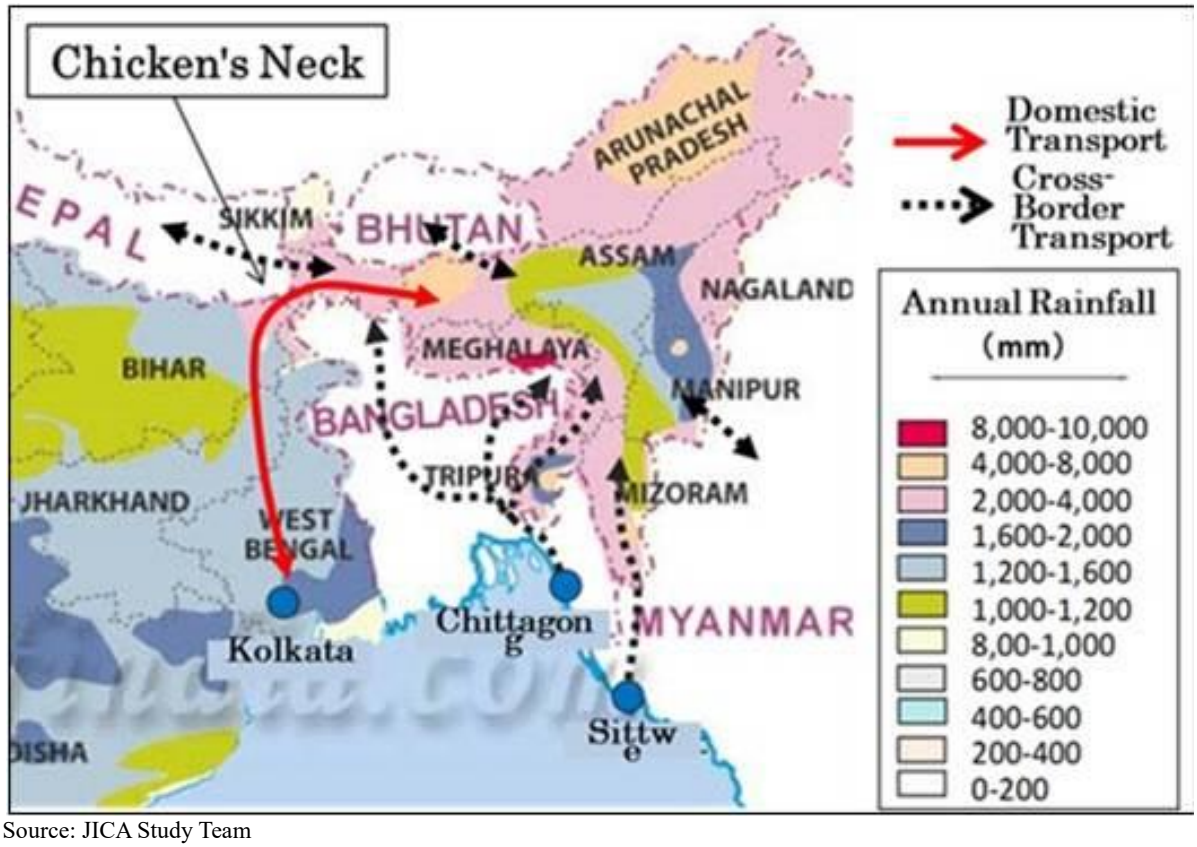
CHAPTER 1 INTRODUCTION

1.1 Background of Study

Development of the road network in the North-East (NE) states of India is of utmost importance for the country, which has been experiencing rapid economic growth in recent years.

The North-Eastern states (Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and Arunachal Pradesh) are located far from the mainland of India, connected by a "chicken's neck" surrounding Bangladesh (the narrowest width is only 22km). Cross-border trade agreements with Bangladesh and Myanmar have yet to be enacted. Therefore, transit cargoes must change trucks and go through import/export procedures at the border, which increases the freight cost making this region isolated from the mainland.

In India, the development of National Highways (NH) in the mainland has been progressing while those in the North-Eastern states have been stagnant due to insufficient budget and technical difficulty. Only 28.5% of the roads are paved (national average is 63.4%) and only 53% of the national highways have more than 2 lanes (national average is 77.9%). Some parts of the area have a yearly precipitation of more than 10,000 mm that results in frequent landslides and road blocks. The Brahmaputra River, which stretches along 600km through the central portion of the state in Assam, with the widest width up to 20km, has only four bridges crossing over it currently. All the bridges are toll-free. The delay of road development and frequent landslides have been creating bottlenecks of traffic hindering smooth cargo transportation and economic development of the area.



Source: JICA Study Team

Figure 1-1: North-East States Annual Rainfall

To improve the present situation, the Government of India has set a Special Accelerated Road Development Programme for North-East (SARDP-NE) under the Twelfth Five-Year Plan (April 2012-March 2017), aiming to develop the national road network between the major cities in the

area. It is also considered as one of the more important policies by the Modi administration.

The Japan International Cooperation Agency (JICA) has conducted "the Information Collection Survey on Cross Border Transport Infrastructure Improvement in South Asia" in 2013, and made recommendations to strengthen the connectivity in the region and improve relevant infrastructure. Considering many existing difficulties on the trade routes between the North-Eastern states and other regions, road developments on several routes are proposed.

Under these circumstances, the Government of India has requested loan assistance from the Government of Japan for the improvement of eight existing roads (total length of 1,242km), and rehabilitation of two existing bridges, and one new bridge in the North-Eastern states. JICA conducted the Preparatory Study for Road Network Improvement in the North-Eastern States of India (hereinafter referred to as Phase 1) including 1) prioritization of the proposed projects for Japanese ODA loans by analyzing the current conditions, 2) collection and analysis of data for the top two priority projects and review of F/S conducted by India, and 3) examination of the top two priority projects as candidates for Japanese Official Development Assistance (ODA) loans.

As priority criteria, consistency with the high-level plan, project maturity, traffic demand (v/c), and EIRR were chosen. Based on the results of the evaluation, NH54 and NH51 have been selected as the top two priority projects to be studied, followed by NH40 and Dhubri Bridge. During the study, it was identified that NH54 contained sections that might suffer significant social/ environment impacts from the planned road expansion. Four bypasses to avoid overcrowded sections with pavement improvement (10 m width) for the said sections have been proposed and an additional study was conducted.

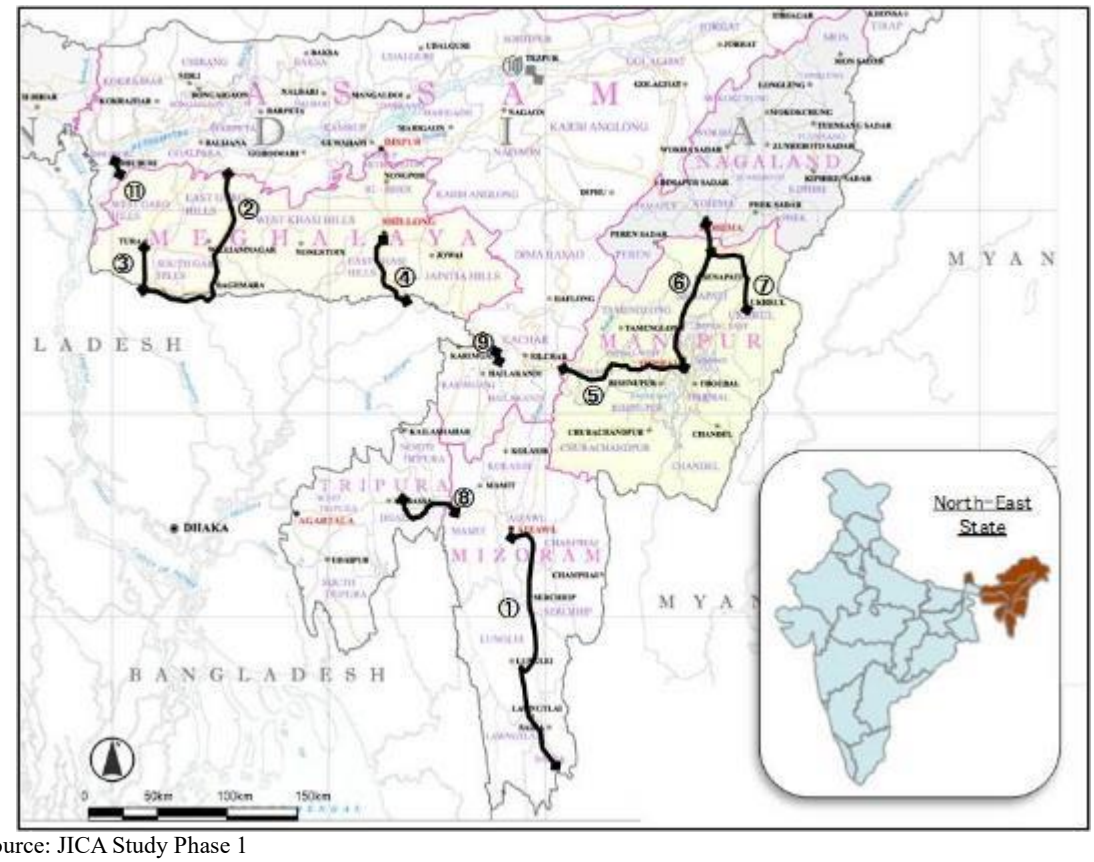
This preparatory study is the 3rd phase (hereinafter referred to as Phase 3) following Phase 1 and Phase 2 focusing on the Dhubri Bridge as the candidate for Japanese ODA loan. A required study for loan evaluation includes; project costs, implementation plan, maintenance and operation structures, environmental and social considerations, etc.

It is expected that the first loan evaluation will include NH54 and NH51 as Phase 1, NH54 bypasses and NH40 as Phase 2, to be followed by Dhubri Bridge as Phase 3.

1.2 Prioritization of Project Implementation

1.2.1 Study Roads

Eleven study roads in total were initially requested by GOI to GOJ to be considered in the study as shown in Figure 1-2 and Table 1-1. However, GOI has decided to implement No.10 (Koliabhomora Bridge Project) without assistance from GOJ and has removed it from the list. The security situation in the NER has been aggravated since 2015, when the study started by GOI, and the security situation factor has also been included in prioritizing project implementation.



Source: JICA Study Phase 1

Figure 1-2: Project Road for the Study

Table 1-1: The List of Study Roads

No.	Study Roads Section	Length	Request Type
①	Aizawl – Tuipang Section, NH54, Mizoram	381km	Improvement
②	Dudhanal – Dalu Section, NH62, Meghalaya	196km	Improvement
③	Tura – Dalu Section, NH51, Meghalaya	54km	Improvement
④	Shillong – Dawki Section, NH40, Meghalaya	84km	Improvement
⑤	Imphal – Jiribam Section, NH53, Manipur	221km	Improvement
⑥	Imphal - Kohima Section, NH39, Manipur	138km	Improvement
⑦	Ukhrul – Tadubi Section, NH102A, Manipur	115km	Improvement
⑧	Manu - Simlung Section NH44A, Tripura	110km	Improvement/New
⑨	Badarpurghat Bridge near Silchar, Assam	360m	Improvement/New
⑩	Koliabhomora Bridge near Tezpur, Assam	2.5km	Improvement
⑪	Dhubri – Phulbari Section, Assam	Bridge: 18km, Access Road: 21km	New Bridge

Source: JICA Study Phase 1

1.2.2 Evaluation Criteria

Evaluation criteria is applied to determine prioritization of project implementation for yen loan scheme, based on the results of the study of present conditions and major issues, traffic demand forecast, and economic analysis in the foregoing sections. Proposed evaluation criteria are

consistent with the above plan; project maturity, traffic demand, and EIRR. Table 1-2 shows the proposed evaluation criteria and score weighing. The total length of the priority project will be around 450km, based on the annual budgetary quota for road sector project loan for India.

Table 1-2: Evaluation Criteria of Project Prioritization

Criteria		Evaluation Contents (Score)			Weighting (Average:10)
		High (10-8)	Middle (7-4)	Low (3-0)	
1	Consistency with upper plan	Listed in National Road Development Plan (e.g. SARDP-NE)	Listed in International Road Development Plan (e.g. Asia Highway)	Others	5
2	Project maturity	DPR、EIA、RAP are prepared	DPR、EIA、RAP are being prepared	DPR、EIA、RAP are not yet prepared	10
3	Traffic demand supply Gap (V/C)	Demand supply gap in year 2020 (V/C>0.75)	Demand supply gap in year 2020 (V/C 0.75-0.50)	Demand supply gap in year 2020 (V/C <0.50)	10
4	EIRR	EIRR>15%	EIRR 12% - 15%	EIRR<12%	25

Source: JICA Study phase 1

In light of prioritizing projects as candidates for Japanese Official Development Assistance (ODA) loans, a half of weighting goes to EIRR considering the importance of economic viability; then, project maturity and traffic demand are also added to the weighting. Finally consistency with upper plan is added with a smaller value, which is different from that of EIRR.

1.2.3 Results of Project Prioritization

Results of project prioritization based on the evaluation criteria is shown below in Table 1-3.

Table 1-3: Results of Project Prioritization

Criteria		1				2			
		NH54: Aizawl-Tuipang				NH62: Dudhanai-Dalu			
		0-55	55-125	125-250	250-381	0-30	30-87	87-91	91-183
1	Consistency with upper plan	SARDP NE, Phase-B	SARDP NE, Phase-B	SARDP NE, Phase-B	SARDP NE, Phase-B		SARDP NE, Phase-B	SARDP NE, Phase-B	SARDP NE, Phase-B
		10	10	10	10		10	10	10
2	Project maturity	DPR under preparation	DPR under preparation	DPR is mostly prepared	DPR is mostly prepared	DPR Consultant being procured	DPR Consultant being procured	DPR Consultant being procured	DPR Consultant being procured
		6	6	8	8	3	3	3	3
3	Traffic demand (V/C)	1.22	1.92	1.60	1.87	0.29	0.22	0.64	0.64
		10	10	10	10	3	2	6	6
4	EIRR	15.1				7.3			
		8				2			
Total Score		**41**	**41**	**43**	**43**	**11**	**15**	**19**	**19**
Combined Score		**42**				**17**			
Ranking		**2**				**9**			

Criteria		3		4				
		NH51: Tura-Dalu		NH40: Shillong-Dawki				
		0-10	16-60	0-28	28-43	43-75	75-82	82-84

1	Consistency with upper plan			Asia Highway No.1	Asia Highway No.1	Asia Highway No.1	Asia Highway No.1	Asia Highway No.1
				7	7	7	7	7
2	Project maturity	DPR is mostly prepared	DPR is mostly prepared	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured
		8	8	3	3	3	3	3
3	Traffic demand (V/C)	2.50	5.48	1.16	0.78	0.39	3.90	0.39
		10	10	10	7	4	10	4
4	EIRR	22.0		16.8				
		10		9				
Total Score		**43**	**43**	**39**	**36**	**33**	**39**	**33**
Combined Score		**43**		**36**				
Ranking		**1**		**4**				

Criteria		**5**			**6**			**7**
		NH53: Imphal-Jiribam			**NH39: Imphal-Kohima**			**NH102A: Ukhrul-Tadubi**
		0-3	3-145	145-221	0-8	8-107	107-138	0-115
1	Consistency with upper plan				Asia Highway No.1	Asia Highway No.1	Asia Highway No.1	
					7	7	7	
2	Project maturity	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured
		3	3	3	3	3	3	3
3	Traffic demand (V/C)	0.17	1.28	1.28	0.25	0.78	0.78	1.71
		2	10	10	2	7	7	10
4	EIRR	22.6			18.7			14.0
		10			9			4
Total Score		**30**	**38**	**38**	**31**	**36**	**36**	**23**
Combined Score		**38**			**36**			**23**
Ranking		**3**			**4**			**7**

Criteria		**8**				**9**	**11**	
		NH44A: Manu-Simlung				**Badarpurghat Bridge**	**NH127B: Dhubri-Phulbari Bridge**	
		0-16	16-67	67-97	97-110	0-0.36	0-18	18-39
1	Consistency with upper plan	SARDP NE, Phase-B	SARDP NE, Phase-B	SARDP NE, Phase-B	SARDP NE, Phase-B			
		10	10	10	10			
2	Project maturity	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured	DPR Consultant is being procured
		3	3	3	3	3	3	3
3	Traffic demand (V/C)	2.07	1.26	1.26	1.26	1.10	0.98	9.80
		10	10	10	10	10	9	10
4	EIRR	3.5				-0.2	18.7	
		2				0	9	
Total Score		**23**	**23**	**23**	**23**	**18**	**35**	**36**
Combined Score		**23**				**13**	**35**	
Ranking		**7**				**10**	**6**	

Source: JICA Study Phase 1

1.2.4 Conclusion of Project Priority for Yen Loan Scheme

The project roads are categorized into three priority groups based on the project prioritization results. Remarks for project implementation are also mentioned below in Table 1-4.

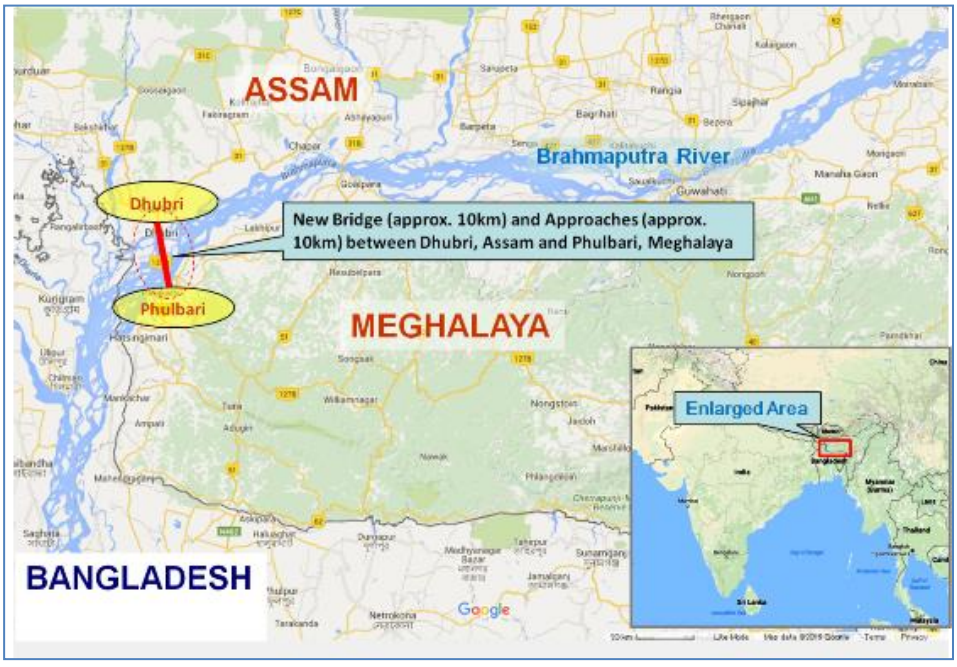
Table 1-4: Conclusion of Project Priority for Yen Loan Scheme

Group	Project	Priority	Remarks
Phase 1	NH51 (Tura-Dalu) Meghalaya NH54 (Aizawl-Tuipang) Mizoram	1 2	NH54 Study identified additional potential bypasses
Phase 2	NH54 (Four bypasses) Mizoram NH40 (Shillong-Dawki) Meghalaya	(2) 4	
Phase 3	NH127B (Dhubri-Phulbari) Assam	6	
Others	NH53 (Imphal-Jiribam) Manipur NH39 (Imphal-Kohima) Manipur NH102A (Ukhrul-Tadubi) Manipur NH44A (Manu-Simlung) Trpura NH44 (Badarpurghat Bridge) Assam NH62 (Dudhanal-Dalu) Meghalaya	3 4 7 7 10 9	Projects in Manipur are currently suspended until the security situation improves

Source: JICA Study Team

1.3 Outline of the Project

The locations and outline of the Project are shown below.



Source: JICA Study Team

Figure 1-3: Project Locations

Table 1-5: Tentative Outline of the Project

Project Name	Road Network Improvement in North-East States of India (Phase 2) (hereinafter referred to as "the Project")
Project Objectives	The Project aims at improving the road connectivity within the North-East region of India, and with other areas by improving and constructing national highways (including bridges) in the region, thereby further contributing to the economic development in the region.
Project Overview	Construction of a new bridge connecting Dhubri, Assam and Phulbari, Meghalaya (bridge length: approx. 10km, approaches: approx. 10km)
Project Area:	North-East States of India
Counterpart (C/P) Agencies	Ministry of Road Transport and Highways (MORTH) National Highways and Infrastructure Development Corporation Limited (NHIDCL)

Source: JICA Study Team

Although the Dhubri Bridge in Table 1-1 has lengths of 18km bridge and 21km access road, the 21km access road has been removed from this project and the state government has taken it over. The 18km bridge has become approx. 10km bridge and approx. 10km approaches after detailed surveys including site surveys. Table 1-1 shows projects requested by the Government of India and Table 1-5 shows projects after detailed survey. Since this project has come to have a bridge as the main portion, the length of the project has become shorter.

1.4 Objectives of Study

The objectives of the study are to develop a project plan including the project purpose and outline, project costs, implementation plan, maintenance and operation structures, environmental and social considerations, etc. This will provide the Government of Japan with the basis for a loan evaluation in the form of a Japanese Official Development Assistance (ODA), in response to the loan request from Government of India to Government of Japan.

CHAPTER 2 PRESENT CONDITION OF STUDY ROAD

2.1 Present Status of Roads and Transportation in Study Area

2.1.1 National Highway Network in North-Eastern States

The total length of national highways in the North-East is 13,258km, and these are being developed and maintained by the state Public Works Department (PWD), Border Roads Organization (BRO), National Highways Authority of India (NHAI) and National Highways and Infrastructure Development Corporation (NHIDCL) under the Ministry of Road Transport and Highways (MORTH). Of the total length of 13,258km, about 12,476km is with the NHIDCL and respective state's PWD. The remaining length of 782km is with NHAI. The Ministry has been paying special attention to the development of national highways in the North-Eastern Region and 10% of the budget allocation is earmarked for NER. The national highway network mainly connects state capitals and major districts, as well as the international cross border network as shown in Figure 2-1.

Source: Ministry of Development of North-Eastern Region

Figure 2-1: National Highway Network in the North-Eastern Region

The details of national highways and their development and maintenance works taken up under various schemes during the Fiscal Year 2014-15 in the North-Eastern Region are as follows:

(i) Length under National Highway Development Project (NHDP) Phase-III 110km
(ii) Length of national highways, state roads under SARDP-NE, Phase A: 4,099km, Phase B: 2,392km, Arunachal Pradesh package of Roads and Highways: 2,319km

The status of national highways in each state in the North-Eastern Region is shown in Table 2-1.

Table 2-1: Numbers and Lengths of National Highways in North-Eastern States

No.	Name of State	National Highway No.	Total Length (km)
1	Arunachal Pradesh	52, 52A, 153, 229, 52B Ext, 37 Ext, 315 New, 713 New, 513 New, 313 New, 113 New, 713A New	2513.05
2	Assam	6 New, 31, 31B, 31C, 36, 37, 37A, 37E, 38, 39, 44, 51, 52, 52A, 52B, 53, 54, 61, 62, 117A New, 127B New, 127E New, 151, 152, 153, 154, 315A New, 127C New, 127D New, 329 New, 427 New, 627 New, 702 New, 702B New, 702C New, 702D, 715A New	3811.67
3	Manipur	39, 53, 102 New, 102A New, 102B New, 102C New, 129A New, 108A New, 129 New, 137 New, 137A New, 150, 155, 702A New	1545.74
4	Meghalaya	40, 44, 51, 62, 127B New	1204.36
5	Mizoram	6 New, 44A, 54, 54A, 54B, 102B New, 150, 154, 302 New, 306A New, 502A New	1381.00
6	Nagaland	36, 39, 61, 129 New, 150, 155, 702 New, 702A New, 702B New, 702D	1150.09
7	Tripura	44, 44A, 108A, 208 New, 208A New, 108B New	805.0

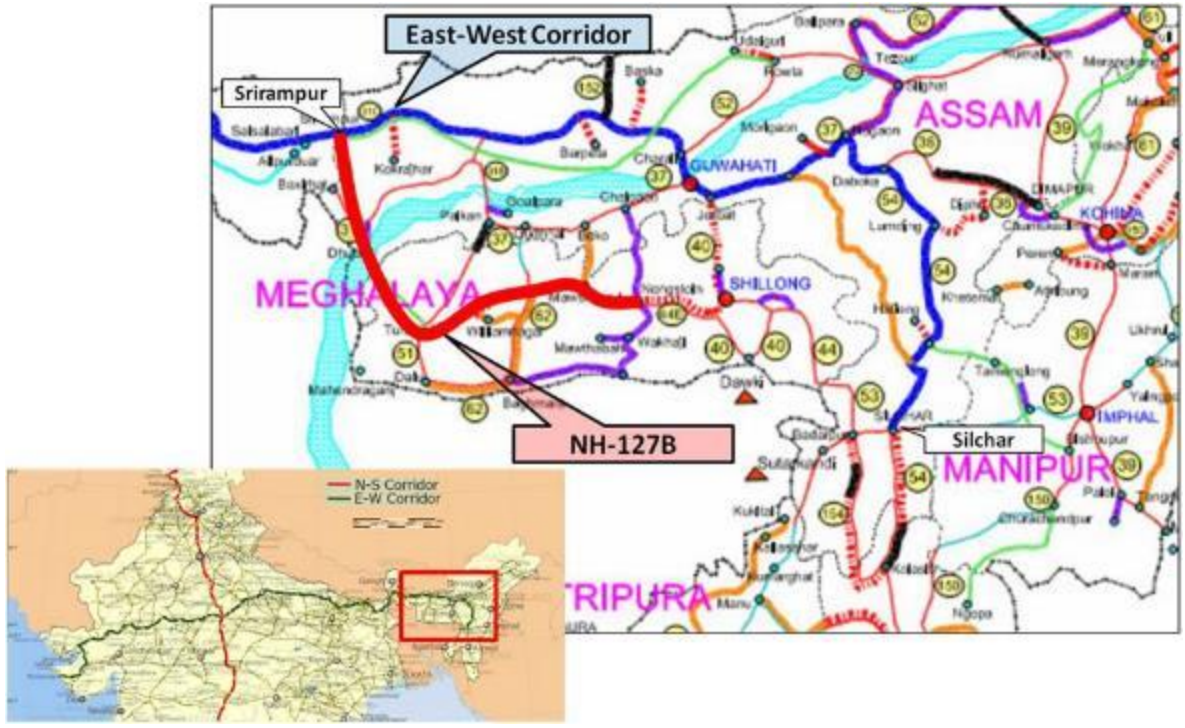
Source: MORTH Annual Report 2015-16

2.1.2 Transport Infrastructure Development Projects in North-Eastern Region

The Government of India has focused on time-bound completion of critical transport infrastructure of the North-Eastern Region; viz. road, rail, inland water transport (IWT), airport and air connectivity. Some of the critical ongoing projects are: (i) East West Corridor (Srinampur to Silchar), (ii) SARDP-NE, (iii) Bogibeel Bridge, (iv) Railway gauge conversion (Lumding-Silchar and Rangia-Murkong selek), (v) New railway lines (Jiribam-Tupul-Imphal), (vi) Airport hangers in the Lokapriya Gopinath Bordoloi International Airport (Guwahati). The government has also proactively taken initiatives for promoting linkages with other parts of the country, and for close bilateral relations with the neighboring countries and other South East Asian countries in accordance with the 'Act East Policy'. Establishing closer ties between India and Bangladesh will also go a long way in promoting peace and development in the North-Eastern Region.

2.1.3 Road Network Connectivity

The East-West Corridor forms the backbone of the road network in India, together with the Golden Quadrilateral and the North-South Corridor. The East-West Corridor starts at Srirampur and ends at Silchar in North-East. This project aims to improve the connectivity of the North-Eastern Region with the rest of India through a 670km long four-lane divided highway between Srirampur and Silchar. The Corridor does not go beyond Assam. The entire section of the East-West Corridor was completed in 2015. NH127B will directly connect the North-Eastern Region to the East-West Corridor. The under-developed south areas of the region will be connected via the East-West Corridor to other important cities in the region, and further to all areas in India contributing to better goods transportation and economic development.

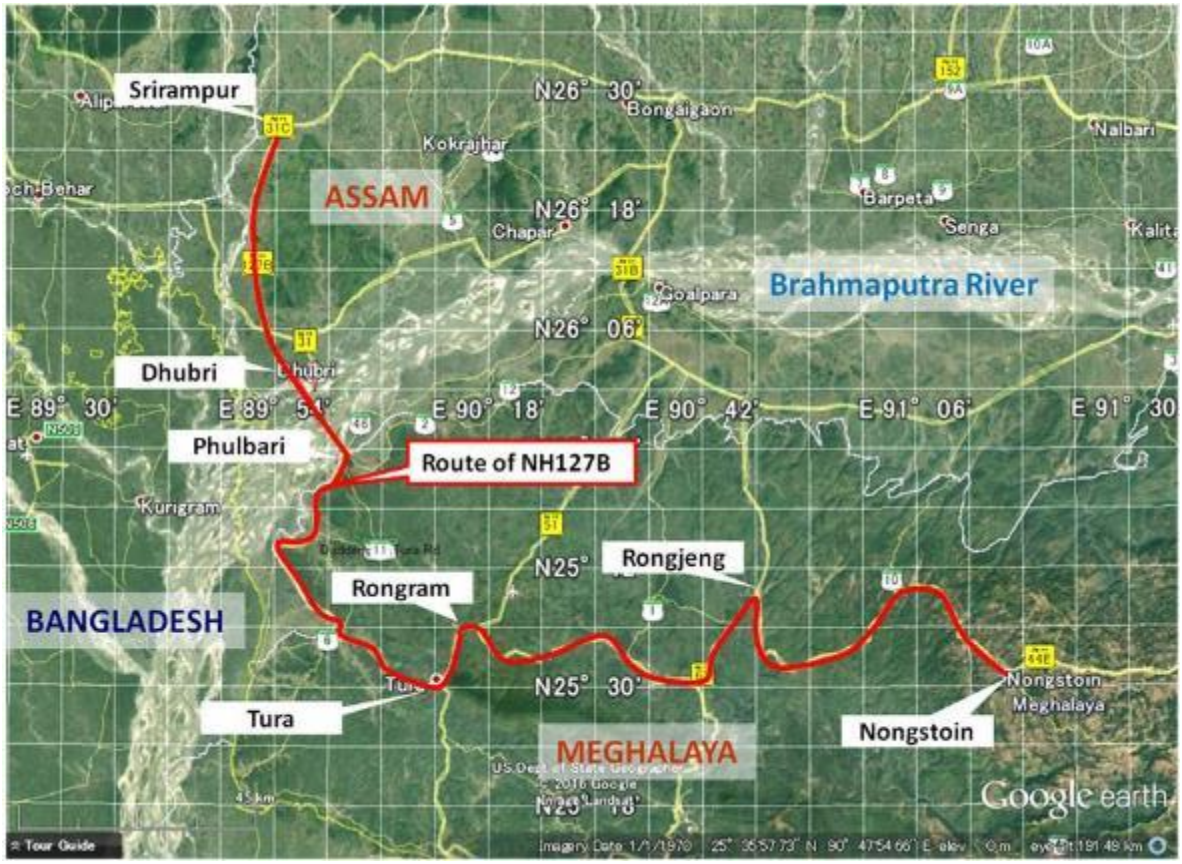


Source: JICA Study Team

Figure 2-2: Road Network Connectivity in North-West

The proposed bridge alignment is a part of the newly declared NH-127B, which crosses the Brahmaputra River (MORTH Gazette notification no. S.O. 312(E), dated 22nd February 2012). Currently, only small boats are operating to cross this section since a road crossing is missing on NH-127B.

NH-127B starts at Srirampur on NH-31C (new NH-27) at Assam and terminates in Nongstoin on NH-44E (new NH106) at Meghalaya; connecting enroute to Dhubri in Assam and Phulbari, Tura, Rongram and Rongjeng in Meghalaya. Currently, the road conditions of most sections are extremely poor. The road width is narrow and non-paved sections prevail. Even the paved sections have numerous potholes making the drivability very poor. NH-127B comprises of the following segments.



Source: JICA Study Team

Figure 2-3: Route of NH127B

Table 2-2: Segments of NH127B

NO	Segment	Description
1	Srirampur to Balajan	Existing road, tentative length 40.5km, average width 6m, pavement very bad, DPR under way
2	Balajan to Adabari	Existing road, tentative length15km, average width 4m, pavement very bad, DPR under way
3	Adabari to Bridge Approach	New alignment, tentative length 1.0km, average width 4m, DPR under way
4	Dhubri to Phulbari	New alignment, tentative length 20.0km, ferry section, this project
5	Phulbari to Tura	Existing road, tentative length 81.0km, average width 10m, pavement bad, DPR to start
6	Tura to Rongram	Existing road, tentative length 14.5km, average width 10m, pavement bad, DPR to start
7	Rongram to Rongjeng	Existing road, tentative length 96.0km, average width 10m, pavement bad, DPR to start
8	Rongjeng to Nongstoin	Existing road, tentative length 103.0km, average width 10m, pavement good, improved

Source: JICA Study Team based on DPR

The alignment of the proposed bridge over Brahmaputra between Dhubri in Assam and Phulbari in Meghalaya is the most important segment of this National Highway, as it will eradicate the existing missing link over the Brahmaputra River. This will culminate in establishing the surface transport connectivity between two very important centers in the North-Eastern India, which hitherto is fully dependent on ferry services for this purpose. The alignment location of the new bridge connecting

Dhubri, Assam and Phulbari, Meghalaya (hereinafter referred to as Dhubri Bridge) is presented as Figure 2-4.

Source: JICA Study Team based on DPR

Figure 2-4: Alignment Location Map

2.1.4 Ferry Facilities

The project site falls under the territory of Assam and Meghalaya states in North-East India. Dhubri is a district town in the Assam state located at the north bank of Brahmaputra. Phulbari is a small township, partly in Assam (South Salmara – Mankachar District) and mostly in the West Garo Hills district in the state of Meghalaya. An International border with Bangladesh is located about 11km away from Dhubri.

The main modes of transportation between these two towns are by ferry and passenger boats across the Brahmaputra River. These ferry services are operated by private businessmen and are controlled by the local District Commissioner's office and Inland Water Transport Department. There are four popular ferry stations or 'ghats', namely Netai Dhubuni Ghat, Jogomaya Ghat, Panchu Ghat and New Ghat, which are used by the local people on the Dhubri end.

There is no permanent jetty structure at these ghats. Simple footholds which are made of wood and bamboo are being used. The entire embarking and disembarking operations is a major safety hazard for the local people. Only small load goods that people carry by hand can be transported. Motorcycles are transported occasionally but it involves hard work and time to get them on board and to get them ashore. The locations of various ferry Stations along the Dhubri bank are presented in Figure 2-5.

Source: JICA Study Team based on DPR

Figure 2-5: Locations of Ferry Facilities at Dhubri

The bank line along South bank of Brahmaputra River is no different. The make-shift ferry stations on the South bank are Fakirgung Ghat, Jaleswar Ghat, Phulbari Ghat, Hatsimari Ghat and Sukchar Ghat. Major goods transported through these points are jute, groceries, cotton, cashews etc. During the dry season, the Phulbari Ghat becomes non-navigable. The Saikhoa Ghat downstream is used in lieu.

Boat Landing at Dhubri

Boat landing at Phulbari

Source: JICA Study Team

Figure 2-6: Phulbari Ghat

There are several river islands in between the stretch of Dhubri to Phulbari. Most of the islands get inundated during the rainy seasons, however, settlements were observed on the islands during the reconnaissance survey of the river. The ownership of these islands have been studied in detail by the DPR consultant, and notification has been submitted to NHIDCL. The main occupations of the island settlers are cultivation and fishing.

Brahmaputra River has been identified as National Waterway–2 by the Government of India (Refer to Figure 2-5). This waterway is to be maintained and used by the Inland Waterways Authority of India (IWAI), and is to be used for river transportation by Class VII vessels as defined in the IWAI notification.

Dhubri is the entry point from Bangladesh. Customs Clearance offices and Border Security Force camps have been located at Dhubri for immigration and other related services. The IWAI is presently constructing a new Roll-on/Roll-off jetty at Dhubri. The construction is at an early stage as recognized in the Figures below.

Source: MDONER

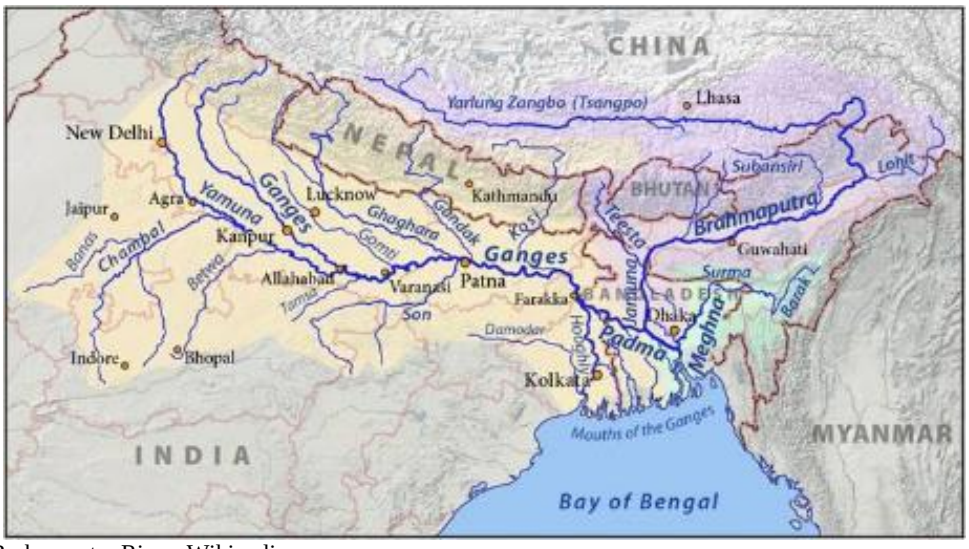
Figure 2-7: National Waterway-2 Project

Source: JICA Study Team based on DPR

Figure 2-8: Construction of Roll-on/Roll-off Jetty at Dhubri

2.1.5 Present Status of Brahmaputra River

The Brahmaputra River originates from the Chemayungdung Glacier in the Himalayas (China) at an elevation of 5,210m. This is the longest river in India (2900km). The river touches three countries, China, India, and Bangladesh. With its origin from the Angsi Glacier, located on the northern side of the Himalayas in Burang County of Tibet, where it is known as the Yarlung Tsangpo River. It flows across southern Tibet and breaks through the Himalayas in great gorges and into Arunachal Pradesh in India, where it is known as Dihang (or Siang). The river then flows southwest through the Assam Valley as Brahmaputra. The river enters Bangladesh after flowing past Dhubri and then it is known as the Jamuna, eventually merging with the Padma, the main distributary of the Ganges, then the Meghna, before emptying into the Bay of Bengal. Figure 2-9 below shows a map with locations of Bridges over the Brahmaputra River.



Source: Brahmaputra River, Wikipedia

Figure 2-9: Basin of Brahmaputra River

Brahmaputra is an important river for irrigation and transportation in North-East India. The river is prone to catastrophic flooding, mainly in the spring, due to melting of the snow from the Himalaya Mountains. The Brahmaputra mainly passes through rolling terrain in Assam. It is a classic example of a braided river and is highly susceptible to channel migration and avulsion. It is also one of the few rivers in the world that exhibits a tidal bore. It is navigable for most of its length.

The flow of the river is as follows; starts from the Himalayas east of the Indo-Nepal border, the south-central portion of the Tibetan plateau above the Ganges basin, south-eastern portion of Tibet, the Patkai-Bum hills, the northern slopes of the Meghalaya hills, the Assam plains, and the northern portion of Bangladesh. The basin, especially south of Tibet, is characterized by high levels of rainfall.

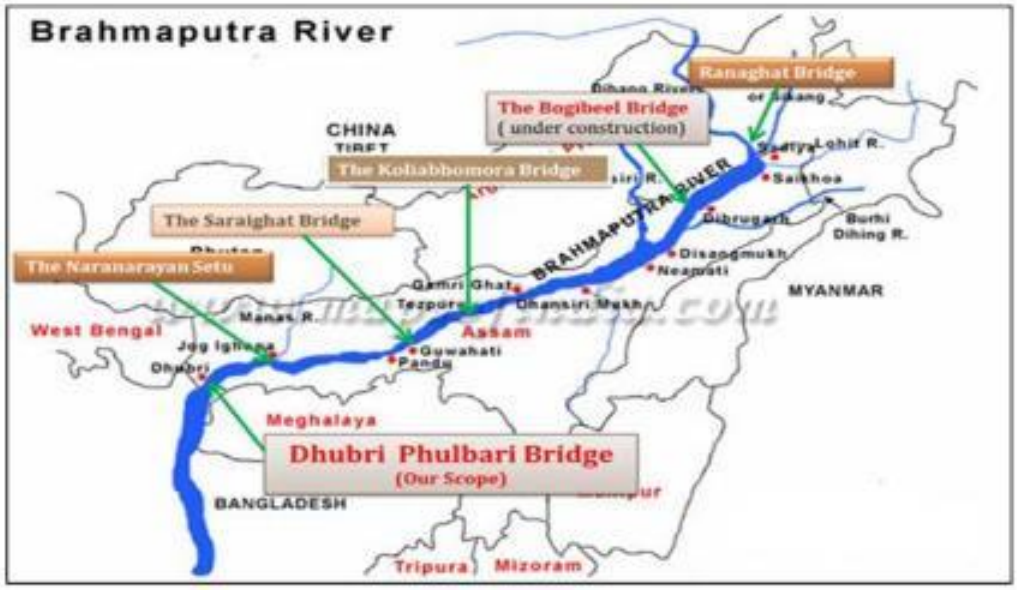
The river is mighty and is named as Brahma-putra ('Son of the Creator') in Assam. Several rapidly rushing Himalayan streams feed into it including the Subansiri, Kameng, Bhareli Dhansiri, Manas, Champamati, Saralbhanga, and Sankosh Rivers. The main tributaries from the hills and from the plateau to the south are the Burhi Dihing, the Disang, the Dikhu, and the Kopili. The river divides into two channels between Dibrugarh and Lakhimpur Districts, —the northern Kherkutia channel and the southern Brahmaputra channel. The two channels join again about 100km downstream, forming the Majuli Island, which is the largest river island in the world.

Deforestation in the Brahmaputra watershed has resulted in increased siltation levels, flash floods, and soil erosion in critical downstream habitats, such as the Kaziranga National Park in middle Assam. Occasionally, massive flooding causes huge losses to crop, life, and property. Periodic

flooding is a natural phenomenon which is ecologically important because it helps maintain the lowland grasslands and associated wildlife. Periodic floods also deposit fresh alluvium, replenishing the soil of the Brahmaputra River Valley.

The location of the Project is about 500km upstream from the river mouth, the Bay of Bengal. It is about 20km from the border with Bangladesh. The average annual flow is about 571 mil m3, and the average flow rate is about 18,099m3/s. The velocity of the flow changes by season and points in the river. It is about 1m/s at the surface of the water near the bank at Dhubri, and it becomes as fast as 4m/s at the surface of a main flow channel. The depth also varies by place. The deepest of the cross section of the river along the bridge alignment is about 10m in the monsoon season, and about 4m in the dry season. The river banks and islands forms gentle slope. Some of those in the bank are used as paddy fields, which are submerged during the monsoon season. The annual sediment flow is about 0.8 mil t. The transparency of the water is low, containing silty clay brown in color. People, light goods, motorcycles, bicycles, etc. are being transported by about 20 to 30 small boats.

The Brahmaputra is the widest at the location of the proposed bridge. The East- West flow takes an orthogonal turn just after passing Dhubri. The banks are not defined and wide areas get inundated during the floods, especially upstream from Dhubri. There are two perennial channels along each bank of the river. Two major tributaries merge with Brahmaputra at this location – the Gadadhar in the North bank (upstream from Dhubri) and the Jinjiram on the South bank. Cross currents and vortexes could be attributable to non-uniform bed slopes. The crow's flight distance from bank to bank is about 8.7km. As the local folklore goes, if we try to tame the river (incidentally one of the few male rivers in India) he will destroy us, but if we use the river for the well-being of the local people then he will embrace us. The figure below shows names and locations of bridges across the Brahmaputra River. The four bridges in service are all toll-free.



Source: JICA Study Team based on DPR

Figure 2-10: Bridges over the Brahmaputra River

2.2 Present Status of National Highway Development

2.2.1 Organizations Related to National Highway Development

(1) Ministry of Road Transport and Highways (MORTH)

The Ministry of Road Transport and Highways (MORTH) was formed in 2009 by splitting the former Ministry of Shipping, Road Transport and Highways into two independent Ministries. The MORTH oversees construction and maintenance of national highways, administration of the Motor Vehicles Act (1988), and Central Motor Vehicles Rules (1989), formation of broad policies relating to road transport, environmental issues, automotive norms, fixation of use fee rate for national highways, authority relating to cross-border movement of vehicular traffic with neighboring countries, etc.

(2) National Highways Authority of India (NHAI)

The National Highways Authority of India (NHAI) was set up through an Act of Parliament, namely the National Highways Authority of India Act (1988). It is responsible for the development, maintenance and management of national highways entrusted to it by MORTH, and for all matters related to or incidental thereto. The NHAI became operational in February 1995. As of March 31, 2015, out of a total 55,561km of national highway that are planned to be developed/ upgraded by NHAI, 32,620km (excluding terminated contracts) of national highway have been awarded, of which 23,866km have been completed and 8,754km are in progress. Projects for additional 18,012km is to be awarded in due course.

Figure 2-11: NHAI Logo

(3) Indian Academy of Highway Engineers (IAHE)

The Indian Academy of Highway Engineers (IAHE) is a registered society under the administrative control of MORTH. Its name was changed from the National Institute for Training of Highway Engineers (NITHE) in 2010. It is a collaborative body of both central and state governments, and was set up in 1983 with the objective of fulfilling the long-felt need for the training of highway engineers in the country, both at the entry level and during the service period. IAHE offers approx. 80 training courses for about 1,700 trainees on a wide range of areas relating to roads from planning, construction, maintenance, quality control, road safety, contract management, ITS, etc. A new training building and facilities were constructed in Noida, Uttar Pradesh, on 1 October 2001. The training facilities include an air-conditioned lecture hall, lecture rooms, a library, a computor room, a material testing training room, lodging with a cafeteria, leisure room, faculty rooms, etc. IAHE has been adding facilities according to the growing demand of training.

Source: IAHE

Figure 2-12: IAHE Logo

(4) National Highways & Infrastructure Development Corporation LTD (NHIDCL)

In February 2014, the Cabinet approved the set up and operation of a new corporate entity under MORTH to exclusively carry out the task of construction/ up-grading/ widening of national highways in parts of the country which share international boundaries with neighboring countries, so as to promote regional connectivity with neighboring countries on a sustainable basis. An approximate aggregate length of 10,000km has been identified to begin with for development through this company. The company also proposes to improve road connectivity and efficiency of the international trade corridor, by expanding about 500kmkm of roads in the North Bengal, and the North-Eastern Region of India to enable efficient and safe transport regionally with other South Asia Sub-regional economic Cooperation (SASEC) member countries. These projects are being funded by the Asian Development Bank (ADB).

Source: NHIDCL

Figure 2-13: NHIDCL Logo

(5) Indian Roads Congress (IRC)

Indian Roads Congress (IRC) is the apex body of road sector engineers and professionals in India. IRC was formally registered as a society in 1937. IRC has more than five million associates (direct/indirect) and over 16,700 registered members comprising of engineers and professionals of across all stakeholders of the road sector. IRC have published Codes of Practices for Specifications & Standards, Special Publications on Guidelines and Manuals, publications on behalf of MORTH, and other informative publications for road-related public organizations. In December 2015, the IRC held their 76th Annual Session in Indore, which had an attendance of 2,000 members from across the public and private sector in the road industry.

Source: IRC

Figure 2-14: IRC Logo

2.2.2 Development Programs for National Highways

(1) Outline of Road Network in India

India has one of the largest road networks in the world with over 5,232,000km of roads. It is comprised of national highways, expressways, state highways (SH), major district roads (MDR), other district and village roads. Historically, investments in the transport sector have been made by the Government. However, to encourage private sector participation, the Ministry has laid down comprehensive policy guidelines for private sector participation in the development of national highways. Categories of roads and corresponding lengths of overall road network in India are shown in Table 2-3.

Table 2-3: Categories and Lengths of Road Network in India

No.	Category	Length (km)
1	National highways / Expressways	100,475
2	State highways	148,256
3	Other Roads	4,983,579
	Total	5,232,310

Source: MORTH Annual Report 2015-16

(2) Present Status of Each National Highway Development Program

The Ministry of Road Transport and Highways (MORTH) has been entrusted with the responsibility of the development of road transport and highways in general, and the construction and maintenance of national highways. All roads other than national highways in the states fall within the jurisdiction of respective state governments. To assist the state governments in the development of state roads, MORTH provides financial assistance out of the Central Road Fund (CRF), and Inter State Connectivity and Economic Importance (ISC&EI) scheme. Besides the National Highways Development Project (NHDP) and National Highway Interconnectivity Improvement Programme (NHIIP), MORTH is implementing SARDP-NE and Development of Roads in Left Wing Extremism (LWE) schemes, which includes national highways and state roads. The ministry is also responsible for evolving standards and specifications for roads and bridges in the country, besides acting as a repository of technical information on roads and bridges. The present status of each national highway development program is shown in Table 2-4 below.

Table 2-4: Present Status of National Highway Development Programs

Program Name	Total Length	Completed	Completed In 2015
NHDP	54,478	24,324	1233
I: GQ, EW-NS Corridors, Port Connectivity, Others	7,522	7,521	1
II: 4/6-laning North South-East West Corridor, Others	6,647	5,903	48
III: Upgrading, 4/6-laning	12,109	6,734	252

Program Name	Total Length	Completed	Completed In 2015
IV: 2-laning with Paved Shoulders	20,000	1,825	709
V: 6-laning of GQ and High-Density Corridor	6,500	2,319	223
VI: Expressways	1,000	0	0
VII: Ring Roads, Bypasses, Flyovers, Others	700	22	0
SARDP-NE	6,190	1,829	82
LWE	5,422	3,904	334
NHIIP	1,120	239	157

Source: MORTH Annual Report 2015-16

(3) National Highways Development Project (NHDP)

NHDP Phase I and II comprise of the development of national highways to 4 or 6-lane standards. The developments are (a) Golden Quadrilateral (GQ) connecting 4 major metropolitan cities; Delhi-Mumbai-Chennai-Kolkata, (b) North South & East West Corridors (NS-EW) connecting Srinagar to Kanyakumari and Silchar to Porbandar, with a spur route from Salem to Cochin, (c) Road connectivity of major ports of the country to national highways, and (d) Other national highway stretches.

NHDP Phase I, which was approved by the Cabinet Committee on Economic Affairs (CCEA) in December 2000 at an estimated cost of Rs. 303 million (in 1999 price), is comprised of 5,846km for GQ, 981km for NS-EW Corridor, 356km for Port Connectivity and 315km for other national highways, a total of 7,522km. This was completed in 2015.

NHDP Phase II, which was approved in December 2003 at an estimated cost of Rs. 343 million, comprises mostly of the NS-EW Corridor (6,151km) and other national highways of 486km in length, the total length being 6,647km. 48km of this was completed in 2015.

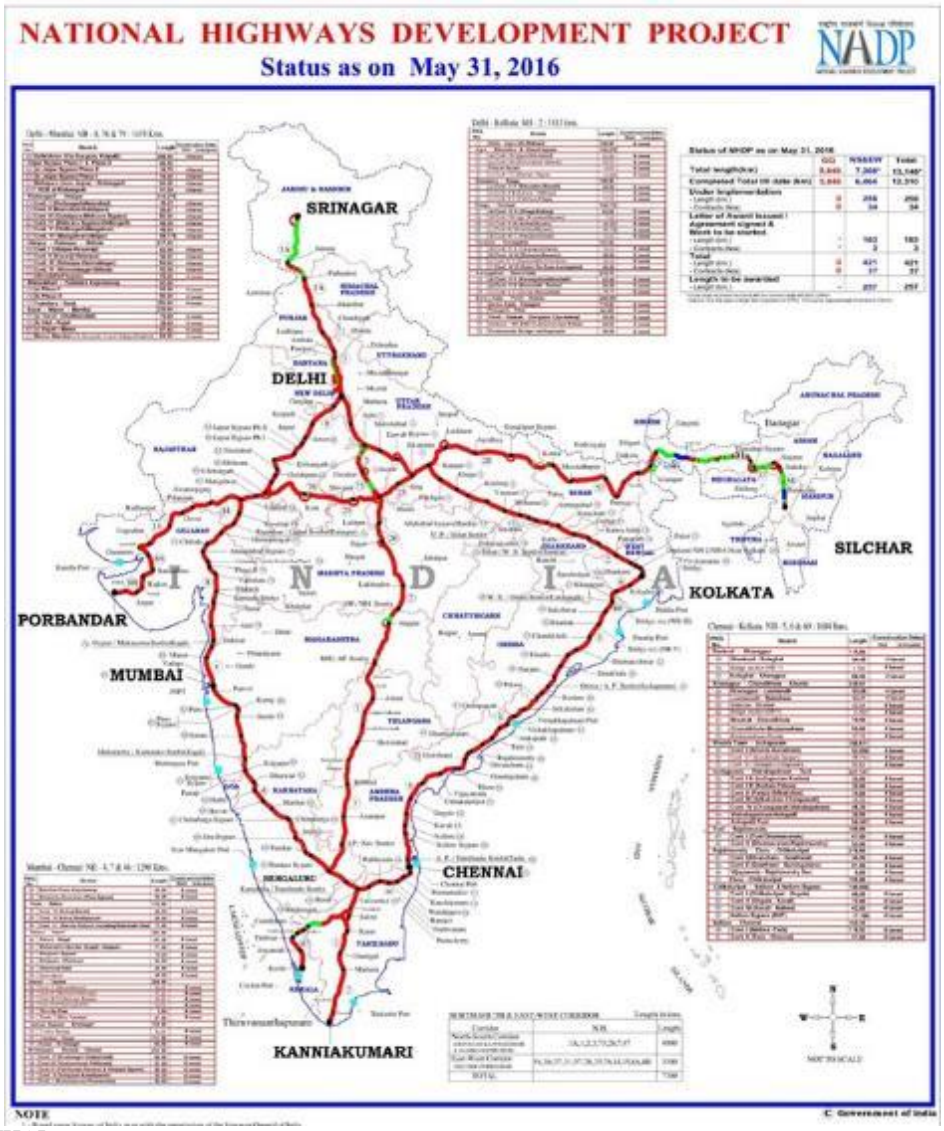
NHDP Phase III covers the 4-laning of 4,000km of national highways on a Build-Operate-Transfer (BOT) basis and was approved in March 2005. Additional sections have been added since the following years and so far, 12,109km has been identified at an estimated cost of Rs. 806 million. By December 2015 - 6,734km out of the 12,109km has been upgraded to four-lanes and an additional 3,313km is currently under implementation. During 2015, 252km was completed.

NHDP Phase IV envisages upgrading about 20,000km of national highways to 2-lane paved With shoulder at an estimated cost of Rs. 850 million. This phase was approved in July 2008. 13,203km is entrusted to NHAI. 1,825km have already been four/two-lane up to the end of 2015, and 4,704km is currently under implementation. During 2015, 709km were completed.

NHDP Phase V consists of the 6-laning of 6,500km of existing 4-lane national highways (approved October 2006) at an estimated cost of Rs. 4,121 million. Thiskm includes 5,700km for GQ and 800km for other areas. Of the 6,500km, a length of 2,319km has already been 6-laned by the end of 2015, and 1,756km is currently under implementation. During 2015, 223km were completed.

NHDP Phase VI envisages development of 1,000km of fully access-controlled expressways under the Public Private Partnership (PPP) model following a Design-Build-Finance-Operate (DBFO) approach. This phase was approved at an estimated cost of Rs. 1,668 million in November 2006. It is planned that Rs. 900 million will come from the private sector and the balance of Rs. 768 million will be government funding for bridging the viability gap, as well as meeting the cost of land acquisition, utility shifting, consultancy, etc.

NHDP Phase VII covers the construction of standalone ring roads, bypasses, grade separators, flyovers, elevated roads, tunnels, road over bridges, underpasses, service roads, etc., with a BOT (Toll) model. This phase was approved in December 2007 at an estimated cost of Rs. 1,668 million.

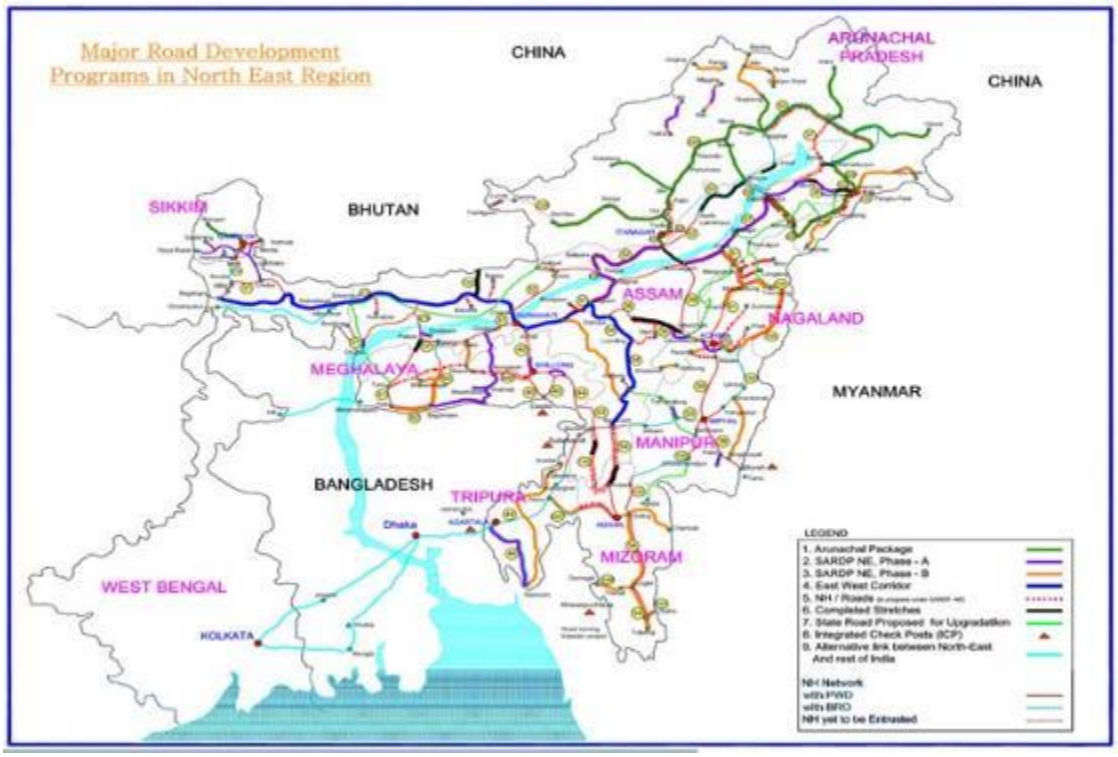


Source: NHAI

Figure 2-15: National Highways Development Project (as of May 31, 2016)

(4) Special Accelerated Road Development Programme for the North-East (SARDP-NE)

Special Accelerated Road Development Programme for the North-East (SARDP-NE) aims at improving road connectivity of district headquarters and remote places of the North-Eastern Region with state capitals. It envisages 2/4-laning of about 7,530km of national highways and the 2-laning/improvement of about 2,611km of state roads. This will ensure the connectivity of 88 district headquarters in North-Eastern states to the nearest national highways with at least 2-lane roads. The Programme has been divided into Phase A, Phase B, and Arunachal Pradesh Package of Roads and Highways.



Source: Ministry of Development of North-Eastern Region (MDONER)

Figure 2-16: Major Road Development Programs in North-Eastern Region

Phase A is the improvement of 4,099km of roads consisting of 3,014km of national highways and 1,085km of state roads at an estimated cost of Rs. 2,177 million. Km BRO, state PWD and NHIDCL have been assigned with the development of 3,213km of the roads at an estimated cost of Rs. 1,282 million. Of the remaining 886km, 112km is to be implemented by NHAI on a BOT (annuity) basis, 20km by Arunachal Pradesh PWD and 752km by NHIDCL. The works are in various stages of progress and the likely date of completion for Phase A is March 2017.

Phase B involves 2-laning of 2,392km of NH and the 2-laning/improvement of 1,331km of state roads. Phase B is approved only for DPR preparation.

The Arunachal Pradesh Package of Roads and Highways covering 2,319km (2,205km national highways and 114km state/general staff roads (GS roads)) of road stretch was approved as part of SARDP-NE in January 2009. Out of this, 776km has been approved for execution under a BOT (Annuity) basis and approval for tendering by EPC basis has been given for the remaining 1,543km. By December 2015, works for a total length of 1,675km at a cost of Rs. 1,529 million have been awarded. The remaining length of 644km is either under estimate examination or DPRs are under preparation.

SARDP-NE stagnated for a long time due to the security situations and the lack of implementation capability of executing agencies. NHIDCL was newly set up under MORTH in Feburary 2014 to break the deadlock. The Modi administration has placed importance on road development in the North-Eastern Region. According to a media report (Infracircle), the length of 1,646km in Phase A was completed as of June 2016. Phase B will start after the completion of Phase A.

(5) Development of Roads in Left Wing Extremism (LWE) Affected Areas

The Government of India approved the Road Requirement Plan for the development of 1,126km of national highways and 4,351km of State Roads (total 5,477km) to 2-laning at a cost of Rs. 730 million in the 34 Left Wing Extremism (LWE) affected districts in the State of Andhra Pradesh,

Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha and Uttar Pradesh for all-inclusive growth of these areas.

MORTH has set up the LWE Division under the Chief Engineer for sanctioning and implementing the above Programme through respective state PWD. The detailed estimates for 5,422km have been sanctioned at an estimated cost of Rs. 859 million, out of which, works on 5,263km length costing Rs. 701 million have been awarded. Development of 3,904km have been completed up to January 2016, and the cumulative expenditure incurred so far is Rs. 540 million. The development of roads under the Programme is scheduled to be completed by March 2017, except for the works that are yet to be awarded.

(6) National Highways Interconnectivity Improvement Projects (NHIIP)

Rehabilitation and upgrading to 2-lane roads with paved shoulders of stretches for various national highways in the states of Bihar, Karnataka, Odisha, Rajasthan and West Bengal is being taken up with loan assistance from the World Bank (WB) under Phase-I of NHIIP. Eleven stretches, involving 15 civil works comprising a total length of 1,120km amounting to Rs. 519 million (WB share is US$ 500 million) is envisaged in the Programme. The Cabinet approved the project in April 2013. Completion of the project is slated by March 2022.

The Project components include A: Road Improvement and Maintenance, B: Institutional Development Component, and C: Road Safety. The loan is to be amortized in 18 years, including a 5-year grace period.

(7) National Expressway Network Plan

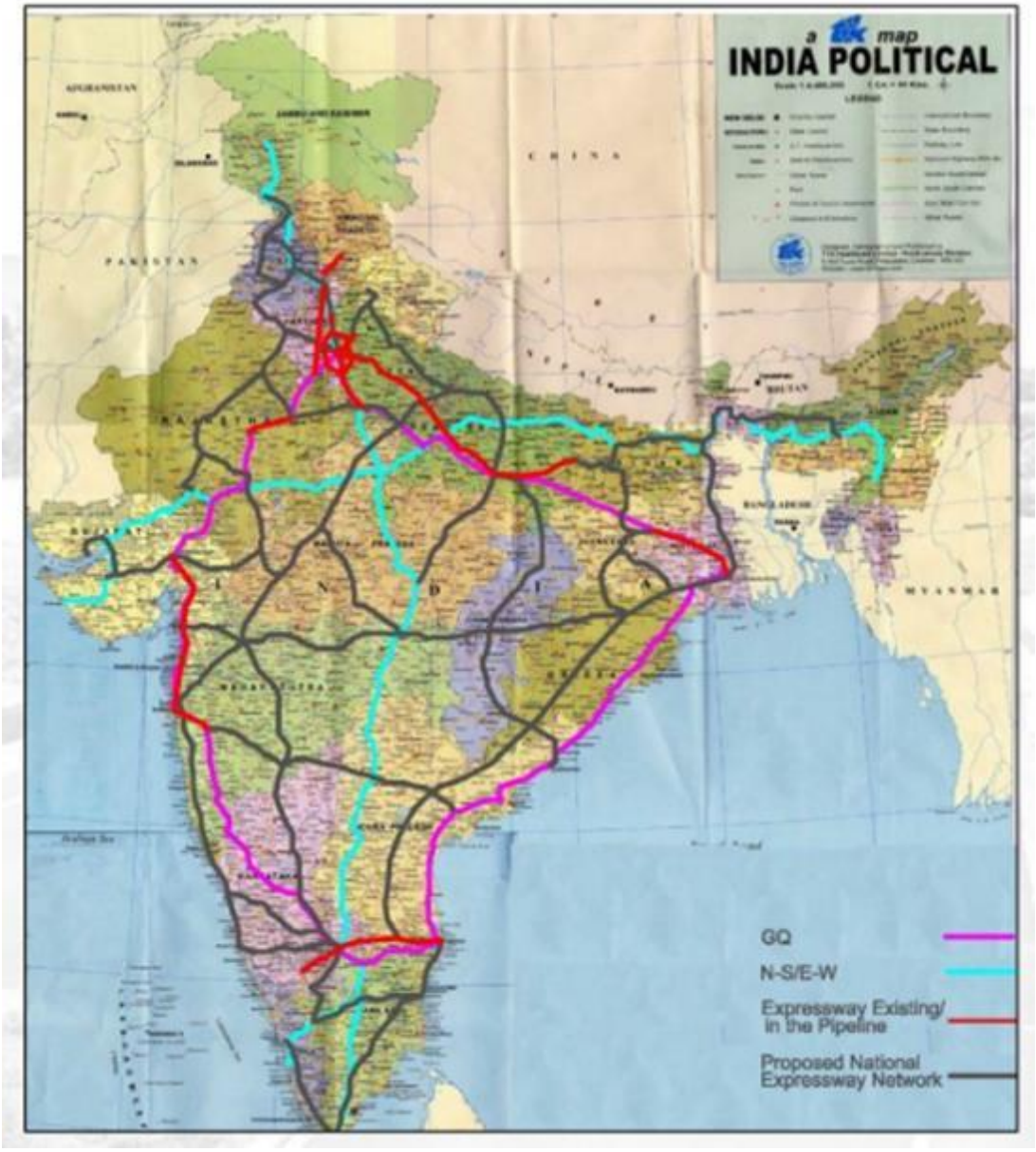
The study on the "Formation of Master Plan for Indian National Expressway Network" in 2009 highlighted the urgency of developing an expressway network in India in three phases by the year 2022. The present national highway system cannot cope with the current and anticipated traffic requirements, as is already evident from the levels of congestion along the existing arterials. By all indications, roads will continue to remain the backbone of the inland transportation system.

The study, having considered the existing and already proposed expressway segments in various states, revealed the need to construct an additional 18,637km of expressway network. The network developed shall be both supplementary and complimentary to the existing arterial network including the North - South and East - West Corridor, and the GQ.

A project is considered viable by BOT with a threshold FIRR of 12%. Results of the financial analysis have been presented in the report. The need to provide 40% Viability Gap Funding (VGF) for some segments, and the need to take up certain segments on annuity basis cannot be discounted. The study has considered the funding options of VGF of 20% with 20 years of the concession period as scenario I by adopting the Ministry's toll rate (2008) for prioritization of expressway segments.

Financial analysis suggests that to be financially viable, a link must cater to Average Annual Daily Traffic (AADT) of 25,000 passenger car units (PCU) under scenario I, while the same would be 15,000 PCU under scenario II, which has VGF of 20% with 30 years of the concession period. The expressways shall have at least a 4-lane divided carriageway cross section. The Right of Way (ROW) shall be a uniform 90m. It will be a Toll Expressway Network with toll rates as per the Ministry's Guideline (2008).

The network shall be completed in 3 phases spanning up to 2022. In the first phase, 11 projects covering 3,53km were awarded by 2012. In the second phase (2013-17), 4,310km will be added. In the third phase (2018-22), another 4,310km will be added. The third phase may also see the development of an additional 5,226km of expressways on the annuity model.



Source: MORTH

Figure 2-17: Proposed National Expressway Network

2.2.3 Cross Border Connectivity Projects in the North-Eastern Region

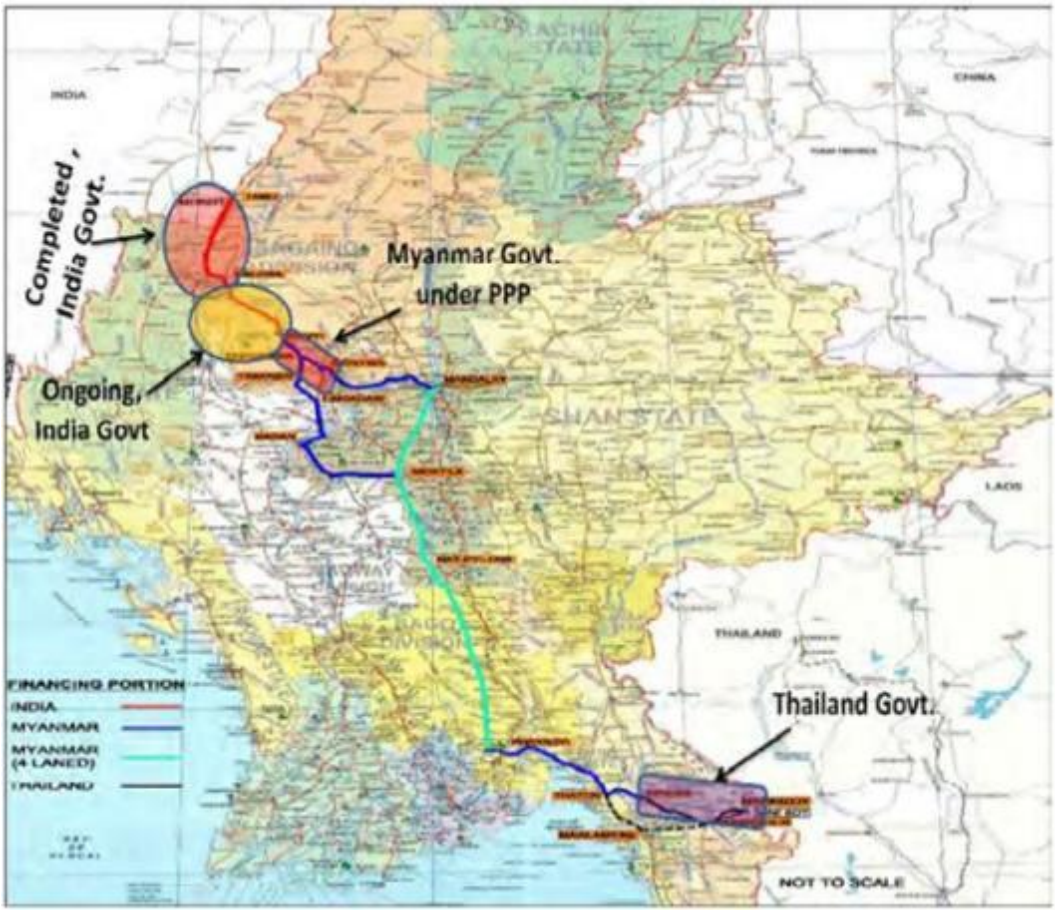
(1) India-Myanmar-Thailand Trilateral Highway Project

India has been implementing several cross-border connectivity projects to Southeast Asia to strengthen the ASEAN-India Strategic Partnership. The India-Myanmar-Thailand Trilateral Highway is poised to create a new dynamic in India's multi-faceted ties with the region. With the new Government of India focusing with renewed vigor on spurring the economic uplift of India's North-Eastern states, the gateway to ASEAN, enhanced connectivity promises to bring new prosperity to this region. The ASEAN-India road connectivity in the present form runs along Asian Highway (AH1) and the India-Myanmar-Thailand Trilateral Highway.

On the Trilateral Highway, the Tamu-Kalewa Friendship Road is being constructed in Myanmar with India's assistance (Figure 2-19). About 132km have been completed and handed over to Myanmar. Work on the other 28km is under progress. India has also undertaken the task of repair/upgrade of 71 bridges on the Tamu-Kalewa Friendship Road, and upgrade of a 120km

Kalewa-Yargyi road segment to highway standard. Myanmar has agreed to undertake upgrade of the Yargyi-Monywa stretch to highway standard by 2016.

This project would help in establishing trilateral connectivity from Moreh in India to Mae Sot in Thailand via Myanmar. Separately, the Government of India has taken initiatives to prepare DPR for construction of Chaungma-Yinmabin section (30km); and upgrade the Yinmabin-Pale-Lingadaw section (50km) from single to double lane. India has also announced the extension of the Trilateral Highway to Cambodia, Lao PDR and Vietnam.



Source: Ministry of External Affairs, Government of India

Figure 2-18: India-Myanmar-Thailand Trilateral Highway Project

(2) Kaladan Multi Modal Transit Transport Project

The Kaladan Multi Modal Transit Transport Project was jointly identified by India and Myanmar to create a multi-modal mode of transport for the shipment of cargo from the eastern ports of India to Myanmar, as well as to the North-Eastern part of India through Myanmar. This project, which will connect Sittwe Port in Myanmar to the India-Myanmar border, is expected to contribute to the economic development of the North-Eastern states of India, by opening the sea route for the transportation of goods. It also provides a strategic link to the North-East, thereby reducing pressure on the Siliguri Corridor. Since the project is of political and strategic significance, it was decided to execute it through India's grant assistance to Myanmar.

The Ministry of External Affairs (MEA) for the Government of India entered into a Framework Agreement with the Government of Myanmar in April 2008 to facilitate implementation of the project. As shown in the figure below (Figure 2-19), the components of this project include (i) construction of an integrated port and inland water transport (IWT) terminal at Sittwe including dredging; (ii) development of a navigational channel along the Kaladan river from Sittwe to

Paletwa (158km); (iii) construction of an IWT - Highway transshipment terminal at Paletwa; and (iv) construction of six IWT barges (each 300 ton capacity) for transportation of cargo between Sittwe and Paletwa. The Framework Agreement and two protocols (Protocol on Transit Transport and Protocol on Maintenance) were signed by India and Myanmar on 2nd April, 2008. A substantial portion of the construction of the integrated Port and IWT jetty at Sittwe is complete. Construction of IWT terminal at Paletwa started in April 2013. NH 54 (Lawngtlai), which crosses the Myanmar border is also in progress on the Indian side in Mizoram.

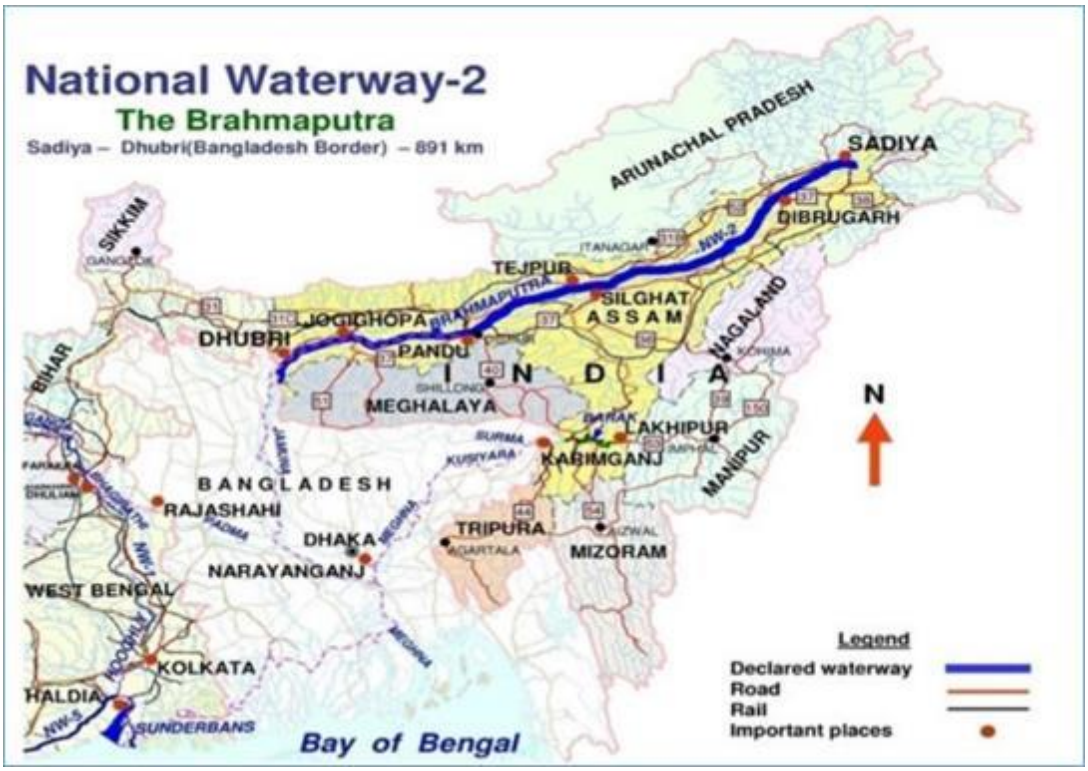
Source: Inland Waterways Authority of India (IWAI)

Figure 2-19: Kaladan Multimodal Transit Transport Project

(3) National Waterway-2 Brahmaputra Project

North-East India has many large and small rivers providing facilities for water transport, especially in the plains areas. From ancient times until roads were constructed, the Brahmaputra and Barak rivers were commonly used as the main medium of transport. Especially, Brahmaputra is the life line of the North-Eastern Region. It was declared as National Waterway-2 in 1988 for 891km from Dhubri to Sadia. The Inland Waterways Authority of India (IWAI) maintains the navigational channel at a minimum of 45m width and 2.5m depth, which is the standard for National Waterway-2.

Necessary aids for facilitating 24-hour navigation are maintained between Dhubri and Silghat, while daytime navigation marks are posted in further upper sections of the river. Terminal facilities for loading and unloading cargo are being maintained by IWAI at strategic locations such as Dhubri, Jogighopa, Pandu, Silghat, Neamati and Dibrugarh. Pandu (Guwahati) is being developed as a multi modal transport hub which can serve the entire North-Eastern Region. A permanent terminal at Dhubri in Assam is under construction with full facilities as a first major terminal on the Brahmaputra. It has been proposed to upgrade the existing temporary terminal at Jogighopa to a bulk cargo handling terminal for products like Meghalaya coal, with rail connectivity up to the terminal.



Source: Ministry of Development of North-Eastern Region (MDONER)

Figure 2-20: National Waterway-2 Brahmaputra Project

2.2.4 On-going Road Projects in the North-Eastern Region through International Cooperation

There are several ongoing road projects in the North-Eastern Region funded through international cooperation agencies as shown in the Table below.

Table 2-5: On-going Road Projects in the North-Eastern Region

International Donor	Project Name
World Bank	Assam State Road Project
World Bank	Mizoram State Road Project I-II
Asian Development Bank	North-Eastern States Roads Investment Program

Source: JICA Study Team

(1) Assam State Road Project (World Bank)

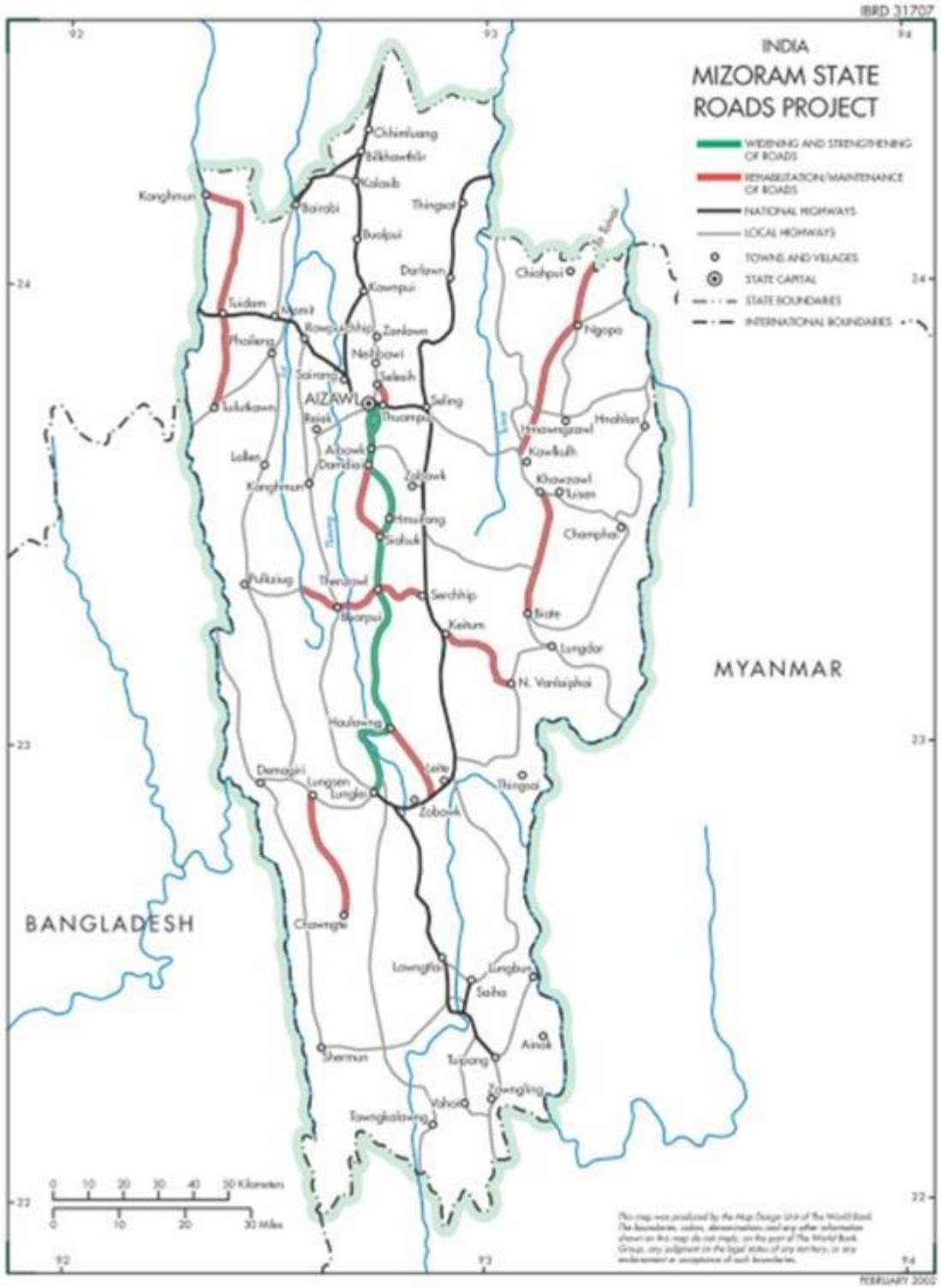
This project development objective is to enhance the road connectivity of Assam by assisting the public works roads department to improve and effectively manage its road network. There are three components to the project: (a) Improvement of priority sections of the secondary roads to improve state connectivity and facilitate regional integration, (b) Road sector modernization and performance enhancement to support implementation of the Road Sector Modernization Program (RSMP) to carry forward and deepen various institutional development initiatives already underway, (c) Road safety management to support the building of road safety management capacity of related agencies through developing and implementing a multi-sector road safety strategy.

(i) Approval Date (as of board presentation) : March 13, 2012
(ii) Closing Date : March 31, 2018
(iii) Total Project Cost : US$ 400.00 million

(2) Mizoram State Road Project I (World Bank)

This project's development objective is to improve the management and carrying capacity of the Mizoram core state road network. The project comprises of six components; (a) Improvement (widening and strengthening) of about 184km state highways, (b) Implementation of the Resettlement and Indigenous People Development Plan (R&IPDP), Environmental Management Plan (EMP), and land acquisition and utility relocation plan associated with the road improvement component, (c) Rehabilitation and maintenance of about 520km of state roads, (d) Design, supervision and technical advisory services for civil works, (e) Institutional strengthening, including equipment, TA, training, and pre-investment studies, and (f) Road safety engineering interventions.

(i) Approval Date (as of board presentation) : March 14, 2002
(ii) Closing Date : December 31, 2010
(iii) Total Project Cost : US$ 70.00 million



Source: World Bank

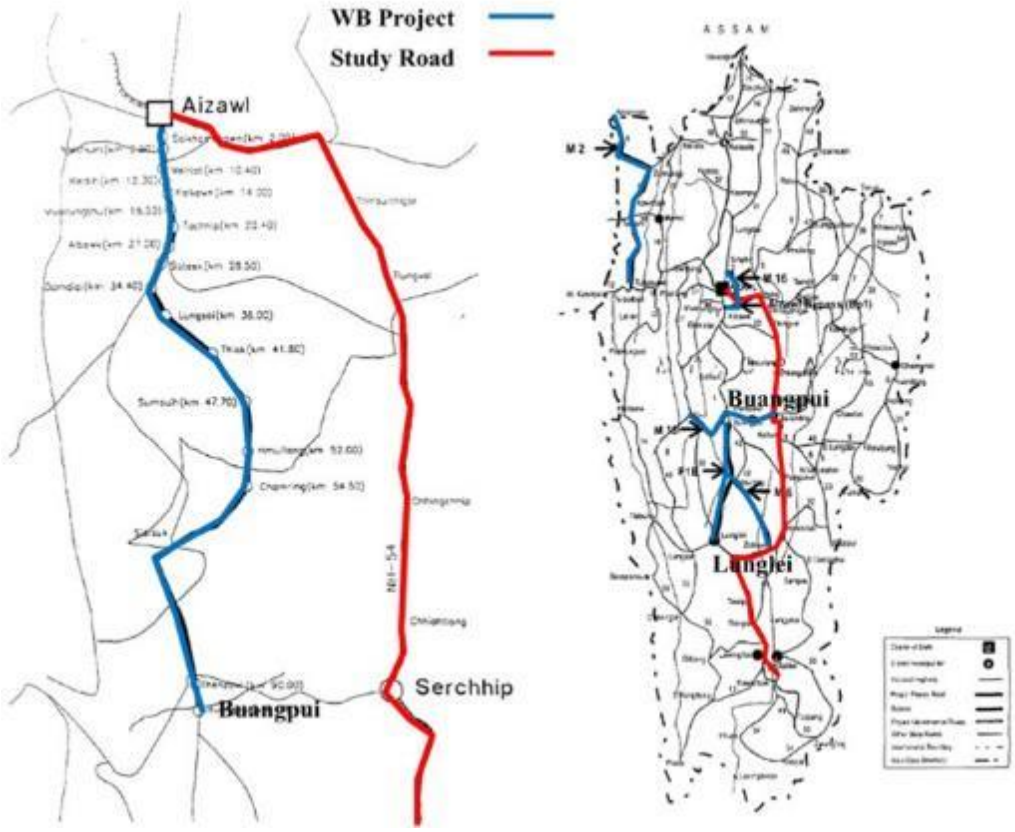
Figure 2-21: Location of Mizoram State Road Project I (World Bank)

(3) Mizoram State Road Project II (World Bank)

The objective of the Second Mizoram State Roads Regional Transport Connectivity Project is to increase transport connectivity along regional trade corridors in Mizoram. There are three components to the project: (a) Improvement of priority cross-border roads and trade-related infrastructure including widening and strengthening of 91km of road, and preparation studies for

approximately 330km of road, (b) Construction or improvement of trade-related infrastructure along project roads including market facilities and a truck stop, (c) Road sector modernization and performance enhancement through institutional strengthening to support gradual transformation of PWD into a modern road agency, which will carry forward and deepen various institutional development initiatives, introduced under the Mizoram State Road Project I.

(i) Approval Date (as of board presentation) : June 12, 2014
(ii) Closing Date : October 31, 2020
(iii) Total Project Cost : US$ 107.00 million



Source: JICA Study Team Phase 1

Figure 2-22: Location of Mizoram State Road Project II (World Bank)

(4) North-Eastern States Roads Investment Program (ADB)

The Condition Survey of Roads in the North-Eastern Region was conducted in October 2005, which showed that approximately 70% of roads in the region were in poor condition, and barely 20% were in serviceable condition. Most state highways and major district roads were of inadequate width. The average travel speed on these roads was found to be approximately 40km/hour for light vehicles and about 25km/ hour for trucks and buses.

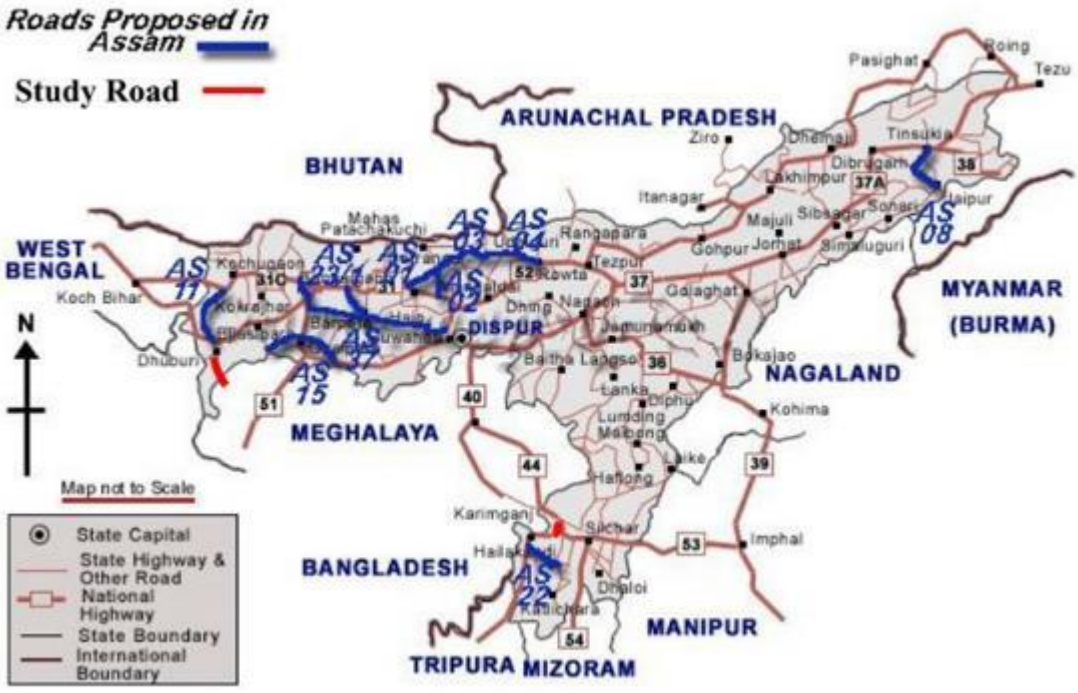
The Government of India approached the Asian Development Bank (ADB) for assistance in its effort to improve the condition of some of the more trafficked state highways and district roads in various states throughout the North-Eastern Region. ADB approved a Project Preparatory Technical Assistance towards preparing a Feasibility Study (F/S) for the upgrade and reconstruction of state highways and district roads, institutional development and capacity building of state PWDs in the region. Eventually, a total length of 433.7km of roads was selected for the proposed scheme covering the states of Assam, Manipur, Meghalaya, Mizoram, Sikkim and Tripura.

(i) Approval Date (as of board presentation) : May 19, 2011
(ii) Closing Date : May 31, 2016
(iii) Total Project Cost : US$ 298.2 million

Table 2-6: North-Eastern States Roads Investment Program (ADB)

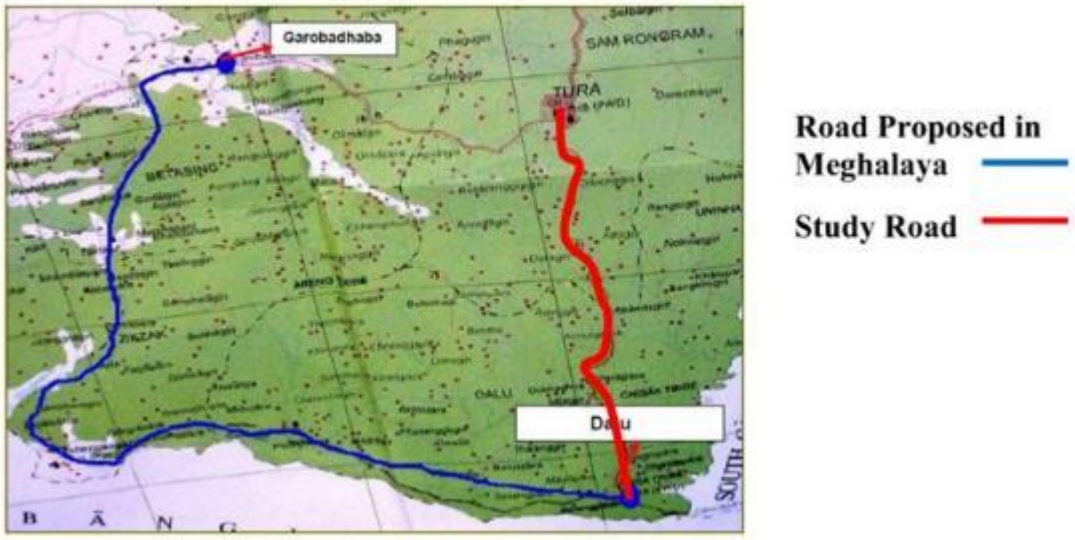
State	Name of Road	Length (km)	Cost (Rs. cr)
Assam	Kalikuchi - Barpeta	58.5	169.94
	Bilaspara - Fakiragram (NH-31)	16.2	
	Tamulpur - Paneri	43	292.57
	Paneri - Udalguri	18.6	
	Major Bridges	1.3	
Meghalaya	Garobada - Dalu	93.4	196.82
Sikkim	Meli - Nayabazar	9.5	95.39
	Nayabazar - Namchi	19.7	
Manipur	Tupul - Kasom Khullen	93.2	277.01
Mizoram	Serchhip - Buarpui	55	167.9
Tripura	Udaipur - Melaghar	20.3	69.16

Source: MDONER



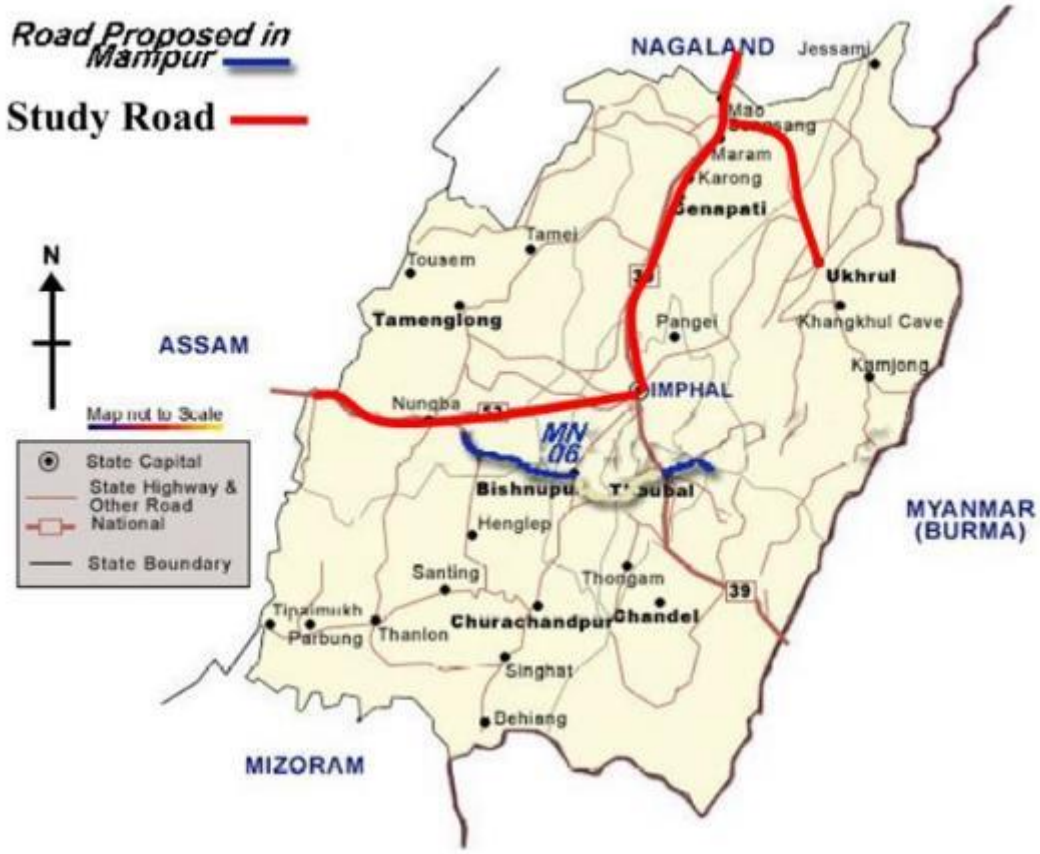
Source: JICA Study Team Phase 1

Figure 2-23: North-Eastern State Roads Investment Program (Assam)



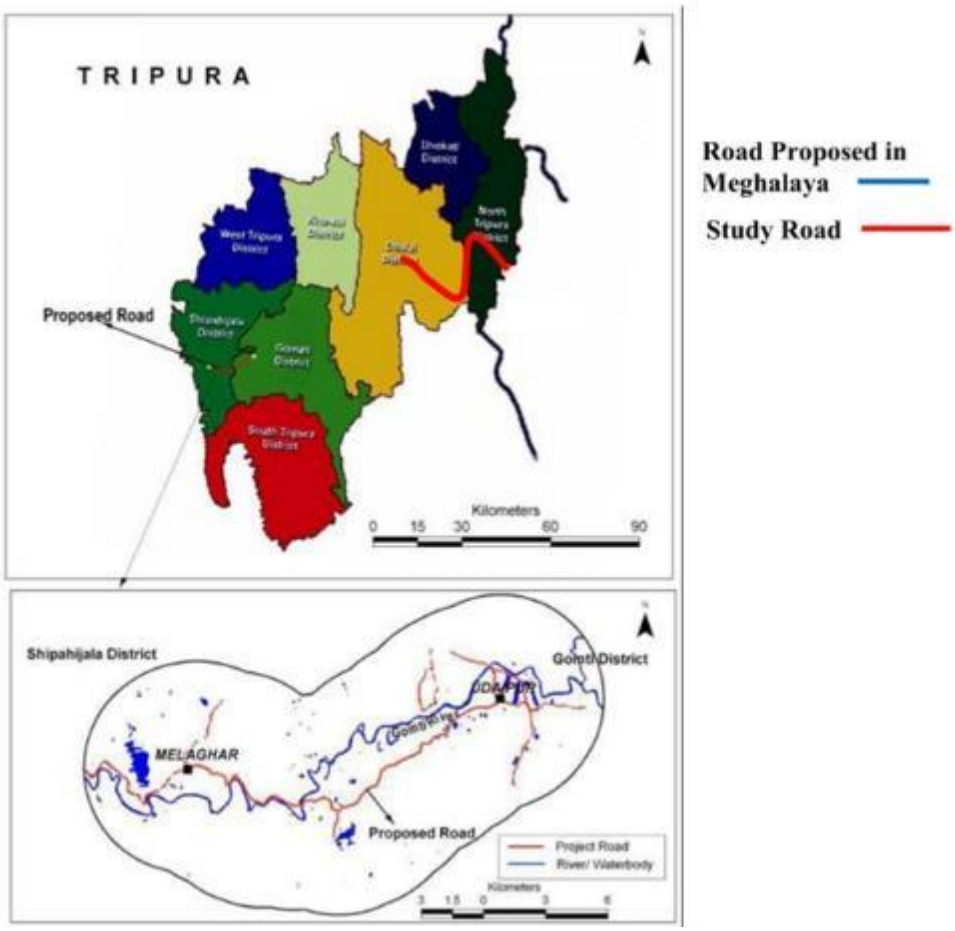
Source: JICA Study Team Phase 1

Figure 2-24: North-Eastern State Roads Investment Program (Meghalaya)



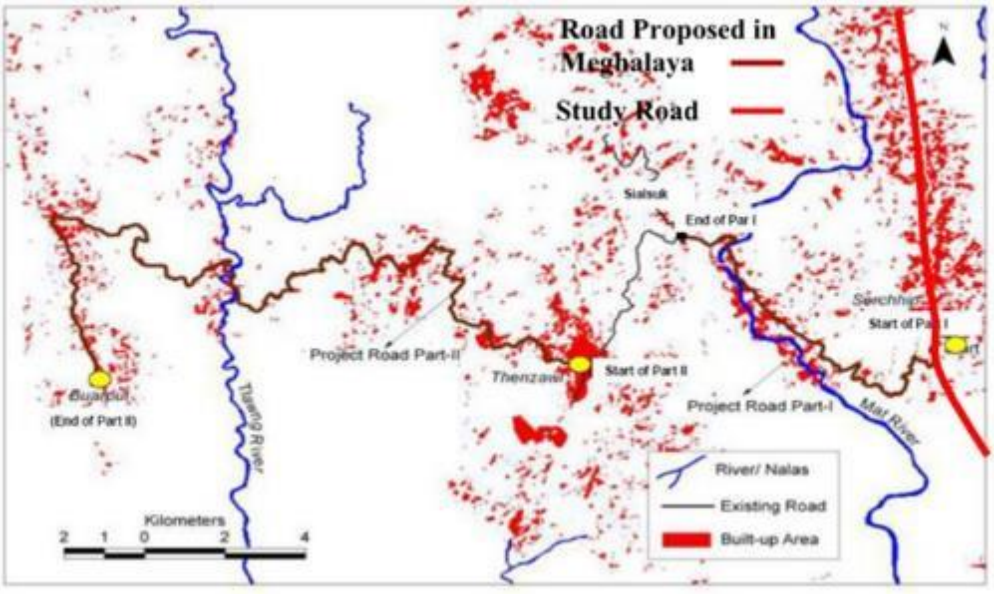
Source: JICA Study Team Phase 1

Figure 2-25: North-Eastern State Roads Investment program (Manipur)



Source: JICA Study Team Phase 1

Figure 2-26: North-Eastern State Roads Investment program (Tripura)



Source: JICA Study Team Phase 1

Figure 2-27: North-Eastern State Roads Investment program (Mizoram)

2.3 Socioeconomic Conditions

2.3.1 Dhubri District (Assam)

(1) Area and Location

The Dhubri district is situated in the far western corner of Assam. The district is at 30m above sea level on average. The Brahmaputra River flows through the district. Although the Dhubri District is comprised of three districts; Dhubri, Bilasipara and South Salmara-Mankachar, which is located the southern area across the Brahmaputra, has been separated in 2015. The present Dhubri district consists of two districts. The district of Dhubri is surrounded by the Kokrajhar district to the north, Meghalaya and Bangladesh to the south, the Bongaigaon and Goalpara district to the east, and West Bengal and Bangladesh in the west. The total area of the Dhubri district is 2,176 sq.km, including about 290km from the State capital, Dispur.

(2) Administrative Division

Administratively as stated above, the Dhubri district has two sub-divisions namely Dhubri and Bilasipara along with six revenue circles (Tehsils) with twelve blocks. According to the 2011 Census, the total rural population of the district stands at 1,444,043 covering a rural stretch of 2,810.76 sq.km.

(3) Population and Literacy Rate

As per the Census data in 2011, 1,949,258 persons lived in Dhubri, out of which about 89% are rural. About 80% of the total population is Muslims and 20% is Hindus. The population density of the district is 896 persons per sq.km, which is much higher than the state density of 340 persons per sq.km. The literacy rate of the Dhubri district is 58.34%, compared to 72.19% of the state total. Of this, the male literacy rate is 63.10% and female literacy is 53.33%.

(4) Human Development Index

The Dhubri district is positioned at the bottom in the Human Development Index (HDI) list of Assam with considerable lags in the development of the district. The major HDI components of the Dhubri district are shown in the following Table:

Table 2-7: Human Development Index (HDI) of Dhubri

Location	HDI Value	Income Index	Education Index	Health Index
Dhubri	0.214	0.102	0.454	0.086
Assam	0.407	0.286	0.595	0.343

Source: Human Development Report, 2011, GOI

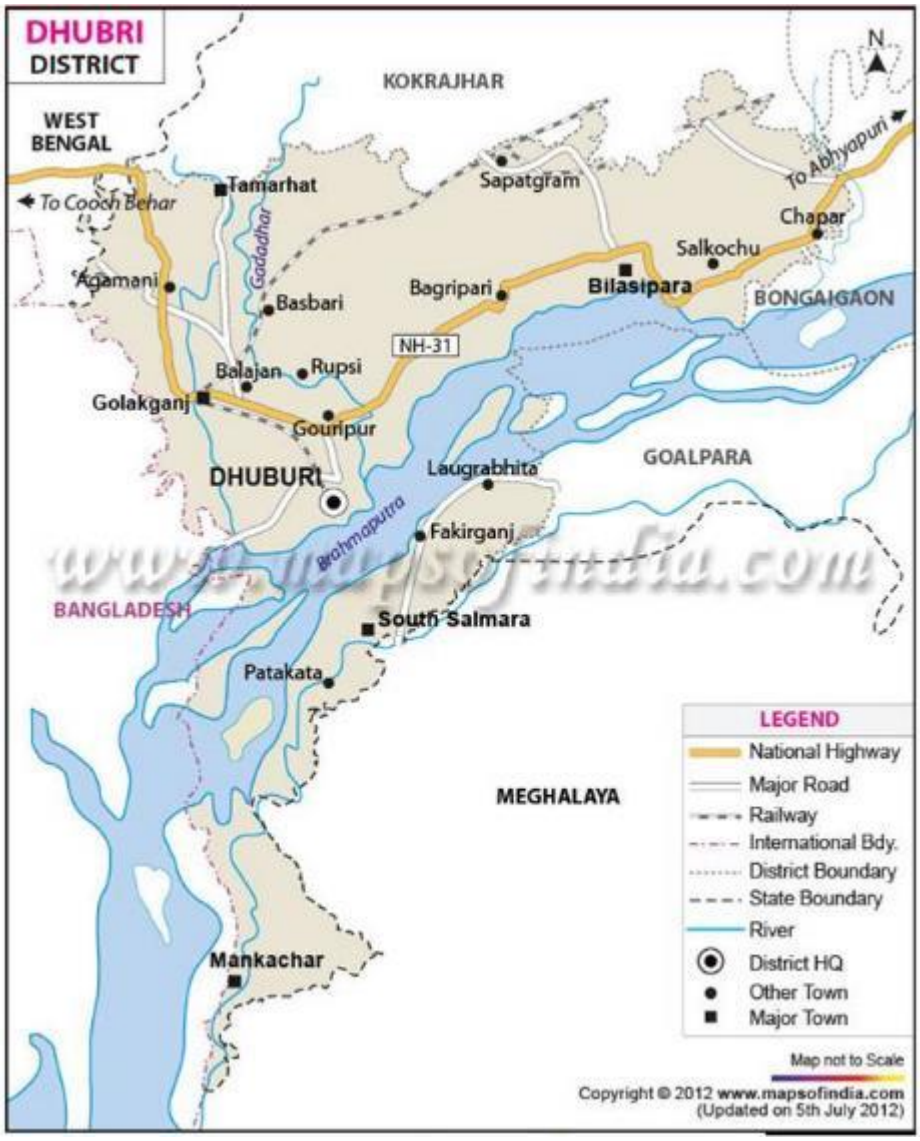
Regarding the gender related development index (GDI), Dhubri also ranks at the bottom of the list at 21st, just before Karimganj and Nagaon.

(5) Economy

The Dhubri district is primarily dependent on agriculture and forest products. Livestock farming and dairying practices are common in rural households. The main source of income is surplus from rice production along with cash crops including Jute and mustard seed. Wheat, corn, beans, and vegetable are also cultivated. In the forest regions, mainly timber and bamboo add to the income along with boulder and sand. Fish, milk, meat and eggs add an additional small contribution to the economy. Land revenue collection is very small in amount, whereas excise duty occupies a majority of the Government's income. Devoid of any industrial production, the district's economy is low in Assam.

(6) Transport

The district mostly relies upon road transport. Air and water transport systems have not been well developed in Dhubri. Railway connectivity in the area is not sufficient enough to meet the transport needs of the people. Further improvement of transport infrastructures is required.



Source: Mapsofindia.com

Figure 2-28: Location Map of Dhubri and South Salmara-Mankachar

2.3.2 South Salmara-Mankachar District (Assam)

(1) Area and Location

The South Salmara-Mankachar district is newly formed. The district is situated in the far western corner of Assam. Elevation is an average of 30m above sea level. The district of South Salmara-Mankachar is surrounded by the Dhubri and Kokrajhar district to the north, Meghalaya & Bangladesh to the south, the Bongaigaon and Goalpara district to the east, West Bengal and Bangladesh to the west. The total area of the South Salmara-Mankachar district is 869 sq.km. including about 310km from the State capital Dispur.

(2) Administrative Division:

The name South Salmara-Mankachar comes from the legislative constituency South Salmara and Mankachar. The South Salmara-Mankachar district was created when five new administrative districts were formed in Assam on 15 August, 2015. It was formally inaugurated on 9 February, 2016. At present the district consists of South Salmara-Mankachar and Hatsingimari (Sadar). The district has two revenue circles and two tehsils. According to the 2011 Census, the total rural population of the district stands at 528,952 people covering a rural stretch of 240.32 sq.km.

(3) Population and Literacy

As per the Census data from 2011, 555,114 persons lived in South Salmara-Mankachar out of which about 95% are rural. The population density of the district is 977 persons per sq.km, which is much higher than the state density of 340 persons per sq.km. About 95% of the total population is Muslims and 5% is Hindus. The literacy rate of the South Salmara-Mankachar district is 40%, compared to 72.19% of the state average. Of this, the male literacy rate is 55.26% and female literacy is very low at 44.74%.

(4) Economy

The South Salmara-Mankachar district is primarily dependent on agricultural and forest products. People in rural areas also rely on livestock and dairy farming. The main source of income is surplus from rice production along with cash crops including Jute and mustard seed. Jute, bean, and mustard seed occupy a major share of cash crops. Fish, milk, meat, and eggs add an additional small contribution to the economy.

Currently three tea gardens (whose contribution to the district economy is almost negligible) cover an area of 1,362.33 hectares. Land revenue collection is minimal, whereas tax from check gates and excise duty account for much of the government's income. Devoid of major industrial production, the district spends more for administration, development, and welfare works than it brings in. Its rich natural wealth is yet to be explored and some believe that proper utilization of natural resources could provide a boost for the struggling economy.

(5) Transport

The district mostly relies upon road transport. Air and water transport systems have not been well developed in South Salmara-Mankachar district. There are no Railway stations in this district. There are no National Highways in the district. Transportation takes place through state maintained PWD roads, which are full of potholes.

2.3.3 West Garo Hills District (Meghalaya)

(1) Area and Location

West Garo Hills, as the name suggests, is in the western part of the State of Meghalaya. The Garo Hills district was divided into two districts; the West Garo Hills district and the East Garo Hills district in October 1976. The erstwhile West Garo Hills district was further divided into two administrative districts, West and South Garo Hills on June 1992. The district headquarters of West Garo Hills is Tura, which is the second largest town in Meghalaya after Shillong. The total area of the district is 3,714 sq.km. As the name suggests the district is mostly hilly with plains fringing the northern, western and the south-western borders. The West Garo Hills has three important mountain ranges; Tura Range, Arbella Range and Ranggira Range.

(2) Administrative Division

There are six revenue circles and six community development blocks (CD) in the district. There are a total of 1,507 villages in the districts, of which 1,469 are inhabited. Under Article 244(2) of the Indian Constitution, the provisions of Sixth Schedule is applicable to the district.

(3) Population and Literacy

As per the Census data in 2011, the demographic profile of the district shows that 79.54% of the total rural population in the district belongs to minority communities, of which Christians comprise 66%. The population density in the district, which stands at 175 persons per sq.km is significantly higher than the state average of 132 persons.

The literacy rate in the district is 67.58%, which is lower than the state average of 74.43%. Although the literacy rate in the urban areas of the district is 91.3%, in rural areas the literacy rate is very low at 64.2%, lower than the state average. The female literacy rate in the district is 51.8%, which is significantly lower than the state averages.

(4) Economy

The economy of the West Garo Hills district is basically agrarian in nature with about 80% of the population dependent on agriculture. The agro-climatic conditions of the district are conducive for various agricultural activities including rice as a main product. Agriculture in the district is characterized by the dependence on rainfall, predominance of seasonal crops and traditional methods of cultivation.

Dairying is practiced mostly by landless laborers in the district. Traditionally, dairy farming is a subsidiary occupation of the farmers in the district. This activity provides economic security by serving as a hedge against crop failure. The district has the highest poultry production in the state. The milk production from indigenous cattle and buffaloes is also the highest in the state.

(5) Transport

Tura, the largest city of the district, is well connected by roads to other places in the district, as well as with the rest of Meghalaya and Assam. Bus services via the Meghalaya Transport Corporation and other private transport services connect Tura with all major places in the districts of Garo Hills and to Shillong (323km away), the capital of the State. The district headquarters is connected to Guwahati (220km away), the capital of Assam, which is also the nearest railhead, and to Siliguri in North Bengal. The town is connected to Dhubri in Assam by road and river transport. Helicopter services are available from Tura to Shillong and Guwahati. NH51 connecting Paikan on NH37 in Assam with Tura (which extends further to Dalu) near the Bangladesh border is the main road link for the district. However, rural road connectivity in the district is low, as only 29% of the rural areas are reported to have paved roads.

Source: JICA Study Team

Figure 2-29: Location Map of West Garo Hills

CHAPTER 3 ISSUES OF DPR AND RECOMMENDATIONS

3.1 Issues of Road Section

3.1.1 Connecting Roads

(1) Dhubri Bridge and Connecting Roads

The Dhubri Bridge Project includes short approach roads connecting to each side of the bridge. However, the effect of the bridge construction will not be fully utilized until the bridge is connected to major cities that produce traffic demand of using the bridge. Therefore, improvement of connecting roads together with the bridge construction is a matter of great importance.

The Dhubri Bridge is the 20-km section of NH127B that crosses the Brahmaputra River. Currently, small boats are being used to transport people and light freight across this section. NH127B is a national highway stretching about 371km starting from Srirampur in Assam and terminating at Nongstoin in Meghalaya. The section crossing the Brahmaputra River is a missing link of the route. Vehicles and heavy freight from Dhubri to Tura are being forced to detour along the river to cross at the Naranarayan Bridge, which is located about 60km upstream at Goalparakm, consequently increasing the trip by about 150km.

Source: JICA Study Team

Figure 3-1: Dhubri Bridge and Connecting Roads

The south areas of the North-Eastern Region where Dhubri and Phulbari are situated have been left behind development-wise, mainly due to the poor road network connectivity, isolating these areas within the North-East states. The Brahmaputra River reaches as wide as 20km after Dhubri, creating numerous streams and forming many sandbars, typical of a river made up of many braided channels. The sand banks and sandbars that are created in the Brahmaputra River are called the Char Districts, which are features with dire poverty awaiting development.

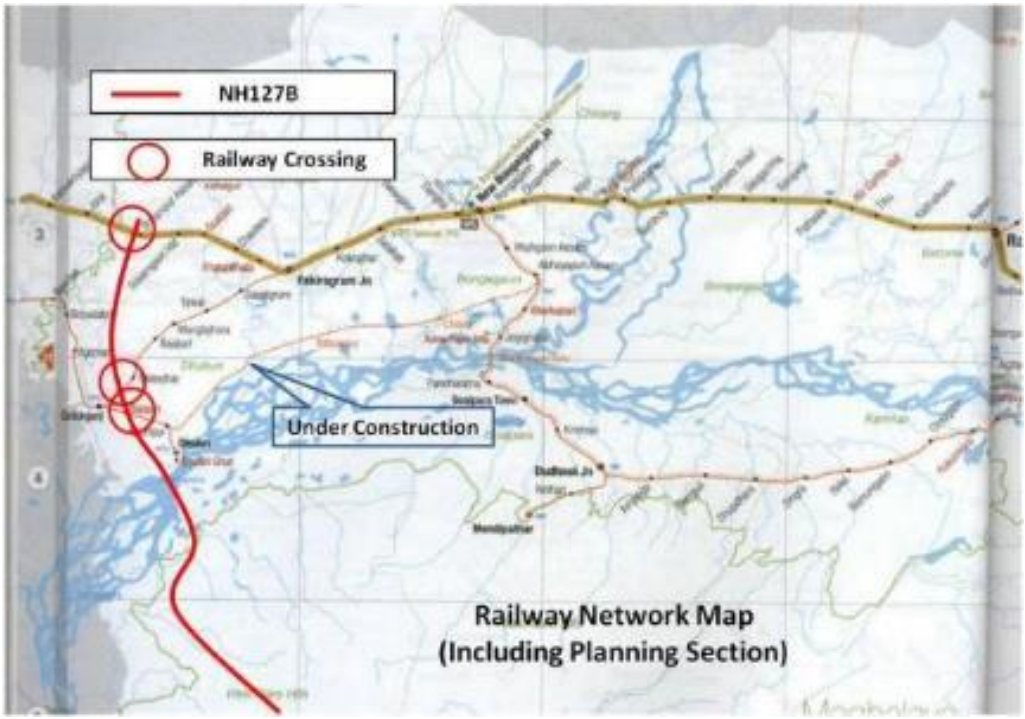
NH127B was newly declared as a national highway in 2012, which includes large areas of the Char Districts. These districts stretch along the border with Bangladesh, where border conflicts occur frequently making the security situation unstable. These areas are situated in a hinterland, which has not only poor traffic access among NE states, but also underdeveloped basic infrastructure. Means of livelihood is also very limited.

Many sections of the roads that were designated as NH127B used to be state highways and district roads, and are currently unpaved and narrow in width. The improvement of these roads concurrently with the construction of the Dhubri Bridge is indispensable for the effectiveness the construction. The GOI is putting in all-out efforts towards the development of these areas in the 12th five-year plan, and the construction of the Dhubri Bridge is of one of the highest priorities.

(2) Railway Crossing

The Ministry of Road Transport and Highways (MORTH) signed a minute of understanding (MOU) with the Ministry of Railways and announced that all railway crossings with national highways will be grade-separated in five years time. Consequently, the all railway crossings of NH127B must be designed as grade separated types.

There are three railway crossings (refer to figure below) in the section of NH127B starting from Srirampur and reaching Dhubri. The railway section starting from Dhubri along the Brahmaputra River heading eastward is currently under construction (see figure below). There are no railway construction plans from Phulbari toward Tura at this moment. However, the idea of a railway-cum-road bridge for the Dhubri Bridge has been reported several times by mass media. MORTH and NHIDCL conferred with the Ministry of Railways on the type of bridge and have agreed to build the Dhubri Bridge as a road only bridge.



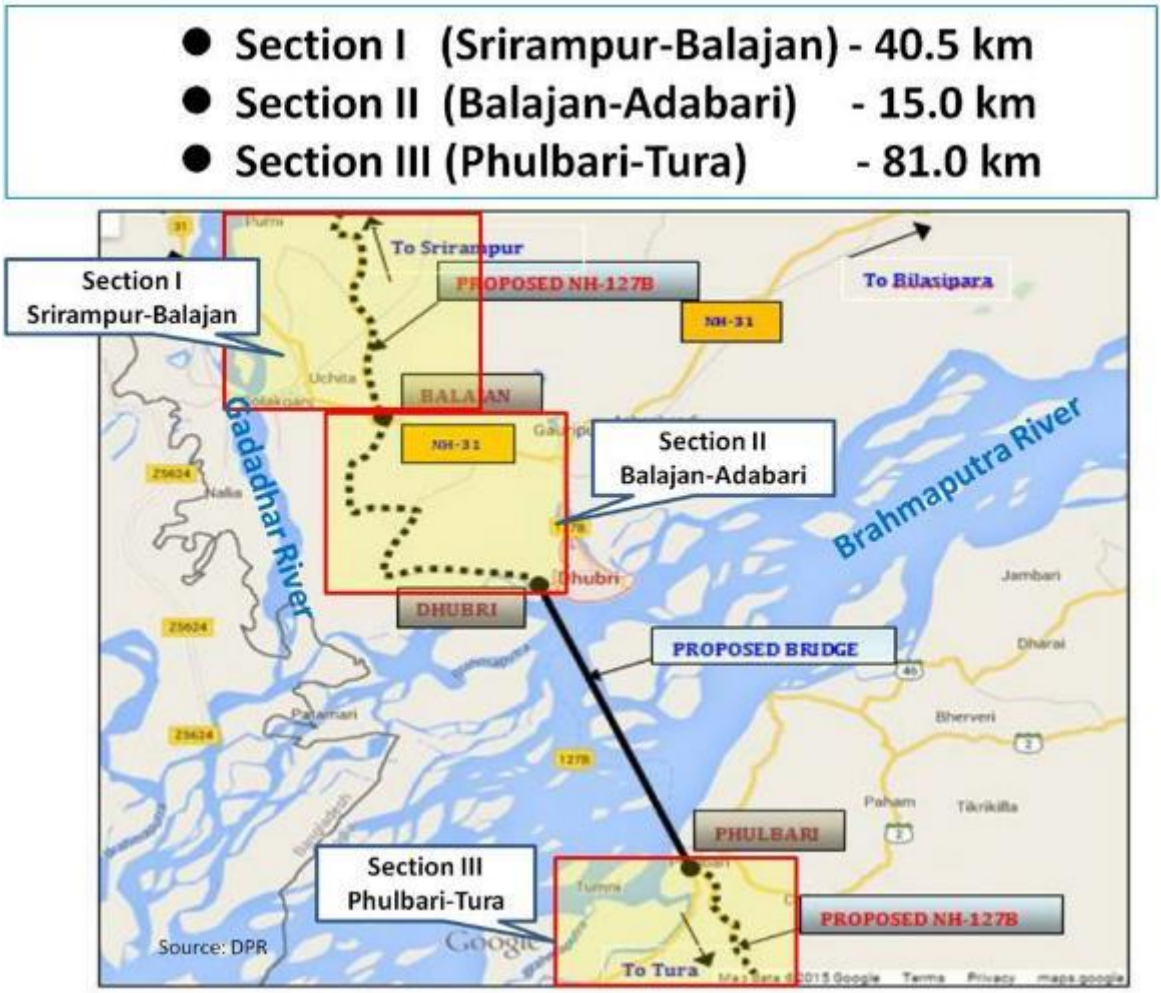
Source: JICA Study Team

Figure 3-2: Railway Crossings of NH127B

(3) Present Conditions of Connecting Roads

The Dhubri Bridge is the section of NH127B crossing the Brahmaputra River. The road extends northward from the end of the bridge to connect to NH31 and further to NH31C, which is a part of

the East-West Corridor at Srirampur. Likewise, it extends southward from the opposite bridge end to Phulbari (and further to Tura) in the West Garo District, which is the second largest city in Meghalaya State. Present conditions of these roads are described below in three separate sections.



Source: JICA Study Team

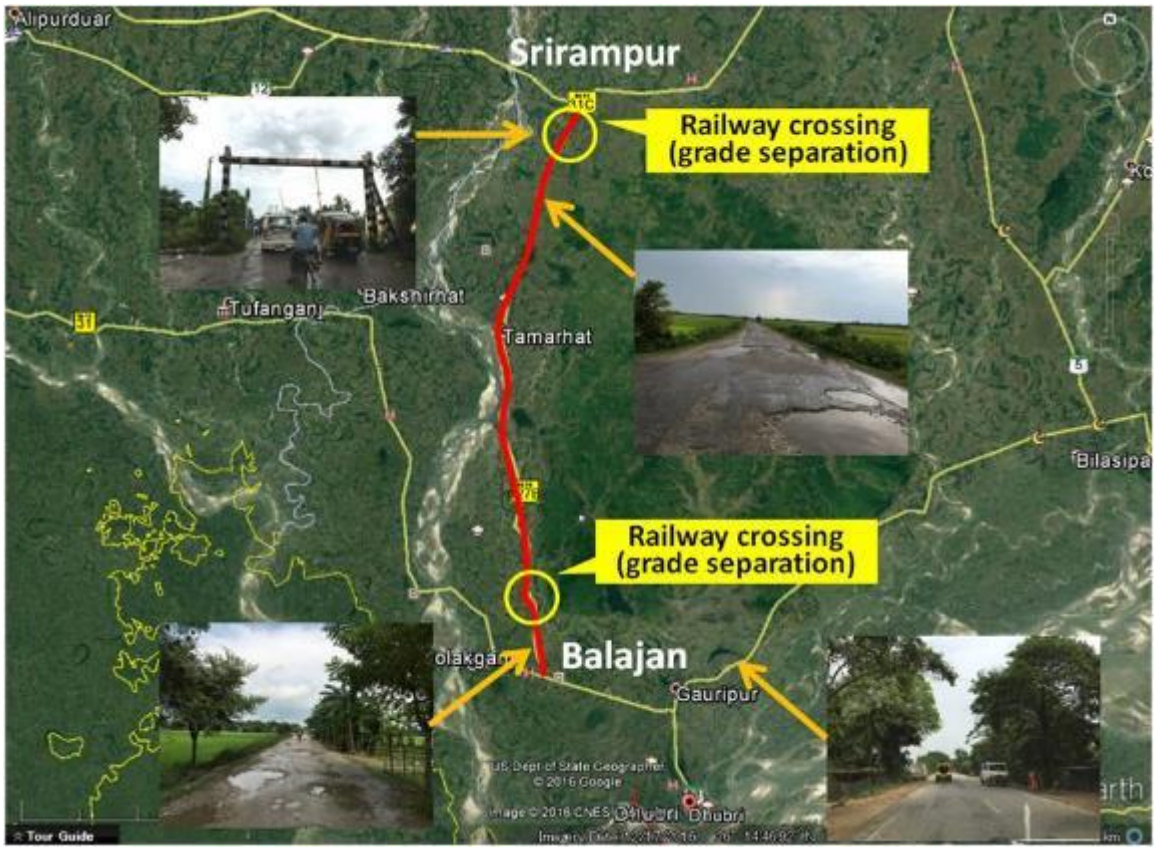
Figure 3-3: Connecting Roads in North and South of the Dhubri Bridge

- **Section I (Srirampur-Balajan) 40.5km**

This section starts from Srirampur, where NH127B connects to NH31C (New NH27) of the East-West Corridor and ends at Balajan connecting to NH31, which runs in parallel with NH31C. This section is a part of the Dhubri-Kochugaon Road. The maintenance of the road is very poor, the paved sections have numerous potholes making the drivability very low. The unpaved sections are even worse and not suitable for vehicle traffic.

The average elevation of Srirampur is about 50m. The road goes through plains with gentle undulations to Balajan, where the elevation goes down to 30m. This route mainly runs through fields and paddies along the Gadadhar River, a tributary of the Brahmaputra River. There are two railway crossings in this section.

Currently, the average vehicle driving speed is about 5km/h, and it takes about eight hours to drive the 40.5km between Srirampur and Balajan. There are no good detours between the two places. However, drivers with detailed knowledge of the areas can drive on paved roads, which are built for tea gardens, to travel between two places in three or four hours. Since these roads are narrow and have several wooden bridges, only small cars can use them.



Source: JICA Study Team

Figure 3-4: Present Conditions of Section I (Srirampur-Balajan)

Source: JICA Study Team

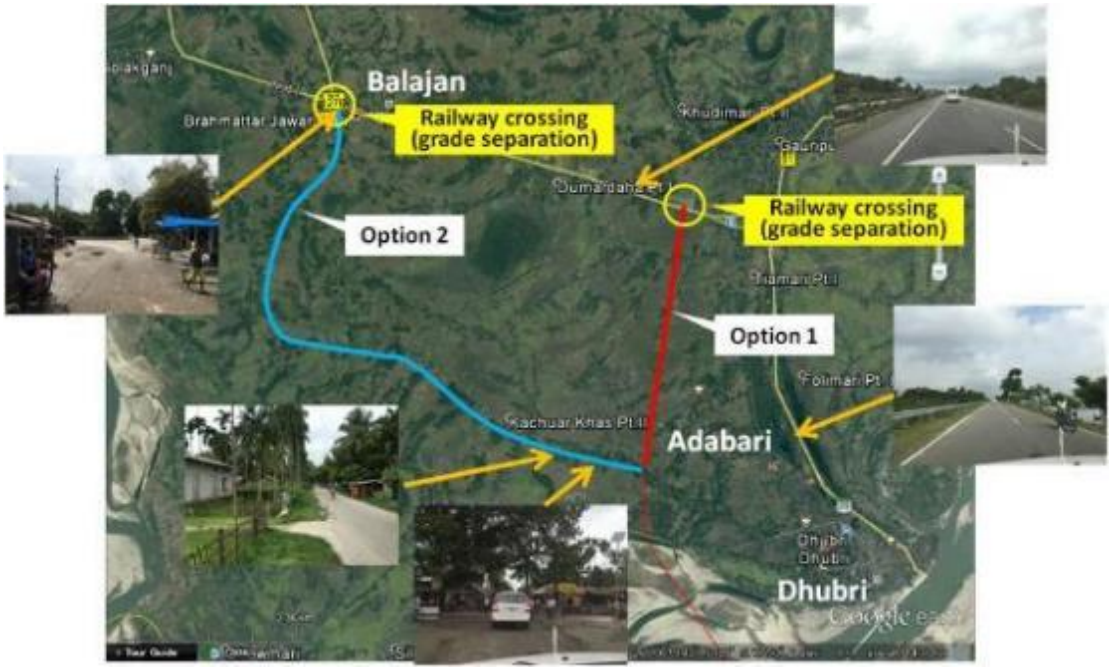
Figure 3-5: Present Conditions of Paved and Unpaved Sections

- **Section II (Balajan-Adabari) 15.0km**

NH31 is an important arterial highway connecting the Dhubri District to Guwahati and Dispur, the central part and state capital of Assam State. The current route of NH127B goes from Balajan to Gauripur overlapping with NH31, and from Gauripur to Dhubri overlapping with the Dhubri-Kochugaon Road as a branch line. Ferries are currently the only way to cross the Brahmaputra River from Dhubri to Phulbari on NH127B.

The starting point of the Dhubri Bridge on the Dhubri side is located at Adabari, avoiding the densely-populated areas of Dhubri. There are two possible options to connect Adabari and Balajan. Option 1 would go northward from Adabari connecting to NH31 with the shortest possible distance, and then would use the existing NH31 to get to Balajan. Whereas option 2 would go along local current backroads to newly build a national highway.

It was decided to adopt option 2 at the tripartite meeting between NHIDCL, Assam State PWD, and JICA held at the NHIDCL Guwahati office on Feb 7, 2017. The main reason to select option 2 was that the work of the connecting roads by PWD had been preceding, and the land acquisition process was already started. It was agreed that the option 2 be considered as a separate project.



Source: JICA Study Team

Figure 3-6: Present Conditions of Section II (Balajan-Adabari)

Source: JICA Study Team

Figure 3-7: Present Conditions of the Balajan intersection and Adabari Rural Road

- **Section III (Phulbari-Tura) 81.0km**

While Phulbari is a small village, Tura is the largest city only next to Shillong in Meghalaya State. Therefore, improvement of the connecting roads up to Tura is very important to attain the effectiveness of the construction of the Dhubri Bridge. Currently, NH127B takes the route of option 1. The elevation of Phulbari is about 30m, and Tura is about 300m. Almost all of sections of option 2 go through mountains. The altitude of Rongram, which is on the way to Tura, is about 400m. Although the length of option 1 would require more road to be built than option 2, it passes mostly through rolling terrains with easier construction, and the development of its corridor can be expected. Therefore, option 1 is a better selection.

Source: JICA Study Team

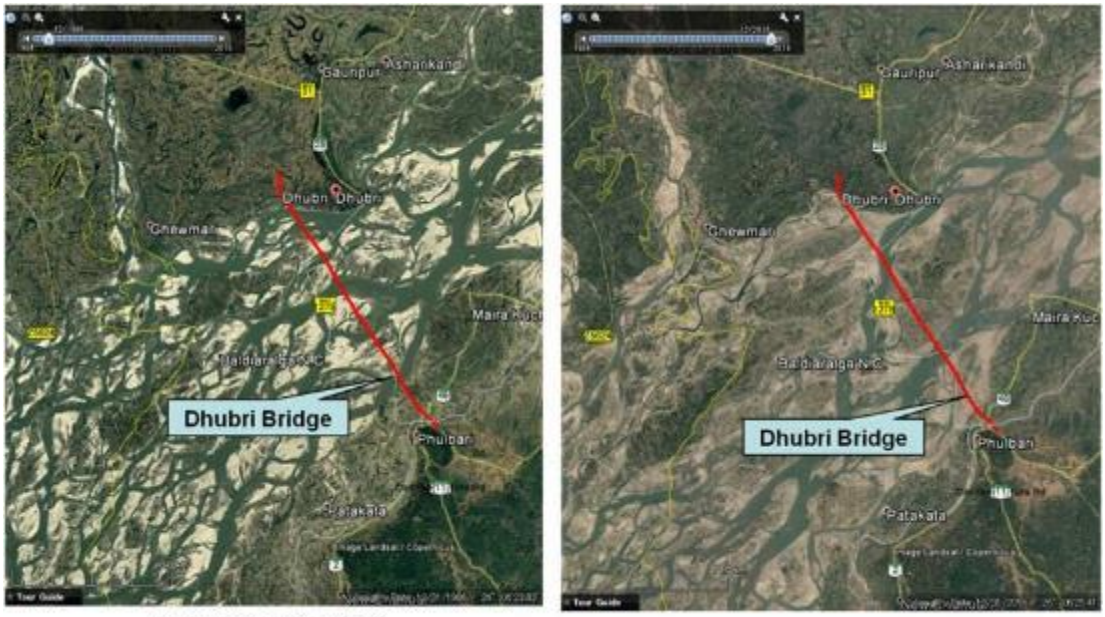
Figure 3-8: Present Conditions of Section III (Phulbari-Tura)

Source: JICA Study Team

Figure 3-9: Present Conditions of the Phulbari Bridge End

(4) Present Conditions of Sandbars and Boat landings

There are many separated streams along the Brahmaputra River, and the sandbars which divide streams are unstable in shape. Sandbars are formed from the accumulation of sand and gravel carried from upstream. They change shapes constantly at every flood and even disappear under water at times. Sandbars are sometimes connected to the river bank. A river with this kind of characteristic is called a braided river, because of the pattern resembling the strands of a braid. The comparison of the picture of Google Earth in 12/1986 and 12/2016 clearly shows the change of sandbars during the 30 years.



Google earth 12/1986 Google earth 12/2016

Source: JICA Study Team

Figure 3-10: Change of Sandbars (12/1986-12/2016)

Sandbars are made up of silt, sand, and gravel. The parts above the water surface maintain vegetation even during the monsoon season. The water depth during the monsoon season between May through October is higher by 5m to 6m compared to the dry season between November and April. Soil erosion of sandbars increases during flooding. Minor soil erosion can be observed at the upstream tips of sandbars even during the dry season.

9/2016 2/2017

Source: JICA Study Team

Figure 3-11: Appearances of Sandbars in the Dry and Monsoon Season

There are no permanent wharfs at Dhubri or Phulbari boat landing places. They use simple footings made of wood and bamboo for boarding/ offboarding a boat. These makeshift footings are unstable

posing a danger for passengers. Small cargos like hand carried bags are transported. Motorcycles are also carried, but it takes a long time to load/unload them.

Source: JICA Study Team

Figure 3-12: Present Situation of the Boat Landing at Dhubri and Phulbari

The area of the Phulbari boat landing point is dried up during the dry season. Simple boat landing footings for embarkation/disembarkation are installed at the tip of the sandbar, and passengers are transported by car up to Phulbari. Passengers have to use a boat again to reach Phulbari because there is a small pond around Phulbari.

Source: JICA Study Team

Figure 3-13: Situation of Phulbari Boat Landing during Dry Seasons

3.1.2 Selection of Road Alignment

(1) Options for Road Alignment

It is imperative to consider various negative impacts incurred by the construction of the road to select the alignment of the road. Major items to consider include a) design conditions given by the river administrator to the bridge plan, b) social impacts from the construction of the road and bridge, c) environmental impacts caused by the construction of the road and bridge, and d) engineering aspects of cost and safety of the road and bridge.

The Inland Waterways Authority of India (IWAI), which is the administrator of the Brahmaputra River, has given the following design stipulations for the Dhubri Bridge regarding the span length and vertical clearance under the girder.

Table 3-1: Design Stipulations for the Dhubri Bridge by IWAI

Parameter	Value (m)
Lateral Clearance	100
Vertical Clearance	10
Navigable Width	12,500

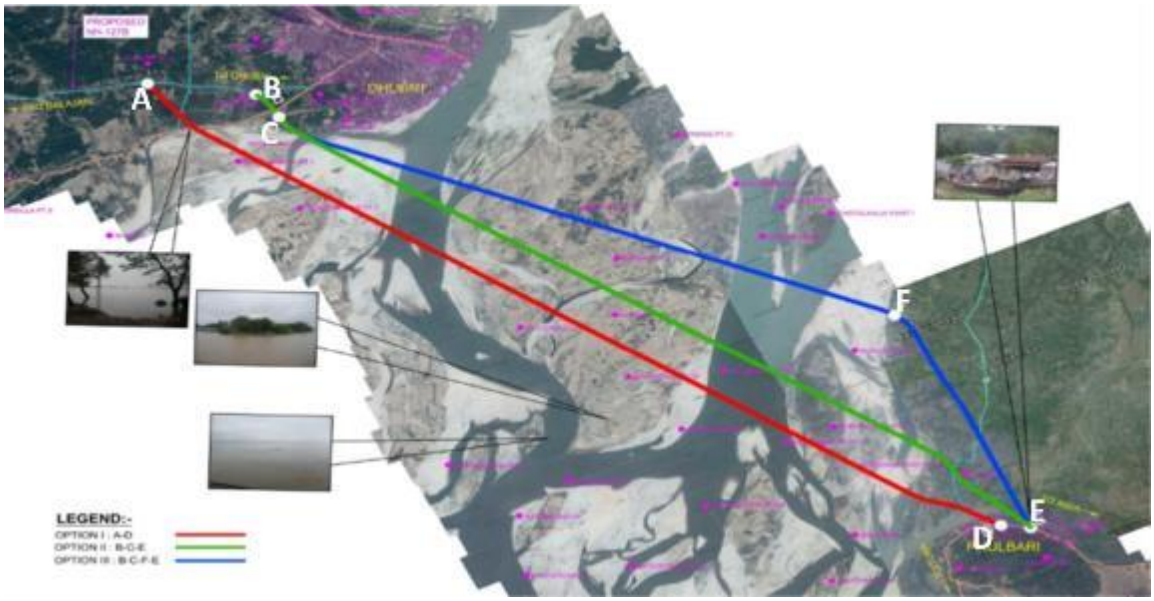
Source: JICA Study Team

The following three options are selected for the comparison of different road alignments and the Dhubri Bridge.

Table 3-2: Options for Road Alignments including the Bridge

Option	Content of Option
Option 1	Crossing the river diagonally to connect Dhubri and Phulbari directly avoiding heavily inhabited areas in Dhubri and sandbars as much as possible (A-D)
Option 2	Crossing the river diagonally to connect Dhubri and Phulbari directly making the length of the road including the bridge the shortest (B-C-E)
Option 3	Crossing the river at right angles to connect Dhubri and Phulbari making the length of the bridge the shortest (B-C-F-E)

Source: JICA Study Team



Source: JICA Study Team based on DPR

Figure 3-14: Options for Road Alignment including Bridge

(2) Indicators for Comparison of Options

The following indicators are selected for the comparison of social impacts, environmental impacts and engineering aspects.

Table 3-3: Indicators for Comparison

Item	Indicator
Social Impacts	The number of house relocations
	Areas for land acquisition
	Length of road alignment passing through inhabited areas on sandbars
Environmental Impacts	Length of road alignment crossing the Brahmaputra River
	Farming areas for land acquisition
	Total length of the road alignment
Engineering Aspects	Length of the bridge
	Length of the approach roads
	The number of curves
	Total length of curves
	Construction cost

Source: JICA Study Team

Regarding social impacts, the number of affected structures is considered as the equivalent to the

scale of resettlement expected from the Project. Size of Land to be acquired is indicative of the scale of possible loss of livelihood considering that the population in the area is largely dependent on their lands. The length of alignment passing through the Permanent Char Land is also included in the parameters to evaluate the impact on the Char people whose socio-economic status are lower than that of inland communities.

Regarding environmental impacts, the total length is indicative of negative impacts such as noise, vibration, and air pollution once operational. As the total length increases, vehicles need to travel longer distance and larger negative impacts are anticipated. Agriculture Land which overlaps with the alignment will be lost due to the construction of the bridge and cause negative environmental impacts such as loss of ecosystem services. The total length over Brahmaputra River is indicative of negative impacts of the project on the river ecosystem and endangered aquatic species such as Gangas river dolphins. The longer the length over Brahmaputra, the larger the damage on the river ecosystem will be.

Regarding engineering aspects and the total length of the bridge, because of higher construction technologies and costs of bridges compared with embankments, a shorter bridge length is rated favorable. Regarding the length of the approach, because of the necessity of new road construction for approaches to connect the bridge and the existing roads, a shorter approach length is rated favorable. Regarding the number of curves, because of the easier drivability of roads with fewer curves, minimal curves is rated favorable. With regards to the total length of curves, because of the requirement of complex structures and higher construction technologies, a shorter length is rated favorable.

(3) Results of Comparison

As for the social aspects, Option 1 has less impact with respect to the number of affected structures and the size of the land to be acquired. Although Option 3 has less impact on the poor, the total score shows Option 1 as the most favorable option.

As for the environmental aspects, differences among the three options were relatively small for the total length and the total length over Brahmaputra, but impacts on agriculture land was most significant for Option 3.

As for the engineering aspects, although Option 1 is unfavorable with respect to a longer bridge length and approaches, it has a fewer curves and a shorter curve length to be favorable. The comprehensive rating gives Option 1 the highest score.

Based on the above, Option 1, which is Crossing the river diagonally to connect Dhubri and Phulbari directly avoiding heavily inhabited areas in Dhubri and on sandbars as much as possible, is most favorable for all the aspects of social impacts, environmental impacts and engineering aspects. The lengths of the approach roads and the bridge is found as follows:

Table 3-4: Lengths of Approach Roads and Bridge

Section		Length (m)	
Northern Approach Road		810	
Bridge	Northern Viaduct	18,360	3,540
	Navigable Bridge		12,625
	Southern Viaduct		2,195
Southern Approach Road		112	
Total		19,282	

3.1.3 Erosion Protections

(1) Collection of Related Data

A riverbed topographic map of the Brahmaputra River was created for the area of 20km width including the Bridge crossing section by riverbed configuration survey. The survey included the Gandadhar River on the north bank and the Jinjiram River on the south bank, and tributaries of the Brahmaptra River, to consider any influence from those rivers.

Existing data and materials were collected from all available resources including the observation data from the Brahmaputra and Barak Basin organization (B&BBO), Shillong of the Central Water Commission (CWC), available literature to assess the catchment areas and hydraulic parameters, interviews of local people, DPR of Naranarayan Bridge, physical model studies conducted by NEHARI (North-Eastern Hydraulic and Allied Research Institute) on behalf of the Brahmaputra Board. These data and materials were studied and analyzed to determine HFL (High Flood Level), LWL (Low Water Level), Maximum discharge, and other necessary parameters. Various simulations were carried out using the US Army Corps of Engineers (USACE) Hydraulic Engineering Centre's River Analysis System (HEC-RAS).

Source: DPR

Figure 3-15: Riverbed Topography around the Dhubri Bridge

(2) Erosion Analysis

Building structures in a river may cause erosion of banks and riverbed. There are two kinds of erosions, contraction scour and local scour. Contraction scour occurs from reduction of flow area in the river when it approaches a bridge. This reduction of flow area is followed by an increase in flow velocity which results in the removal of sediments and rocks. The local scour is caused due to increased velocity of water around a bridge pier and abutment due to formation of vortices and wakes. The contraction scour and the local scour together constitute the total scour around piers. Hydraulic parameters used for the analysis are shown in the table below.

Table 3-5: Hydraulic Parameters

Parameters	Values
High Flood Level（HFL）	30.36 m
Low Water Level（LWL）	23.00 m
Average Riverbed Slope	1/14,700
Maximum discharge for a 100 year return period	100,306 m3/s
Maximum discharge for a 10 year return period	71,225 m3/s
Maximum water velocity at HFL	4.5 m/s

Source: DPR

The analysis produced the following conclusions.

- The contraction scour will not occur.
- The largest local scour of 11.08 m during the maximum discharge for a 100 year return period will occur around piers.

(3) Erosion Countermeasures for Abutment

When an embankment behind a bridge abutment is exposed to HFL, plans of revetment for embankment protections are necessary considering the topography and possible flow directions of flooding. The abutments of the Dhubri Bridge are described below.

The A1 abutment is planned to be built in the rice paddies. There is a P6 pier about 360m away from the A1 abutment. There is a paved rural road near the P6 pier, partly acting as a river bank. The location of A1 abutment is behind the solid and stable ground at Dhubri. It is not likely that A1 abutment will be exposed to high velocity flooding. The critical velocity of flooding to cause scour is calculated as 0.43 m/s and the value will not be higher around A1 abutment.

On the other hand, A2 abutment faces the Jinjiram River, a tributary of the Brahmaputra River, and there is a possibility of scouring due to the flow of this river. Therefore, the following revetment shall be designed.

A1 Abutment (Dhubri)

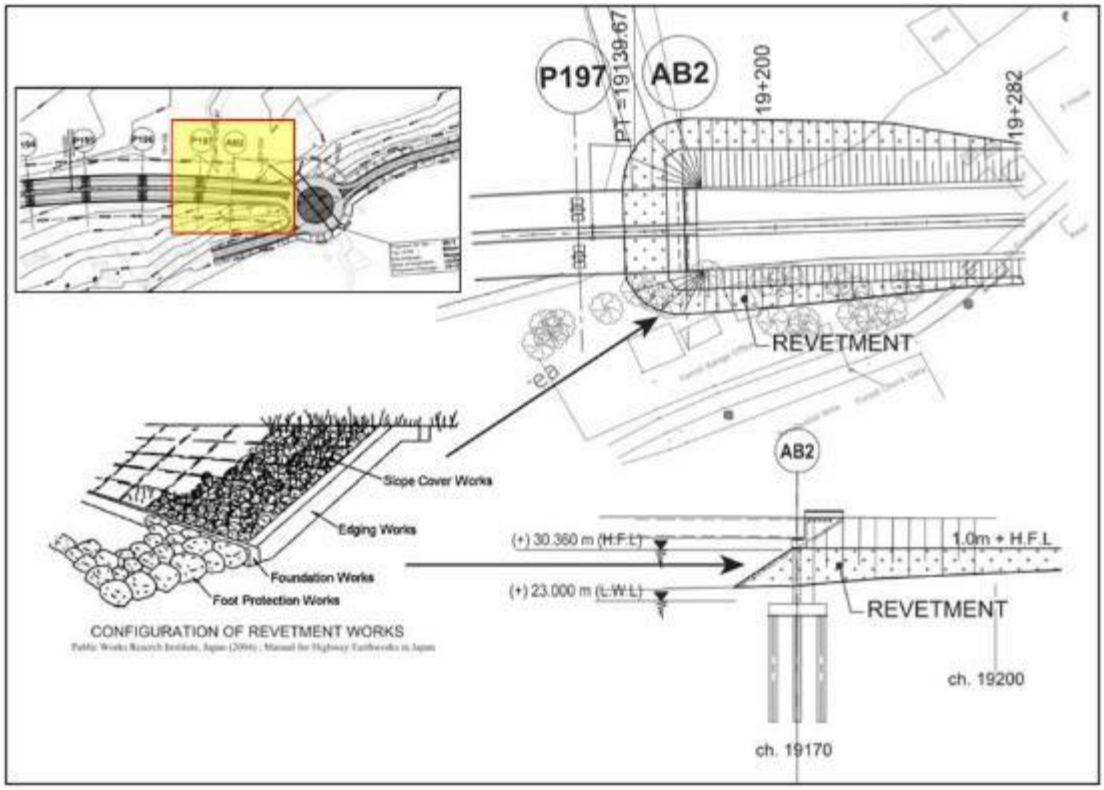
A2 Abutment (Phulbari)

Source: DPR

Figure 3-16: Present Situation of the Locations of A1 and A2 Abutment

Source: JICA Study Team

Figure 3-17: View of the Area near P6



Source: JICA Study Team

Figure 3-18: Revetment Design for A2 Abutment

3.1.4 Design of Intersections

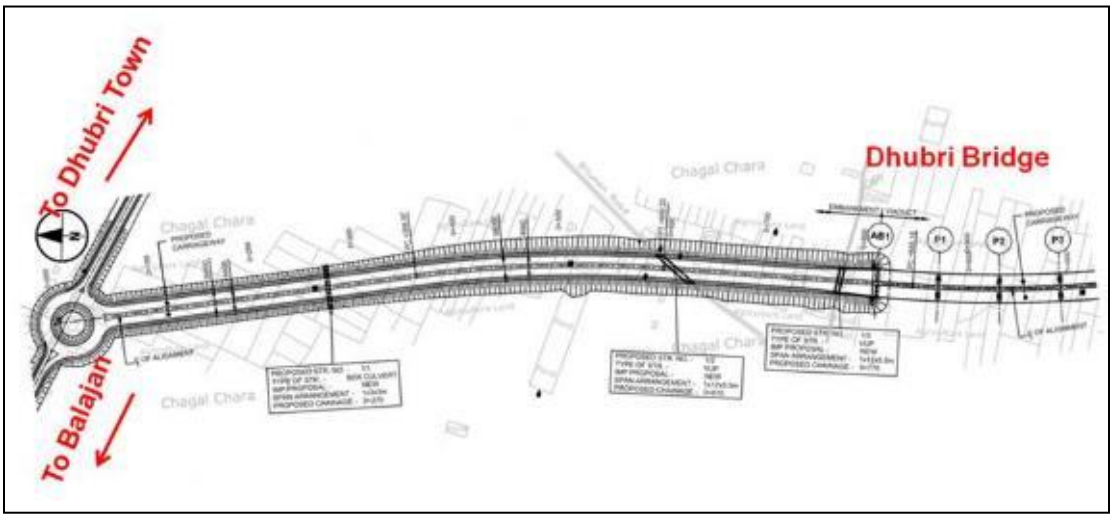
The Dhubri Bridge has a special feature as it acts as a border for the states of Assam (Dhubri) and Meghalaya (Phulbari). At an ordinal state border, collection of state taxes and vehicle check for overloading and others are necessary.

IRC:SP:84-2014 stipulates in its Section-3 Intersections and Grade Separators as ”3.2 At-grade Intersections, 3.2.1 The type of intersections to be adopted shall be decided on the basis of parameters like number of intersecting legs, traffic volume/speed, type of traffic control etc.

Properly designed intersections shall be provided at all at-grade crossings. Rotary shall not be provided on the Project highway."

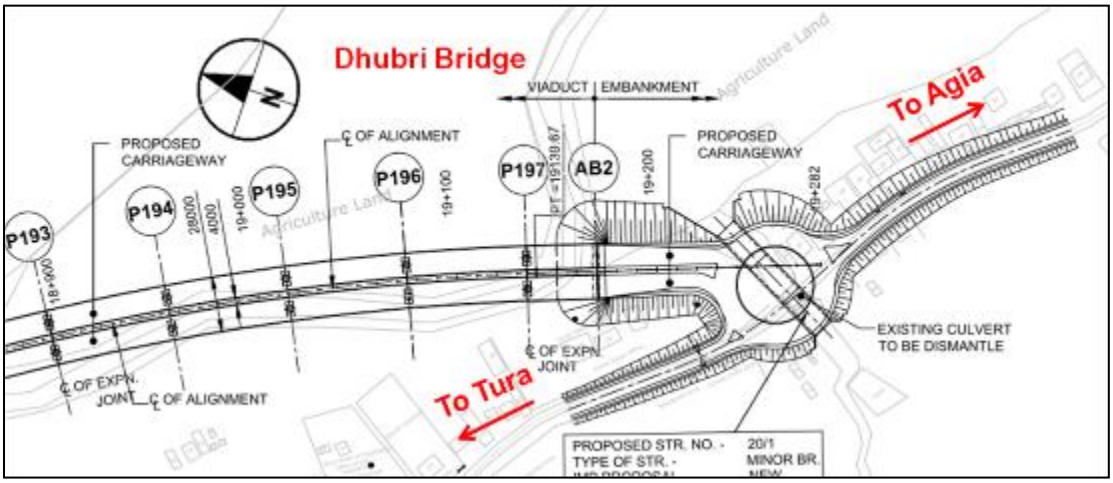
The provisions of IRC:SP84-2014, are generic provisions and deviations from them are allowed as per specific project requirements. These deviations will be documented in Schedule D of the Tender Documents. The specific reasons for adopting at grade junction / roundabout are given below:

- Provision of a junction is envisaged as a "Traffic Calming Measure". Roundabouts provide an unhindered circulation, knowing the disregard to "Give way" in Indian Traffic Scenario. Although traffic signals control running speeds, they requires steady supply of electricity giving some restriction to installation locations. Rotary intersections with central islands force oncoming vehicles to reduce the speed intercepting the straight line movement.
- As this bridge demarcates the border of two states, it is envisaged that many future facilities like RTO Checkpoint, BSF Checkpoint (A checkpoint is already in the char, which checks all boats going between Dhubri and Phulbari), will be set up near the bridge. Hence, "Traffic Calming" will be very essential to ensure proper traffic safety.



Source: JICA Study Team

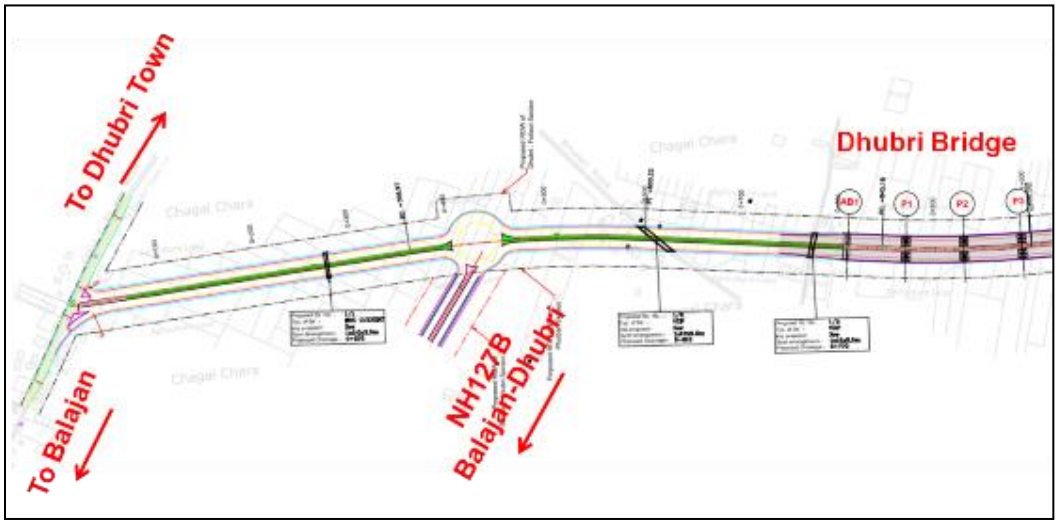
Figure 3-19: Intersection Plan at the Dhubri Side



Source: JICA Study Team

Figure 3-20: Intersection Plan at the Phulbari Side

On the Dhubri side, it is necessary for the Dhubri Bridge to connect to NH127B coming from Srirampur via Balajan. It was decided at the Guwahati Office of NHIDCL on Feb 2, 2017 at the tripartite meeting between NHIDCL, Assam State PWD, and JICA to provide a roundabout at the midpoint between the starting point of the Dhubri Bridge (on the Dhubri side) and the rural road connecting Balajan and Dhubri.



Source: JICA Study Team

Figure 3-21: Roundabout Plan between the Dhubri Bridge and NH127B

3.2 Issues of Bridge Section

The Dhubri Bridge is planned to cross Brahmaputra River diagonally to link Dhubri and Phulbari. While the width of the river is only about 2km at the nearest Bridge (Nara Narayan) located about 60km upstream, it widens significantly to about 15km width off the shore of Dhubri. The elevation of water surface, as well as discharge of the Brahmaputra River greatly fluctuates from season to season, and the locations of water channels vary due to thick alluvium of easily erodible soils surrounding the river. A majority of the area is submerged at the Design High Flood Level (+30.360m). During rainy seasons, most of the sandbars are submerged except for those in high areas, while several sandbars emerge in the dry season. The largest sandbar off the shore of Dhubri reaches up to about 5km in width during the dry season, but its size and location are unpredictable.

Because the Dhubri Bridge is quite long, a structural plan that will satisfy both the economy and a short construction period is preferable. The selection of structural type at the navigational portion is the most important choice in the bridge planning. Since the construction of the Extradosed Bridge governs the construction period of the entire Dhubri Bridge, the study will focus on the Extradosed Bridge selected by DPR.

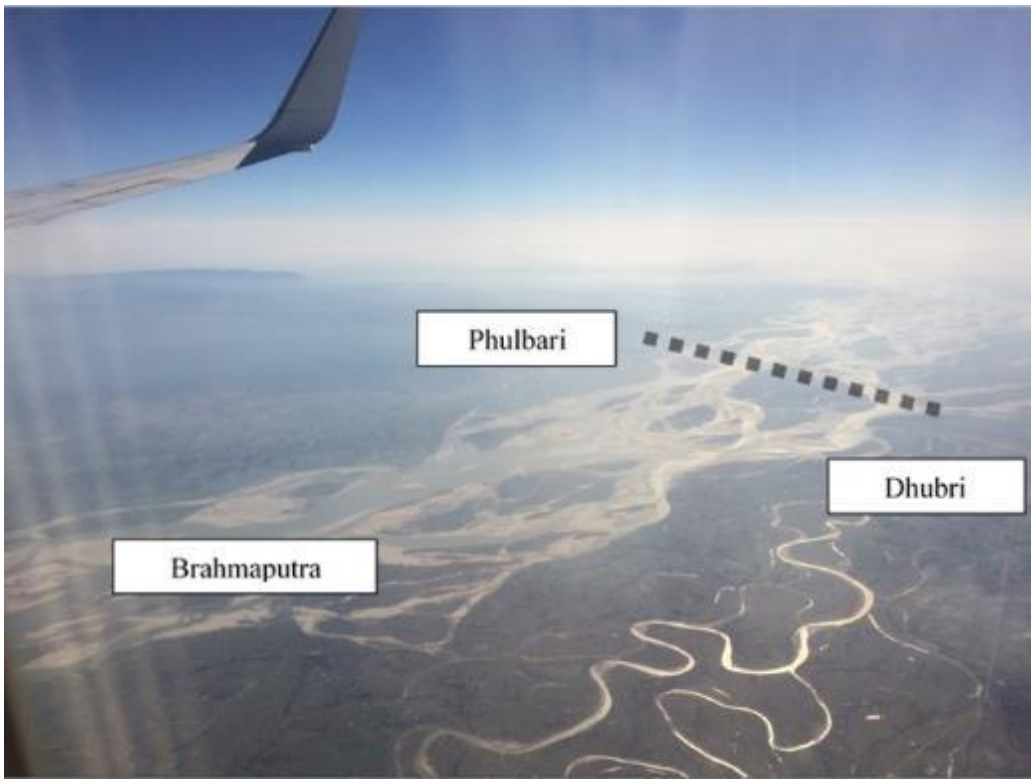
Rainy Season	Dry Season
	
Landing place at Dhubri	Landing place at Dhubri
	
Landing place at Dhubri Town	Landing place at Dhubri Town

Figure 3-22: Difference of Water Level between Rainy and Dry Season

(1) Length of Bridge Section

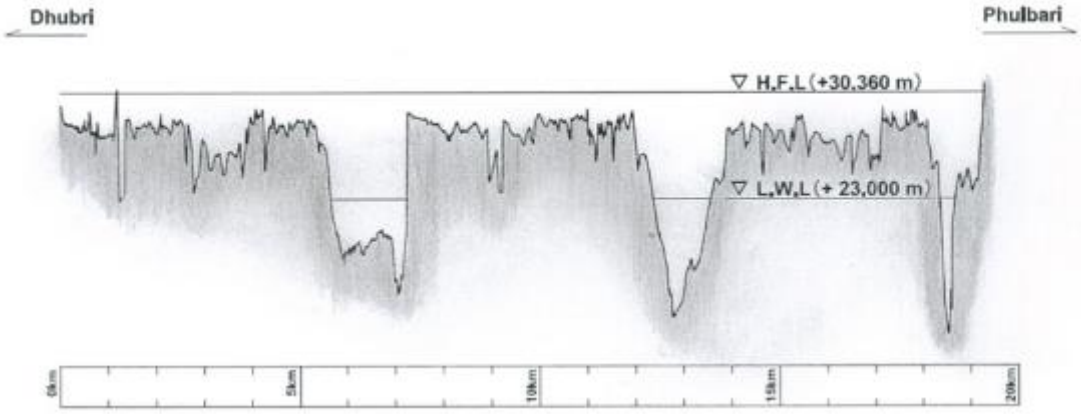
Considering the width of the river exceeds 15km and the locations and sizes of channels as well as sandbars often vary, the total bridge length is set to be about 18.5km. Considering the instability of the river and channels, constructing a long span bridge of 12.5km for the navigational portion and connecting it with short span viaducts is deemed appropriate. There are no clear natural levees on either sides of the shores along the river, and therefore, it is an appropriate judgment to locate the

start and end points of the bridge section in the back-swamps behind the present river shores considering the effects of future floods.



Source: JICA Study Team

Figure 3-23: Brahmaputra River (Sep. 2016)



Source: JICA Study Team

Figure 3-24: Land Profile and Water Elevations (Bridge Location)

A view of the upstream side from Dhubri

A view of the downstream side from Dhubri

Erodible sandbar

Shore of Brahmaputra River

A barge moored at Dhubri

A boat moored at Dhubri

Source: JICA Study Team

Figure 3-25: Brahmaputra River at Dhubri (Sep. 2016)

(2) Bridge Plan

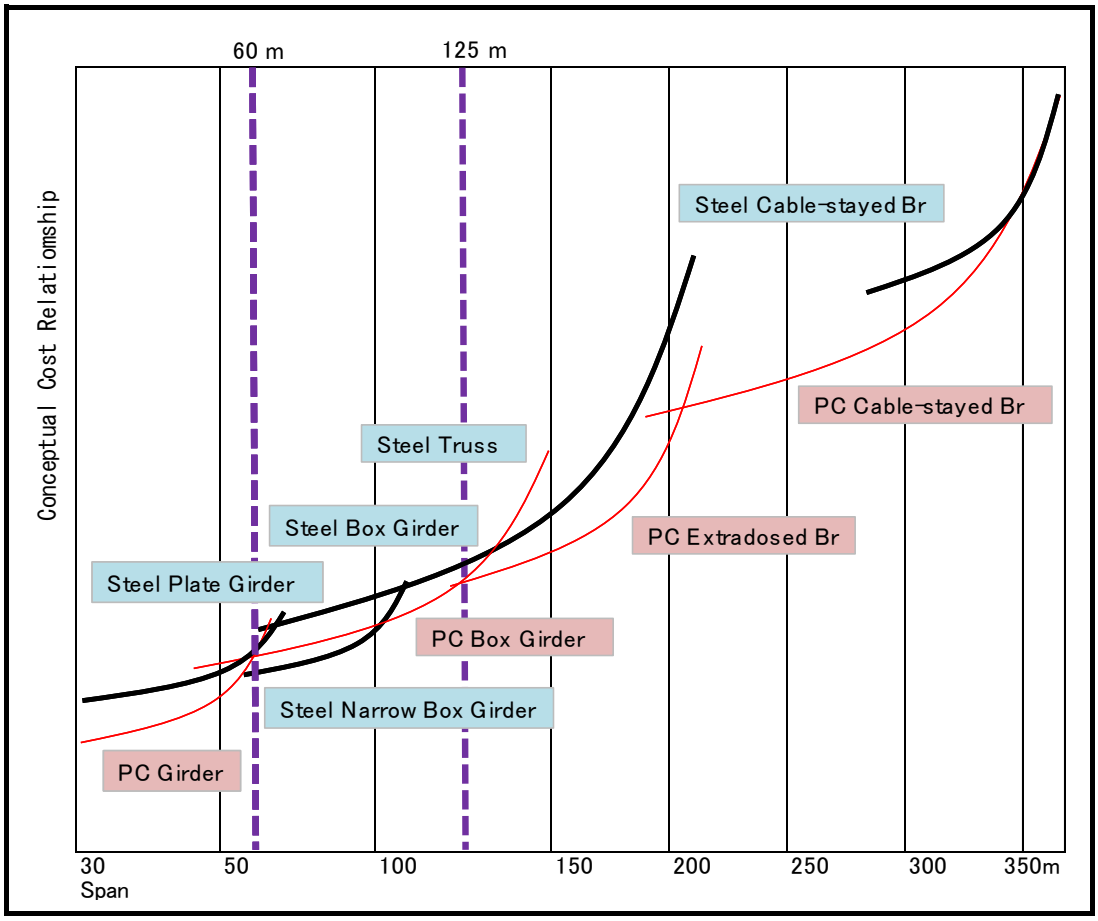
Since the Brahmaputra River is used for water transportation, the Inland Waterways Authority in India (IWAI) requests a clearance of 100m width by 10m height for navigation. To satisfy this requirement, a span of 125m for the navigational portion and 60m for viaduct portions are set. After discussion with IWAI, the length of the navigational portion was decided to be 12,625m. Extradosed PC Girder Bridge type was selected for the navigational portion, and PC Box Girder for the viaduct portions, which are generally considered economical for the respective span lengths.

The bridge planning is summarized in Table 3-6. Fig. 3-26 shows the locations of the Dhubri Bridge connecting Dhubri (left) and Phulbari (right), with the navigational portion from B to C, viaduct portions of Dhubri from A to B and Phulbari from C to D.

Table 3-6: Bridge Type Selected in DPR

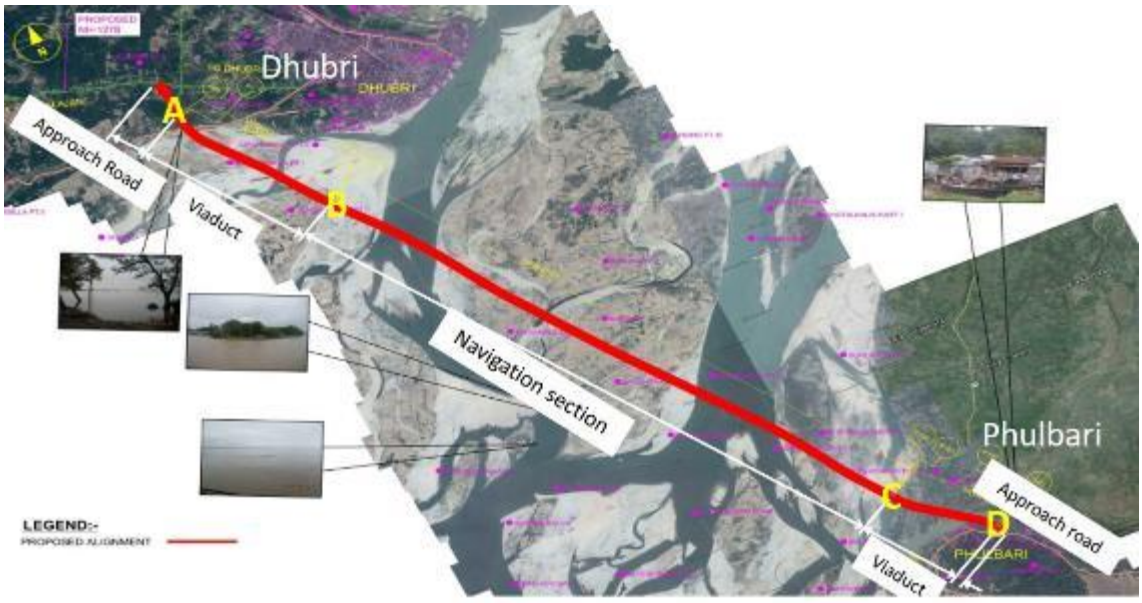
Portion	Superstructure	Span Arrangement
Viaduct (Dhubri)	PC Box Girder	59@60m=3,540m
Navigation	Extradosed PC Girder	62.5+100@125+62.5m=12,625m
Viaduct (Phulbari)	PC Box Girder	36@60=2,195m
Total		18,360m

Source: JICA Study Team



Source: JICA Study Team

Figure 3-26: Economical Bridge Types for Different Spans in Japan (Conceptual)



Source: JICA Study Team

Figure 3-27: Location of Dhubri Bridge (Dhubri to Phulbari)

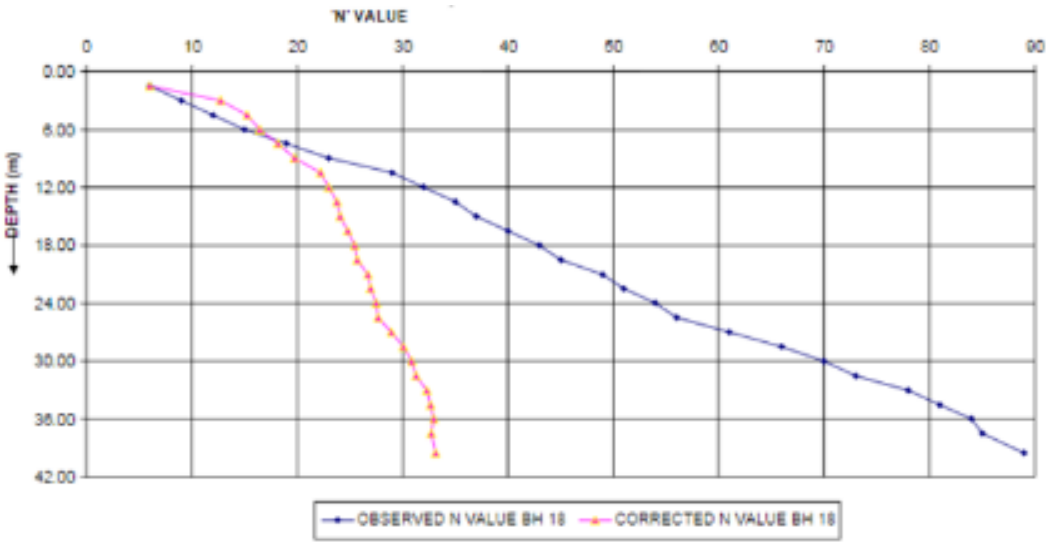
(3) Foundation

It is reasonable to select open well foundations for substructures since it can; cope with thick deposits of erodible soils, requires no special construction machines, a technology already established in India and utilized on the Brahmaputra River, and is regarded as safe from scouring. The diameter of open caissons[1] can be reduced according to the magnitude of loads from superstructure, but the minimum size is controlled by the size of the bucket of the excavator.

A Japanese Design Manual (Design Manual for Facilities Constructed in River) recommends that the area obstructed by newly constructed piers should be within 7% of the entire vertical sectional area of the river. This manual provides the ideal width of piers to minimize the effect of scouring.

The viaduct portions run in shallow water or on land in dry seasons. The magnitude of loads from superstructures is lighter than the navigational portion due to shorter spans, and it is reasonable to apply pile foundations, which are more economical than open well foundations in such conditions. The distribution of N-value at P-17 Pier is shown in Fig. 3-27. Considering the future excessive scouring, it is preferable to check the stability of pile foundations with exposed piles.

[1] A small cofferdam that is set in place, pumped dry, and filled with concrete to form a foundation as for a pier (Merriam-Webster)



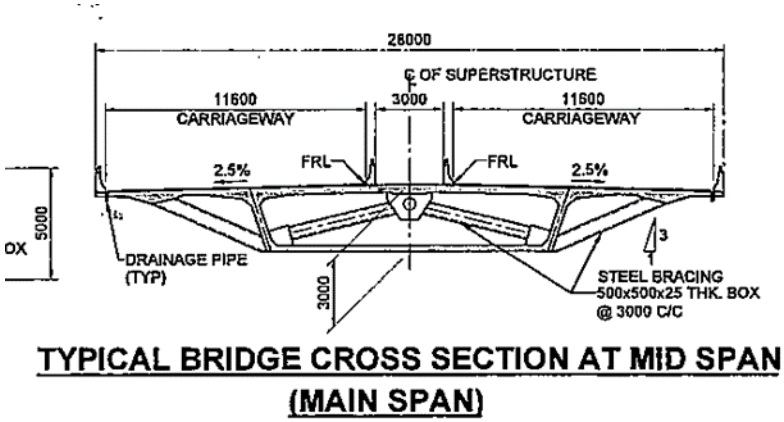
Source: DPR

Figure 3-28: Distribution of N-Values at P-17

(4) Extradosed Bridge

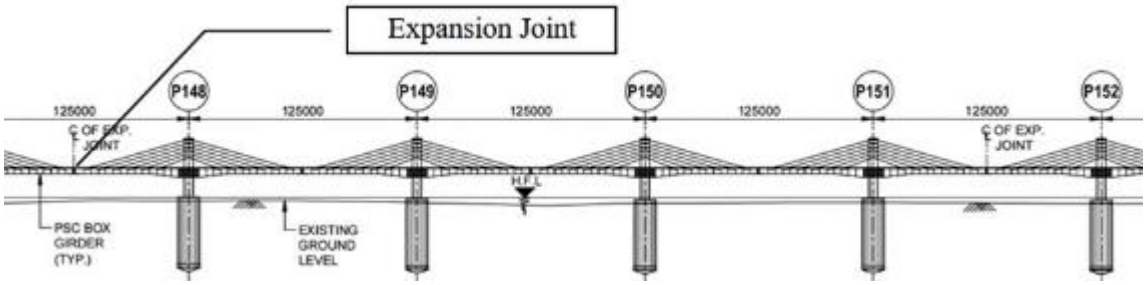
DPR has selected an Extradosed PC Bridge type with deck supported by single-plane cable system in the center of the box girder. The steel frame system housed in the box girder distributes the concentrated force of cables to the section of box girder. If the majority of the space of the box girder is occupied by the frame, it may restrict maintenance abilities in future. It is important to consider the maintenance in the design of girder section. It should be noted that some inspection and repair equipment should be brought into the girder. Because a single-plane cable system is applied, it is important to design (or strengthen to secure) sufficient transverse rigidity of the girder.

Expansion joints tend to be the most vulnerable component of the bridge. It is better to choose a type and materials with sufficient durability and easy maintenance. The expansion joints of the starting and ending point of the navigational portion are located on their respective piers, but all remaining expansion joints are in the midpoints of the spans. Creeping of concrete may result in a downward deformation and bump at the expansion joints shared by the adjacent side spans.



Source: DPR

Figure 3-29: Steel Brace inside Girder



Source: DPR

Figure 3-30: Location of Expansion Joints

(5) Construction Plan

Many materials, as well as construction equipment including cement, reinforcement bars and cables, which are necessary for construction of the Dhubri Bridge must be transported from outside of the North-West States. Taking Kolkata as the base of transportation of such cargo to Dhubri, the possible modes of transportation are truck/trailer, barge, and railway. The comparison of these transportation modes is shown in Table 3-8. It is important to select the most appropriate transportation mode considering the size, quantity, stocking capacity at the site, seasonal restrictions, capacity of transportation mode, and cost. Railway is considered the most effective way because it is economical without seasonal restrictions, and is suitable for the transportation of large amounts.

However, since there is neither an available railway nor appropriate landing facility on the shore of Phulbari, only road transport can be relied on.

To transport by truck from Dhubri to Phulbari, a long way must be travelled to cross the Nara Narayan Bridge located about 60km upstream. Moreover, there is no direct national highway from Nara Narayan Bridge to Phulbari along the south shore of the Brahmaputra River. It should be noted that there is a significant constraint of transportation to Phulbari.

To cope with the disadvantages in transportation to Phulbari, it is reasonable to plan major construction yards and plants on the Dhubri side. In this case, it is impossible to use the nearest railway station, Dhubri Station, because the route passes through the densely populated area. Although Gauripur Station is farther than Dhubri Station, the distance can be shortened to about 5km once the temporary site road is constructed from the construction yards in Dhubri to the station, effectively making it the most appropriate railway station.

Table 3-7: Distance to Nearest Railway Station (Existing Road)

Railway Station	Distance
Dhubri Station	5,000 m
Gauripur Station	6,650 m

Source: JICA Study Team

Source: Locations added to Google Earth

Figure 3-31: Major Road Network

Table 3-8: Comparison of Transportation Modes

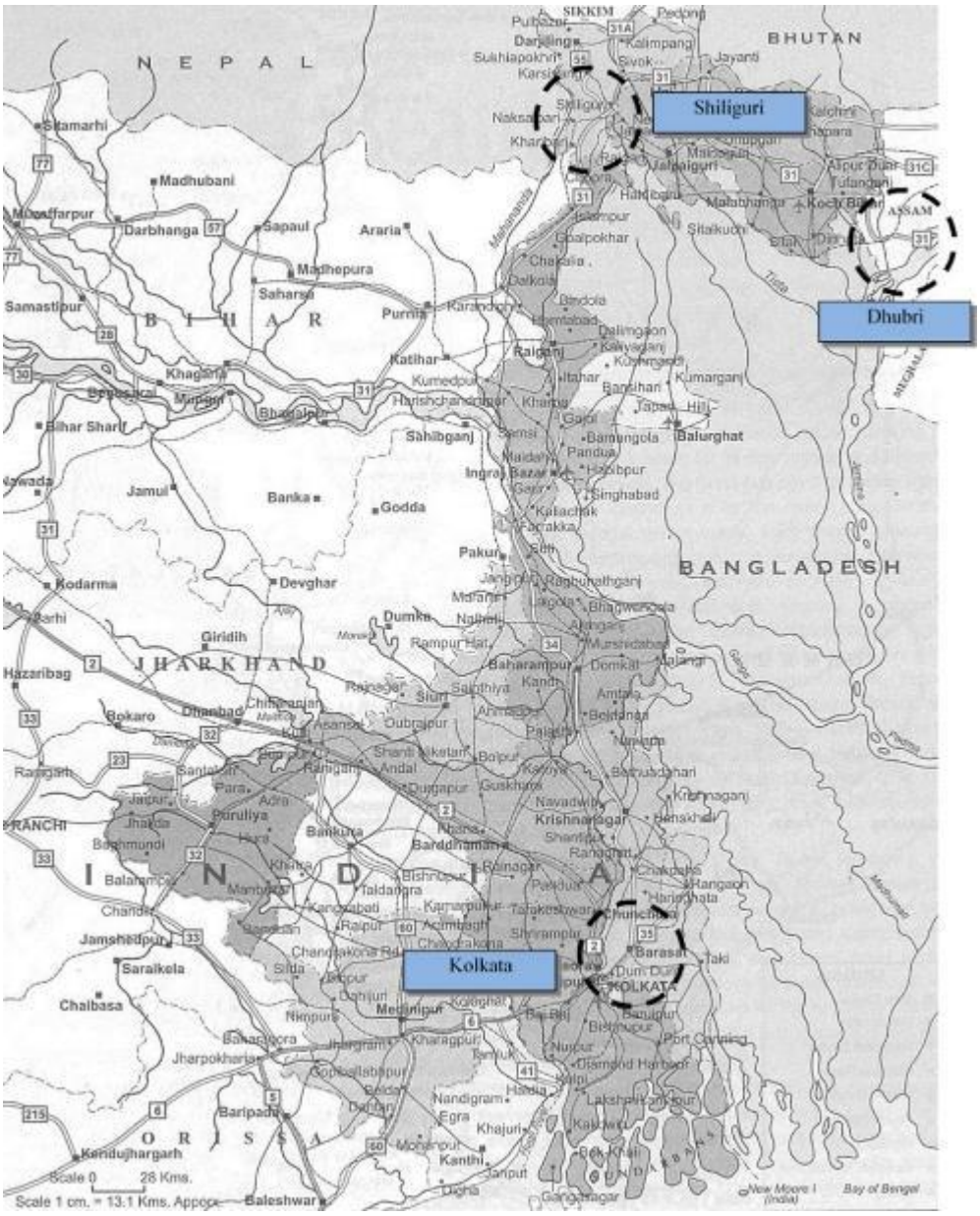
Mode	Truck, Trailer	Barge	Railway
Travel Distance	About 900km (via NH-34、NH31)	About 1,200km (via Hugli、Ganga、Jamuna River)	About 1,000km
Max. Cargo Size	10m(L)×2.5m(W) ×2.5m(H) 3.67m height limit to cross under railways, Vehicle:25ton	Barge:60m(L)×15m(W) Weight:800ton	10m(L)×2.4m(W) Weight:200～500ton
Period	5～7days	Loading: 5days, Navigation:21days Unloading: 5days, Return:21days, Total: 52days	5～7days
Feature	Relatively easy to adjust travel time and route	Suitable for large and heavy goods	Suitable for large amount of goods. Most stable travel time
Seasonal Condition	None (More time needed in the rainy season than dry season)	Navigable only from September to December	None
Cost	More expensive than railway	Most costly	Most economical
Advantage	Available throughout the year and no need for reshipment. Shortest time of transportation.	Suitable for large cargo which cannot be transported by road or railway.	Available throughout the year. Direct transport from Kolkata to Shiriburi. Dhubri has railway. Suitable for large quantity of goods.
Disadvantage	Not appropriate for large quantity of goods. May cause traffic jams along the road.	Jetty and facility are needed in Dhubri and Phulbari.	No railway station in Phulbari. Limitation of size.

Source: JICA Study Team

Table 3-9: Distance from Kolkata

Section	Road Distance
Kolkata – Shiliguri	About 650km
Shiliguri – Dhubri	About 250km
Total	About 900km

Source: JICA Study Team



Source: JICA Study Team

Figure 3-32: Distance from Kolkata


Power lines crossing above the road (NH-34)


Trailer carrying steel pipes (NH-3)


Bridge over Ganga River (NH-34)


Check point by police (NH-34)


Road improvement and repair (NH-34)


Section between Shiliguri～Dhubri (NH-31)

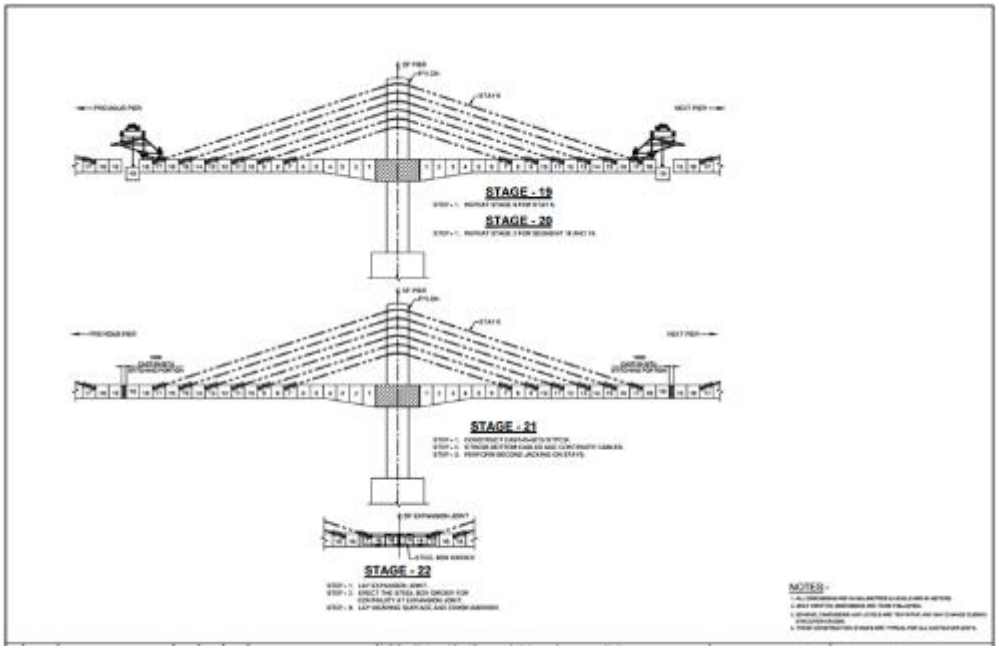
Source: JICA Study Team

Figure 3-33: Road Condition between Kolkata and Dhubri (Feb. 2017)

The most important challenge in the construction planning is the selection of the construction method of a series of 100 spans of Extradosed Bridge over the Brahmaputra River; and it is important to take into account economical, technical reliability, and planned period aspects based on the local conditions. An Extradosed Bridge is constructed by erecting girders from the pylon on the pier using precast segments, or placing in-situ concrete along the length. Considering the difficulty of the transportation of materials to Phulbari compared to Dhubri, major site yards should be situated at Dhubri. The full width of the girder for Dhubri Bridge is 28m. If the heavy precast segments are carried from the site casting yard to the exact location of erection in the river, a large temporary facility such as a jetty should be used for loading/ unloading from the barges and as a temporary passage to carry heavy goods. Due to this, in-situ concrete placement seems to be a

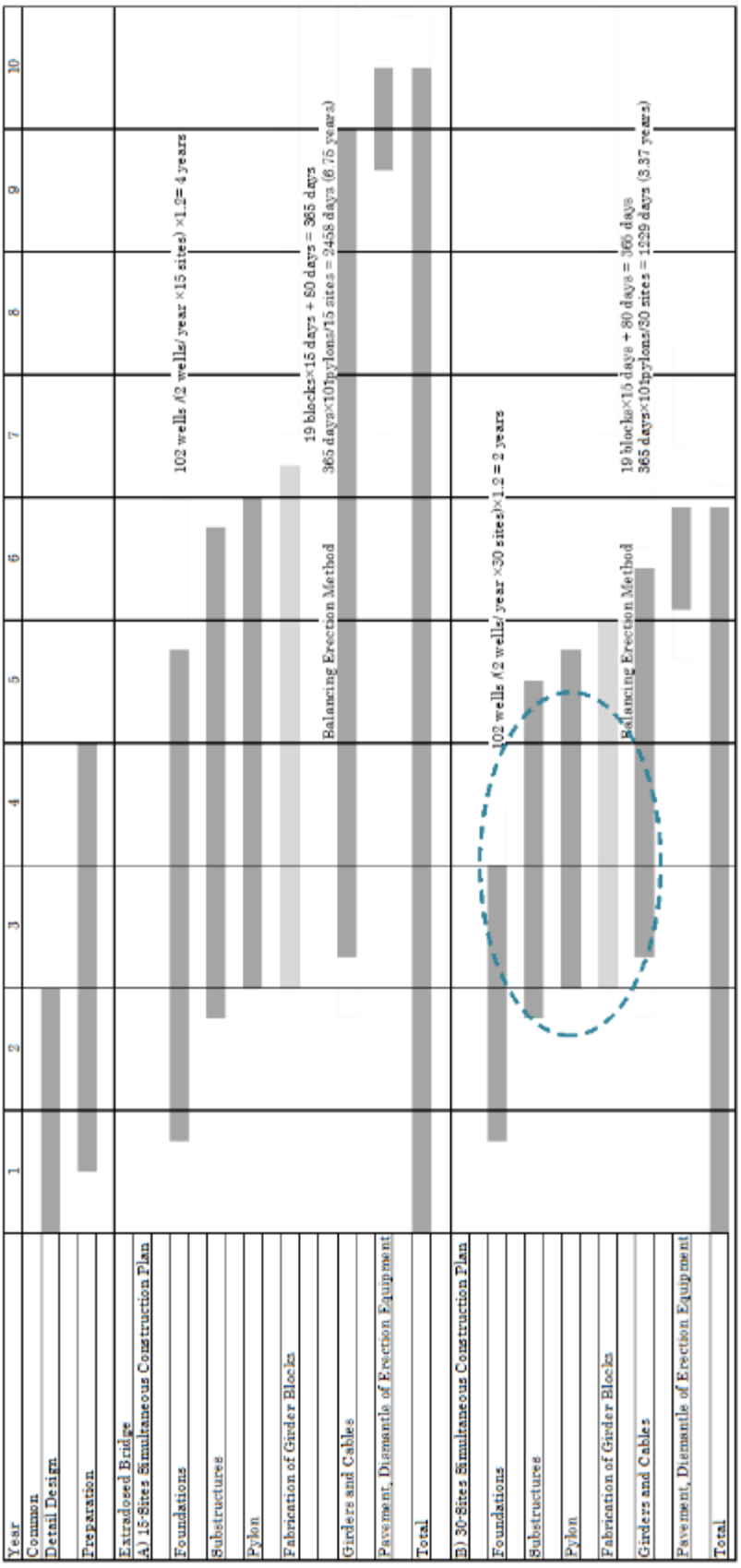
practical method compared with precast segment erection. In this case, a large temporary facility is also required to transport large amounts of fresh concrete to the site as scheduled.

According to previous experiences of precast segment construction in Japan, 7 days were needed to complete each segment, while 10 to 15 days were needed for in-situ concrete placement. Suppose the construction period of the Dhubri Bridge is 6 years (referencing Japan's experiences), it is then necessary to conduct 30 sites in parallel for the navigational portion. 15 parallel constructions may be considered as practically maximum considering the provision of fresh concrete, which has strict time requirements from mixing until placement from the mixing plant to the site in the water channels or sandbars. Under this assumption, more than 9 years of construction may be necessary. The estimated period with simultaneous construction at 15 and 30 sites is compared in the following figure.



Source: DPR

Figure 3-34: Erection Process of Extradosed Bridge Girders



Source: JICA Study Team

Figure 3-35: Construction Period of Extradosed Bridge

(6) Comments on DPR

Because the Dhubri Bridge is of vital importance for the development of North-Eastern States, it is important to complete the construction as scheduled and prevent delays in construction. This project operates at more than 100 construction sites on the Brahmaputra River which exhibits significant change from season to season. The difficulty is expected in the construction, rather than the design. Although the construction works is under the responsibility of the contractors, the scale of the project is greater than the past experiences, therefore it is important to conduct an in-depth study on the construction method in advance to ensure the quality required by the design. Some comments are summarized in the following Table.

Because these points are important in judging Dhubri Bridge's possibility of being constructed according to plan, JICA Study Team submitted a written opinion to NHIDCL and DPR Consultant. NHIDCL and DPR Consultants then provided countermeasures from the said opinions. Due to the need of detail elaboration about the countermeasures, all the groups (JICA, NHIDCL and DPR Consultant) exchanged opinions on site, confirm the countermeasure descriptions via email and verified details via web conference. A conference was held for the four groups (NHIDCL, DPR Consultant, JICA Study Team and JICA) and finally concluded that the planned extradosed bridge construction is possible.

The details about the countermeasure is explained in Chapter 5 Preliminary Design of Dhubri Bridge article 5.4 Bridge Design.

Table 3-10: Comments on DPR

Item	Comment
Material procurement	A large amount of materials is needed, that is why the stable production, transportation, and on-site storage should be confirmed. Likewise, the capacity of production and delivery period of the manufactures should be confirmed.
Construction schedule	The construction time frame should include necessary time for detail design and procurement of materials. Sufficient study of construction method should be conducted to manage multiple sites simultaneously that are subject to significant seasonal changes of the Brahmaputra River.
Temporary facilities	A Jetty, temporary roads, concrete mixing plant and such facilities are expected to be large. Proper preparation and maintenance is necessary. Since the cost of large temporary facilities is greater than that for common works, expenses should be properly estimated.
Workers, Inspectors	Many workers and inspectors are needed along with the development of works. It is important to secure and manage a number of experienced workers and inspectors.
Measures against flooding	A flood of 10-year return period may occur during the construction period, and therefore, countermeasures for flood disaster should be considered.
Corrosion prevention	Repainting of steel is expected to be difficult and durable rust-proofing methods should be applied.
Railway station	When railway is utilized for transporting materials, access roads and loading/unloading facilities should be studied.

Source: JICA Study Team

CHAPTER 4 TRAFFIC SURVEY AND PROJECTIONS

4.1 General

Phase 1 study has conducted preliminary traffic analysis concerning the approach road and new bridge between Dhubri – Phulbari section. DPR consultant has also conducted extensive traffic survey and analysis. In this study, these existing analyses have been reviewed and updated.

4.2 Study Road Network

The proposed bridge and approach road is a part of the newly declared National Highway NH 127B. NH 127B starts at Srirampur on NH 31C (new NH 27) in Assam and ends in Nongstoin on NH 44E (new NH-106) in Meghalaya. The proposed bridge over Brahmaputra River is the most important segment of NH 127B as it will connect the missing link where currently only transport mode available is the ferry services. The new bridge will establish an alternative land transport connectivity between Assam and Meghalaya. The location of the proposed bridge and surrounding road network is shown below.

Source: JICA Study Team

Figure 4-1: Location of the Proposed Bridge and Surrounding Road Network

4.3 Traffic Analysis in the DPR

4.3.1 Traffic Survey

Traffic surveys including traffic count, OD survey, axle load survey and ferry surveys were conducted in February 2016 at the locations summarized below.

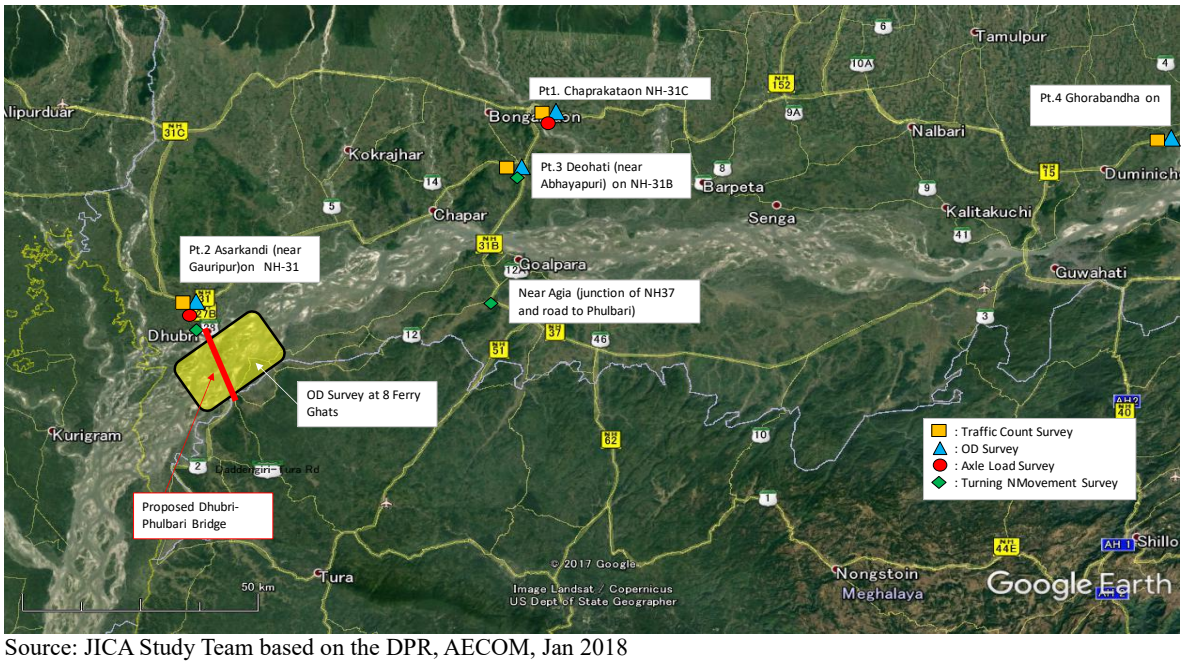
- 7-day traffic count was conducted at four locations
- 1-day (24 hours) OD survey at 3 locations
- 2-day (24 hours),axle load survey at 2 locations
- 2-day OD survey at 8 ferry ghats
- 1-day (12 hours) turning movement at 3 locations

Details of traffic surveys and location map are shown below.

Table 4-1: Traffic Survey Details

Sl.	Type of Survey	Duration	Sta.No.	Survey Location
1	Traffic count	7 days x 24 hrs	V1	On NH 31C near Bijni
2			V2	On NH 31 near Gauripur.
3			V3	On NH 31B near Abhayapuri
4			V4	On NH 52 at a point on Jalimura-Magaldai
5	OD Survey	24 hrs	OD1	On NH 31C near Bijni
6			OD2	On NH 31 near Gauripur.
7			OD3	On NH 31B near Abhayapuri between the NH 31 and NH 31B intersection and Nara Narayan Setu stretch
8			OD4	On NH-31B near Abhayapuri between the NH-31
9	Axle load survey	2 normal days (24 hours)	AX1	On NH-31C near Bijni
10			AX2	On NH-31 near Gauripur.
11	OD cum count at Ferry Ghats (Passenger & Goods)	2 days (Ferry working hours)	ODF1	Netai Dhopani Ghat, Dhubri
12			ODF2	Ponchu Ghat, Dhubri
13			ODF3	Jogomaya Ghat, Dhubri
14			ODF4	New Ghat, Dhubri
15			ODF5	Phulbari Ghat, Phulbari
16			ODF6	Salamara Ghat, Phulbari
17			ODF7	Fakirganj Ghat, Fakirganj
18			ODF8	Kachari Ghat, Dhubri
19	Turning Movement Survey	12 hours on a Working day	TMC1	Near Gauripur (Junction of NH31 & Road to Dhubri)
20			TMC2	Near Abhayapuri (Junction of NH31 & NH31B)
21			TMC3	Near Agia (Junction of NH37 & Road to Phulbari)

Source: DPR, AECOM, Jan 2018



Source: JICA Study Team based on the DPR, AECOM, Jan 2018

Figure 4-2: Location of Traffic Surveys in the DPR

4.3.2 Origin and Destination Survey

Origin and Destination (OD) surveys were conducted for one day (24 hours) at four locations. Roadside interview method in accordance with IRC: 102-1988 was used. Both passenger and commercial vehicles driving on the project road were stopped randomly and interviewed with police assistance. OD Zone map is shown in Figure 4-3 below.

Combined OD matrices were computed based on the total sample size of the passenger and commercial vehicles, and the Zone Influence Factors (ZIF, expressed in %) for the passenger cars, buses, 2-axle trucks and 3-axle trucks were evaluated.

ZIF represents the relative contributions of various zones to trip generation, which is calculated as:

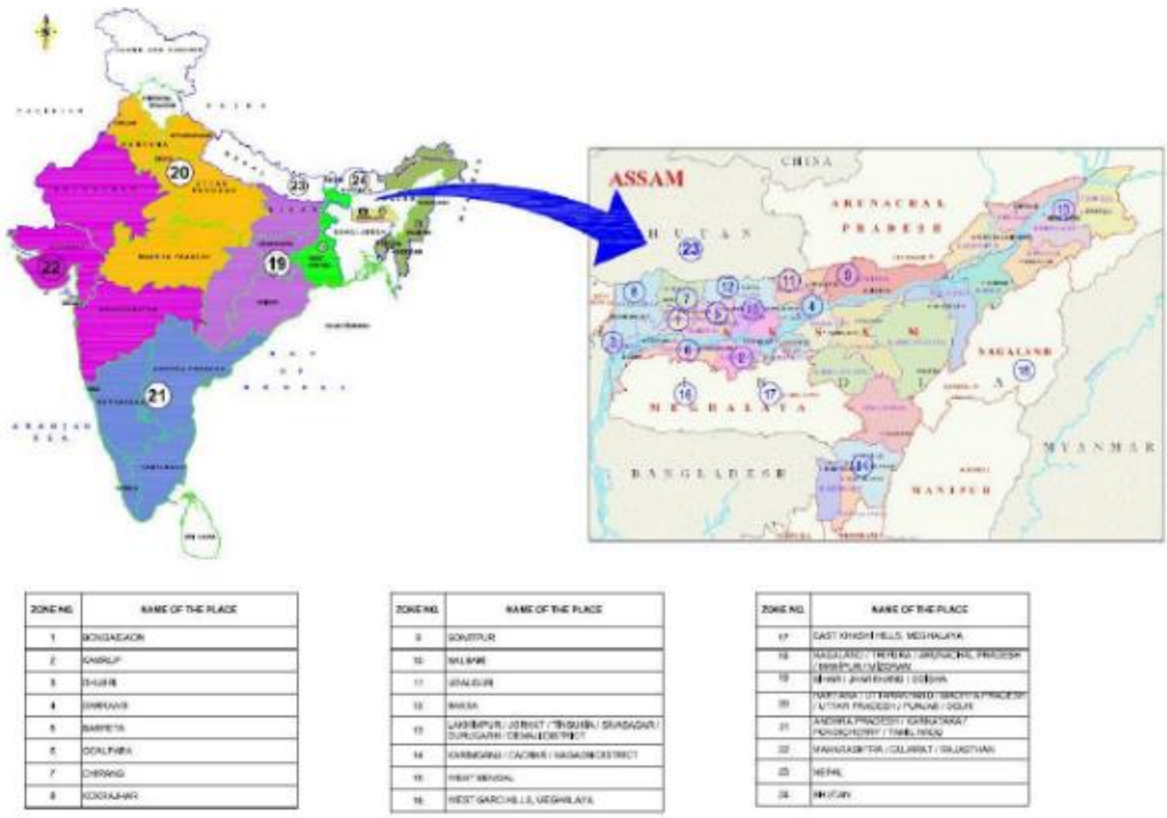
$$ZIF_i = \frac{Oi+Di}{2\ \Sigma i=1,n,j=1,n \ \cdot Tij}$$

Where,

ZIF_i is the Zone Influence Factor of Zone *i*
O_i is the number of trip productions from Zone *i*
D_i is the number of trip attractions from Zone *i*
T_{ij} is the number of trips between Zone *i* and *j*

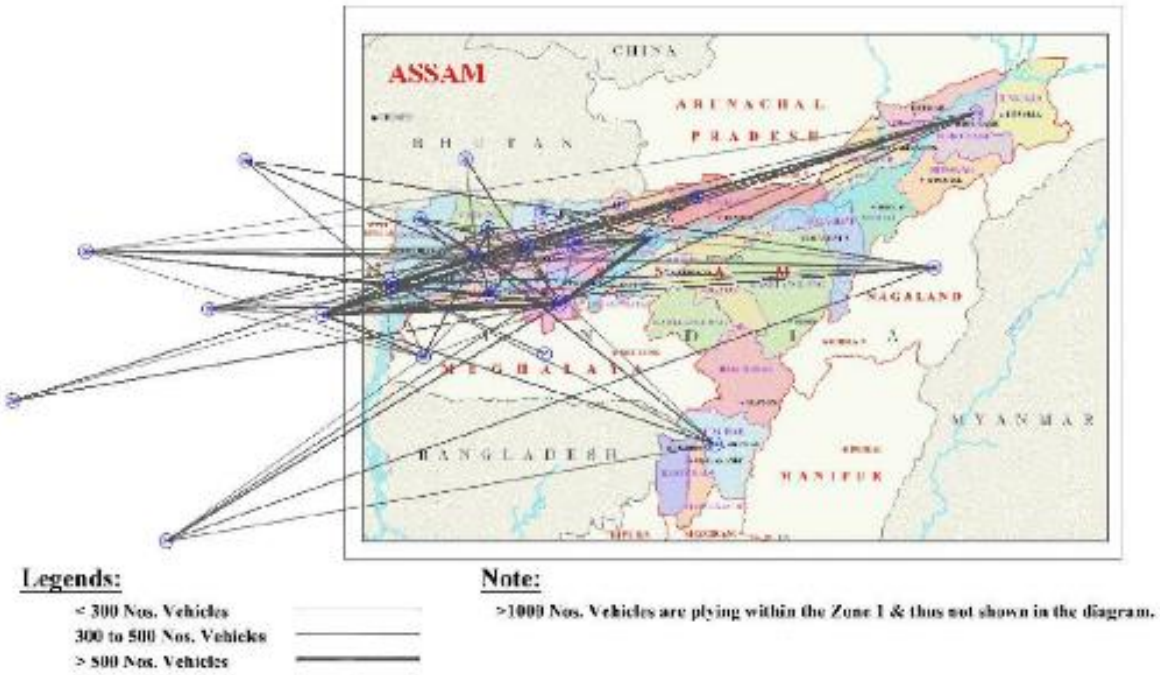
For the passenger cars, the ZIF for Bongaigaon, Kamrup, Dhubri & Darrang contributes to about 75% of the total passenger cars. For buses, the ZIF for Bongaigaon, Kamrup, Dhubri and Darrang, Barpeta and Goalpara contributes to about 88%. For 2-axle trucks, the ZIF for Bongaigaon, Kamrup, Dhubri, Darrang and Barpeta, Goalpara contributes to about 88%. For 3-axle trucks, the ZIF for Bongaigaon, Kamrup, Dhubri and Darrang contributes to about 56% of the total.

It is observed that passenger vehicle trips are distributed mainly within Assam, while commercial vehicles were mostly heading to West Bengal and other states. The desire lines considering the OD matrices for the passenger and commercial goods vehicles (combined for all the locations) are shown in Figure 4-4 and Figure 4-5.



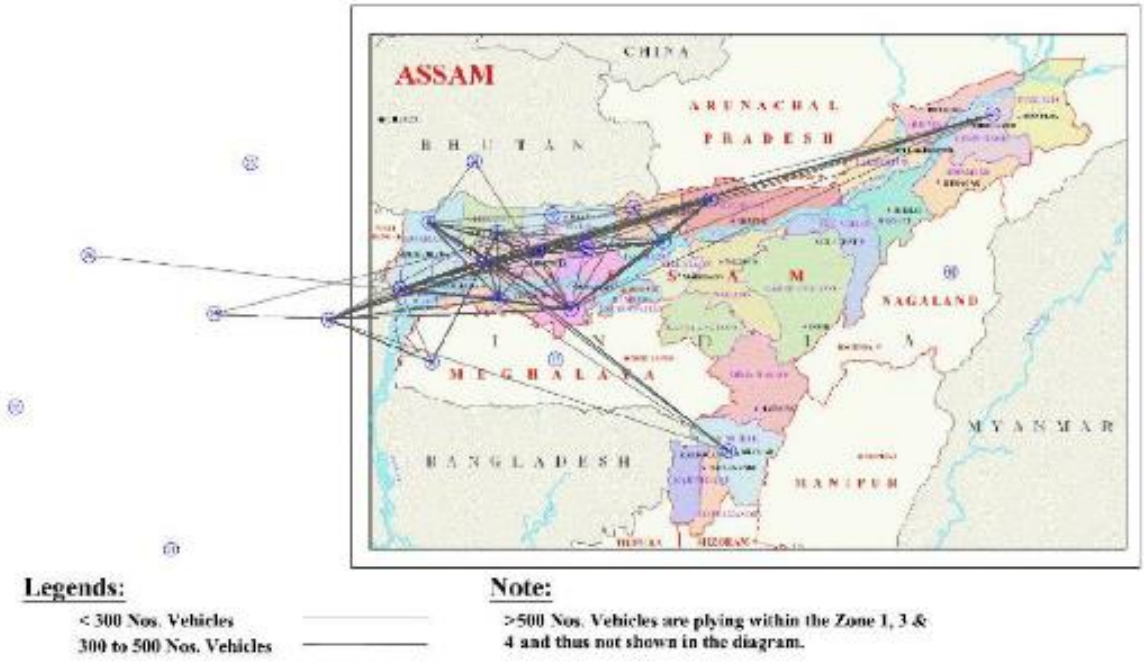
Source: DPR, AECOM, Jan 2018

Figure 4-3: OD Zone Map



Source: DPR, AECOM, Jan 2018

Figure 4-4: Desire Line for Commercial Goods Vehicles



Source: DPR, AECOM, Jan 2018

Figure 4-5: Desire Line for Passenger Vehicles

4.3.3 Average Daily Traffic

The traffic volume counts were conducted at fifteen (15) minute intervals and aggregated to one (1) hour volumes. The daily volumes were averaged for Average Daily Traffic (ADT). PCU factors given in IRC-106: 1990 shown below were referred to express ADT in Passenger Car Unit (PCU). The result of ADT and PCU is shown below.

Table 4-2: Traffic Type and PCU

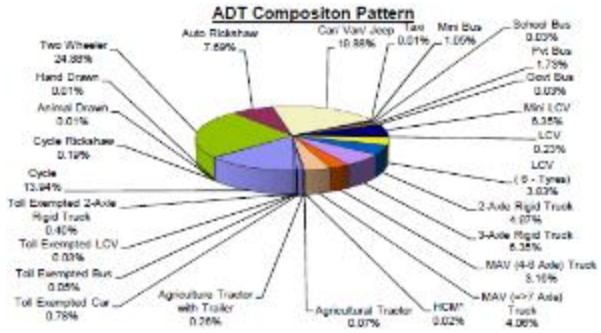
Passenger Vehicles		Commercial Goods Vehicles	
Category	PCU	Category	PCU
Two-wheeler	0.5	Truck (2-Axle)	3.0
Three-wheeler/Auto Rickshaw	2.0	Truck (3-Axle)	4.5
Car	1.0	Truck (4 to 6-Axle)	4.5
Bus	3.0	Truck (7 & more Axle)	4.5
Mini Bus	1.5	Light Commercial Vehicle (LCV)	1.5
Bicycle	0.5	Tractor with Trailer	4.5
Rickshaw	2.0	Tractor without Trailer	1.5
		Animal drawn vehicle	6.0

Source: IRC 64-1990

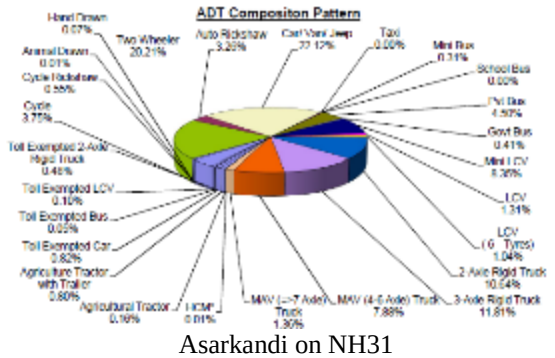
Table 4-3: ADT

Vehicle Type	Unit	Chaprakata on NH31C	Asarkandi on NH31	Deohati on NH31B	Ghorabandha on NH52
Total fast-moving vehicles	No.	9,411	7,927	7,119	16,858
	PCU	15,749	16,603	14,276	22,955
Total slow-moving vehicles	No.	1,551	364	673	986
	PCU	815	272	362	613
Total ADT	No.	10,962	8,291	7,792	17,844
Total PCU per day	PCU	16,564	16,875	14,637	23,568

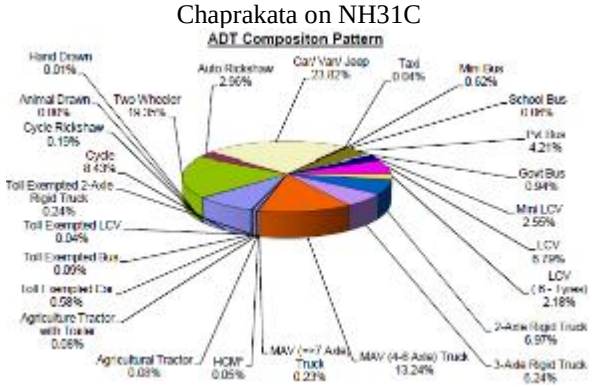
Source: Extracted from DPR, AECOM, Jan 2018



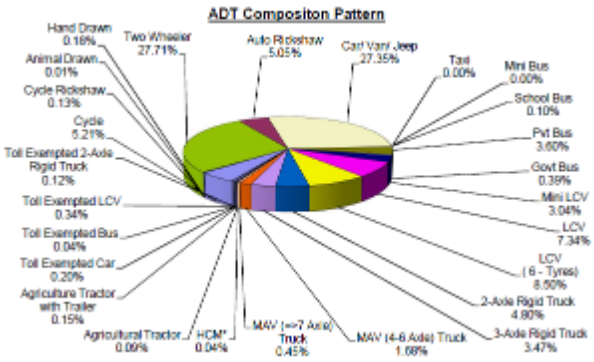
Chaprakata on NH31C



Asarkandi on NH31



Deohati on NH31B



Ghorabandha on NH52

Source: Extracted from DPR, AECOM, Jan 2018

Figure 4-6: ADT Composition

It was observed that at all the locations, a large portion of vehicles were Commercial goods vehicles. The contribution of passenger vehicles is between 10-20% while that of commercial goods vehicles is between 52-70%.

4.3.4 Diversion Traffic Analysis in the DPR

The method of estimating diversion traffic in the DPR is explained in this section.

Step 1: The following zone pairs were identified to calculate divertible traffic volume.

The Northern bank: Zone 1, 3, 5, 15, 19 , 20 and 22
The Southern bank: Zone 2, 6, 16 and 17

Step 2: Divertible traffic were extracted from OD matrices. At present, the traffic captured at the traffic survey point no. 2 on NH-31 (the closest location to the proposed new bridge) and crossing the river is pasesing through the traffic survey point no.3 on NH-31B and existing bridge at Goalpara. Therefore, the OD pairs counted at NH-31 was excluded when counting divertible traffic from OD matrix of NH-31B to avoid double counting. The traffic captured at traffic counting point no.1 on NH-31C and crossing the river do not overlap with those from NH-31. The OD pairs at each traffic survey point for counting divertible traffic is shown below.

Table 4-4: OD Pairs Captured for Divertible Traffic

NH31C		
Vehicle Type	Zone Pairs	
2 axle,LCV,Car	1	16
2 axle, 3 axle,MAV,Car	2	15
2 axle, 3 axle,MAV,LCV	2	19
Car,Bus	2	3
Car	3	6
3 axle,MAV	13	15
Car	15	6
Car	16	3
MAV	19	13
2 axle, 3 axle,MAV	20	2
MAV	22	2
NH31B		
Vehicle Type	Zone Pairs	
2 axle,3 axle,MAV,Car,Mini Bus,Bus	16	1
2 axle	16	5

NH31		
Vehicle Type	Zone Pairs	
2 axle, 3 axle,MAV,LCV,Car,Bus	2	3
2 axle, 3 axle,MAV,LCV,Car,Bus	2	15
2 axle, 3 axle,MAV	2	19
3 axle,MAV,LCV	2	21
3 axle,MAV	2	22
3 axle,MAV,LCV	2	20
2 axle, 3 axle	3	16
MAV,Car,Mini Bus,Bus	3	6
MAV,Car	6	15
2 axle, 3 axle,MAV,LCV,Car	13	3
2 axle, 3 axle,MAV,LCV,Car	15	13
2 axle, 3 axle,MAV,LCV,Car,Bus	16	15
MAV	16	1
3 axle	16	21
2 axle, 3 axle,LCV	17	3
MAV	19	13
MAV	19	16
3 axle	20	13
3 axle	20	16

Step3: For each OD pair above, diversion ratio was calculated in accordance with IRC SP-30. Diversion ratio was calculated by comparing Generalized Cost comprises of Vehicle Operation Cost and Travel Time Cost for current routes and expected new routes when the new bridge is constructed. In case it is more cost effective to use the new route thought theproposed bridge, diversion ratio becomes higher. The result of diversion ratio is shown below.

Table 4-5: Diversion Ratio

Location	Car	Bus Truck	Truck
NH31C	44%	38%	32%
NH31	47%	39%	77%
NH31B	39%	39%	39%

Source: DPR, AECOM, Jan 2018

Step 4: Divertible traffic by vehicle type was counted, and based on its share in the OD samples, it is further extended based on based on the peak season ADT to derive the annual divertible traffic volume. The result shows that 3,661 vehicles (in peak ADT) is currently crossing the river according to the OD survey result.

Table 4-6: Total Divertible Traffic

	NH 31C							
	Category of Vehicles							
	Car	Mini	Bus	LCV	2xl	3xl	MAV	合計
Total Potetntial Divertible Traffic	**26**	**0**	**1**	**9**	**34**	**59**	**80**	209
Sample Size	*417*	*21*	*43*	*192*	*171*	*151*	*176*	1171
Share of Vehicles Crossing the River	**6%**	**0%**	**2%**	**5%**	**20%**	**39%**	**45%**	
Peak Season ADT	*2441*	*117*	*200*	*1164*	*556*	*710*	*807*	5995
No. of Vehicle Crossing the River	**152**	**0**	**5**	**55**	**111**	**277**	**367**	967
	NH 31							
	Category of Vehicles							
	Car	Mini	Bus	LCV	2xl	3xl	MAV	合計
Total Potetntial Divertible Traffic	**67**	**2**	**50**	**43**	**61**	**152**	**129**	504
Sample Size	*355*	*10*	*91*	*97*	*141*	*234*	*179*	1107
Share of Vehicles Crossing the River	**19%**	**20%**	**55%**	**44%**	**43%**	**65%**	**72%**	
Peak Season ADT	*2054*	*27*	*415*	*905*	*900*	*999*	*781*	6081
No. of Vehicle Crossing the River	**388**	**5**	**228**	**401**	**389**	**649**	**563**	2623
	NH 31B							
	Category of Vehicles							
	Car	Mini	Bus	LCV	2xl	3xl	MAV	合計
Total Potetntial Divertible Traffic	**1**	**1**	**1**	**0**	**2**	**1**	**1**	7
Sample Size	*175*	*2*	*65*	*155*	*65*	*94*	*186*	742
Share of Vehicles Crossing the River	**1%**	**50%**	**2%**	**0%**	**3%**	**1%**	**1%**	
Peak Season ADT	*2082*	*49*	*414*	*916*	*554*	*496*	*1071*	5582
No. of Vehicle Crossing the River	**12**	**25**	**6**	**0**	**17**	**5**	**6**	71

Total	3661

Source: JICA Study Team based on the information in the DPR

STEP 5: Diversion ratio calculcated by vehicle type in Step 3 is multiplied to the total divertible traffic at each point to derive diverted traffic. Furthermore, OD survey was not conducted for 2-wheelers and auto rickshaws, but it was observed that they contribute to about 23% and 5% of the ADT. Considering this, 10% and 5% of the diverted traffic were considered for 2-wheelers and 3-wheelers respectively. The diverted traffic was then calculated as 2,499 in total. In addition, diverted traffic from ferry was assumed as 116 vehicles, which makes total diverted traffic to the proposed new bridge in base year (2016) as 2,615 vehicles.

Table 4-7: Total Diverted Traffic

Location		Category of Vehicles										
		Car	Mini	Bus	LCV	2xl	3xl	MAV	Sum of Diverted Traffic	2-wheeler	Auto Rickshaw	Net Traffic
			Bus		Truck							
% of Diverted Traffic	NH-31C	44%	38%		32%					10%	5%	
	NH-31	47%	39%		77%							
	NH-31B	39%	39%		39%							
NH-31C		67	0	2	18	36	89	117	**329**	33	16	**378**
NH-31		182	2	89	309	300	500	434	**1,816**	182	91	**2,089**
NH-31B		5	10	2	0	7	2	2	**28**	3	1	**32**
Total		**254**	**12**	**93**	**327**	**343**	**591**	**553**	**2,173**	**218**	**108**	**2,499**

Source: JICA Study Team based on the information in the DPR

4.3.5 Traffic Forecast Result from the DPR

Traffic growth rate by vehicle type was estimated at intervals of 5 years up to 2046. The growth rates of different modes were computed by the elasticity approach. The relationship between traffic volume and causative factors which influence the growth and volume of traffic was determined from the growth of past traffic volume, as well as major economic indicators of the influence zone. The results of traffic forecasts for the most likely scenario during the Peak Season ADT is shown below:

Table 4-8: Result of Traffic Forecast

Year	2016 (Base)	2027 (bridge opening)	2030	2040	2045
Daily vehicle (Nos)	2,615	4,810	5,373	7,817	9,463
Daily vehicle (PCU)	7,598	13,187	14,547	20,237	23,913

Source: Extracted from Final DPR, AECOM, Jan 2018

Based on these results, the DPR recommended; i) the traffic demand exceeds the design service volume for 2-lane highway at Level of Service B (18,000 PCUs per day in accordance with IRC SP: 73-2015) in the year 2037, which is 10 years after the opening year, and ii) considering strategic importance and the long-term scenario, it is recommended to construct a 4-lane bridge as it is structurally designed for 120 years.

4.4 Traffic Projection

4.4.1 General

The DPR consultant's traffic survey and analysis, as well as their method complies with the IRC requirements. In this study, the traffic analysis in the DPR was reviewed, and the traffic forecast was updated. The target year of traffic projection was set to 2046, the same as in the DPR.

4.4.2 Traffic Type

Traffic projection of the proposed bridge is based on the following, as per the DPR:

a) Diverted traffic – Analyzed based on OD matrices for commercial goods and passenger traffic
b) Converted traffic – Analyzed based on ferry traffic for both commercial goods and passenger
c) Induced traffic – Likely to use the bridge in the initial years after the bridge opening

4.4.3 Existing and Base Year Traffic

(1) Daily variation and Peak Hour

The daily variation was not significant. At all the locations, the passenger traffic moves mostly during the daytime and the traffic volume is very small between 22:00 pm to 4:00 am. Most of the slow-moving traffic occurs during the daytime and it is negligible during the night time.

Commercial goods traffic movement remains almost the same throughout the day at Chaprakata on NH31C, but it increases between 18:00 pm and 22:00 pm. At Asarkandi on NH31, commercial goods traffic increases between 04:00 am and 09:00 am, while it decreases between 23:00 pm and 04:00 am. At Deohati on NH 31B, commercial goods traffic increases between 17:00 pm and 22:00 pm. At Gorabandha on NH52, commercial goods traffic remains almost the same throughout the day.

Below table shows the peak hour factor at each location. From this, it can be said that traffic distribution in a day is fairly uniform.

Table 4-9: Peak Hour Factor

No.	Location	Peak Hour	Peak Hour Factor (%)
1	Chaprakata on NH-31C	17:00 – 18:00	7.52%
2	Asarkandi on NH-31	11:00 – 12:00	6.76%
3	Deohati on NH-31B	18:00 – 19:00	6.97%
4	Ghorabandha on NH-52	11:00 – 12:00	6.57%

Source: DPR, AECOM, Jan 2018

(2) Seasonal Correction

To set the seasonal variation factor, petrol and diesel sales data for the years 2013, 2014 and 2015 were collected from fifteen (15) petrol stations. Then the average sales of petrol and diesel were calculated month-wise for three (3) years for estimating the Average Seasonal Correction Factor (ASCF) and Peak Seasonal Correction Factor (PSCF).

Table 4-10: Seasonal Factor

	Diesel				Petrol			
Month	Sale in littre	Seasonal Index	Average seasonal correction factor	Peak seasonal correction dactor	Sale in littre	Seasonal Index	Average seasonal correction factor	Peak seasonal correction dactor
Jan	146,524	0.90	0.86	1.11	39,099	0.94	0.97	1.06
Feb	**160,206**	**0.98**	**0.79**	**1.02**	**37,154**	**0.90**	**1.02**	**1.12**
Mar	162,726	1.00	0.78	1.00	40,851	0.98	0.92	1.02
Apr	138,134	0.85	0.92	1.18	41,029	0.99	0.92	1.01
May	110,521	0.68	1.15	1.47	41,484	1.00	0.91	1.00
Jun	97,551	0.60	1.30	1.67	34,021	0.82	1.11	1.22
Jul	105,797	0.65	1.20	1.54	36,539	0.88	1.03	1.14
Aug	87,055	0.53	1.45	1.87	30,730	0.74	1.23	1.35
Sep	94,088	0.58	1.35	1.73	33,509	0.81	1.13	1.24
Oct	123,585	0.76	1.02	1.32	39,746	0.96	0.95	1.04
Nov	136,426	0.84	0.93	1.19	39,114	0.94	0.97	1.06
Dec	156,513	0.96	0.81	1.04	39,991	0.96	0.94	1.04
Average		0.78				0.91		

Source: DPR, AECOM, Jan 201Nov 20168

(3) Annual Average Daily Traffic (AADT)

The ASCF was applied to the ADT to derive AADT, while the PSCF was applied to the ADT to derive Peak Season ADT. The summary of AADT is shown below.

Table 4-11: AADT

Vehicle Type	Unit	Chaprakata on NH31C	Asarkandi on NH31	Deohati on NH31B	Ghorabandha on NH52
Total fast-moving vehicles	No.	8,758	7,135	6,450	15,758
	PCU	13,457	13,801	11,935	20,016
Total slow-moving vehicles	No.	1,551	364	674	986
	PCU	815	272	362	613
Total AADT	No.	10,309	7,499	7,123	16,744
Total PCU per day	PCU	14,272	14,073	12,296	20,629

Source: JICA Study Team based on DPR, AECOM, Jan 2018

(4) Base Year Traffic

The base year was set to 2016 and its traffic volume estimated in the DPR was used for the traffic projection. The conditions/assumptions to determine the base year traffic is summarized below:

a) Based on the OD survey results, diversion analysis conducted in the DPR was used to estimate the percentage of traffic likely to get diverted to the new bridge.
b) OD was not conducted for 2-wheelers and auto rickshaws, but it was observed that 2-wheelers and auto rickshaws contribute to about 23% and 5% of the ADT. For the proposed bridge, 10% and 5% of the diverted traffic were considered for 2-wheelers and 3-wheelers respectively.
c) The ferry survey showed that about 2,550 people and 59 tons of goods cross the river daily, and about 67% of passenger traffic as well as 8.7% of commercial goods traffic were considered to shift to the proposed bridge as converted traffic.
d) From the observation of the weight and type of goods carried by ferries, it was considered that 80% of converted traffic will use LCV and the other 20% will use 2-axle truck.
e) The traffic that was assumed to convert from ferry service was added to the diverted traffic.
f) The opening year of bridge was considered in 2022. (in the JICA study team's estimate, opening year is 2025)
g) No diversion traffic was assumed from NH 52, because it is outside the zone of influence of the proposed bridge and it is unlikely to divert due to the existing two bridges nearby NH 52 (Jogighopa and Saraighat bridges).
h) Induced traffic after the opening of the bridge was considered at 2% in the 1st and 2nd years, and 1 % in the 3rd year. From the 4th year onwards, it was not considered

The diversion analysis was conducted in the following process, and the result is shown in Table 4-12.

a) Demarcate alternative route between the zone
b) Calculate Vehicle Operating Cost (VOC) in accordance with IRC: SP: 30-2009 for each category of the vehicle (car, bus, truck)
c) Calculate Travel Time Cost (TTC) for each category of vehicle
d) Calculate Generalized Cost (GC) which is the sum of VOC +TTC

Table 4-12: Diversion Ratio

Location	Car	Bus Truck	Truck
NH31C	4460%	1038%	3332%
NH31	4759%	3960%	7177%
NH31B	3959%	539%	6639%
NH52	0%	0%	0%

Source: DPR, AECOM, Jan 2018Nov 2016

Considering all the above, the base year traffic on the proposed bridge is estimated as below.

Table 4-13: Base Year Traffic

Vehicle Type / Traffic	2-Wheeler		Auto Rickshaw		Car		Mini-Bus		Bus		Total No. of Vehicle
	No.	PCU	No.	PCU	No.	PCU	No.	PCU	No.	PCU	
Diverted Traffic from Road	218	109	108	108	254	254	12	36	93	279	2,499
Diverted Trafic from Ferry	60	30			17	17			25	75	116
Base Diverted Traffic (2016)	278	139	108	108	271	271	12	36	118	354	2,615
Vehicle Type / Traffic	LCV		2-Axle Truck		3-Axle Truck		MAV				Total PCU
	No.	PCU	No.	PCU	No.	PCU	No.	PCU			
Diverted Traffic from Road	327	491	343	1,029	591	2,660	553	2,489			7,454
Diverted Trafic from Ferry	13	20	1	3							145
Base Diverted Traffic (2016)	340	510	344	1,032	591	2,660	553	2,489			7,598

Source: JICA Study Team based on the DPR, AECOM, Jan 2018

4.4.4 Traffic Projection

For the traffic projection, Socio-economic indicators such as NSDP, per capita income as well as the number of registered vehicles were considered.

Table 4-14: Economic Indicators for Assam

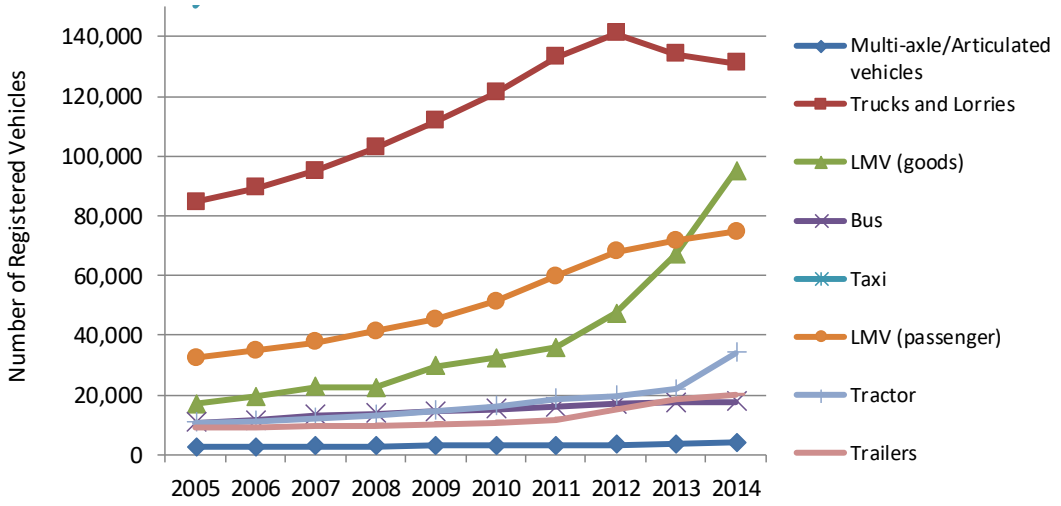
Year	Net State Domestic Product (Constant Price, Crore INR)	Population	Per Capita Income (INR)
2005	47,181	28,114,000	16,782
2006	48,602	28,506,000	17,050
2007	50,797	28,896,000	17,579
2008	52,968	29,282,000	18,089
2009	56,123	29,660,000	18,922
2010	61,294	30,037,000	20,406
2011	65,726	30,413,000	21,611
2012	69,035	30,791,000	22,421
2013	73,081	31,167,000	23,448
2014	77,376	31,540,000	24,533
CAGR (%)	5.7	1.3	4.3

Source: Basic Statistics of North-Eastern Region 2015, Government of India, North-Eastern Council Secretariat

Table 4-15: Number of Registered Vehicles in Assam

Year	Multi-axle/Articulated vehicles	Trucks and Lorries	LMV (goods)	Bus	Taxi	LMV (passenger)	Tractor	Trailers	Total
2005	2,506	84,612	16,852	10,776	150,523	32,386	10,823	8,953	317,431
2006	2,597	89,204	19,371	11,378	172,780	34,906	11,270	9,050	330,236
2007	2,698	95,092	22,587	13,091	194,828	37,691	12,231	9,386	365,987
2008	2,770	102,795	22,451	13,732	215,817	41,267	13,170	9,830	398,832
2009	2,890	111,595	29,703	14,460	240,811	45,266	14,586	10,307	444,725
2010	3,016	121,116	32,473	15,084	277,376	51,185	16,177	10,805	500,250
2011	3,118	132,972	35,788	15,984	318,627	59,742	18,714	11,620	566,231
2012	3,266	140,917	47,296	17,035	366,884	67,921	19,655	15,290	643,319
2013	3,493	134,173	67,176	17,306	445,177	71,633	21,955	18,309	738,958
2014	3,896	131,068	95,116	17,765	543,016	74,520	34,098	19,928	865,381
CAGR (%)	5.03	4.98	21.20	5.71	15.32	9.70	13.60	9.30	13.08

Source: DPR, AECOM, Jan 2018



Source: The JICA Study Team

Figure 4-7: Trend of Number of Registered Vehicles

The elasticity from past trends was calculated in accordance with the IRC: 108-1996. The perspective growth rate of socioeconomic indicators, expected elasticity for transport demand, as well as growth rate from the DPR, which are shown below, were used for traffic projections.

Table 4-16: Growth Rate of Socio Economic Indicator

Indicators	2016-20	2021-25	2026-30	2030-2046
Net State Domestic Product	5.2	4.70	4.40	4.00
Per Capita Income	3.9	3.50	3.30	3.10
Population	1.3	1.20	1.10	0.90

Source: DPR, AECOM, Jan 2018

Table 4-17: Expected Elasticity for Transport Demand

Vehicle type	2016-20	2021-25	2026-30	2030-2046
Multi-axle/Articulated vehicles	0.9	0.81	0.73	0.66
Trucks and Lorries	1.12	1.01	0.91	0.82
LMV (goods)	1.5	1.35	1.22	1.09
Bus	4.41	3.97	3.57	3.21
Taxi	2.5	2.25	2.03	1.82
LMV (passenger)	2.56	2.30	2.07	1.87
Tractor	1.7	1.53	1.38	1.24
Trailers	1.74	1.57	1.41	1.27

Source: DPR, AECOM, Jan 2018

Table 4-18: Expected Traffic Growth rate in the DPR (most likely case)

Vehicle Type	2016–20	2021–25	2026–30	2030–46
2 Wheeler	8.6%	7.1%	5.9%	4.8%
Auto Rickshaw	3.3%	2.8%	2.3%	1.7%
Car	9.8%	7.8%	6.7%	5.6%
Mini–Bus	5.7%	4.8%	3.9%	2.9%
Bus	5.7%	4.8%	3.9%	2.9%
LCV	7.2%	5.9%	5.0%	4.1%
2–Axle Truck	5.9%	4.8%	4.0%	3.3%
3–Axle Truck	5.9%	4.8%	4.0%	3.3%
MAV	4.9%	4.0%	3.4%	2.8%

Source: JICA Study Team based on the DPR, AECOM, Jan 2018

The result of traffic projection in the “most likely case” is presented below. Operation year of the new bridge is set for 2027. From this result (slightly less traffic than the DPR), the proposed bridge is recommended to be four-lane bridge.

Table 4-19: Result of Traffic Projection

in Numbers	2016	2020	2027	2030	2035	2040	2046
2 Wheeler	218	303	479	598	756	956	1,266
Auto Rickshaw	108	123	148	166	181	197	218
Car	254	369	612	781	1,026	1,347	1,868
Mini-Bus	12	15	20	24	28	32	38
Bus	93	116	158	187	215	249	295
LCV	327	432	634	771	943	1,153	1,467
2-Axle Truck	343	431	590	697	820	965	1,172
3-Axle Truck	591	743	1,016	1,201	1,413	1,662	2,020
MAV	553	670	871	1,012	1,162	1,334	1,574
Total	2,499	3,203	4,529	5,438	6,544	7,893	9,918
in PCU	2016	2020	2027	2030	2035	2040	2046
2 Wheeler	109	152	240	299	378	478	633
Auto Rickshaw	108	123	148	166	181	197	218
Car	254	369	612	781	1,026	1,347	1,868
Mini-Bus	36	45	61	72	83	96	114
Bus	279	348	475	560	646	746	885
LCV	491	648	951	1,157	1,415	1,729	2,201
2-Axle Truck	1,029	1,294	1,770	2,092	2,460	2,894	3,516
3-Axle Truck	2,660	3,345	4,574	5,406	6,359	7,480	9,088
MAV	2,489	3,013	3,920	4,553	5,228	6,002	7,083
Total	7,454	9,337	12,750	15,087	17,775	20,968	25,606

Source: JICA Study Team

The design capacity of 2-lane and 4-lane roads in Level of Service -B is shown below.

Table 4-20: Design Service Volume for Highways in PCU/Day

No. of Lanes	Terrain	Capacity
2-lane with paved shoulders	Plain	18,000
	Rolling	13,000
4-lane with paved shoulders	Plain	40,000
	Rolling	40,000

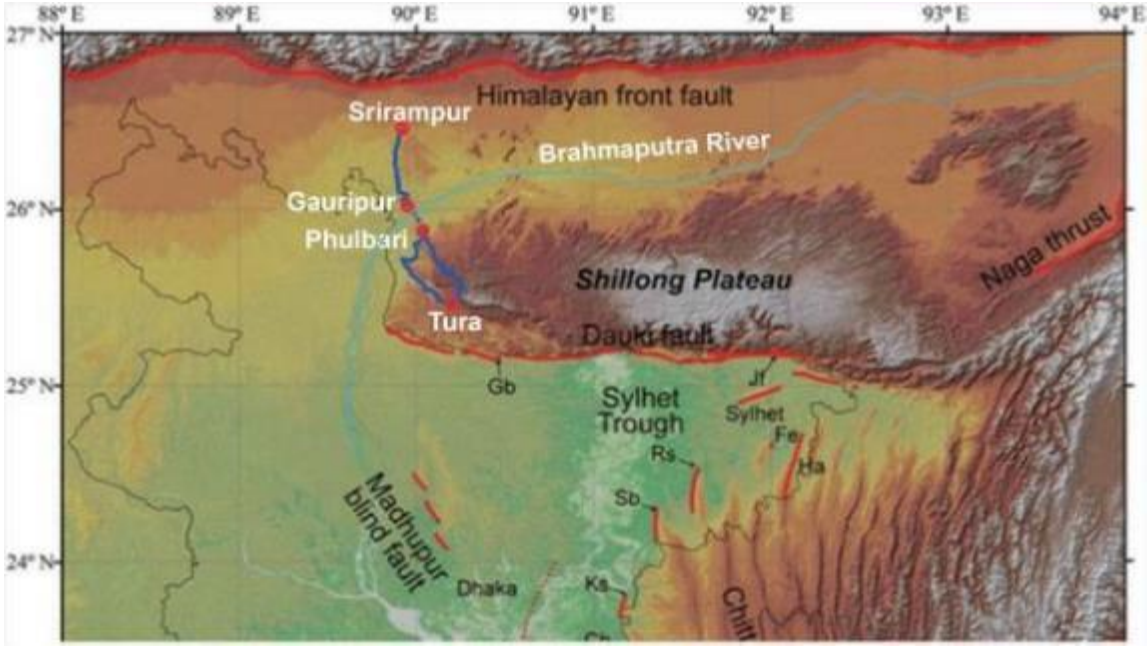
Source: IRC SP73-2015, SP84-2014

CHAPTER 5 PRELIMINARY DESIGN OF DHUBRI BRIDGE

5.1 Natural Condition Surveys

5.1.1 Geomorphology

In North-Eastern India, the Brahmaputra flows from east to west between the Himalayan Range and Shillong Plateau. The Brahmaputra changes course southward around the west end of the Shillong Plateau. The proposed route is where the Brahmaputra changes course southward, and passes through from Srirampur on the right bank of the Brahmaputra to Tura in the left bank.



Source: Mohammad Atikul Islam (2014)

Figure 5-1: Topographic Map of North-Eastern India

Along the proposed route, the right bank (north side) of the Brahmaputra is low land plains, and the left bank (south side) of the Brahmaputra is hilly or low mountain ranges. Although there are vast low plains area on the north bank, there is a low flat hill where relative elevation of about 15 - 20m.

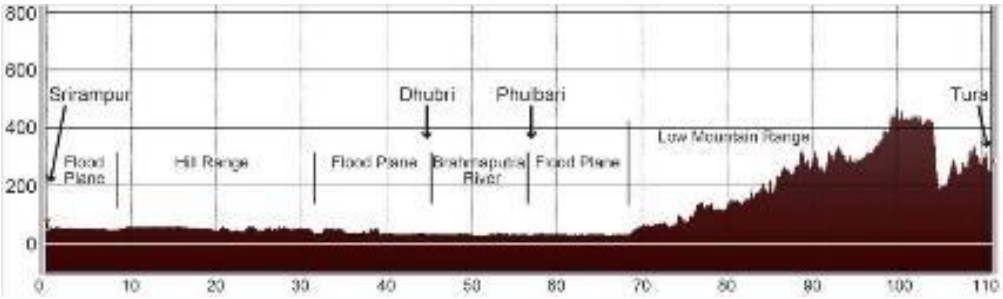
Figure 5-2 shows a relief map of the proposed route. Dark brown color is low level land. The lighter the color is, the higher the ground elevation becomes. White color area at the southern part of this image is about 1300m elevation. The darkest part is the river channels of Brahmaputra. The ground level of Brahmaputra river channel at the proposed road crossing is about 25m.

Figure 5-3 shows the cross section along the strait line from Srirampur to Tura. Low lands extend from the Brahmaputra to Srirampur, and relatively high hill ranges can be seen in the low lands. Between the Brahmaputra and Tura, the land is low plains for 10km from the Brahmaputra, and elevation of the ground gradually becomes higher and hills extend farther away from the low plains area.

Figure 5-4 is a photograph of the Brahmaputra taken from the air (September 20, 2016), and the alignment of the Dhubri Bridge is represented on it.

Source: JICA Study Team

Figure 5-2: Relief Map around the Proposed Route



Source: JICA Study Team

Figure 5-3: Topographical Cross Section between Srirampur and Tura

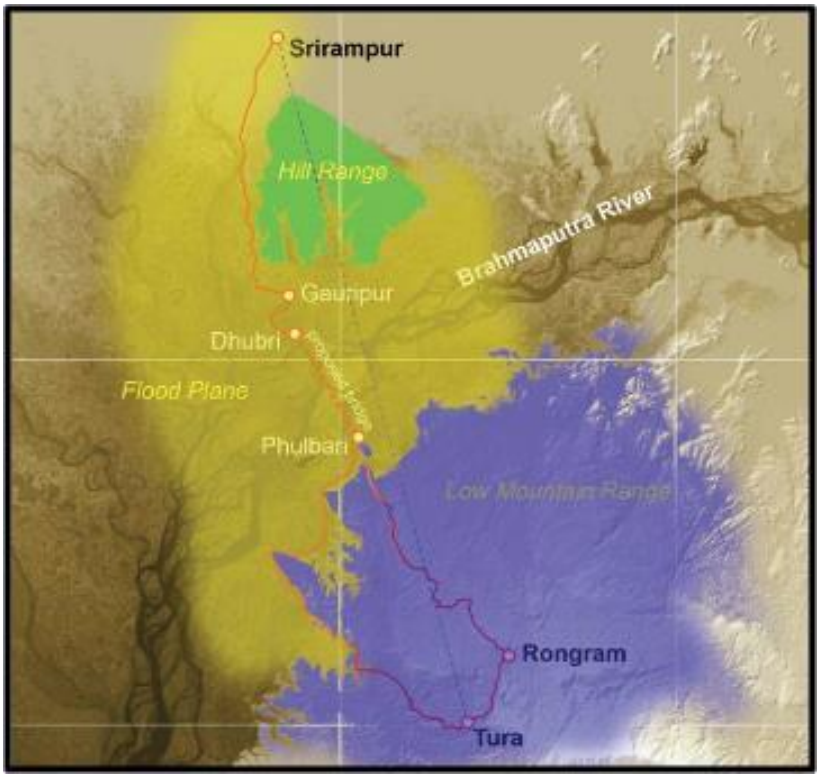
Source: JICA Study Team

Figure 5-4: Aerial Photo of the Location of Proposed Dhubri Bridge

5.1.2 Geology

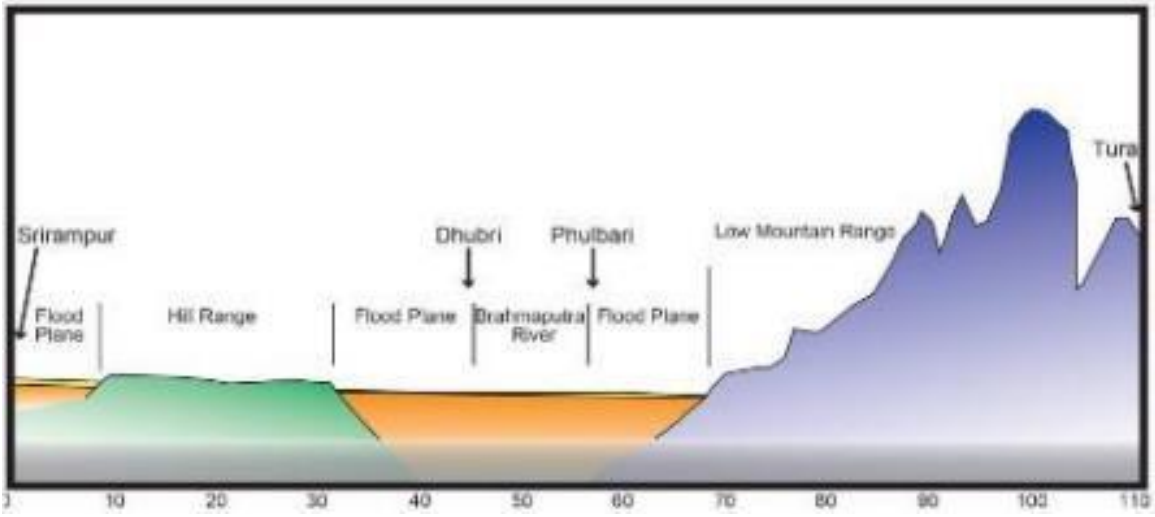
(1) Geology around the Project Site

The landform around the Brahmaputra reflects geological classification. In Figure5-2, the area of the flood plain in dark brown color reflects Quaternary, the area of hill ranges in light brown color in the north reflects Tertiary (Miocene), and the area of low mountain ranges in light brown to white in the south reflects Gneiss respectively. Figure 5-5 is a geological map along the proposal route.



Yellow Quaternary, Green: Tertiary, Blue: Gneiss (partially; Cretaceous-Tertiary Sediments)
Source: JICA Study Team

Figure 5-5: Geological Map



Source: JICA Study Team

Figure 5-6: Geological Cross Section between Srirampur and Tura

Quaternary is sediments from the Brahmaputra or its tributaries. According to the boring data along the proposed Dhubri Bridge, sediments of Quaternary consists almost entirely of sand. Quaternary can be classified into Alluvium and Diluvium. Alluvium (which covers Diluvium) consists of loose sand and some clay. The thickness of Alluvium is about 10m at the channel of the Brahmaputra, and may be the same in the tributaries area. Diluvium is homogeneous and consists of compacted sand.

Tertiary forms the low hill range between Srirampur and the Brahmaputra. Details of the Tertiary around this area are not clear, though generally, Tertiary consists of soft rocks.

Gneiss in this area is a part of Pre-Cambrian formation. Generally, fresh Gneiss is very hard, however, Gneiss near the ground surface could be soft from weathering. Gneiss may be covered with Cretaceous – Tertiary Sediments partially. The Cretaceous – Tertiary Sediments (although not specifically known for this area) may be relatively soft compared with Gneiss.

(2) Geology of the Proposed Dhubri Bridge

Soil investigation from boring has been executed along the proposed Dhubri Bridge, between Dhubri and Phulbari. Only Quaternary sediments were confirmed by the boring survey, with maximum depth of about 80m. It is hard to distinguish between Alluvium and Diluvium from the boring results. Assuming N-value 15 is the division between Alluvium and Diluvium, the depth of Alluvium is about 10m from the ground surface. Diluvium (below alluvium) may be over 50m thick. The Alluvium consists of fine sand according to observation visits to islands in the Brahmaputra; and pebble, boulder or clay were not observed. Diluvium consists of only sand, as pebble and boulders are not present, according to the boring survey.

6m high low bluff of a sandbank made of fine sand, brown color upper layer may be organic sand
Source: JICA Study Team

Grey color loose fine sand in a Sandbank

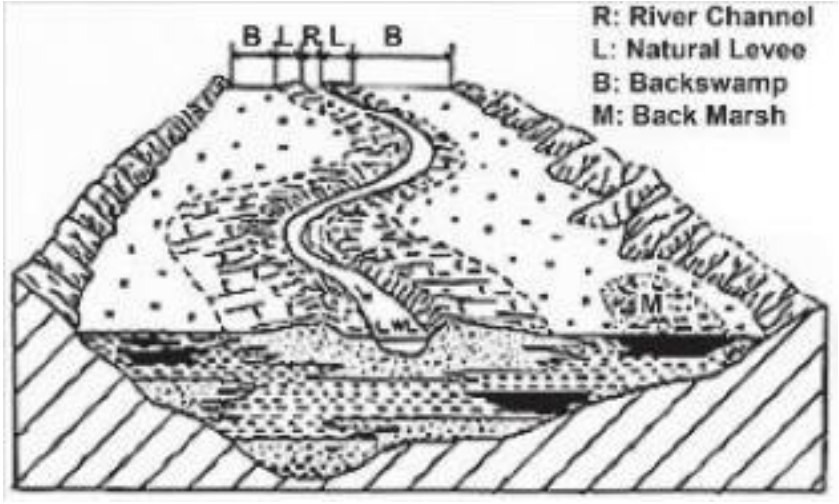
Figure 5-7: Alluvium in Sandbanks

(3) Access Road on the Right Bank of the Brahmaputra (Dhubri - Srirampur)

Between Dhubri – Srirampur on the right bank of the Brahmaputra, flood plains extend along the proposed route. Traces of former river channels and oxbows can be seen on the food plain as shown in Figure 1.8. Clayey soil may cover parts of this former river channel and the oxbows. There are natural levees consisting of sand between the traces of the former river channels or the oxbows. Settlements are formed on the natural levees because their ground elevation is higher than the former river channels or oxbows, and the natural levees are well drained.

Source: Google Earth (26˚11′37″N, 89˚51′36″E)

Figure 5-8: Oxbows and Old Channels in the Right Bank of Brahmaputra River



Source: Geospatial Information Authority of Japan (web)

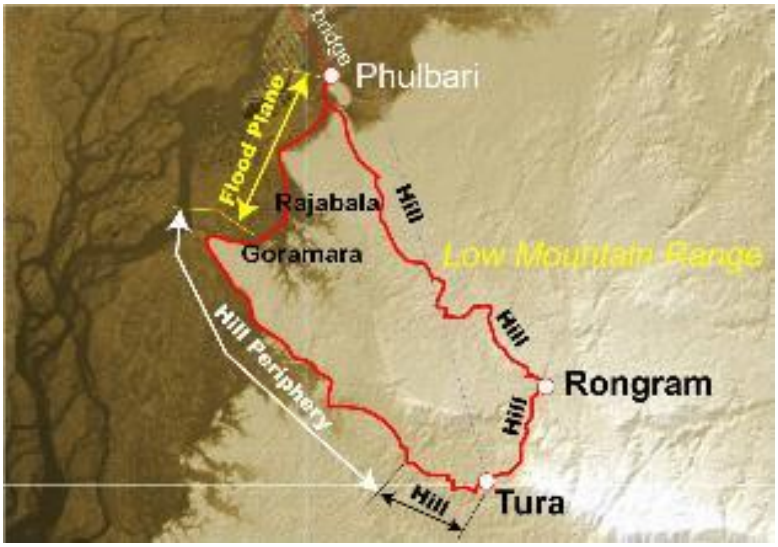
Figure 5-9: Diagram of Flood Plain and Natural Bank

Source: JICA Study Team

Figure 5-10: Flood Plain on Right Bank of Brahmaputra River (near Gauripur)

(4) Access Road on the Left Bank of the Brahmaputra (Phulbari - Tura)

The geographical features of the left bank (south side) of the Brahmaputra can be classified into two kinds, namely flood plain and hill range. The proposed east route goes along the hill range or low mountain range, and the proposed west route goes along three types of ground.
Along the west route, the section from Phulbari to Goramara passes through flood plain, then from Goramara to Damalgre passes through the zone surrounding by hill, and from Damalgre to Tura passes through the hill range.



Source: JICA Study Team

Figure 5-11: Classification of Landforms between Phulbari and Tura

a. Flood Plain

The north half of the section between Phulbari and Goramara is flood plain formed from the Brahmaputra, and is the same ground type as the proposed Dhubri Bridge, where investigation boring works were done. The south half of the section is also flood plain consisting of sediments transferred from the southern hills. The sediments may consist of loose sand and soft clay, however, its thickness is thinner than that of the north half.

Source: JICA Study Team

Figure 5-12: Flood Plane on Left Bank of Brahmaputra River (Near Rajabala)

b. Hill Range

Gneiss forms the hill range. Nonweathered gneiss is very hard rock, however, the gneiss near the ground surface in these gentle hills may be strongly weathered. Generally, fresh gneiss is light grey in color, and weathered gneiss is reddish brown soft rock. According to the papers, there is Cretaceous – Tertiary Sediments in the low mountain range (the hill range). Cretaceous – Tertiary Sediments are hard rocks when fresh. However, it has been exposed to weathering, and are mostly reddish brown color soft rocks.

Source: Google Earth (25˚36´41˝N, 90˚01´18˝E)

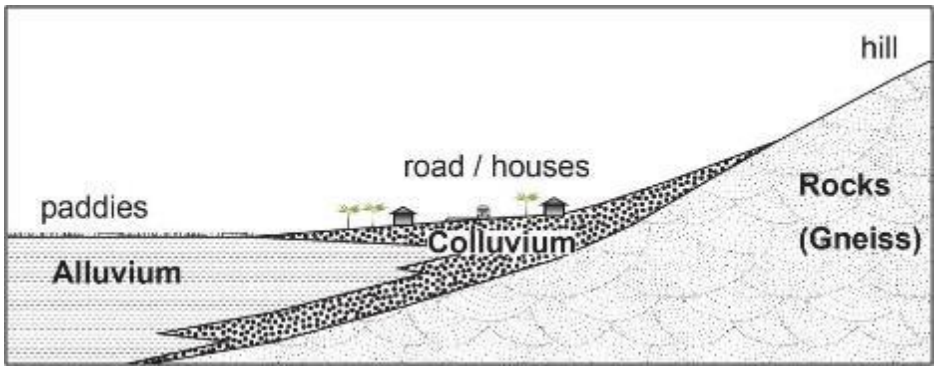
Figure 5-13: Aerial photo of Quarry in the Hill

c. Zone Surrounding Hill

The debris that flow from the hill range is deposited in the zone surrounding the hill. The debris is similar to an alluvial fan deposit. Generally, the composition of alluvial fans are mixtures of sand gravel and some clay, and has wide particle size distribution. Houses and roads were constructed in this area because the ground level is higher than flood plain, and ground which does not contain soft clay drains well.

Right side area which is full of bumps are hills made up of Gneiss, left side area which is dark color is the flood plain, colluvium is in between.
Source: Google Earth (25˚41´49˝N, 89˚55´18˝E)

Figure 5-14: Boundary Area between Hill and Flood Plain



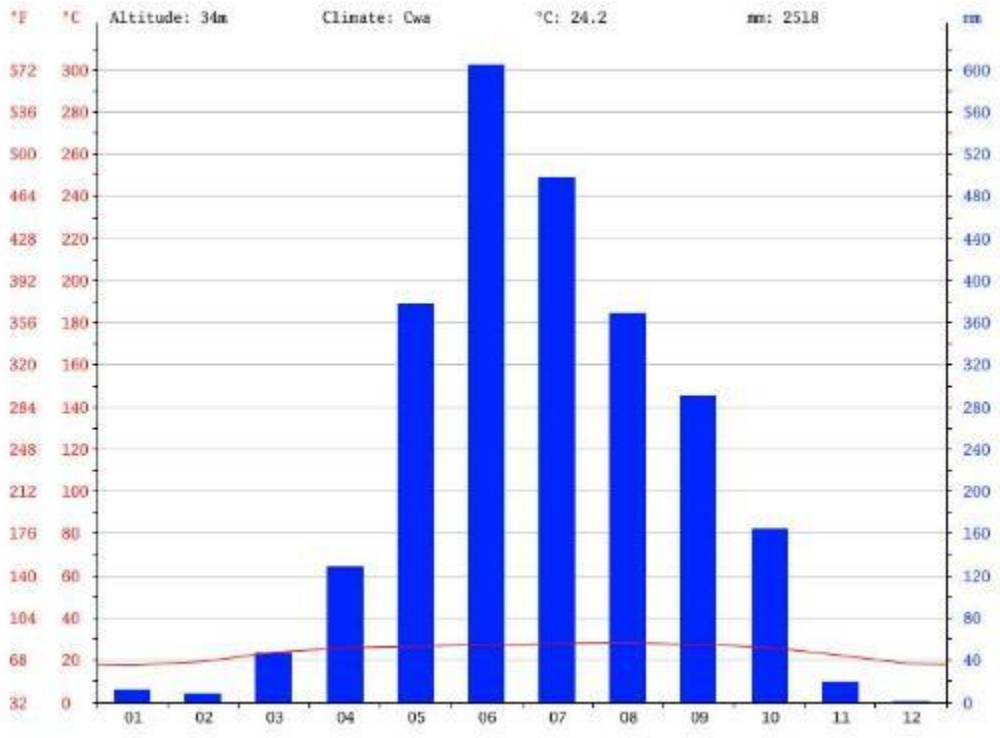
Source: JICA Study Team

Figure 5-15F: Diagram of Cross Section at Periphery of Hill

5.1.3 Rainfall and Climate in Dhubri

The climatic condition of the Dhubri District is unique compared to other districts of Assam. The period from May to October is considered as the flood season in this district (State Disaster Management authority, Assam: SDMASSAM, 2010). The climate is warm and temperate in Dhubri. The summers here have a good deal of rainfall, while the winters have very little. This climate is considered to be "Cwa" according to the Köppen-Geiger climate classification.

The average annual temperature is 24.2°C, ranging between low of 10.5°C (in December/January) and high of 30°C (in July/August). Annual precipitation here averages 2,518mm. The driest month is December, with 1mm of rainfall. Most of the precipitation here falls in June, averaging 604mm.



Source: Climate-Data.org

Figure 5-16: Rainfall and Temperature in Dhubri

5.1.4 Topographical Survey

(1) Reconnaissance

Reconnaissance of the entire proposed alignment was carried out in detail to establish the locations of horizontal and vertical control points. The reconnaissance team considered the basic layout of the land, habitations and vegetation density.

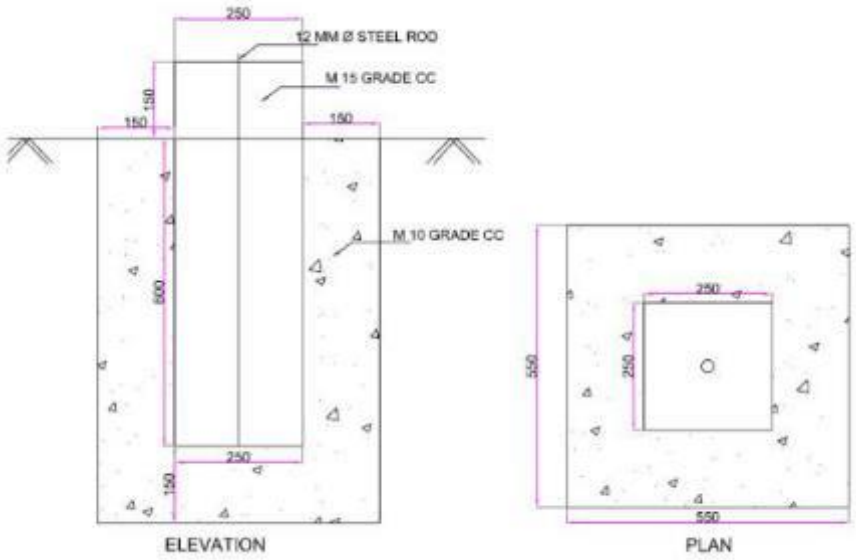
(2) Establishment of Horizontal Control Points & Planimetric Control Survey

The primary horizontal control points were established through "post processing" method, within a tolerance of 100mm, by using dual frequency GPS on a pair of permanent ground markers (PGMs) at 5km intervals. The coordinate system used is UTM-WGS84 and the coordinates of the Permanent Ground Markers are presented below in Table 5.1. The construction detail of the PGMs along with specifications is also presented below in Figure 5-17.

Table 5-1: Details of Permanent Ground Markers

Ref ID	Zone	Easting	Northing	Elevation	Latitude	Longitude	Zone	Easting	Northing	Remarks
GPS1A	45	794101.35	2882646.6	29.33	26.033	89.939				
GPS1A1	45	793927.95	2882723.9	29.51	26.034	89.937				
GPS-1	45	794104.01	2881504.8	30.865	26.023	89.939				
GPS-2	45	794281.13	2881472	30.84	26.022	89.94				
GPS-3	45	794785.41	2880292.1	28.82	26.012	89.945				
GPS-4	45	794888.38	2880310	29.14	26.012	89.946				
GPS-5	45	798045.35	2875653.9	28.948	25.969	89.977				
GPS-6	45	798042.58	2875458.1	28.643	25.967	89.976				
GPS-7	45	800078.94	2872655.4	29.248	25.942	89.996				
GPS-8	45	800154.04	2872612.7	29.503	25.941	89.997				
GPS-7A	45	801351.69	2871002.5	28.138	25.926	90.008	46	200341.58	2870963.7	*
GPS-7B	45	801503.47	2870741.4	28.563	25.924	90.01	46	200481.23	2870696	
GPS9	45	803678.48	2867584.9	26.863	25.895	90.031	46	202509.41	2867443.3	
GPS10	45	803765.29	2867662.9	28.293	25.896	90.032	46	202599.7	2867517.3	
GPS11	45	803835.77	2867219.7	27.728	25.892	90.032	46	202649.82	2867071.3	
GPS12	45	803938.95	2867227.8	27.618	25.892	90.033	46	202753.26	2867074.7	

* Since the alignment traverses through two zones viz. 45R & 46R, the co-ordinates of zone 46R are given in two formats.
Source: DPR



Source: DPR

Figure 5-17: Permanent Ground Markers

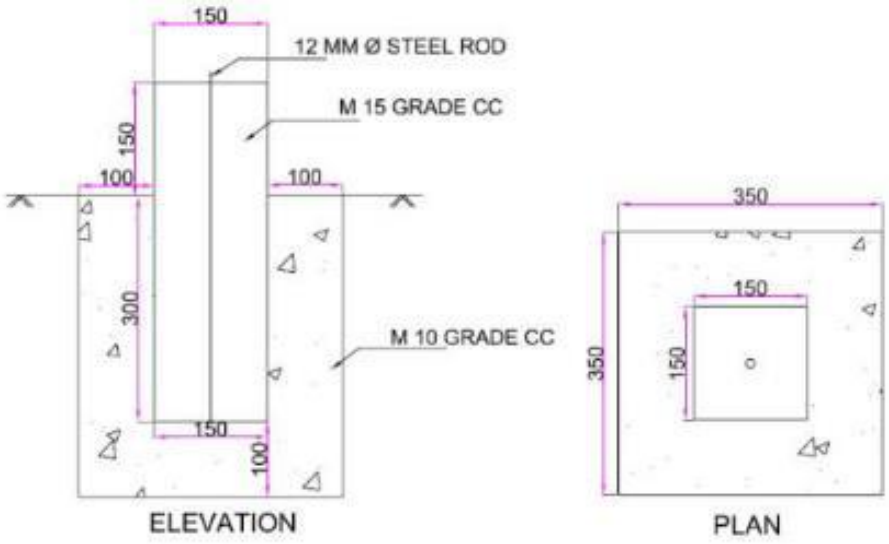
A closed traverse survey was carried out using Total Station, and the intermediate secondary traverse stations (TS) was connected from one PGM to the next PGM. The tolerance limit adopted in the traverse survey is 1:10000, as per clause 8.2.3 of IRC:SP:19-2001. Temporary Benchmarks (TBMs) were established at traverse points @250m intervals. In cases where TBMs overlapped with PGMs, only PGMs were provided. The coordinates of the Temporary Bench Marks are presented in the Table below. The construction detail of the TBMs along with specifications is also presented below in Figure 5-18.

Table 5-2: Details of Temporary Benchmarks

Ref ID	Zone	Easting	Northing	Elevation	Latitude	Longitude	Zone	Easting	Northing	Remarks
P-1	45	794053.374	2882669.053	29. 560	26.033	89.938				
P-2	45	794090.924	2882419.637	28.245	26.031	89.939				
P-3	45	794122.150	2882169.653	28.040	26.029	89.939				
P-5	45	794107.780	2881667.128	27.527	26.024	89.939				
P-6	45	794157.563	2881340.025	29.100	26.021	89.939				
P-7	45	794254.599	2881200.459	27.950	26.020	89.940				
P-8	45	794399.873	2880993.439	28.400	26.018	89.941				
P-9	45	794523.142	2880747.840	28.500	26.016	89.943				
P-10	45	794698.716	2880594.763	28.000	26.014	89.944				
P-11	45	794846.671	2880394.008	28.935	26.012	89.946				
P-12	45	795153.716	2880002.357	27.125	26.009	89.949				
P-13	45	795290.779	2879791.792	26.215	26.007	89.950				
P-14	45	795423.859	2879581.750	26.355	26.005	89.951				
P-15	45	795562.445	2879372.848	26.905	26.003	89.953				
P-16	45	795755.595	2879200.337	29.390	26.002	89.954				
P-17	45	795845.535	2878962.465	29.500	25.999	89.955				
P-18	45	795992.907	2878756.696	27.715	25.998	89.957				
P-19	45	796145.244	2878560.686	27.910	25.996	89.958				
P-20	45	796298.293	2878363.407	28.490	25.994	89.960				
P-21	45	796452.686	2878167.457	27.820	25.992	89.961				
P-22	45	796607.288	2877970.163	26.875	25.990	89.963				
P-23	45	797556.950	2876504.057	29.148	25.977	89.972				
P-24	45	797686.058	2876288.211	28.733	25.975	89.973				
P-25	45	797807.690	2876076.271	28.548	25.973	89.974				
P-26	45	797934.157	2875859.175	27.773	25.971	89.975				
P-27	45	798202.583	2875438.143	27.963	25.967	89.978				
P-28	45	798339.985	2875227.457	27.763	25.965	89.979				
P-29	45	798539.684	2875014.534	28.393	25.963	89.981				
P-30	45	798618.515	2874812.682	28.918	25.961	89.982				
P-31	45	798767.658	2874613.456	27.883	25.960	89.983				
P-32	45	798899.463	2874401.252	28.058	25.958	89.985				
P-33	45	799031.964	2874165.652	28.803	25.955	89.986				
P-34	45	799177.313	2873980.705	28.748	25.954	89.987				
P-35	45	799317.835	2873787.237	28.498	25.952	89.989				
P-36	45	799418.982	2873573.139	28.663	25.950	89.990				
P-37	45	799503.387	2873296.967	29.563	25.948	89.991				
P-38	45	799742.369	2873173.290	28.443	25.946	89.993				
P-39	45	799871.686	2872947.069	28.858	25.944	89.994				
P-40	45	800047.551	2872762.735	29.008	25.943	89.996				
P-42	45	800341.799	2872357.664	24.173	25.939	89.999				
P45	45	801649.460	2870528.890	28.103	25.922	90.011	46	200617.334	2870476.957	*
P46	45	801774.930	2870315.312	28.223	25.920	90.013	46	200732.889	2870257.861	
P47	45	801907.087	2870108.552	27.968	25.918	90.014	46	200855.438	2870045.270	
P48	45	802031.046	2869870.523	28.058	25.916	90.015	46	200968.365	2869801.820	
P49	45	802135.995	2869672.624	28.903	25.914	90.016	46	201064.141	2869599.328	
P50	45	802271.276	2869428.057	27.853	25.912	90.017	46	201188.080	2869348.831	
P51	45	802394.893	2869048.088	27.148	25.909	90.018	46	201294.171	2868963.611	
P52	45	802616.799	2868812.196	27.623	25.906	90.021	46	201505.041	2868717.816	
P53	45	802812.758	2868521.148	27.428	25.904	90.022	46	201687.468	2868418.114	
P54	45	803024.362	2868288.705	29.173	25.902	90.025	46	201888.205	2868176.239	
P55	45	803154.016	2868074.068	28.413	25.900	90.026	46	202007.897	2867955.902	
P56	45	803401.465	2867957.746	28.433	25.899	90.028	46	202249.755	2867828.385	
P57	45	803592.187	2867750.317	28.133	25.897	90.030	46	202430.778	2867612.455	

*Since the alignment traverses through two zones viz. 45R & 46R, the coordinates of zone 46R are given in two formats

Source: DPR



Source: DPR

Figure 5-18: Temporary Benchmarks

(3) Establishment of Vertical Control Points

The request for the value of GTS Benchmarks has been submitted to Survey of India, and the data is still pending. In absence of the data, the vertical control points were established from the benchmark at the Central Water Commission, Dhubri, (Easting – 799245, Northing –2880785) with the R.L. being 30.19m. The location of the CWC benchmark at Dhubri is schematically presented as seen in the Figure below. The vertical control points will be updated to GTS datum upon availability of the GTS Benchmarks. Double Tertiary (DT) levelling was carried out to establish the levels at all PGMs, TBMs and Traverse Stations. The accuracy for levelling adopted was 6K mm, where K =kms of level run. The levels of the PGMs and TBMs are given in Table 5.1 and 5.2 respectively.

Source: DPR

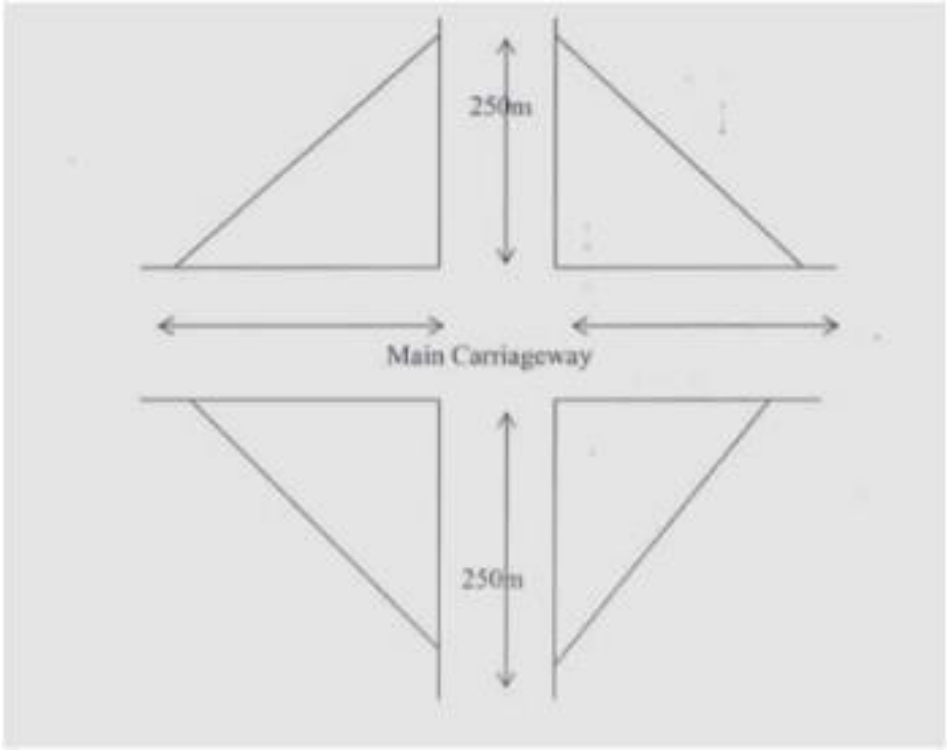
Figure 5-19: CWC Benchmark

(4) Detailed Survey for Proposed Alignment Corridor

Corridor Width:

a. The surveys extended a minimum of 30m beyond either side of the centre line of the proposed carriageway or land boundary, whichever is more.

b. Where existing roads cross the alignment, the survey extended a minimum of 250m on either side as shown in Figure below.



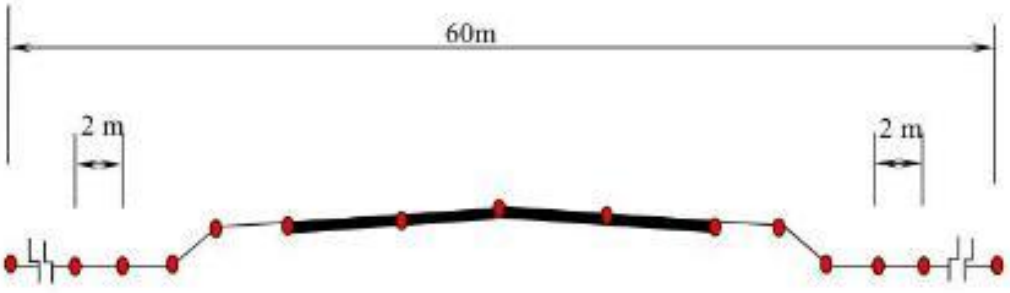
Source: DPR

Figure 5-20: Survey Area for Road Crossing

Detailed Survey for creation of Digital Terrain Model:

a. The detailed survey was done to create a Digital Terrain Model (refer to Annexure) with the Mx Road software. In order to create a digital terrain model for design purposes, survey data was collected as "strings" or points, as appropriate.
b. The topographic surveys for longitudinal and Cross-Sections covered the following:

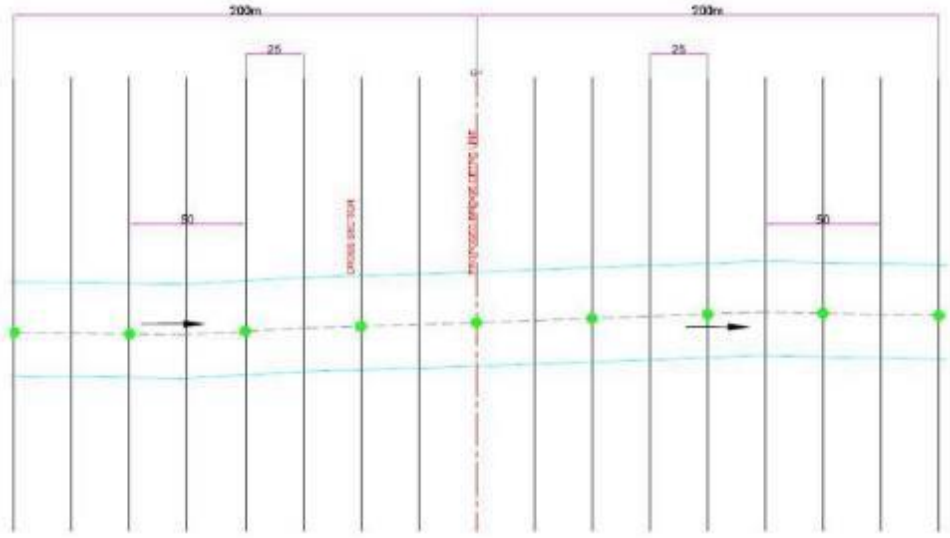
- Longitudinal section along the final centre line @25m intervals on straight sections, and @10m intervals on curves with radius less than 1000m
- Cross Section at every 25m interval for the full corridor width. At new alignment sections, the distance between the cross-section points was 2m. At existing alignment sections, the cross section was recorded as shown in Figure below.



Source: DPR

Figure 5-21: Cross Section Record

Longitudinal and Cross – Sections for major and minor streams crossing the alignment (other than Brahmaputra) – Long Section @50m intervals for a length of 200m from the proposed centerline, on both upstream and downstream side; Cross section @25m intervals for a length of 200m from the proposed centerline, on both upstream and downstream side, as shown in Figure below.



Source: DPR

Figure 5-22: Cross Section Record Perpendicular to Bridge Axis

Detailed Survey for existing features

The features picked up during the survey included, but not limited to the following:

- Trees (position and girth measured 1.5m from ground level). The type of trees (species of trees) was recorded. Where there were groups of trees at very close intervals, the boundary of trees from start to end was recorded. Also, the number of trees and girth size was indicated in the AutoCAD drawing for such tree groups.
- Building fronts or outlines within the survey corridor of 60m (to be classified by construction type). While mapping buildings, the number of stories of the building was indicated (like s-for single, d-for double etc.).
- All over ground utilities such as electricity, high tension lines, telephone, water supply pipelines, bore wells, etc. If underground utilities could not be identified by inspection and manhole covers, they were noted along with their approximate depth from the existing ground level (by enquiry or by visual inspection). The existing clearance from the ground level was noted and presented in drawing for all overhead utilities crossing the alignment.
- Culverts, Bridges and other structures – all abutment / headwall outline and piers
- For all culverts, invert levels on upstream and downstream was recorded
- Land use details were recorded along the study road (such as agricultural land, barren land, villages / towns etc.) and mapped accordingly in the AutoCAD drawings. The limits of the villages / towns, along with their names, was also clearly marked in the drawing.
- All existing road appurtenances like; km post, Hectometre posts, boundary etc.

(5) Cross Section Survey of the River Bed

A detailed Cross Section Survey of the Brahmaputra River was done to generate the Detailed Terrain Model for Hydraulic Model Study. The co-ordinates of the cross sections are presented in the Table below. Figure 5-23 below depicts a representation of the river topography in the study area.

Table 5-3: List of River Cross Section Coordinates

Sl. No.	CS No.	Remarks	Start Coordinate			End Coordinate		
			Zone	Easting	Northing	Zone	Easting	Northing
Brahmaputra River								
	CS-1	5km downstream from Bridge Location	45R	789619	2879569	46R	202485	2864020
	CS-2	4km downstream from Bridge Location	45R	790169	2879730	46R	202876	2865631
	CS-3	3km downstream from Bridge Location	45R	791003	2880084	46R	203884	2866232
	CS-4	2km downstream from Bridge Location	45R	791849	2880743	46R	205082	2866410
	CS-5	1km downstream from Bridge Location	45R	792486	2881659	46R	206243	2866445
6	CS-6	Proposed Bridge Centre line	45R	793853	2882195	46R	204991	2869154
7	CS-7	1km upstream from Bridge Location	46R	207722	2867425	45R	794805	2882324
8	CS-8	2km upstream from Bridge Location	45R	796301	2882081	46R	207252	2869574
9	CS-9	3km upstream from Bridge Location	46R	207142	2870397	45R	797347	2883341
10	CS-10	4km upstream from Bridge Location	45R	797814	2884400	46R	206964	2872108
11	CS-11	5km upstream from Bridge Location	45R	799569	2884593	46R	207035	2873084
12	CS-12	6km upstream from Bridge Location	45R	799811	2886024	46R	208082	2873199
13	CS-13	7km upstream from Bridge Location	46R	208629	2874090	46R	201447	2884993
14	CS-14	8km upstream from Bridge Location	46R	209101	2875000	46R	202067	2886216
15	CS-15	9km upstream from Bridge Location	46R	203418	2885834	46R	209997	2875627
16	CS-16	10km upstream from Bridge Location	46R	211239	2875581	46R	204363	2886249
17	CS-17	11km upstream from Bridge Location	46R	205257	2886659	46R	212150	2876045
18	CS-18	12km upstream from Bridge Location	46R	206336	2886836	46R	212426	2877579
19	CS-19	13km upstream from Bridge Location	46R	212900	2878502	46R	207373	2887282
20	CS-20	14km upstream from Bridge Location	46R	208034	2887964	46R	213772	2879146
21	CS-21	15km upstream from Bridge Location	46R	214501	2879850	46R	207459	2890078
Gadadhar North Bank								
1	CS1_north tr	Cross section on Gadadhar River at confluence	46R	199954	2882545	46R	200199	2882657
2	CS2_north tr	Cross section on Gadadhar River at 250 m upstream of confluence	46R	199865	2882740	46R	200120	2882819
3	CS3_north tr	Cross section on Gadadhar River at 500 m upstream of confluence	46R	199800	2883023	46R	200088	2883032
4	CS4_north tr	Cross section on Gadadhar River at 750 m upstream of confluence	45R	800200	2883299	46R	200084	2883241
5	CS5_north tr	Cross section on Gadadhar River at 1km upstream of confluence	46R	199818	2883572	46R	200158	2883466
Jinjiram South Bank								
1	CS1_south tr	Cross section on Jinjiram River at Confluence	46R	201188	2867325	46R	201212	2866787
2	CS2_south tr	Cross section on Jinjiram River at 250 m upstream of confluence	46R	201451	2867380	46R	201448	2866795
3	CS3_south tr	Cross section on Jinjiram River at 500 m upstream of confluence	46R	201717	2867387	46R	201673	2866806
4	CS4_south tr	Cross section on Jinjiram River at 750 m upstream of confluence	46R	201987	2867364	46R	201901	2866812
5	CS5_south tr	Cross section on Jinjiram River at 1km upstream of confluence	46R	202248	2867389	46R	202147	2866860

Source: DPR

Source: DPR

Figure 5-23: River Topography

5.1.5 Borrow Pits Survey

In identifying borrow pits, it has been checked with relevant authorities of the state government that the usage does not infringe any environmental regulations. It has been check with indoor tests that the materilas qualify all quality requirements for construction materials. Regarding the procurement of sediment, quarry and other construction materials, the status of acquisition of licenses in terms of nature and social environment will be confirmed at the implementation stage.

(1) Earth and Soil

Earth and soil for construction of embankment fill and sub-grade is available in sufficient quantities from the nearby areas of the project site, and certain prominent potential extraction areas that have been identified. This soil is mainly available from cultivated lands.

Table 5-4: Details of Borrow Area Location of Soil

Borrow Area No.	Type of Borrow Area	Location / Name of Place	Approx Distance from the Project Site	Approx Quantity Available (M3)	Royalty	Rate (Rs/m^3)	Contact Details	Remarks
BA-1	Open Area	Motichar	0.900km (R/S)	25000	-	73/m^3	Anoar Ali Mob. No. - 9957196352	
BA-2	Open Area	Chagolchora - 1 (Plashkhandi)	1.200km (R/S)	22500	-	80/m^3	Kasem Ali Mob. No. - 9859188996/ Mosiruddin Ali Mob. No. - 8724043450	
BA-3	Open Area	Motichar	0.700km (R/S)	15000	-	*	Safir Uddin	* Owner did not disclose Rate & Mob. No.
BA-4	Open Area	Adabari-1 (Nabazoti Gao)	1km (R/S)	10000	-	*	Amar Ali	* Owner did not disclose Rate & Mob. No.
BA-5	Open Area	Adabari - 2	1.200km (R/S)	45000	-	77/m^3	Sekh Makbul / Sekh Jalil Mob. No. - 8876217145	
BA-6	Open Area and Agricultural Field	Chagolchora	1.25km (R/S)	30000	-	80/m^3	Nariyel Mob- 8402868485	

Source: DPR

(2) Coarse Aggregate Quarry

Assam and Meghalaya have huge sources of natural construction material which is currently being used by the government/ private organizations for various construction works. Presently, Tokrabandha Hill in Assam is one of the sources for natural stone and the river bed material of Gangadhar / Sankosh are used for construction purposes. Those stone crusher units are not too far from the quarries and supply coarse aggregates of necessary sizes.

Table 5-5: Details of Coarse Aggregate Quarry Location

Identification No	Quarry Name	Location / Name of Place	Distance from the Project Site	Capacity (m^3/ day)	Approx Quantity Available (m^3)	Royalty	Rate (Rs/m^3)	Lease Holder Name / Contact Details	Remarks
Q/01	Tokrabandha Hill Stone (Quarry No-2)	Chirakuta, Tokrabandha, Dhubri.	63km	200	200000	200 /m3	960 /-	Mohendra Kr. Sethia Mubarak Hussian (Manager) Mob. No. - 9613765782	Rates are including transportation charges and all other taxes to proposed bridge site at Dhubri.
Q/02	Tokrabandha Hill Stone (Quarry No-6)	Chirakuta, Tokrabandha, Dhubri.	63km	250	200000		1000 /-	Abdul Latif Mob. No. - 9613290019	
Q/03	Tokrabandha Hill Stone (Quarry No-5)	Chirakuta, Tokrabandha, Dhubri.	63km	200	200000		1050 /-	Paresh Paul Mob- 8399894885	
Q/04	Sonamukhi Hill Stone (Quarry No-4)	Sonamukhi, Dhubri.	63km	100	200000	-	-	-	Owner did not disclose details
Q/05	Moronggiri and Bouldergiri Quary	Meghalaya	12km	30	75000	220/ m^3	800 /-	Tuston M. Sangma Mob- 8731909117	Rates are excluding transportation charges and all other taxes to proposed bridge site at Phulbari
Q/06	Singimari Quary	Meghalaya	25km	100	150000	-	800/- per cft for boulder or 63mm- 700/m^3, 40mm- 1000/m^3 20mm- 1200/m^3 10mm- 1400/m^3 12mm- 1300/m^3 6mm- 1450/m^3 dust- 150/m^3	B Simasto Mob- 8731509197	The rates are excluding transportation charges and royalty charges / other taxes as applicable.
QR/01	Gangadhar River M.M Unit	Baghdokra, Kamandanga, Dhubri,Assam- 783332	55km	1000 on demand (normally 300)	-	220/ m^3	850 /-	Hasanu Zzaman Sheikh 9401348823) and Raju (9435548823	Rates are excluding, transportation charges and all other applicable taxes.
QR/02	Sonkosh River Quary	Kachugaon Division, Rayamana Forest, Kokrajhar, Assam	80 km	100	-	220/ m^3	800/- per cft for boulder or 63mm- 2900/m^3 40mm- 2800/m^3 20mm- 2800/m^3 10mm- 2700/m^3 6mm- 2400/m^3	Mahabul Hussain Mob- 9678863671	Rates are including transportation charges and all other applicable taxes to the proposed bridge site at Dhubri.

Source: DPR

(3) Fine Aggregate

Adequate quantities of sand are readily available in the peripheral area of the project site. The quality of the sand varies from one location to another.

Table 5-6: Details of Sand Quarries

Identification No	Source of Sand / River Name	Location / Name of Place	Approx Distance from the Project Site	Approx Delivery Capacity (m^3/Day)	Royalty	Rate of Sand (Rs per cum)			Stockyard Name / Contact Details	Remarks
						ZONE III	ZONE I	ZONE II		
FA/01	Tipkai	Khoraghat, Flakata, Dhubri.	35km	400	190 / m^3	-	400	480	Chandu Barman Mob.No. - 7896606053	Rates are excluding transportation charges and all other applicable taxes
FA/02	Tipkai	Khoraghat, Flakata, Dhubri.	35km	450	190 / m^3	-	400	480	Agual Shakh Mob.No. - 9678568517	
FA/03	Tipkai	Khoraghat, Flakata, Dhubri.	35km	350	190 / m^3	-	400	480	Saheb Hussan Mob.No. - 7399822728	
FA/04	Tipkai	Khoraghat, Flakata, Dhubri.	35km	500	190 / m^3	-	400	480	Ajay Adhikary Mob.No. - 9854783784	
FA/05	Gangadhar River	Tamarh at, Dhubri.	55km	1000	190 / m^3	375	400	450	Hassan Us Jamman (Raju) Mob.No. - 9435548823	
FA/06	Sonkosh River	Kachugaon Division, Kokrajhar	80km	500	190 / m^3	400	425	500	Mahabul Hussain Mob- 9854899030	
FA/07	Rongai River	Chibinang, Meghalaya	7km	-	-	-	-	-	Forest Department	Sand can be collected free of cost by obtaining permission from Police Station & Forest Office.

Source: DPR Zone classification as per IS – 383

Source: DPR

Figure 5-24: Collecting Samples from the Crush

5.1.6 Boring Investigation

(1) Locations of Investigation

The overall objectives of the exploration were to study and evaluate the stratigraphy of the said project locations, and to obtain Geotechnical parameters of the subsurface formations for foundation design and construction. Soil Investigations have been carried out at each pier and abutment locations.

(2) In-situ Testing

For Geotechnical investigation work, Geo. Machine was installed at specified borehole locations.

Stability of the rig was ensured by making the ground level. Boreholes were dug by auguring, shell boring & rotary mud circulation boring method. Standard Penetration Tests (SPT) was conducted in accordance with the IS: 2131-1981.

Table 5-7: Summary of In-situ Testing

GI Type	Item	Number of Tests
Field tests in Soil	SPT	Every 1.5m intervals for all Boreholes

Source: DPR

(3) Laboratory Testing

Laboratory testing was directed primarily towards the determination of Engineering and Index properties of soil at the site. All the tests were performed as per the contract specification and in accordance with relevant Indian Standards.

Table 5-8: Summary of Laboratory Testing

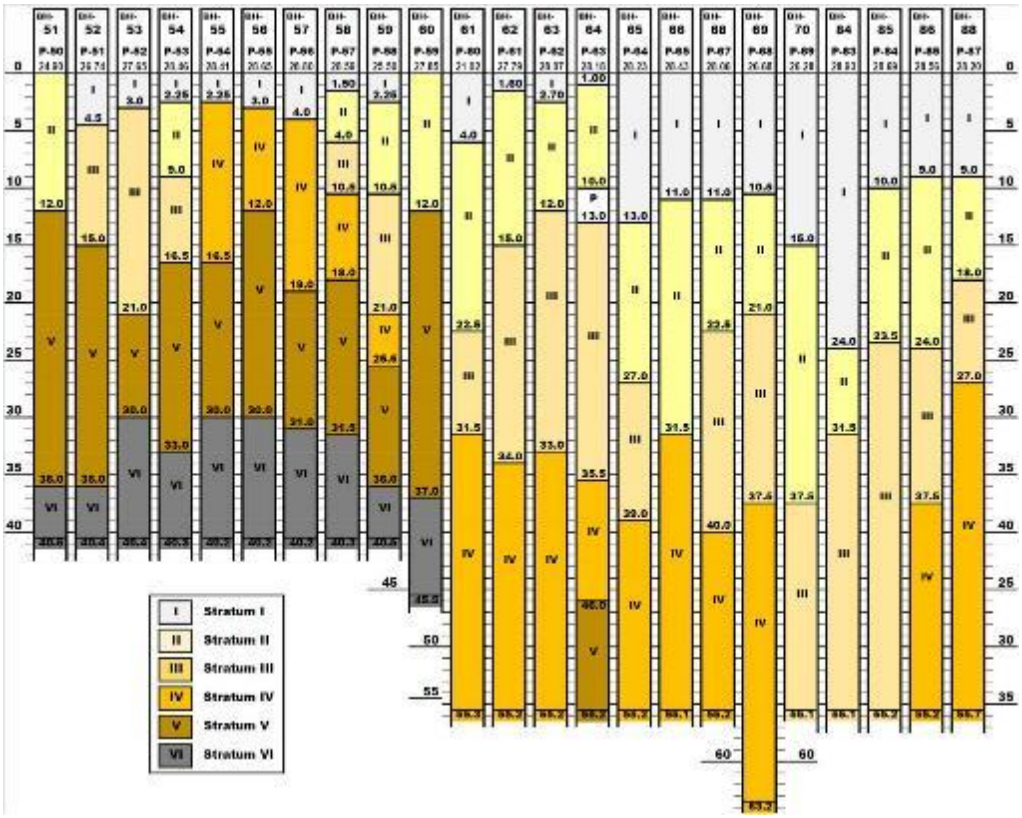
GI Type	Item	Approximate Sampling Location	No. of Tests
Laboratory Testing on Soil	Atterberg Limits	Disturbed samples for the tests are collected at all depths where SPT is carried out	At all places where disturbed samples are collected
	Sieve analysis and Hydrometer analysis		
	Specific Gravity		
	Natural Moisture Content	Undisturbed samples are collected every 3m depths below filled up layer for all Boreholes	UDS samples collected for all Boreholes
	Dry & Bulk Density		
	Triaxial Testing (Unconsolidated Undrained)		
	Direct Shear Box Testing		
	Consolidation Test		

Source: DPR

(4) Testing Conclusion

Bore logs, field and laboratory tests were studied together. Based on standard penetration tests conducted, laboratory tests results, index properties and soil classification, the following stratification of the sub soil deposit (namely Stratum I through Stratum VI) was concluded. With increased depth, the N-value becomes higher in these Stratums varying from 20 to more than 100.

- Stratum I layer is 1-24m thick just below the ground surface and consists of mainly loose sand and some soft silt/clay. This layer is present at almost all boreholes. N values vary from 5 to 30.
- Stratum II is present at almost all boreholes. This layer, which lies below Stratum I from 5 to 22m thick consists of mainly medium dense sand and slightly cohesive soil. N values vary from 6 to 50.
- Stratum III is present at many boreholes. Dense to very dense, light silver, medium to fine grained micaceous silty sand with kankars occasionally observed. N values vary from 20 to more than 100.
- Stratum IV is present at many boreholes. Hard, light grayish, micaceous sandy silt with traces of clay. N values are mostly more than 100.
- Stratum V is present at some boreholes. Dense to very dense, grayish/light silver, fine to medium/ medium to fine grained micaceous silty sand with traces of kankars and gravels occasionally. N values are mostly more than 100.
- Stratum VI is present at some boreholes. Very dense/compacted, greyish/light silver, fine to medium grained silty sand with observed gravels/ kankars & mica. N values are mostly more than 100.



Source: DPR

Figure 5-25: Distribution of Stratum I – VI

5.2 Geotechnical Issues and Measures

5.2.1 Ground Condition along Dhubri Bridge

(1) Foundation Ground at Piers

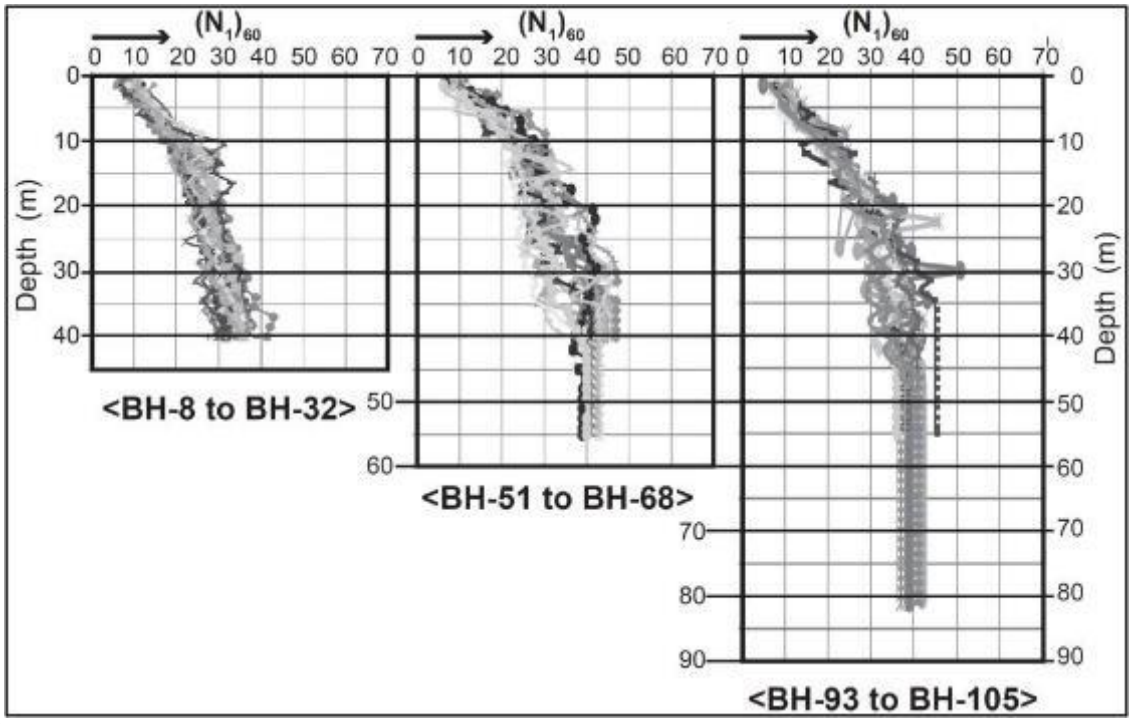
According to the boring tests, the ground along the proposed Dhubri Bridge consists of riverbed sediment (Alluvium) on the surface and Diluvium below. The N-value of Diluvium is small in shallower areas, and become higher with depth. Any sudden changes of N-value are not seen in the boring data. Depth of 30 of the corrected N-value $(N_1)_{60}$ is about 20m in all boring data. Rocks were not found in the boring results.

The possible obstacles to the construction of bridge piers on the flood plain are as follows.

- Soft clay layer: it can cause consolidation settlement often accompanied by negative friction on the foundation piles, and shortage of bearing capacity.
- Loose sand layer: it can cause liquefaction.
- Boulders: existence of boulders in loose soil can make excavation or drilling difficult.

Soft Clay Layer

The ground confirmed by boring along the proposed Dhubri Bridge consists of thin Alluvium and thick Diluvium. $(N_1)_{60}$-value of Diluvium is more than ten (10) in the upper part and more than twenty (20) below 10m in depth. No soft layer was found in the Diluvium. As long as the foundation of the piers is set in the Diluvium, there is no problem with the soft soil layer.
In general, Consolidation settlement occurs in Alluvium clay layer with an N-value of less than 3, but the investigation boring did not detect a N-value below 3. Therefore, there is no layer which can cause consolidation settlement, and negative friction won't occur on foundation piles.



Source: DPR

Figure 5-26: Variation of Field SPT 'N' Values along Different Depth

Liquefaction

In general, liquefaction occurs from strong seismic motion in homogenous fine sand of which N-

value is less than 20 under the groundwater level. N-values of the ground along the bridge exceed 30 deeper than 10m from the surface. As long as the depth of piers is deeper than 10m, the piers will not be affected by liquefaction.

Boulders

Since the river bed gradient and current of the Brahmaputra is very gentle around the proposed Dhubri Bridge, rocks and boulders that flow out from the Himalayas cannot be transported to this area. The riverbed is covered with sand and boulders are not found. Also, hard material or excessively high N-values are not found in the boring data. There would not be obstacles to excavation works.

(2) Foundation Ground at Abutments (AB1, AB2)

The foundations of both abutments may not be a problem as long as the proper pile foundations are proposed. Alluvium (soft soil) on the ground surface can cause some of the following problems on the embankments behind the abutments.

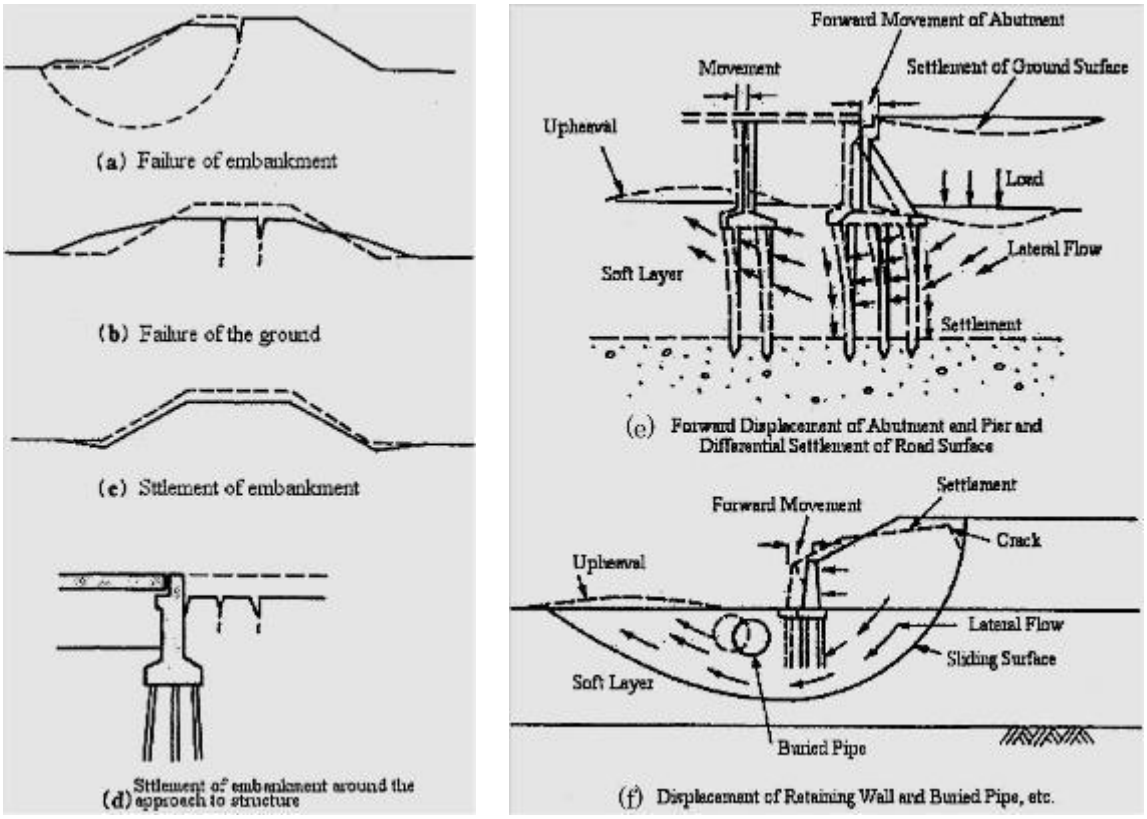
- Consolidation settlement by burden pressure of the embankment
- Slip failure of Embankment
- Liquefaction

To ascertain the above problems, detailed investigations such as boring and cone penetration test at the proposed embankment are required.

5.2.2 Access Road on Right Bank (North Side) of the Brahmaputra

There will not be any cut slope problems in this section, since this road goes through the flat plain. The following soft ground problems may occur during road construction:

- Slip failure of Embankment (Figure 5-27 (a))
- lack of bearing capacity for embankment (Figure 5-27 (b))
- Consolidation settlement by burden pressure of the embankment (Figure 5-27 (c,d))
- Liquefaction
- Damage on Structures by consolidation settlement (Figure 5-27 (e))
- Damage on Structures by slip failure (Figure 5-27 (f))



Source: PWIR Japan (2004), Manual for Highway Earthworks in Japan

Figure 5-27: Examples of Damages to Embankment on Soft Ground

Generally, the problem would be more serious if the soft layer is thick, Alluvium (soft soil) may not be so heavy in this area according to the boring data along the proposed Dhubri Bridge. Therefore, most of the soft soil issues related to structures such as retaining wall could be solved by using piles which reach down to hard ground. If the base ground of embankment is soft, measures against soft soil such as ground improvement works or replacement would be required.

Detailed investigations such as borings and cone penetration tests at the proposed embankment are necessary to confirm the ground condition.

5.2.3 Access Road on Left Bank (South Side) of the Brahmaputra

The ground of the left bank (south side) of the Brahmaputra can be classified into three different kinds namely, flood plain, hill, and zones surrounding the hill. The proposed east route goes along the hill range or low mountain range, the proposed west route goes along all three types of ground.

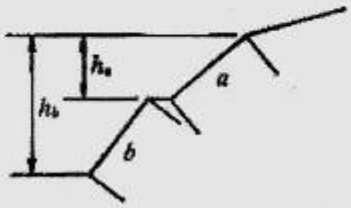
(1) East Route (Phulbari – Rongram – Tura)

The east route goes through a hill range. Since high cut slopes are not expected in this gentle hill range, there will not be serious problems of cut slopes. Also, serious landslides are not expected in this hill range as it consists of hard rocks. However, surface failures on small cut slopes, collapse of road shoulders, and failure of embankment at cut and bank sections could possibly occur. The most effective method to prevent cut slope failure is to keep the gradient of cut slope stable. Basically, a slope that consists of hard rock can be cut with steep gradient, and a slope that consists of soft or weak rocks should be cut with gentle gradient. The figure below shows standard gradients of cut slope.

Soil classification		Cut Slope Height	Gradient
Hard rock			1:0.3 to 1:0.8
Soft rock			1:0.5 to 1:1.2
Sand	Not dense, and poorly graded		1:1.5 to
Sandy soil	Dense	Less than 5m	1:0.8 to 1:1.0
		5 to 10m	1:1.0 to 1:1.2
	Not dense	Less than 5m	1:1.0 to 1:1.2
		5 to 10m	1:1.2 to 1:1.5
Sandy soil mixed with gravel or rock masses	Dense, or well graded	Less than 10m	1:0.8 to 1:1.0
		10 to 15m	1:1.0 to 1:1.2
	Not dense, or poorly grade	Less than 10m	1:1.0 to 1:1.2
		10 to 15m	1:1.2 to 1:1.5
Clayey soil		0 to 15m	1:0.8 to 1:1.2
Clayey soil mixed with rock masses or cobble-stone		Less than 5m	1:1.0 to 1:1.2
		5 to 10m	1:1.2 to 1:1.5

Notes

1) The cut slope height and gradient when a single gradient is not opted for because of the soil composition and other reasons are based on the ideas shown below.



ha : cut slope height for slope surface a

hb : cut slope height for slope surface b

- The gradient does not include a berm.
- The cut slope height vis-à-vis the gradient means the total cut slope height covering the entire cut slopes above the cut slope in question.

2) Silt is to be classified into the Clayey soil.

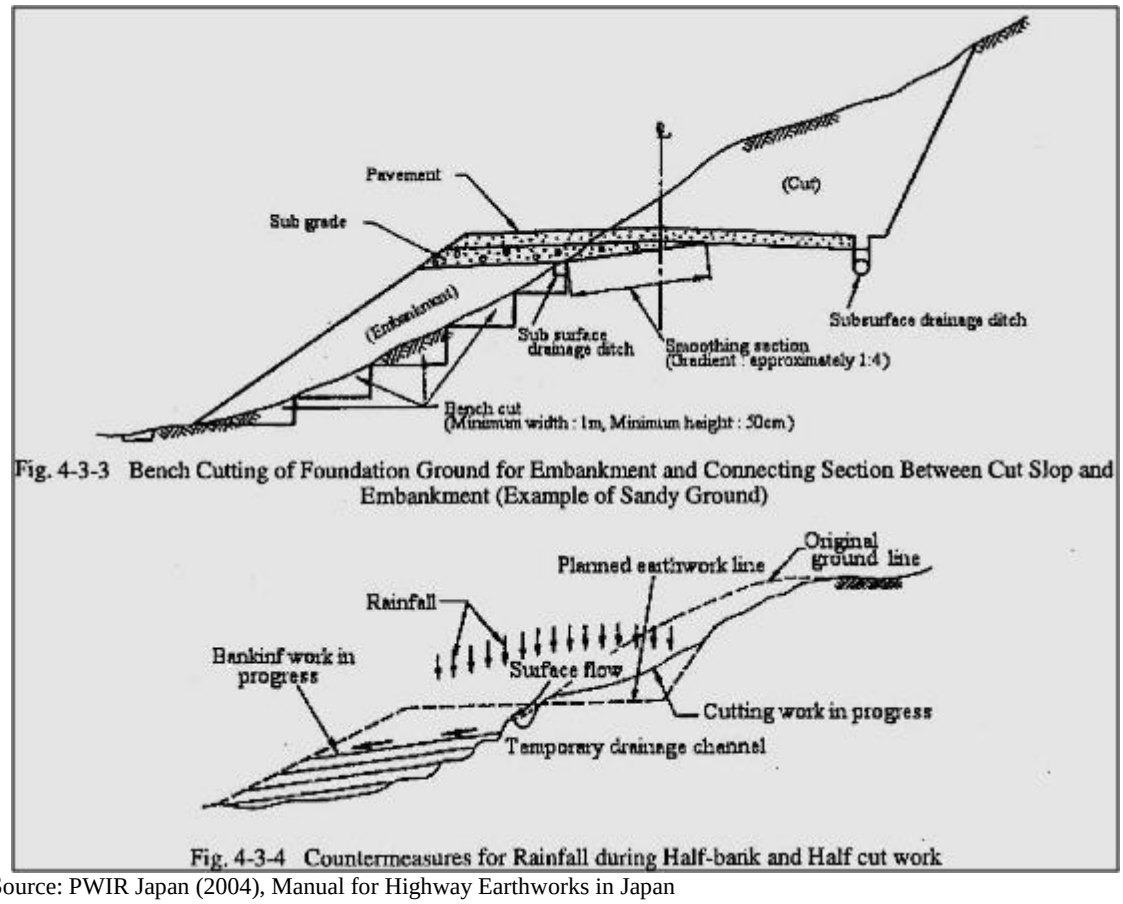
3) The table is not applicable to soils not included in the above table.

4) In planning of planting for slope, it also takes into consideration the slope gradient suitable for planting.

Source: PWIR Japan (2004), Manual for Highway Earthworks in Japan

Figure 5-28: Cut Slope Stable Gradients

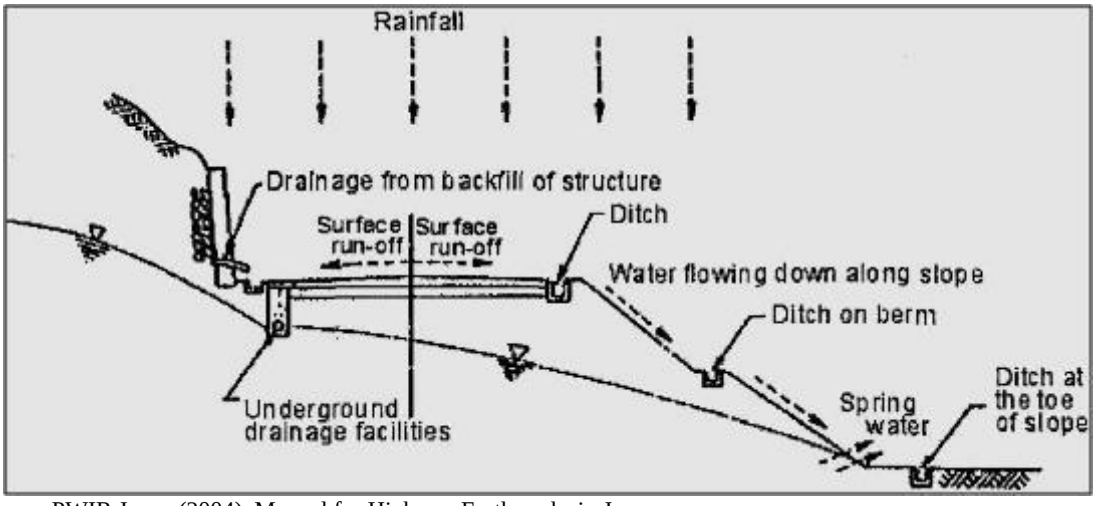
At cut and bank section, measures as shown in the Figure below are required to stabilize the embankment.



Source: PWIR Japan (2004), Manual for Highway Earthworks in Japan

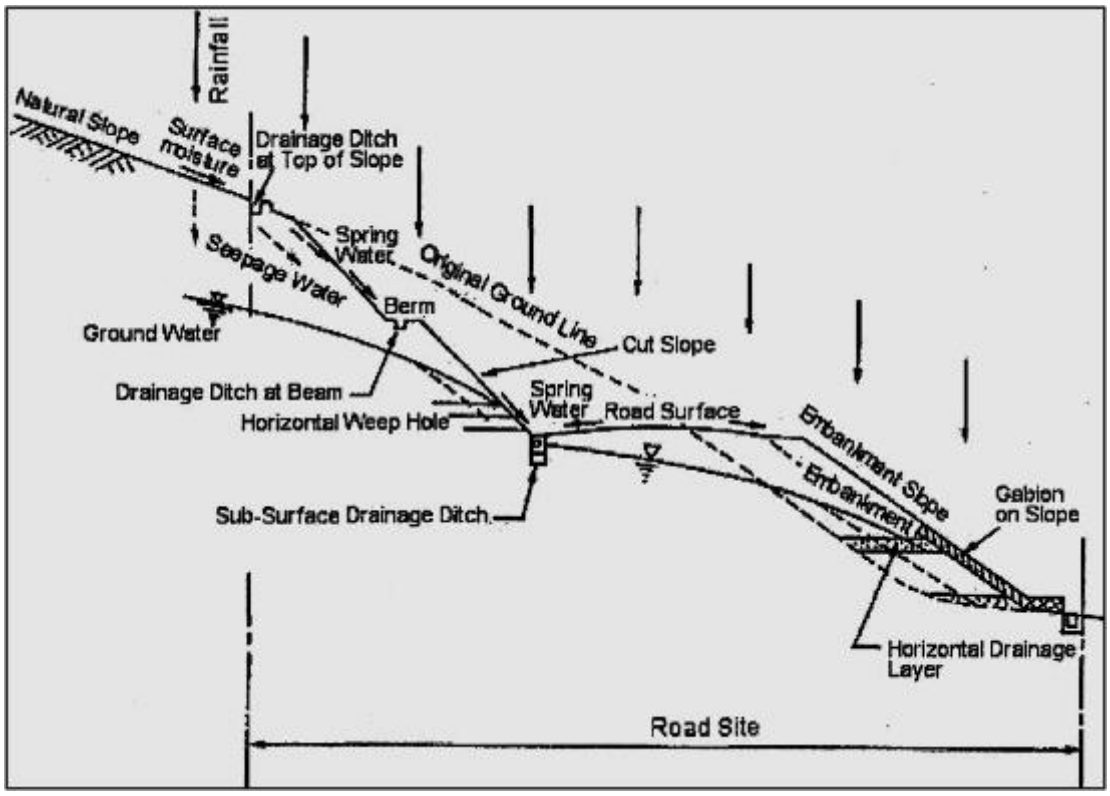
Figure 5-29: Stabilization Works for Embankment on Hilly Area

Heavy rainwater and high groundwater could influence stability cut and embankment slopes in the rainy state of Meghalaya. At cut slopes and embankment slopes, control of the surface water and the groundwater is very important as shown in the Figures below.



Source: PWIR Japan (2004), Manual for Highway Earthworks in Japan

Figure 5-30: Drainage System for Mountainous Road Embankment

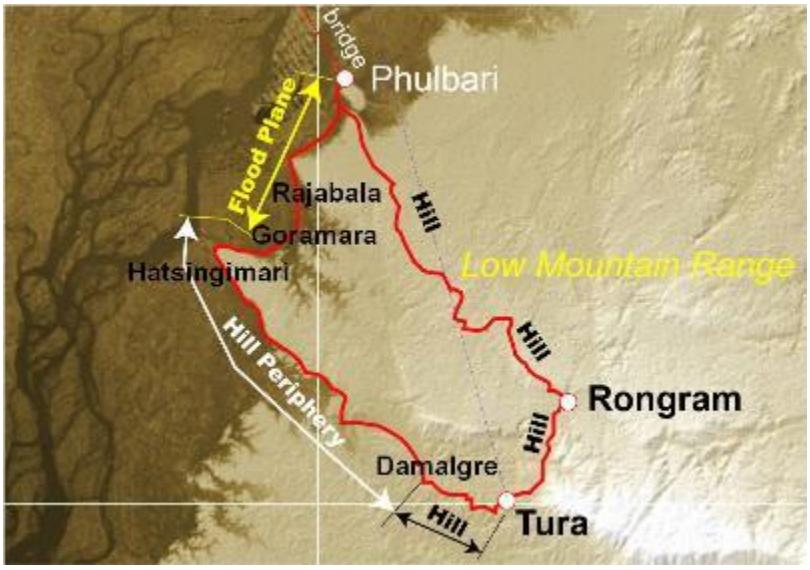


Source: PWIR Japan (2004), Manual for Highway Earthworks in Japan

Figure 5-31: Drainage System for Cut/Embankment Sections of Roads

(2) West Route (Phulbari - Rajabala - Hatsingimari - Garobadha - Tura)

Along the west route, the route from Phulbari to Goramara passes through flood plain, Goramara to Damalgre passes through the zone surrounding by hills, and Damalgre to Tura passes through the hill range.



Source: JICA Study Team

Figure 5-32: Classification of Landforms from Phulbari to Tura

Flood plane

The condition of the flood plain on the left bank of the Brahmaputra is almost same as the flood

plain on the right bank. There would be the same issues as the access road on the right bank of the Brahmaputra, such as embankment and bridge foundations on soft ground.

Hill Range

The condition of the hill range along the west route is same as the east route, such as proper selection of the cut slope gradients.

Zones Surrounding Hills

The zone surrounding the hill forms very gentle slopes and contains no soft clay. As a base for the road, the ground in this area does not have any serious issues. The ground may consist of loose sand gravel, therefore, retaining walls are required in case excavation works are proposed.

Larger drain capacity than estimated volume of water flow should be considered at a dirty and rough stream where debris flow and driftwoods are expected upon site inspection where cross drain or bridge is proposed.

5.3 Road Design

5.3.1 Design Standards

(1) General

This section describes the design standards and principles based on which the various designs shall be carried out. These proposed standards are consistent with the parameters recommended in the relevant standards of the Indian Roads Congress (IRC). The aim of this chapter is to update the Design Standards for the project. The standards are primarily based on IRC: SP: 84-2014[2], along with other IRC publications and MORTH circulations, and relevant recommendations from the International standards. As far as possible, uniformity of design standards shall be maintained throughout the length of the Project Highway. In case of any changes, it shall be incorporated in a gradual manner.

(2) Terrain Classification

The following terrain classification as in the table below recommended by IRC: 73-1980[3] is proposed to be adopted. Short stretches (say less than 1km) of varying terrain shall not be taken into consideration while deciding the terrain classification for a given section of Project Highway.

Table 5-9: Terrain Classification

Terrain Type	Percentage Cross Slope of the Country
Plain	0 – 10
Rolling	>10 – 25
Mountainous	>25 – 60
Steep	>60

Source: IRC: 73-1980

The proposed alignment predominantly follows the plain terrain as per the above classification and hence, the geometric design has been done based on IRC: 73-1980 for plain terrain.

(3) Guiding Principles

For the geometric design of the project road, the following has been taken into consideration:

[2] IRC: SP: 84-2014 Manual of Specifications & Standards for Four Laning of Highways Through Public Private Partnership

[3] IRC: 73-1980 Geometric Design Standards for Rural (nonurban) Highways 1990

- The designed facility shall not become obsolescent before the design year.
- Design shall be consistent and the standards applied for different elements shall be compatible with one another.
- The design shall cover all geometric aspects of road, including signage grade separated structures, etc.
- The design will be done aiming at minimizing vehicle operating cost, including initial construction cost & cost of maintenance.
- The design will take into consideration the environmental, aesthetic, and landscaping aspects of the project road.

(4) Design Speed

Design speed is the basic parameter, which governs the geometric characteristics of the road. The proposed design speed for different terrain categories as per IRC: SP: 84-2014 are as given in the table below as per IRC: SP: 84-2014.

Table 5-10: Design Speed

Terrain	Cross Slope of the Ground	Design Speed (km/h)	
		Ruling	Minimum
Plain and Rolling	Up to 25 percent	100	80
Mountainous and Steep	More than 25 percent	80	65

Source: IRC: SP: 84-2014

Since the proposed alignment is predominantly through plain terrain, the ruling design speed of 100km/hr and the minimum design Speed of 80km/h has been proposed to be adopted. In general, the ruling design speed shall be adopted for the various geometric design features of the road. Minimum design speed shall be adopted only where site conditions are restrictive and adequate land width is not available.

(5) Right of Way (ROW)

The minimum Right of Way (ROW) of 60m shall be available for a 4-lane highway. At junction locations, the ROW width has been increased suitably to accommodate the updated design proposal.

(6) Lane width

The width of a basic traffic lane is taken to be 3.5m.

(7) Median

The project road will have raised median and its width is proposed to be 5.0m inclusive of the 0.5m kerb shyness, which shall have the same pavement composition as the main carriageway. The medians will be edged with 225mm high, non-mountable concrete kerbs.

(8) Shoulders

The shoulder widths on the edge (left side of carriageway) are proposed as shown in the table below as per IRC: SP: 84-2014.

Table 5-11: Width of Shoulders in Plain and Rolling Terrain

Type of Section	Width of Shoulder (m)		
	Paved	Earthen	Total
Open country with isolated built up area	1.5	2.0	3.5
Built up area	2.0	-	2.0
Approaches to grade separated structures	2.0	-	2.0
Approaches to bridges	1.5	2.0	3.5

Source: IRC SP: 84-2014

Where embankment is more than 6m high, kerbs with a channel shall be at the end of paved shoulder to channelize the drainage as an erosion control device in accordance with Section 6 of IRC: SP: 84-2014, and earthen shoulder shall be raised up to the level of the kerb.

(9) Roadway Width

On horizontal curves with radius up to 300m, the width of the pavement and roadway in each carriageway shall be increased (see Table 5-12 below) as per IRC: SP: 84-2014.

Table 5-12: Extra width of Pavement and Roadway in Each Carriageway

Radius of Curve	Extra Width
75 - 100 m	0.9 m
101 - 300 m	0.6 m

Source: IRC: SP: 84-2014

(10) Crossfall

The crossfall on straight sections of road carriageway, paved shoulders and paved portion of medians shall be 2.5 percent for bituminous surface, and 2.0 percent for cement concrete surface.

The crossfall shall be unidirectional for either side of the carriageway sloping towards the shoulder in straight reaches, and towards the lower edge on horizontal curves. The camber on the existing road shall be modified to unidirectional crossfall.

The crossfall for earthen shoulders on straight portions shall be at least 0.5 percent steeper than the slope of the pavement, and minimum of 3.0 percent for paved shoulders. On super elevated sections, the earthen portion of the shoulder on the outer side of the curve would be provided with reverse crossfall of 0.5 percent, so that the earth does not drain on the carriageway and the storm water drains out with minimum travel path.

(11) Geometric Design

Geometric design shall conform to IRC: 73-1980, except as otherwise indicated in IRC: 84-2014. All horizontal curves shall consist of a circular portion flanked by spiral transitions at both ends. Super Elevation shall be limited to 7 percent, if the radius of curve is less than the desirable minimum radius. It shall be limited to 5 percent, if radius is more than desirable minimum.

a) Radii of horizontal curves

The desirable minimum and absolute minimum radii of horizontal curves for various classes of terrain are given in the Table below as per IRC: SP: 84-2014.

Table 5-13: Radii of Horizontal Curves

Type of Terrain	Desirable Minimum Radius	Absolute Minimum Radius
Plain and Rolling	400 m	250 m
Mountainous and Steep	150 m	75 m

Source: IRC: SP: 84-2014

b) Sight distance

The safe stopping sight distance and desirable minimum sight distance for divided carriageway for various design speeds are given in Table below as per IRC: SP: 84-2014.

Table 5-14: Safe Sight Distance

Design Speed (km/h)	Safe Stopping Sight Distance (m)	Desirable Min. Sight Distance (m)
100	180	360
80	130	260
60	90	180
40	45	90

Source: IRC: SP: 84-2014

c) Gradients

The ruling and limiting gradients are given in the Table below as per IRC: SP: 84-2014.

Table 5-15: Gradients

Type of Terrain	Ruling Gradient	Limiting Gradient
Plain and Rolling	2.5%	3.3%
Mountainous	5.0%	6.0%
Steep	6.0%	7.0%

Source: IRC: SP: 84-2014

Ruling Gradients shall be adopted as far as possible. Limiting Gradient shall be adopted in difficult situations and for short lengths. Long sweeping vertical curves shall be provided at all grade changes. These shall be designed as square parabolas. The design of vertical curves and their coordination with horizontal curves, shall be in accordance with IRC: SP: 23-1993[4]. The vertical alignment has been designed abiding by the following philosophy:

- Vertical curves have been provided at all grade change locations.
- The vertical curve length has not been less than 0.6V (km/h).
- Number of PVI has not been more than 4 in a km.
- At locations of sight deficiency, at least Stopping Sight Distance (SSD) has been provided.

(12) Lateral and Vertical Clearance at Overpasses

Wherever the Project Highway is proposed to be taken above/over a cross road, the minimum clearances at underpasses shall be as follows:

a) Lateral Clearance

- Full roadway width of the cross road shall be carried through the vehicular underpass. The lateral clearance shall not be less than 12m (7m carriageway + 2 x 2.5m shoulder width on either side).
- For Light Vehicular Underpass, the lateral clearance shall not be less than 10.5m including 1.5m wide raised footpath on either side.
- For pedestrian and Cattle underpasses, the lateral clearance shall not be less than 7m.
- Guard rails/crash barriers shall be provided for protection of vehicles from colliding with the abutments, piers and the deck of the structures.

b) Vertical Clearance

[4] IRC: SP: 23-1993 Vertical Curves for Highways

Vertical clearance at underpasses shall not be less than the values given in the Table below as per IRC: SP: 84-2014.

Table 5-16: Vertical Clearance

Type of underpass	Vertical clearance
Vehicular Underpass	5.5m
Light Vehicular Underpass	3.5m
Pedestrian and Cattle Underpass	3.0m (to be increase to 4.5m, in case certain categories of animals such as elephant/camel are expected to cross frequently)

Source: IRC: SP: 84-2014

(13) Median Openings

In open country, median openings shall not be spaced closer than 2km. Additional controlled openings shall also be provided for inspection and diversion of traffic during repair and rehabilitation.

(14) At-Grade Intersections

The type of intersections to be adopted shall be decided on the basis of parameters such as the number of intersecting legs, traffic volume/speed, type of traffic control etc. Properly designed intersections shall be provided at all at-grade crossings. Rotary shall not be provided on the Project highway.

- The intersections shall be designed having regard to flow, speed, composition, distribution and future growth of traffic. Design shall be specific to each site with due regard to physical conditions of the site available. The design of different elements of the intersection shall be done as per IRC: SP: 41-1994[5] including other criteria given in this Manual. MORTH - Type Designs for Intersection on National Highways may also be referred to, wherever required to develop suitable layout and design of At-grade Intersections.
- At multi leg intersections, the points of conflict should be studied carefully and possibilities of realigning one or more of the intersecting legs and combining some movements to reduce the conflicting movements shall be examined. The object shall be to simplify the design and appropriate control devices added to ensure more efficient and safe operation.
- The channelizing islands shall start from the edge of the paved shoulder. This principle shall also apply in case of MORTH - Type Designs for Intersections on National Highways.

(15) Embankment Sections

The height of the embankment shall be measured with respect to the finished road levels. The following principles shall be kept in view while fixing the road level.

- No section of the road is overtopped. Top of subgrade shall be at least 0.5m above the general ground level.
- The bottom of sub-grade shall be 1.0m above the High Flood Level (HFL)/ level of water table. The HFL should be decided by intelligent inspections, local observations, enquiries and studying the past records. This shall be relevant to situations where road alignment is sited within the flood plain, or in the vicinity of water bodies or where ponding of water is encountered and cannot be efficiently drained.

(16) Highway Drainage

Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of a road. Pavement structure, including subgrade must be protected from any ingress of

[5] IRC: SP: 41-1994 Guidelines for the Design of at Grade Intersections in Rural and Urban Areas

water. Otherwise, over a period of time it may weaken the subgrade by saturating it and cause distress in the pavement structure. That is why rapid dispersal of water from pavement and subgrade is a basic consideration in road design.

Also, proper drainage takes away the water from pavement surface quickly and reduces the chance of vehicles hydroplaning. Because of inadequate surface and sub-surface drainage, the structural stability of pavement is undermined by the weakening of pavement structure and subgrade through infiltration of water from the top; and by erosion of shoulders, verges and embankment slopes caused by water running off the pavement.

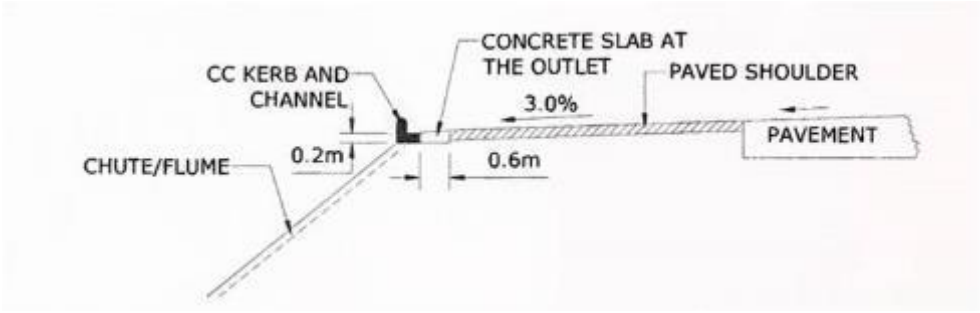
For efficient drainage for the entire Project Highway including structures, directions contained in Clause 309 of MORTH Specifications, IRC: SP: 42-2014[6], IRC: SP: 50-2013[7] and IRC: SP: 90-2010[8] as relevant shall be followed.

The side slopes of the unlined drains shall be as flat as possible and shall not be steeper than 2H: 1V. As far as possible, longitudinal slope shall not be less than 0.3 percent for lined drains and 1.0 percent for unlined drains. Permissible non-erodible flow velocity for corresponding earth surface as mentioned in Clause 9.4 of IRC: SP: 42-2014 shall be kept in view.

For embankments with heights of more than 6m and approaches to bridges, special arrangement for protection of embankment slopes shall be essential in order to ensure that embankment slopes maintain their shape during the monsoon season. In this respect, directions contained in Clause 7 of IRC: SP: 42-2014 may be followed as appropriate for the climatic conditions of the area of the Project Highway.

Drainage arrangement shall include provision of a kerb with channel at the edges of the roadway to channelize the water and Cement Concrete (CC) lined chutes along the slopes at designed intervals; with energy dissipation basin, side channels at the bottom protection of the slope by turfing, vegetation and/or any other suitable type. The drainage system and slope protection shall be kept well maintained at all times.

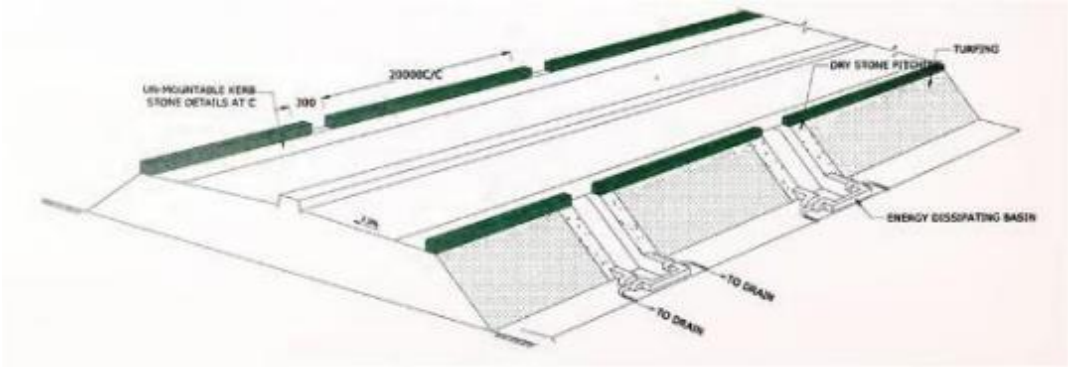
The chute drains and drains at the foot of the embankment shall be of Plain Cement Concrete (M15 grade), over bedding in Cement Concrete M 10.



Source: IRC: SP: 42-2014

Figure 5-33: Detail of CC Kerb and Channel of High Embankment

[6] IRC: SP: 42-2014 Guidelines of Road Drainage
[7] IRC: SP: 50-2013 Guidelines on Urban Drainage
[8] IRC: SP: 90-2010 Manual for Grade Separators and Elevated Structures



Source: IRC: SP: 42-2014

Figure 5-34: Schematic View of Slope Protection of High Embankment

(17) Traffic Control and Road Safety Devices

The multi-lane highways being built under various road development programs are adopting the geometric standards specifications, signage, road markings etc. as per the provisions contained in the codes of practice, and the standards of the Indian Roads Congress supported by the Ministry's specifications. However, accident data demonstrates that motorists leave the roadway for numerous reasons including judgment errors. To ensure long term road safety on these highways, the following suitable engineering measures are essential to adopt to help in improving road safety and leading to reduction of accidents.

Traffic Control Devices, Road Safety Devices and Road Side Furniture shall comprise of road signs, road markings, object markers, hazard markers, studs, delineators, attenuators, safety barriers, pedestrian guard rails, boundary stones, km stones, etc. Guidelines given in IRC: 8-1980[9], IRC: 25-1967[10], IRC: 26-1967[11], IRC: 35-1997[12], IRC: 67-2001[13], IRC: 79-1981[14], IRC: 103-1988[15] and Section 800 of MORTH Specifications shall be used for providing these items unless otherwise specified in this Section.

a) Road Signs

The three types of road signs; mandatory/regulatory signs, cautionary/warning signs and informatory signs, shall be provided as given in IRC: 67-2001 and Section 800 of MORTH Specifications. Proper signs shall be provided for main carriageways, service and slip roads, toll plaza and other project highway facilities. The clustering and proliferation of road signs shall be avoided to enhance their effectiveness.

b) Road Markings

Road markings shall use hot applied thermoplastic materials with glass reflector beads as per relevant specifications. The quality of thermoplastic application shall be ensured by testing actual samples by random selection during application to avoid any possible defections in the quality of materials used. To ensure the readability of road markings, the minimum performance level indicated in relevant codes and specifications for road markings shall be followed, and any shortage shall require reapplication of road markings.

c) Road Delineators

[9] IRC: 8-1980 Type Designs for Highway Kilometer Stones
[10] IRC: 25-1967 Type Designs for Boundary Stones
[11] IRC: 26-1967 Type Design for 200-Meter Stones
[12] IRC: 35-1997 Code of Practice for Road Markings
[13] IRC: 67-2012 Code of Practice for Road Signs
[14] IRC: 79-1981 Recommended Practice for Road Delineators
[15] IRC: 103-1988 Guidelines for Pedestrian Facilities

Circular Iron Posts of 1m height or concrete or any other product with retro-reflective reflector of at least Type IV sheeting as per criteria, placement and spacing given in IRC: 79-1981 shall be provided. This will include low embankments and flat curves where crash barriers are not provided.

Hazard Markers shall be provided as given in IRC: 67-2012. In addition, the objects close to the road shall be painted with black and yellow stripes, using paint conforming to Indian Standard (IS) specification IS: 164-2010[16].

Object Markers shall be provided as given in IRC: 79-1981 and IRC: 67-2012. All physical objects above the Finished Road Level (FRL) that are within 3m from the carriageway edge line shall be illuminated with Object Hazard Markers (OHM). The objects shall include foot path or utility poles of major bridges, or parapet, or concrete barrier, major bridges, Culverts, RE walls of underpasses, or flyovers.

d) Reflective Pavement Markers (Road Studs)

The Reflective Pavement Markers (RRPM), or "road studs" shall be provided to improve the visibility at night time and wet weather conditions. These shall be prismatic retro-reflective type conforming to ASTM D 4280. RRPM shall be provided on curves and approaches, bridges and approaches and junction. The RRPM on shoulder edge line shall be RED in color, and on median edge line shall be AMBER color. RRPM shall be provided on traffic lanes for all curves less than 400m radii and shall be WHITE in color. The RRPM on traffic lane lines shall be placed at the centre of the gap of lane line marking. The RRPM shall be provided for pedestrian crossings to make them visible, and shall be RED color.

e) Traffic Impact Attenuators

Attenuators shall be provided at hazardous locations and gorge areas so as to act as an energy absorber. The attenuators or "crash cushions" shall be composed of W-beam fender panels supported by diaphragm with trigger mechanism or composed of sand barrels as per Clause 814 of the MORTH Specifications, and the contractor/supplier shall confirm the system has been tested in accordance with NCHRP 350, and performs effectively at design speeds up to 100 km/h.

f) Roadside Safety Barriers

The longitudinal roadside barriers are basically meant to shield two types of roadside hazards i.e. embankments and roadside obstacles, and also for preventing the vehicles veering off the sharp curves. Therefore, all embankments with heights of 3m or more shall have safety barriers at the edge of formation, with delineating reflectors fitted on them. W-beam barriers shall be provided along all curves having radii up to 450m for complete length of curves, including transitions and 20m extending before and after the curve.

g) Median Barriers

Head-on-collisions, especially on highways with narrow medians, caused by out-of-control vehicles jumping across the medians are a major source of accidents. Fixed objects on medians also require shielding from the traffic flow. Provision of median safety barriers in such conditions is an important requirement. For all multilane highways where adequate land is available, it is preferable to provide wide depressed medians with widths of 7m or more, but also including W-beam metal crash barriers or wire rope safety barriers at the edges of the median.

(18) Codes & Standards

The following is the list of IRC standards which will be followed:

[16] IS: 164-2010 Specification for Ready Mixed Paint for Road Marking

Table 5-17: List of IRC Standards to Be Followed

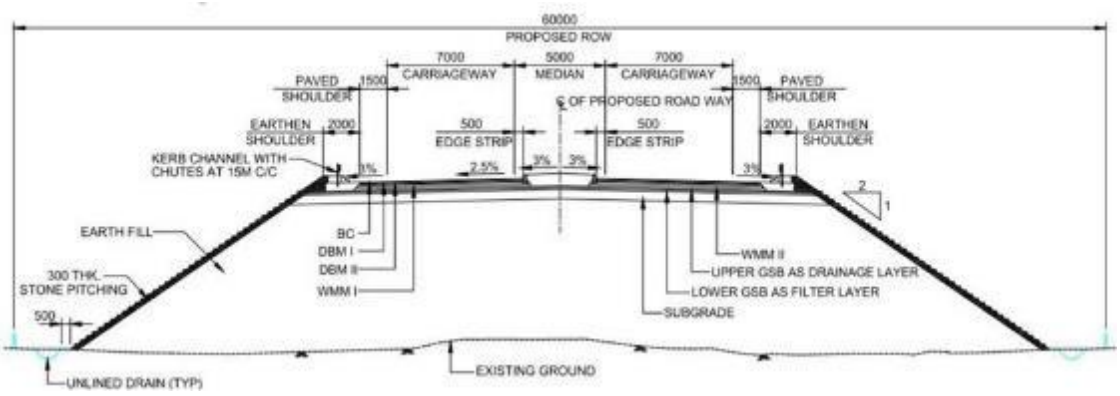
Code	Title
IRC: 8-1980	Type Designs for Highway Kilometer Stones
IRC: 25-1967	Type Designs for Boundary Stones
IRC: 26-1967	Type Design for 200-Meter Stones
IRC: 35-1997	Code of Practice for Road Markings
IRC: 67-2012	Code of Practice for Road Signs
IRC: 73-1980	Geometric Design Standards for Rural (nonurban) Highways 1990
IRC: 79-1981	Recommended Practice for Road Delineators
IRC: 93 - 1985	Guidelines on Design and Installation of Road Traffic Signals
IRC: 103-1988	Guidelines for Pedestrian Facilities
IRC: SP: 23-1993	Vertical Curves for Highways
IRC: SP: 41-1994	Guidelines for the Design of at Grade Intersections in Rural and Urban Areas
IRC: SP: 42-2014	Guidelines of Road Drainage
IRC: SP: 50-2013	Guidelines on Urban Drainage
IRC: SP: 84-2014	Manual of Specifications & Standards for Four Laning of Highways Through Public Private Partnership
IRC: SP: 90-2010	Manual for Grade Separators and Elevated Structures
IS: 164-2010	Specification for Ready Mixed Paint for Road Marking

Source: JICA Study Team

5.3.2 Roadway Design

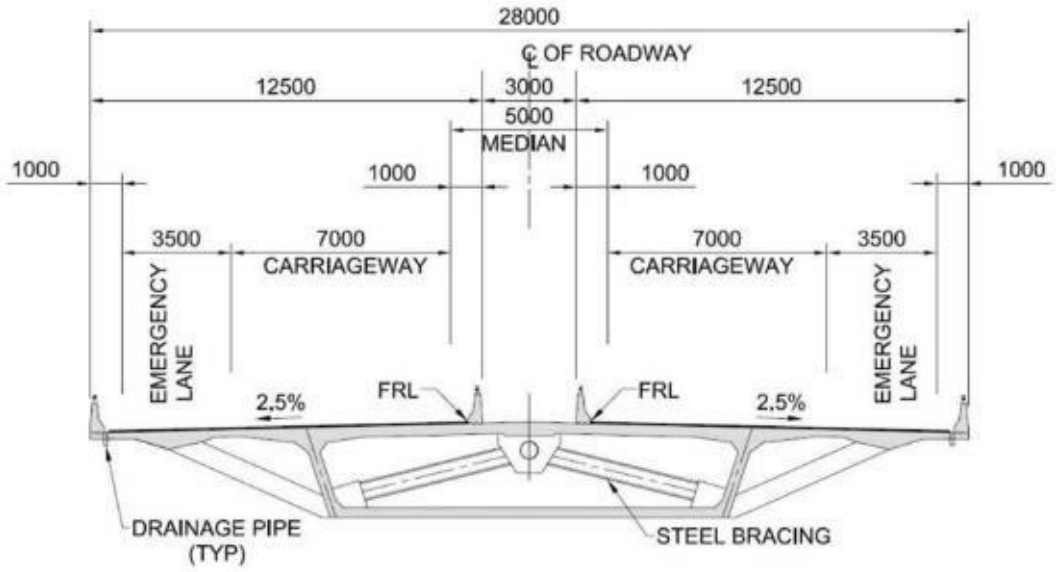
(1) Proposed Cross Section

Typical cross sections of the approach road and the bridge are given in Figures below.



Source: DPR

Figure 5-35: Typical Cross Section of Approach Road



Source: DPR

Figure 5-36: Typical Cross Section at Bridge

(2) Alignment Design

The lengths of the approach roads and the bridge indicated in DPR are as follows:

Table 5-18: Component Length of Dhubri Bridge Project

Component	Length (m)
Northern Approach Road	810
Bridge	18,360
Southern Approach Road	112
Total	19,282

Source: JICA Study Team

a) Horizontal Alignment

The horizontal alignment has been finalized keeping the following parameters in mind:

- Minimization of impact on settlements and permanent structures
- Avoidance of sensitive religious establishments like temples, cemeteries and mazars
- Minimization of impact on environmentally sensitive locations like ponds, trees
- Adherence to safety of road users through proper horizontal geometry

b) Vertical Alignment

The vertical alignment has been finalized keeping the following parameters in mind:

- Adherence to safety of road users through proper vertical geometry
- Adherence to adequate vertical clearance from the HFL
- Adherence to adequate vertical clearance (5.5m) in the cross roads

Basic features of the horizontal and vertical alignment are given in Table 5-9.

Table 5-19: Basic Features of Horizontal Alignment

Basic Features	Values
Design Speed	100km/h
Minimum Curve Radius	1,200 m
Maximum Gradient	1.5%

Source: DPR

Basic features of the horizontal alignment and detailed report on the vertical geometry are given in Tables below respectively.

Table 5-20: Detailed Report for Horizontal Geometry

Sl. No	Curve No.	HIP			Radius (m)	Ls (m)	Included Angle (Δc)			Shift (m)	Rc	θ_s	Total Deviation Angle (Δ)			Es (m)	Ts (m)	Lc (m)	L_{cal} (m)	Start of Curve			End of Curve			V (Km/h)	e (%)	Direction
		Chainage (m)	Northing (m)	Easting (m)			D	M	S	(s)			D	M	S					Chainage	Northing (m)	Easting (m)	Chainage	Northing (m)	Easting (m)			
1	1/1	0+479	2882200.30	794125.31	1200	0	11	36	52.569	0.00	1200	0	11	36	52.560	6.190	122.046	243.256	243.256	0+356.966	2882320.789	794105.874	0+600.222	2882078.366	794120.091	100	3.70	Right
2	2/1	1+293	2881396.20	794090.89	1200	0	40	5	26.982	0.00	1200	0	40	5	26.980	77.382	437.842	839.660	839.660	0+845.175	2881833.638	794109.616	1+684.835	2881049.485	794358.279	100	3.70	Left
3	3/1	2+970	2880031.78	795143.15	5000	0	5	34	22.542	0.00	5000	0	5	34	22.540	5.919	243.357	486.330	486.330	2+726.680	2880224.484	794994.529	3+213.010	2879825.551	795272.346	100	-2.50	Right
4	5/1	4+150	2879031.78	795769.64	15000	0	6	28	1.772	0.00	15000	0	6	28	1.770	23.920	847.449	1693.098	1693.096	3+302.242	2879749.932	795319.721	4+995.340	2878368.873	796297.582	100	-2.50	Left
5	7/1	6+082	2877518.73	796974.64	12000	0	8	28	0.433	0.00	12000	0	8	28	0.430	32.830	888.257	1773.280	1773.280	5+193.887	2878213.562	796421.272	6+967.166	2876750.003	797419.669	100	-2.50	Right
6	9/1	8+203	2875680.49	798038.83	5000	0	3	56	16.803	0.00	5000	0	3	56	16.800	2.954	171.895	343.655	343.655	8+031.080	2875829.252	797952.707	8+374.735	2875537.988	798134.965	100	-2.50	Left
7	11/1	10+644	2873656.43	799404.35	25000	0	1	59	23.915	0.00	25000	0	1	59	23.910	3.770	434.189	868.291	868.291	10+210.258	2874016.365	799161.516	11+078.549	2873305.140	799659.526	100	-2.50	Left
8	15/1	14+437	2870588.26	801633.11	10000	0	6	51	50.416	0.00	10000	0	6	51	50.410	17.967	599.715	1197.995	1197.995	13+836.876	2871073.472	801280.644	15+034.870	2870064.409	801925.055	100	-2.50	Right
9	16/1	15+965	2869234.45	802387.60	5000	0	4	52	26.501	0.00	5000	0	4	52	26.500	4.526	212.798	425.339	425.339	15+772.213	2869420.334	802284.002	16+197.552	2868958.047	802506.606	100	-2.50	Left
10	18/1	17+323	2868124.81	803136.21	1200	0	17	51	12.048	0.00	1200	0	17	51	12.040	14.713	188.487	373.920	373.920	17+134.828	2868281.059	803030.795	17+508.747	2868008.395	803284.453	100	3.70	Left
11	19/1	18+893	2867153.41	804373.24	1200	0	23	53	49.113	0.00	1200	0	23	53	49.110	26.575	253.940	500.497	500.497	18+639.171	2867310.241	804173.519	19+139.668	2866929.110	804492.308	100	3.70	Right

Source: DPR

Table 5-21: Detailed Report for Vertical Geometry

Curve No.	IP		Type of Curve	Curve Length	K Value	Start		End		Gradient	
	Chainage	Level				Chainage	Level	Chainage	Level	In	Out
1/1	0+278.696	32.130	Sag	100	55.556	0+228.696	32.280	0+328.696	32.880	-0.300	1.500
1/2	0+490.000	35.300	Hog	210	140.000	0+385.000	33.725	0+595.000	35.300	1.500	0.000
3/1	2+994.000	35.300	Sag	100	100.000	2+944.000	35.300	3+044.000	35.800	0.000	1.000
5/1	4+100.000	46.360	Hog	200	200.000	4+000.000	45.360	4+200.000	46.360	1.000	0.000
18/1	17+260.000	46.360	Hog	200	200.000	17+160.000	46.360	17+360.000	45.360	0.000	-1.000
19/1	18+366.000	35.300	Sag	100	100.000	18+316	35.800	18+416.000	35.300	-1.000	0.000
20/1	19+170.000	35.300	Hog	60	60.000	19+140	35.300	19+200.000	35.000	0.000	1.000

Source: DPR

5.3.3 Pavement Design

The approach road pavement design has already been predetermined in a previous report (DPR2016). This study is planned based on design criteria IRC: 37-2012[17], ICR: 58-2015[18] for Flexible pavement and Rigid pavement using traffic demand forecast.

From now on, whichever pavement format is adopted, it is necessary to consider the policy of central government for national highways. This approach section is shorter than the bridge section, but it is not factoring the bridge pavement, so the pavement plan for the bridge is shown below.

(1) Design Condition

In general, the performance required for pavement design is shown below.

- Comfort of drivers
- Ensure comfort and safety for the road users by keeping flatness and sliding resistance of the road surface
- Create beautiful road landscape by using pavement materials suitable for neighboring environment

The type of pavement is different between the bridge and embankment section. Because it is necessary to factor in the bridge, and the type of bridge pavement differs according to the deck type. Therefore, in this study the pavement design of a Reinforced Concrete deck-type bridge was performed.

(2) Feature Required RC Deck

Among the features required for pavement on a RC Deck, some of the particularly important features are shown below.

- Waterproofing

The durability of the bridge greatly depends on the effectiveness of waterproofing the deck. Therefore, waterproofing is required for RC deck, including the compatibility with bituminous mixture and the resistance of high temperatures during the asphalt construction.
The materials for waterproofing are divided into two types, sheet type and liquid (sprayed type). In this project, it is recommended that the liquid type be used to its excellent workability.

- Sealing and Bonding

There is no adhesive for the surface of a RC deck, an intermediate sealing layer is required for strong adhesion between the RC deck and waterproof layer. Before adapting the sealing layer, the bridge deck surface must be clean, and free of all bond-inhibiting substances.

(3) Pavement Layer on RC Deck

The pavement design for the RC deck was compared based on parameters of waterproofness, adhesiveness and workability. The comparison the three types of pavement are shown below.

[17] IRC37-2012 Tentative Guidelines for the Design of Flexible Pavements
[18] IRC58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways

Table 5-22: Comparison of Pavement

	Case1		Case 2		Case 3	
Surface Layer	Improved Asphalt- III		Improved Asphalt		Improved Asphalt	
Tack Coat	0.4l/m2		0.4l/m2		0.4l/m2	
Binder Layer	Improved Asphalt- III		Improved Asphalt		Improved Asphalt	
Waterproofing Layer	Liquid System		Sheet System		Liquid System	
Sealing and Bonding Layer	Asphalt Solvent System		Asphalt Solvent System		Asphalt Solvent System	
Thickness	80mm		80mm		80mm	
Waterproofness	Excellent	○	Excellent	○	Excellent	○
Adhesiveness	Excellent. But no case in Asia	△	Excellent	○	Excellent	○
Workability	Good Workability	○	Requires High Skill	△	Good Workability	○
Evaluation					Recommended	

Source: JICA Study Team

From this comparison, Case 3 is recommended based on its excellent Waterproofness, Adhesiveness and Workability.

5.4 Bridge Section

5.4.1 Design Standards

The carriageway configuration of the Dhubri Bridge is determined in accordance with IRC:SP 84-2014. The bridge is designed in accordance with IRC design standards as much as applicable. Main IRC design standards are listed in the table below.

Table 5-23: Major Design Standards

Code No.	Title
IRC:5-2015	Standard Specification & Code of Practice for Road Bridges, Section -1 General Features of Design (Seventh Revision)
IRC:6-2014	Standard Specification & Code of Practice for Road Bridges, Section -2 Loads & Stress (Revised Edition)
IRC:21-2000	Standard Specification & Code of Practice for Road Bridges, Section -3 Cement Concrete Plain & Reinforced (Third Revision)
IRC:24-2010	Standard Specification & Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method) (Third Revision)
IRC:78-2014	Standard Specification & Code of Practice for Road Bridges, Section -7 Foundation & Substructure (Revised Edition)
IRC:112-2011	Code of Practice on Concrete Road Bridges,
IRC:83-2015 (Part I)	Standard Specification & Code of Practice for Road Bridges, Section -9 Bearings, Part I: Roller & Rocker Bearings (Second Revision)
IRC:83-2015 (Part II)	Standard Specification & Code of Practice for Road Bridges, Section -9 Bearings, Part II: Elastomeric Bearings (First Revision)

Source: JICA Study Team

(1) Design Loads

Design loads and their combinations are determined in accordance with relevant IRC design standards. Main load conditions are as follows:

- Live load: Class 70R Loading (IRC 6)
- Live load combination: One lane of Class 70R with one lane of Class A, or three lanes of Class A (IRC 6)
- Impact load: based on IRC 6
- Temperature: +5 to +40 degrees (IRC 6)
- Seismic load: Zone – V, Importance factor = 1.5 (IRC 6)

(2) Pavement

Asphalt pavement of 80mm thickness is used on the deck surface.

(3) Effect of Scour

The discharge and water surface level of Brahmaputra River changes from season to season. Because of the thick erodible soils that exist in and around the site, it is normal that the locations of water channels are unstable, and scouring around the piers is severe. It is important for the scour depth to be considered in the design of foundations, and be estimated not only by calculation but also by referring to the past movements of river bed, hydraulic experiments, and local experiences. Major hydraulic parameters of the construction site are shown in the Table below.

Table 5-24: Hydraulic Parameter

Parameter	Value
High Flood Level (HFL)	30.36m
Lowest Flood Level (LWL)	23.00m
Water Current Velocity at HFL	4.5m/sec

Source: DPR

(4) Navigation Condition

The Brahmaputra River is used for river transportation, and the Inland Waterways Authority of India (IWAI) defines the clearance conditions.

Table 5-25: Clearance for Navigation

Parameter	Value
Horizontal Clearance	100m
Vertical Clearance	10m
Length of Navigation Section	12,500m

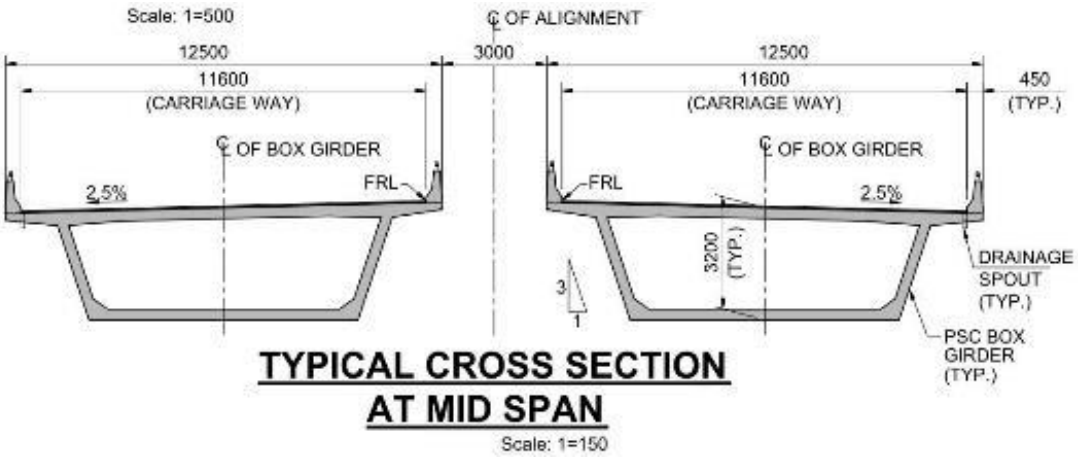
Source: DPR

(5) Carriageway Configuration

The carriageway configuration to provide two lanes for each direction is shown in the Figure below. The median is provided outside of the parapet in accordance with Indian Design Standard (IRC:SP:84-2014, Art. 2.5.1 and Table 6.2).

Based on Indian Design Standard (IRC:SP:84-2014, Art.2.4), the roadway has a total of 4 lanes with 2 lanes on one side measuring 3.5m. However, the Ministry of Road Transportation has instructed to provide a 3.5m emergency lane in both directions and a 0.55m space beside each parapet wall. The road width shall be 11.6m (2 lanes X 3.5m + 3.5m emergency lane + 2 side strip

X 0.55m)



Source: DPR

Figure 5-37: Carriageway Configuration

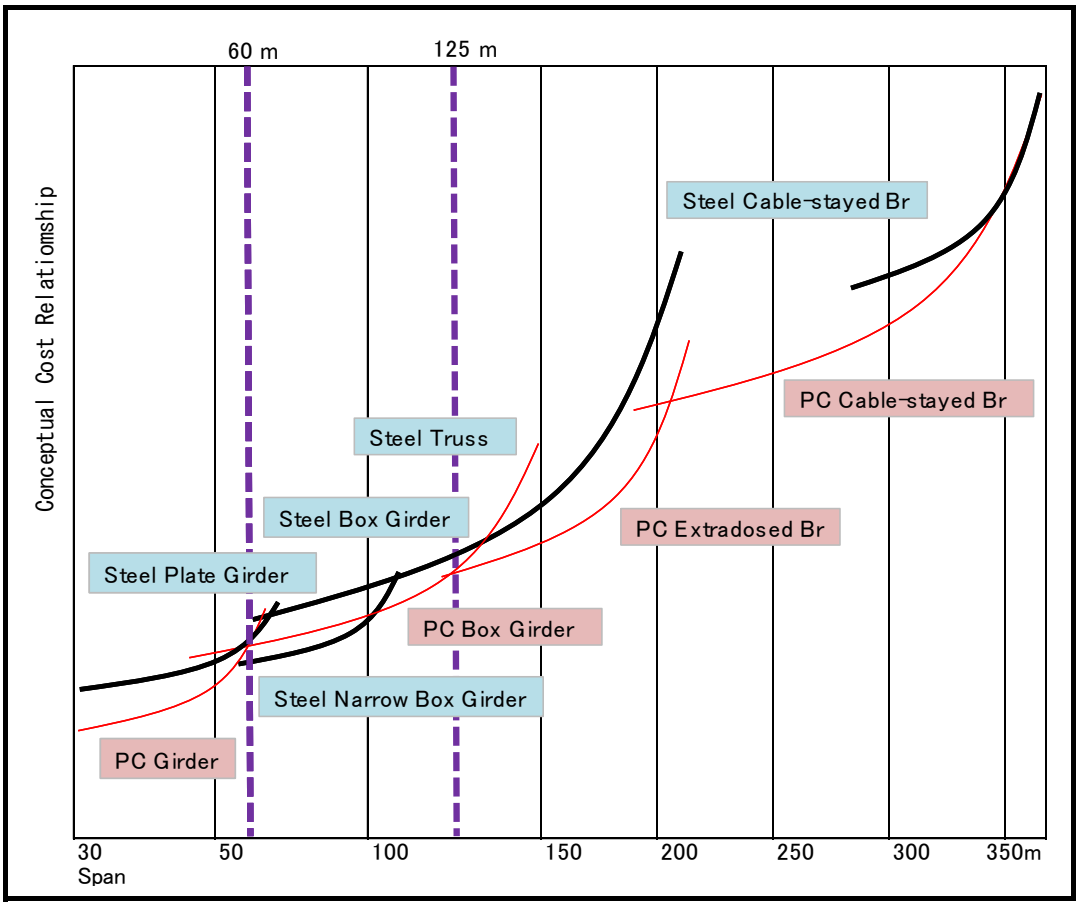
5.4.2 Foundation

For the foundation in the navigational portion where the load from the superstructure is heavy, the open well foundation is the most appropriate choice since it has been constructed in the Brahmaputra River and is also being used throughout India. For the foundation in the viaduct where the load is less compared to that in the navigational portion, the economical pile foundation can be adopted. Hence, DPR's plan need not be modified.

5.4.3 Superstructure

The Dhubri Bridge is the westernmost bridge crossing Brahmaputra River. It is a part of a new road that links the North-Eastern States and West Bengal. Hence, it is an essential bridge that will greatly contribute to the development of the North-East States. The total length of the Dhubri Bridge exceeds 18km, which requires a significant construction cost. Partial completion would not bring any benefit, therefore, the speedy completion of construction is important so as not to reduce the investment returns. In here, the possibility of shortening the construction period based on the DPR plan is investigated.

Fig. 5-38 shows bridge superstructures chosen from bridges with basic conditions according to span. As shown, bridges with PC Box Girder, Steel Plate Girder and Steel Slender Box Girder are common for a 60m span, while PC Extradosed Bridge, Steel Box Girder Bridge and Steel Truss Bridge are common for a 125m span. In addition to the above, the features of recently developed bridge types are being compared. The span and total lengths on the viaduct portions and navigational portion shall be followed accordingly (Table 5-26).



Source: JICA Study Team

Figure 5-38: Bridge Superstructures with Basic Conditions According to Span

Table 5-26: Span Proportion by DPR

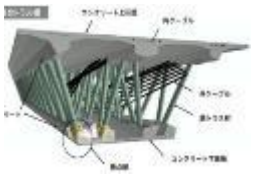
Portion	Span Proportion
Viaduct (North)	59@60m=3,540m
Navigation	62.5+100@125+62.5m=12,625m
Viaduct (South)	36@60=2,195m
Total	18,360m

Source: JICA Study Team

(1) Viaduct Portions

Table 5-26 shows a comparison of economic bridge types for the 60m span. Compared to PC box girder, the construction period can be shortened using steel slender box girder. However, for the Dhubri Bridge, the construction period is governed by the navigational portion. Hence, with the proposed use of an extradosed bridge on the navigational portion, the reduction of construction period of the viaduct portions will not shorten the overall construction period of the Dhubri Bridge. Moreover, in India, the construction cost of steel bridges is higher than PC box girder bridges, thus there is no reason to adopt the steel slender box girder bridge. Indian construction companies are technically capable of constructing a 60-meter PC box girder bridge. Therefore, it is the most suitable technically and economically.

Table 5-27: Comparison of Viaduct Types

Type	PC Box Girder Bridge	Steel Slender Box Girder Bridge	PC Composite Truss Bridge
Images			
Existence (Japan/India)	many / many	few / none	few / none
Applicable Span	30～60m	60～90m	50～110m
Proposed Span	60m	60 or 90m	90m
Erection Method	Span-by-span	Push Launching	Balance Cantilever
Pier Quantity	97	97 or 65	65
Architectural Design	Simple	Simple	Impressive
Construction Cost	Most Economical	Higher than PC box girder bridge	Higher than PC box girder bridge
Advantage	Can be constructed by an Indian Company	Construction Period can be shortened	Weight can be reduced
Disadvantage	Heavy Dead Load	Shortening the construction period has no effect	Requires advance technology; India has no experience yet
Evaluation	Most advantageous	Reason to adopt is low	Reason to adopt is low

Source: JICA Study Team

(2) Navigational Portion

For the 125m span, 4 types are compared namely; DPR's PC Box Girder Extradosed Bridge, Slender Box Girder Bridge (girder height fixable), Composite PC Truss Girder Extradosed Bridge and Steel Truss Bridge (Table 5-28 and Table 5-29).

Table 5-28: Comparison of Navigational Portion (1)

Type	PC Box Girder Extradosed Bridge	Steel Slender Box Girder Bridge
Image		
Existence (Japan / India)	Many / many	Few / none
Applicable Span	100～200m	60～90m
Proposed Span	125m	125m
Erection Method	Balanced Cantilever	Push Launching
Pier Quantity	100	100
Architectural Design	Impressive	Simple
Construction Cost	Most economical	Higher than PC box girder bridge
Advantage	Can be constructed by an Indian company	Construction Period can be shortened
Disadvantage	Precedent cases in the neighboring states	Requires special steel materials
Evaluation	Economical but long construction period	Reason to adopt is low

Source: JICA Study Team

Table 5-29: Comparison of Navigational Portion (2)

Type	Composite PC Truss Girder Extradosed Bridge	Steel Truss Bridge
Image		
Existence (Japan / India)	Few / none	Many / many
Applicable Span	150～200m	60～150m
Proposed Span	180m	125m
Erection Method	Balanced Cantilever	Push Launching
Pier Quantity	83	100
Architectural Design	Impressive	Heavy impression
Construction Cost	Higher than PC Box Girder Extradosed Bridge	Higher than PC Box Girder Extradosed Bridge
Advantage	Construction Period can be shortened	Can be constructed by an Indian company. Construction Period can be shortened
Disadvantage	Requires advanced technology	Existing same types upstream
Evaluation	No reason to adopt	Construction Period can be shortened

Source: JICA Study Team

Based on the above comparison, the PC Box Girder Extradosed Bridge is the most economical but there are site construction concerns that must be considered as cited below. These concerns are

construction issues that risk construction delay if the countermeasure fails. The countermeasure must be clearly defined for the construction of PC Box Girder Extradosed Bridge to proceed as planned.
JICA Study Team submitted to NHIDCL and DPR Consultant a written opinion regarding the importance of countermeasures for the said concerns. NHIDCL and DPR Consultants then provided countermeasures from the said opinions but there was a need to elaborate its details so JICA Study Team had site meetings, exchange of emails and web conference with NHIDCL and DPR Consultant for the details of the countermeasures to be clear enough.

On the other hand, Steel Truss Bridge has a higher construction cost but by adopting the incremental launching erection of superstructure, the river transport of materials can be reduced resulting to a better constructability. With this, a preliminary design of Steel Truss Bridge is carried out in order to conduct a more detailed comparison with Extradosed Bridge.

Described below are the PC Box Girder Extradosed Bridge site construction issues and countermeasures, Steel Truss Bridge preliminary design and the comparison result of the said 2 types of bridge.

(3) PC Box Girder Extradosed Bridge Construction Issues and Countermeasures

Dhubri and Phulbari (on the opposite shore of Brahmaputra River) are the lands connected by Dhubri Bridge and located at the westernmost of the Northeastern Region near the border of Bangladesh, although being a part of the Northeastern Region, the economic development is slow and the transportation infrastructures are poor. Railways are connected to Dhubri but not in Phulbari. Also, in order to transport materials from Dhubri to Phulbari, it is necessary to detour about 60km upstream. In the construction planning of Dhubri Bridge, a careful consideration of material transportation is required.

Moreover, Brahmaputra River that crosses Dhubri Bridge widens up to about 20km and many sandbars exist. Between the rainy and dry season, the difference in water level is above 5m and the shape of sandbars and also the position of water current often change. Given this kind of environmental condition, a careful consideration of material and manpower transportation within the river is necessary.

In addition, Brahmaputra River is well known as a terrible river that often floods, therefore requiring a careful and advanced planning of flood prevention.

Issues and countermeasures about the construction of PC Box Girder Extradosed Bridge with such environmental condition are summarized below.

Table 5-30: Construction Issues of PC Box Girder Extradosed Bridge

Item	Description
A) Materials Procurement and Delivery	A large amount of materials is needed, that is why the stable production, transportation, and on-site storage should be confirmed. Likewise, the capacity of production and delivery period of the manufactures should be confirmed.
B) Construction Schedule	The construction time frame should include necessary time for detail design and procurement of materials. Sufficient study of construction method should be conducted to manage multiple sites simultaneously that are subject to significant seasonal changes of the Brahmaputra River.
C) Temporary Facilities	A Jetty, temporary roads, concrete mixing plant and such facilities are expected to be large. Proper preparation and maintenance is necessary. Since the cost of large temporary facilities is greater than that for common works, expenses should be properly estimated.
D) Workers and Inspectors	Many workers and inspectors are needed along with the development of works. It is important to secure and manage a number of experienced workers and inspectors.
E) Measures against Flooding	A flood of 10-year return period may occur during the construction period, and therefore, countermeasures for flood disaster should be considered.
F) Corrosion Prevention	Repainting of steel is expected to be difficult and durable rust-proofing methods should be applied.
G) Railway Station	When railway is utilized for transporting materials, access roads and loading/unloading facilities should be studied.

Source: JICA Study Team

A) Problems on Material Pocurement and Delivery

Regarding the cement and aggregate, the mainland of Northeastern Region is India's leading producer, therefore manufacture is possible and there is no problem in the supply. For rebars and PC cables there is sufficient supply and manufacturing capacity in India. Furthermore, transportation via road, railway or river is possible, storage facility and concrete manufacturing plants can be secured on site.

However, there is no railway connection to Phulbari and the road condition to reach Phulbari is very poor making the delivery of materials to the Phulbari side troublesome. The JICA Study Team recommends that additional cost for materials transportation to Phulbari should be included. The additional cost estimated by the JICA Study Team is 8.9 Crore INR (Table 5-31).

Table 5-31: Additional Cost for Materials Transportation to Phulbari

Materials	Amount (ton)
Cement	97,273
Steel	34,698
Total	131,971
Necessary # of trailers	131,971 ton /16 ton = 8,248
Additional cost	8,248 x 10,799 INR = 8.9 Crore INR

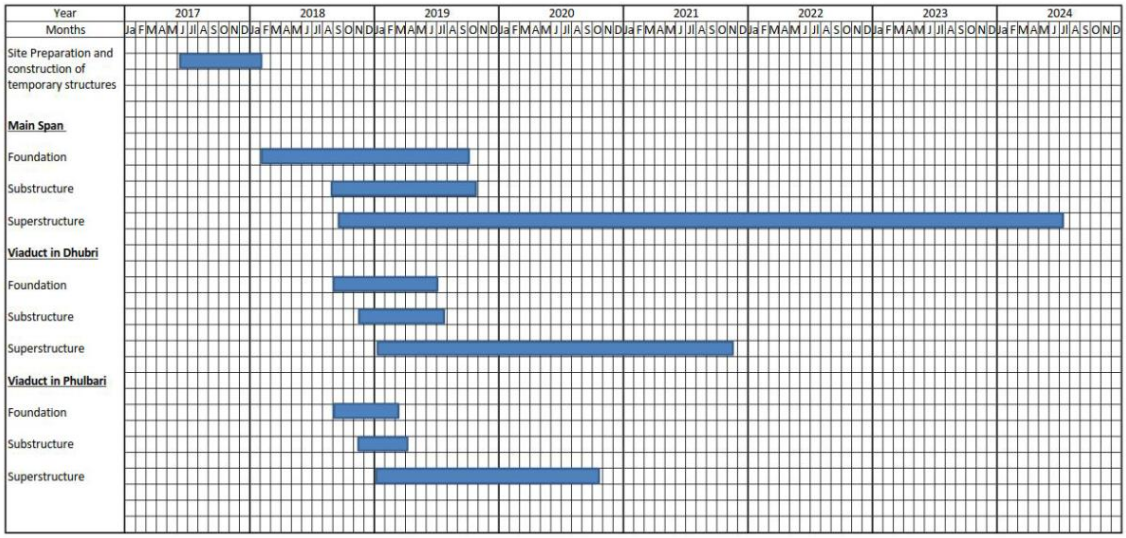
Source: JICA Study Team

B) Review of Construction Schedule

The construction schedule is initially set as 6 years but by reconsidering construction details and dividing the bridge in 4 sections with simultaneous constructions, it allows placement of concrete manufacturing plant and precast block driving yard in each section. By the transportation of precast block via barges and use of wharfs for transportation the whole construction schedule can be

completed in 6 years and 11 months.

Table 5-32: 6 Years and 11 Months Construction Schedule



Source: DPR

However, an operational rate during rainy season especially for foundations and substructures should be carefully reexamined. The JICA Study Team recommnends that an inoperative period of 3 months during rainy season should be applied. Initial site preparation (60 days) should also be included. The additional construction period estimated by the JICA Study Team is 10 months totaling 7 years and 9 months.

Table 5-33: Additional Construction Period Calculation

Item	Duration (day)
Foundation (173) + Substructure (20) + Pier & Pylon (35)	228
Operational Rate = 3/12 = 0.75	228/0.75 = 304
# of cycles for each work-front	3
Additional Days by Operational Rate	(304 – 228) x 3 = 228
Initial Site Preparation	60
Additional Construction Period	(228 + 60)/30 = 10 months

Source: JICA Study Team

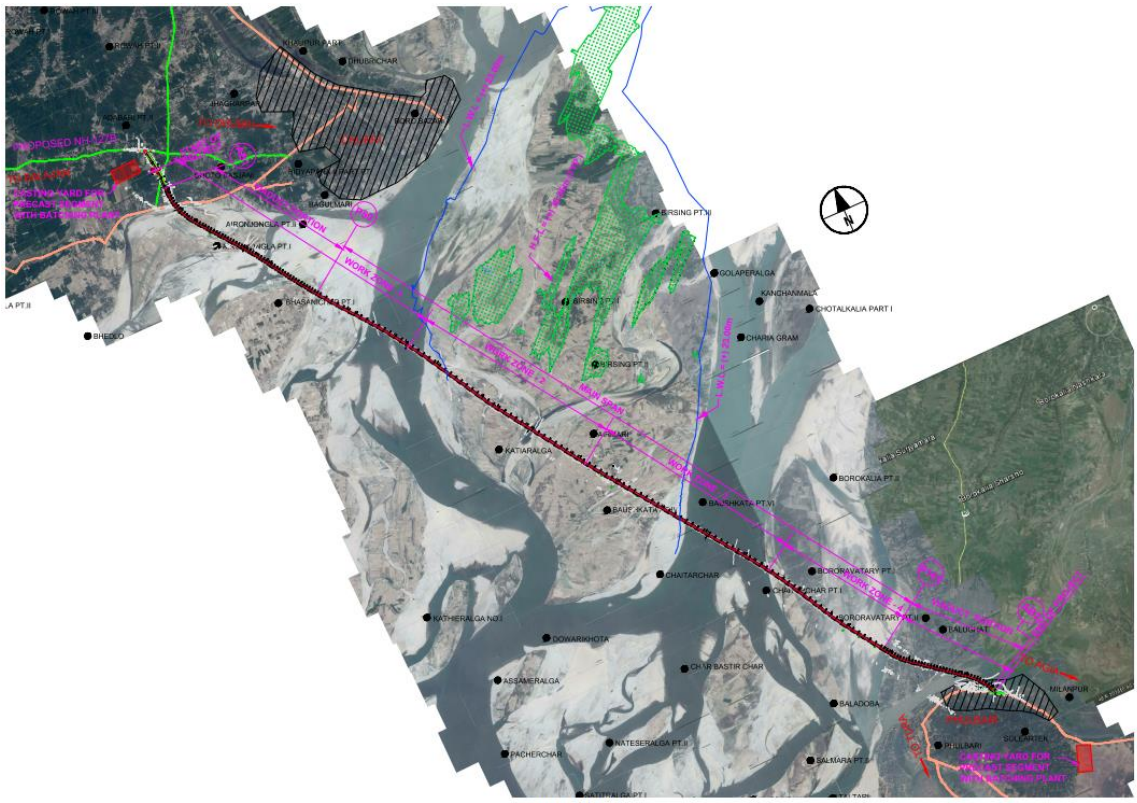
C) Reconsideration of Temporary Facilities

Wharfs, construction road, batching plant and others can be installed on site (Figure 5-39). Crane, vehicles for precast block transport such as large trailer and trolley can be provided with the existing equipment in India (Figure 5-40). Regarding the cost of temporary equipment, an appropriate cost estimate is done by standard integration method, a method that is being used in India. However, the cost of large temporary facilities is greater than that for common works, and additional expenses should be properly estimated. The JICA Study Team recommends that additional cost for temporary facilities should be included because the transport of precast blocks and other materials involves far larger scale than a standard. The additional cost estimated by the JICA Study Team is 64.26 Crore INR.

Table 5-34: Additional Cost for Temporary Facility

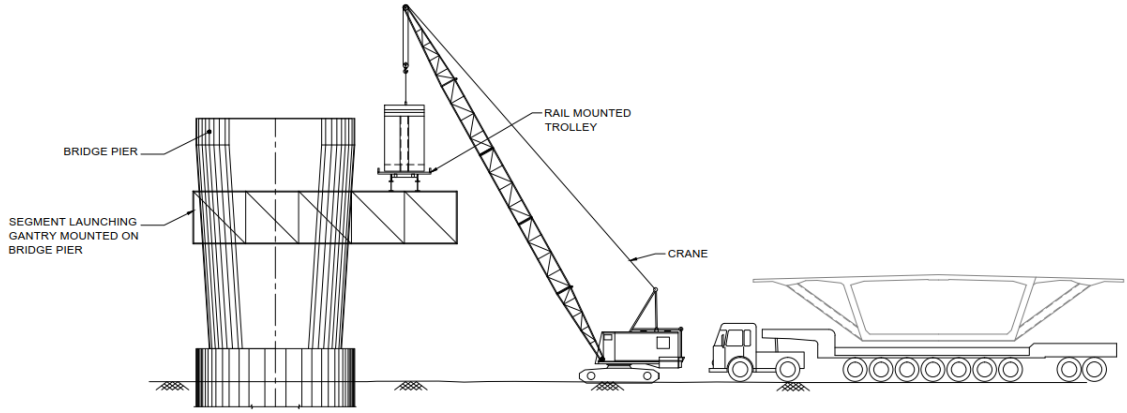
Item	No.	Size (m2)
Temporary Jetty	3	15 x 40 x 3 = 1,800
Unloading Platform	2	10 x 30 x 2 = 600
Temporary Access Road (1)	1	6 x 7,000 x 1 = 42,000
Temporary Access Road (2)	1	6 x 4,500 x 1 = 27,000
Total		71,400
Installation/Removal Cost		71,400 x 0.15 x 60,000 = 64.26 Crore INR

Source: JICA Study Team



Source: DPR

Figure 5-39: Casting Yard and Batching Plant Location Diagram



Source: DPR

Figure 5-40: Large Trailer and Trolley Diagram

D) Mobilization of Workers and Inspectors

There is no problem in the quality of Inspector since we have built the same type of bridge in India. The control and insurance of manpower can also be dealt with even though it is the responsibility of the contractor. However, there are extra-large number of parties (4 parties in each 9 work-fronts) working simultaneously, and the function of construction management should properly be strengthened. The JICA Study Team recommends that additional cost for strengthening the function of construction management should be included. The additional cost estimated by the JICA Study Team is 89.56 Crore INR (Table 5-35).

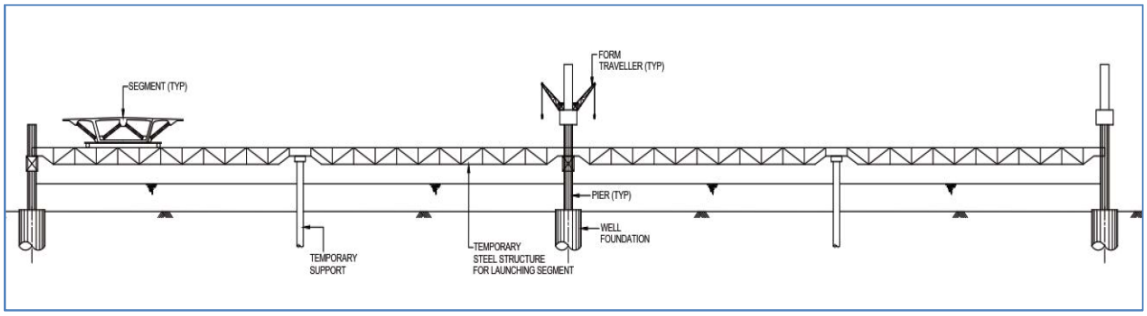
Table 5-35: Additional Cost for Bridge Engineers for Construction Management

Item	Duration
Navigation Section	2,168 days
Additional Days by Operational Rate	228 days
Total	2,396 days (78.9 months)
2 bridge enigineers for each of 9 work-fronts	78.9 x 2 x 9 x 630,600 INR = 89.56 Crore INR

Source: JICA Study Team

E) Measures against Flooding

Assuming the occurrence of a flood with a 10-year recurrence probability during construction, the flood can be dealt with by utilizing the finished substructure and setting up a pier and transportation road (Figure 5-41). The main body of the bridge is designed to correspond to a 100-year recurrence probability flood. However, it is very important to establish a flood alarm monitoring system during construction for disaster preparedness to ensure the safety of construction workers. The JICA Study Team recommends that a flood alarm monitoring system should be prepared. The system should be equipped with functions of meteorological data collection, data analysis, warning and communication, evacuation manual, evacuation drill, etc.



Source: DPR

Figure 5-41: Wharf and Transportation Road Plan Using the Substructure

F) Steel Corrosion Prevention

The location of Dhubri Bridge is inland and the effect of salt is considered to be insignificant, therefore, the expensive weathering steel is not considered. Furthermore, the steel materials exposed to weather are limited that painting can be used as anti-corrosion measure.

G) Railway Station

Railway is a common transportation in India. Also, if it is difficult to use the existing roads, an access road to the station will be constructed. There is no problem in the maintenance of the access road from the site condition.

H) Conclution

The countermeasures for the issues of the construction of PC Box Girder Extradosed Bridge are defined as abovementioned. However, Steel Truss Bridges are less economical than Extradosed Bridges but has construction advantages so on June 8 2017, a meeting of the 4 groups (JICA, JICA Study Team, NHIDCL and DPR Consultants) were held for the comparative study under NHIDCL's Top Managing Director Anand Kumar.

JICA Study Team presented a comparative study between the Extradosed Bridge and Steel Truss Bridge and the discussion on the merits of both bridge types was conducted. Chairman Anand Kumar stated the following:

- Issues on construction of Extradosed Bridge pointed out by JICA Study Team can be dealt with.
- The cost of Extradosed Bridge is lower.
- If there will be a design change, several months will be wasted.
- Since issues of construction is basically the concern of the contractor who bid, PC Box Girder Extradosed Bridge which is DPR's proposal shall be adopted.

Recognizing the importance of efficient construction supervision and completion within the construction schedule, we requested JICA for technical cooperation for the efficient construction supervision.

(4) Preliminary Design of Steel Truss Bridge for the Comparison with PC Box Girder Extradosed Bridge

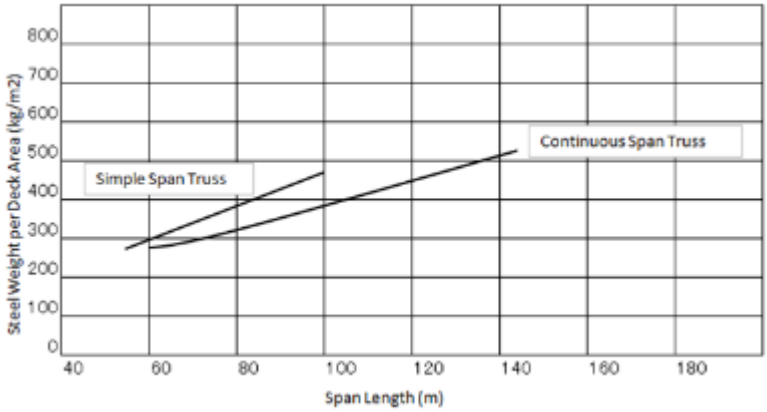
A) Preliminary Design of Steel Truss Bridge

For the preliminary plan of a steel truss, a trial calculation of a 4-span continuous truss bridge is made. The type of truss bridges that have been constructed so far in India are steel truss of simple span combined with railway and with heavy steel weight. In this project, a continuous truss bridge is assumed since it is more economical and advantageous for push launching method compared to simple span.

Fig. 5-42 shows a comparison of steel weights between single span and continuous span steel truss bridges based on Japan's construction projects. Table 5-36 describes comparisons between a single-span truss bridge and a continuous-span truss bridge. A result of a preliminary design is shown in Figure 5-43.

Table 5-37 shows the comparison of preliminary design construction cost with extradosed bridge, the aim is not to justify the adoption of truss bridge and so the slab rebars are not included. In addition, since the steel weight is estimated based on Japan design standards and design examples, weight increase from Indian standards is not included.

In push launching method, an erection nose girder is attached to the end of truss bridge. To improve the construction efficiency, it is preferable to transport the entire continuous truss bridge as one. In the case of single-span with push launching method, temporary structures need to be attached to both ends consequently, requiring dismantling after erection making it unfavorable in construction as compared to continuous truss bridge. Table 5-30 shows the trial calculation steel weights per 125m of a 4-span continuous truss bridge based on Japan standards.



Source: JICA Study Team

Figure 5-42: Steel Volume of Single and Continuous Span Truss

Table 5-36: Single and Continuous Span Truss

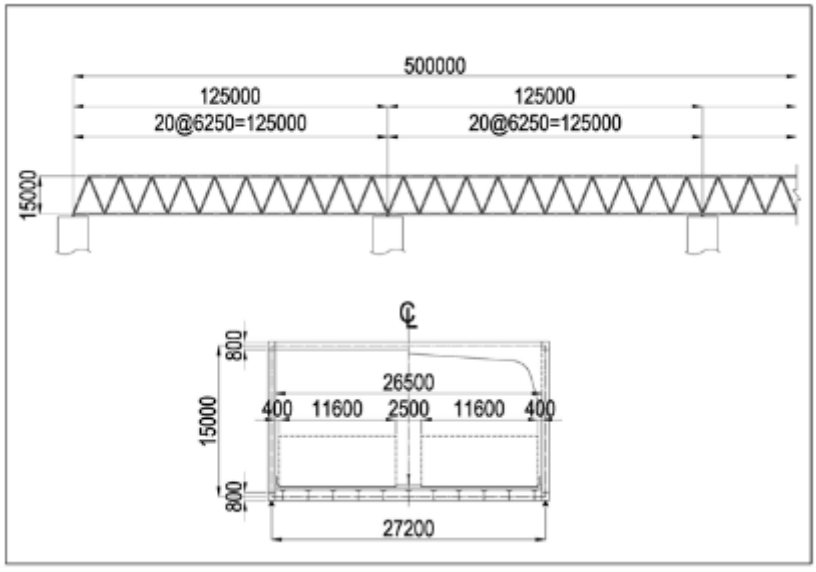
Item	Single Span Truss	Continuous Span Truss
Common Span Length	50～100 m	60～130 m
Advantage	Structure is simple.	Can reduce steel volume, number of bearing supports and expansion joints. Advantage in push-launching erection method. Slender truss lightens the weight.
Disadvantage	More steel volume is needed. More bearing supports and exp. joints are needed. Push launching erection method requires temporary connection to form continuous span truss which is more suitable for the erection method. Necessary reinforcement for erection is larger than continuous span truss.	Some members resist both tension and compression, so some sections need reinforcement due to erection.

Source: JICA Study Team

Table 5-37: Example of Steel Truss (per 125m)

Member		Steel (ton)
Main Truss	Upper Chord	179.53
	Lower Chord	165.66
	Diagonal	330.48
	Transverse Beam	73.69
	Stringer	290.14
	Portal	14.77
Others	Expansion Joint, Guardrail, Drainage	13.52
Total		1067.79

Source: JICA Study Team



Source: JICA Study Team

Figure 5-43: Model of Continuous Span Truss

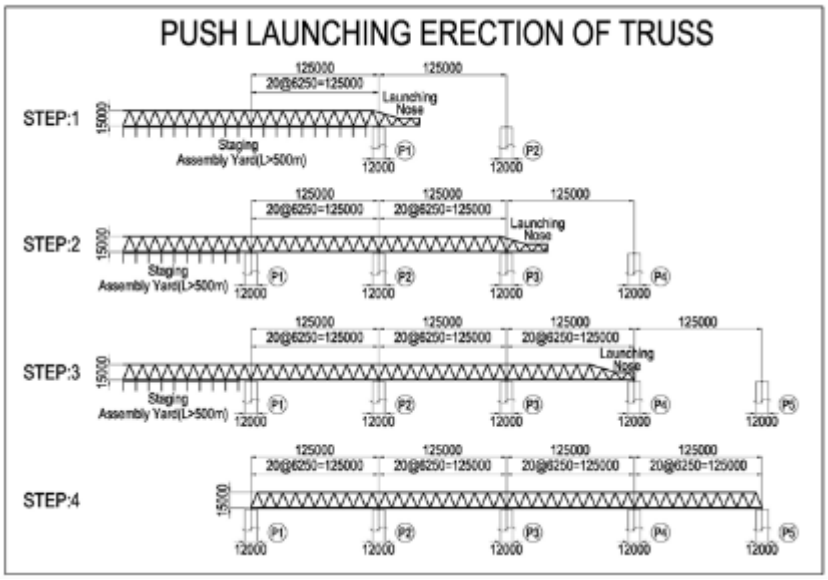
Open well is appropriate for the foundation. An open well (also called open caisson or well) is a cylindrical structure with no lids on top and bottom, it transmits the load to the supporting ground for about 20～50 meters. The construction method is done by the excavation of the inner hollow portion of the cylindrical structure whether underwater or not, if necessary, additional loads are placed while driving the caisson into the ground to reach a predetermined depth, afterwards concrete is poured.

However, since there are a lot of foundations to be built in the waterway, sandbars and shore, it would be better to adopt a construction method that can shorten the construction period. Some techniques are introduced below:

- During excavation, a high-pressure water jet discharging from a pipe attached to the tip of the well is used simultaneously with the grab bucket to accelerate the driving of open wells.
- To efficiently remove the soil underwater, use an air lift pump that utilizes buoyancy.
- Use water-insoluble type concrete during underwater concrete pouring for efficient construction.
- To ease the construction in deep water, use installed caisson method for open wells.

B) Steel Truss Bridge Construction Plan

Members of steel truss are fabricated at temporary site shop on the Dhubri side. Steel plates are transported by railway to the nearest railway station from where trailer trucks or other vehicles transport it to the site shop. Assembly yard is secured by the approach viaduct in Dhubri, and two assembly lines are prepared to erect trusses continuously. The length of the temporary erection nose is affected by the size of truss reinforcement, and determined during the detail design stage. The erection procedure of push launching erection method is illustrated in Fig. 5-41 and the construction schedule is shown in Fig. 5-43.



Source: JICA Study Team

Figure 5-44: Push Launching Erection of Continuous Span Truss

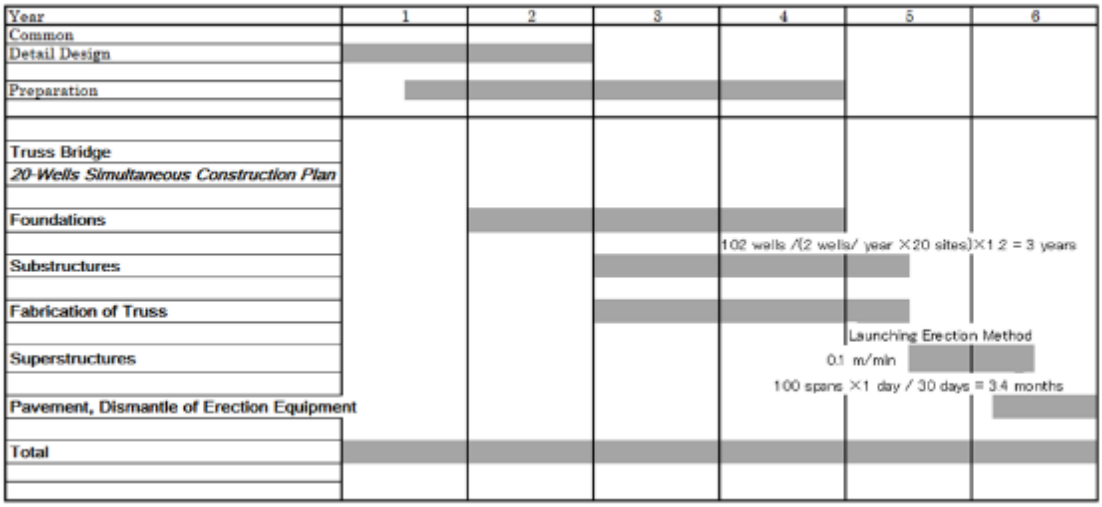
C) Impact to Viaducts

If steel truss is applied to the navigation portion, it is preferable to change the viaduct at Dhubri to steel truss due to the execution of push launching erection method. The same change of viaduct at Phulbari can make the entire erection procedure more simple. Of course, it is possible to not change

the structure of Phulbari viaduct to follow the DPR planning. The type of superstructure of viaduct can be decided during the detail design stage.

Source: JICA Study Team

Figure 5-45: Example of Push Launching Erection



Source: JICA Study Team

Figure 5-46: Construction Period of Continuous Span Truss

Table 5-38: Truss Type of Superstructure

	Viaduct Portion	Navigational Portion
Type of Superstructure	Truss	Truss
Span length	60m	125m
Erection Method	Push launching Erection	Push launching Erection
Construction Period	Shorter construction period than DPR	Shorter construction period than DPR
Cost	Due to steel bridge, superstructure is expensive and foundation/substructure is economical.	Due to steel bridge, superstructure is expensive and foundation/substructure is economical.
Evaluation	Shorter construction period is possible	Shorter construction period is possible

Source: JICA Study Team

D) Comparison of PC Box Extradosed Bridge and Steel Truss Bridge

From the above study, the comparison of plans of DPR and JICA Study Team is summarized in Table below. Because Dhubri Bridge is a long bridge, the type of superstructure should be selected by considering not only rationality of structural type and construction cost, but also construction method and construction period as well.

Table 5-39: Comparison of Bridge Planning

Item	DPR	JICA Study Team
Type of Superstructure	PC Box Girder (59@60m = 3,540m) Extradosed Bridge (101@125m = 12,625m) PC Box Girder (36@60m+35m =2,195m)	Continuous Span Truss (60@60m = 3,600m) (100@125m =12,500m) (37@60m+40m =2,260m)
Erection Method	Span-by-Span (Viaduct) Balanced Cantilever Erection	Push Launching Erection
	Erection from each pier	Launching from Dhubri side
Construction Cost	1.00	1.15
		Based on Japanese design method
Advantage	Economical. Design is completed.	Possible to reduce construction period. Possible to minimize erection work of superstructure in the river. Indian truss bridge technology is improved.
Disadvantage	Management of simultaneous construction at many sites is necessary. Difficulty in transportation. Transportation to Phulbari is unavoidable.	High construction cost. Design of truss bridge is needed.

Source: JICA Study Team

CHAPTER 6 PRELIMINARY PROJECT COST ESTIMATES

CHAPTER 6 The information related to bidding has been deleted.

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Introduction

7.1.1 Background of the project

In India, roads are one of most important modes of ground transportation as they constitute 85% of passenger transportation and 60% of freight transportation in India. However, the development of the road network in mountainous regions of the Northeastern Region of India has been much worse than the rest of the country. This is due to financial and technical reasons. Thus, the Northeastern Region has suffered greater economic disparity compared to other regions.

While 63.4% of the roads in India have been paved, only 28.5% of the roads in Northeastern Regions are paved, out of which only 53% of the national highways are more than 2 lanes. This is because the Northeastern Region is located far from the major areas of India. Furthermore, the roads leading to neighboring countries have been underdeveloped due to security concerns.

The severe natural conditions of the Northeastern Region featured by steep mountains and a prolonged monsoon season have also been obstacles for appropriately developing the road network. Economic growth in this part of the country has therefore been very delayed. The regional connectivity of the road network should promote cross-border trade and commerce and help safeguard India's international borders. This would lead to the formation of a more integrated and economically consolidated South and Southeast Asia. In addition, there would be overall economic benefits for the local population and would promote the integration of the peripheral areas.

The approximate aggregate length of 10,000km of road in the Northeastern Region has been identified for development. The development of the road network envisages creating customized and specialized skills addressing issues like the complexities of geographical terrains and the extensive coordination with the central and state governments.

The Government of India (GOI) thus launched in recent years the "Special Accelerated Road Development Program for Northeastern Region" for which improvement of the road network is of great importance. The GOI stated in their "Twelfth Five Year Plan (from April, 2012 to March, 2017)" that the improvement of national highways in the Northeastern Region should interconnect major cities within the region. It is within this context that the GOI requested that the Government of Japan provides assistance in the carrying out of the design work of two/four lane bridge including approaches over river Brahamputra between Dhubri on the north bank and Phulbari on the south bank in the State of Assam / Meghalaya on NH-127B (length of 20km).

7.1.2 Outline of the Project

The proposed Dhubri bridge will cross the Brahmaputra River and will be a 20-km long, four-lane bridge connecting Dhubri in the Assam State on the north bank and Phulbari in the Meghalaya State on the south bank. The construction site extends over two states, the Dhubri District on the north bank and the South Salmara-Mankachar District on the south bank belong to Assam State and the West Garo Hills Distrct belongs to Meghalaya State. It extends from the starting point (89 ° 55 '45.68 "E & 26 ° 2' 10.49" N) towards the southeast, crossing over the Brahmaputra River and some of the sandbars reaches the south end point (90 ° 1 '59.11 "E & 25 ° 53' 25.98" N).
The locality is a flat lowland with an altitude of 35 m to 42 m. Approximately 500 km from the mouth of Brahmaputra river, annual flow rate 571 × 109 m 3, flow rate 18,099 m 3 / s, flow rate varies greatly in the rainy season dry season and place, but on average 1 m / s in the vicinity of Duburi, the water depth at the deepest part across the bridge is about 10 m in the rainy season about 4 meters in dry season. The banks are naturally sloped towards the river. The yearly sediment load of the Brahmaputra River is 800 million tons. The sandbars are made of sand accumulated by the flooding of the river, and thierlocations and sizes are not constant due to hydrodynamic activity of the river. Some of the sandbars are inhabited by the local people conducting mainly agriculture,

farming, fishingetc. Currently 20 to 30 small boats operate between Dhubri and Pulbari and to carry people and goods, but the time required to cross the river is about 2.5 hours.

A new bridge connecting Dhubri and Phulbri across the Brahmaputra river will improve the connectivity of the road and is the most important section. The construction of the new bridge will further connect the southwestern region of Meghalaya State and other parts of India at the shortest distance, and will greatly expand the transportation network of this region.

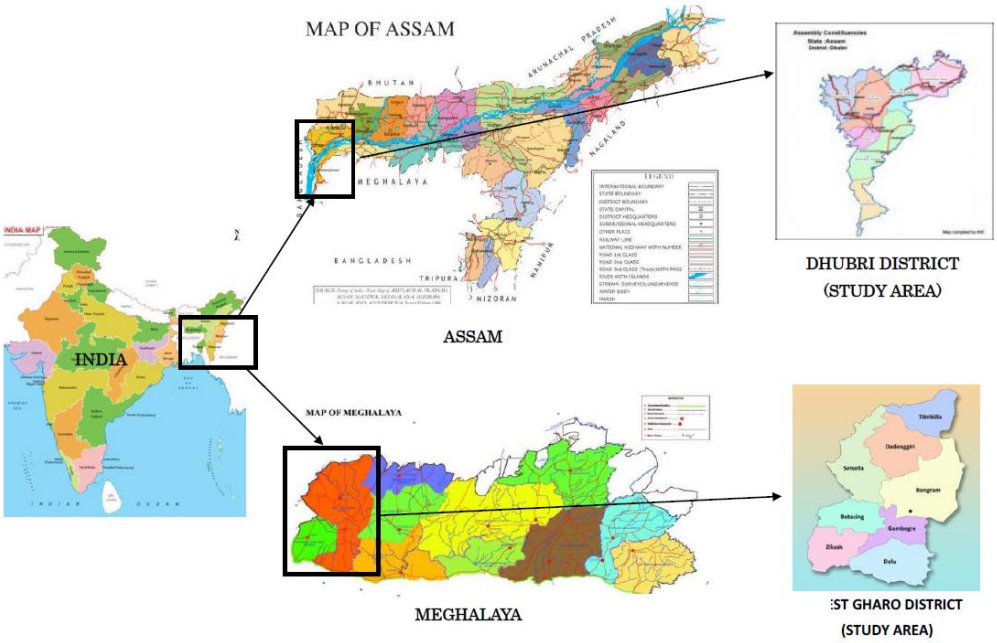


Figure 7-1 Project Location

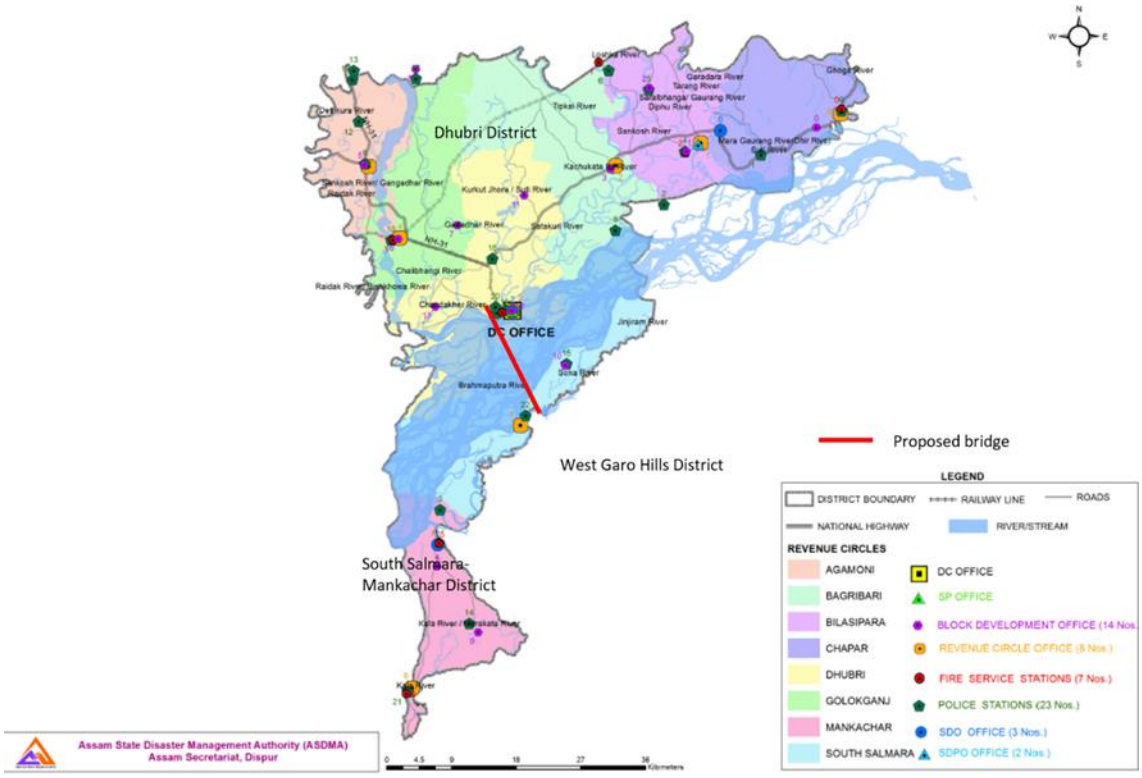


Figure 7-2 Project Site

7.1.3 Background and Purpose of the Study

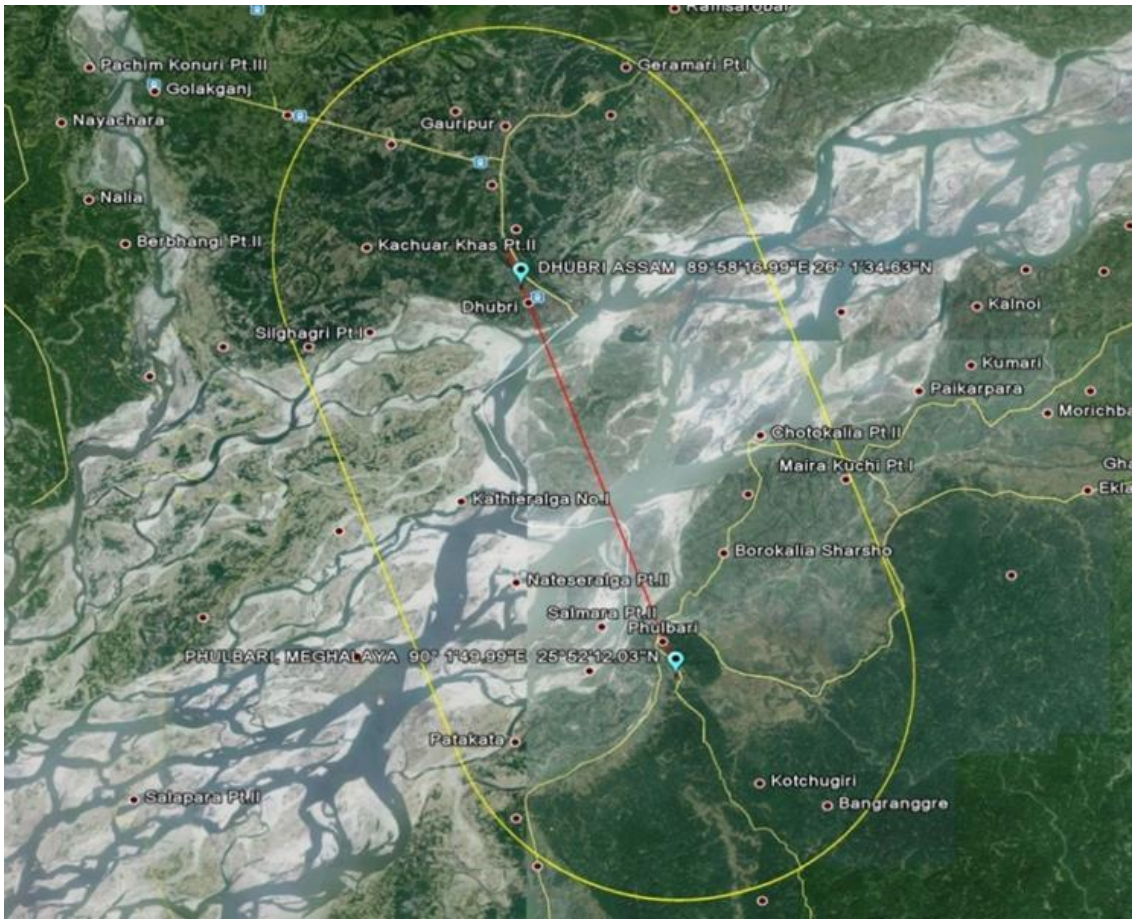
As per the MOEF & CC EIA Notification, dated 14.09.2006 (as amended in August 2013), any highway project falls under Category A if the project entails:
1) New National Highways; and
2) Expansion of National Highways greater than 100km involving additional right of way or land acquisition greater than 40m on the existing alignments and 60m on re-alignments and bypasses.
The proposed Dhubri-Phulbari Bridge project does not require additional land acquisition beyond 60m and has length of approximately 20kmkm. and therefore, does not attract the provisions of the EIA Notification of 2013.

While a DPR consultant undertook a preliminary environmental assessment during the preparation of the DPR for Dhubri-Phulbari Bridge, the project does not require environmental clearance from MOEF & CC. On the other hand, the project has been classified as Category A per JICA's Guidelines for the Environmental and Social Considerations and the project requires a full EIA study including SIA and RAP surveys. It is therefore the JICA Study Team's obligation to carry out EIA/SIA/RAP studies, which supplement the environmental studies carried out by DPR consultants. Thereby additional requirements short of JICA's guidelines are fulfilled.

7.2 Scope of the Study

7.2.1 Geographical Extent

The geographical extent of this study is the area within a 10km radius of the proposed bridge alignment as shown in the Figure below.



Source: JICA Study Team

Figure 7-3: Geographical Extent of the Environmental Study

7.2.2 Contents of the Study

The EIA/SIA/RAP studies carried out by JICA Study Team aimed to:

- Review the environmental assessment undertaken as part of the DPR study;
- Study the legal framework and roles of relevant institutions regardning Enivornmental Clearance and Involuntary Resettlement in India
- Identify gaps between Indian laws and regulations relating to the EIA study and JICA Guidelines for Environmental and Social Considerations;
- Study the baseline of social and environmental conditions along the areas directly and indirectly affected during design, construction operation and maintenance of the NH40 widening project;
- Carry out an analysis of alternatives including a comparison with a "no project' scenario;
- Carry out environmental impact analysis with respect to the proposed project;
-
- Develop measures for mitigating adverse environmental and social impacts and enhancing positive aspects;
- Develop an Environmental Management Plan (EMP) for the mitigation of environmental impacts and the monitoring of the implementation of mitigation measures during the operation and maintenance period;
- Consult and inform the project affected persons (PAPs) and other stakeholders concerned with the project to encourage their active participation.

In addition, the RAP survey covers the following items.
(1) Analysis of the legal framework relating to resettlement
(2) Necessity of resettlement
(3) Implementation of socioeconomic surveys (population census survey, property / land survey, household / living survey)
(4) Compensation for loss of assets, income restoration measures
(5) Preparation of resettlement site plan (if necessary)
(6) Review of grievance redress mechanism
(7) Examination of implementation system
(8) Review of implementation schedule
(9) Examination of cost and financial resources
(10) Review of monitoring system
(11) Support for implementing public consultations

7.2.3 Principles of the Study

(1) Study Components of Natural Environment and Socio-economic Environment

This bridge construction project entails to some extent a negative impact on the natural environment as well as a social impact including a relatively large scale resettlement. The survey covers not only direct and immediate impact but also secondary and cumulative impacts in accordance with JICA guidelines. The survey items include air, water, soil, waste, ecology, involuntary resettlement, the poor, livelihood, occupational safety, etc.

(2) Legal Framework Related to the Project

The legal framework and principles adopted for environment and social consideration of the project have been guided by the existing legislation and policies of the Government of India (GOI), the State Government of Assam and Meghalaya. Since the project is considering getting assistance from JICA, the regulatory/legal framework should be consistent with the national, state, local, as well as JICA Guidelines for Environmental and Social Considerations.

(3) Scope of Resettlement

This project extends to two states, the Assam and Meghalaya states, across the Brahmaputra River. The Char lands (sand bars) in the Brahmaputra River which belong to the Assam state will also be within the scope of land acquisition and resettlement. The Char lands are unique in that the shapes change according to the changes in water level. The area of the Char lands becomes smaller due to a rise in water level during the rainy season (May to October) and expands in dry season (November to April). In this survey, a census survey was carried out based on the list of villages and land plots prepared by the district governments from the land acquisition map produced by DPR consultant (prepared in June 2016). A Resettlement Action Plan (RAP) will be prepared in accordance with relevant Indian laws and regulations, World Bank's safeguard policy and JICA guidelines.

7.3 Baseline Condition of the Natural and Social Environment

7.3.1 Natural Environment

(1) Climate

The **Dhubri district** enjoys a subtropical humid climate with temperatures ranging between 10.5°C (minimum, in December/January) and 30°C (maximum, in July/August). A south west monsoon activates from May and continues up to September/October. The average annual rainfall of the district, as recorded in Dhubri, is 2,363mm with about 65% of rainfall occurring during the

monsoon. The monthly evapotranspiration is about 40% of the rainfall, with the highest in August and lowest in January.

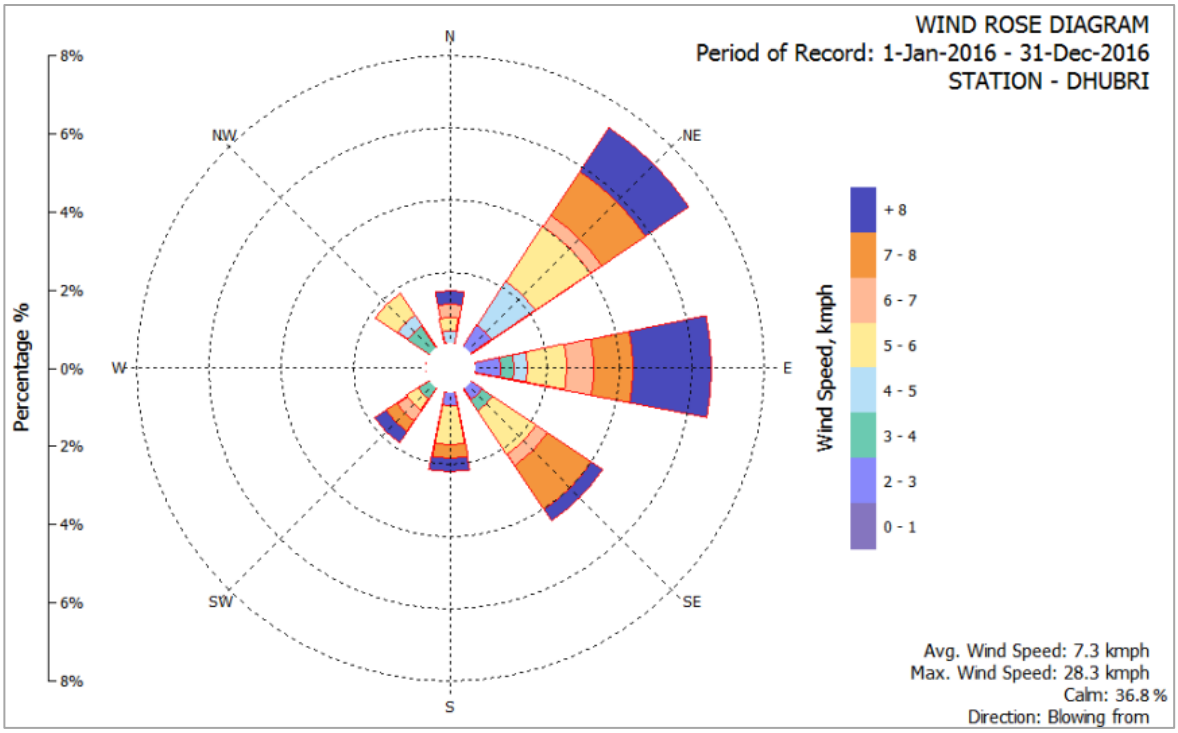
The **West Garo Hills** district has a mildly tropical climate. The climate of the district is largely controlled by the southwest monsoon and seasonal winds. The district being relatively lower in altitude compared to the rest of Meghalaya, experiences a fairly high temperature for most of the year. The average rainfall is 4203.8 mm, of which more than two-thirds occurs during the monsoon, with winter being practically dry. The district receives fairly high rainfall throughout the year. Most of the precipitation occurs during the rainy season, i.e. between April and October, due to the southwest monsoon. The average rainfall recorded at the Tura meteorological station is presented in the Table below.

Generally, light to moderate winds prevail throughout the year with speeds ranging from 1 to 26.5kmph. Winds were light and moderate particularly during the morning hours, while during the afternoon hours the winds were stronger. The wind rose diagram developed during October - November (2016) shown in Figure 7-1 reveals that the pre-dominant wind direction occurs from the north-east direction in the Dhubri district with an average wind speed of 7.2 kmph.
The following Table 7-2 shows the Meteorological Data Parameters in the Dhubri district (January – December 2016).
The wind speed and direction data have been collected for Guwahati from the Indian Metrological Department (IMD) during January - December 2016 and wind rose diagram has been prepared and shown in Figure 7-1.

Table 7-1: Meteorological Data Parameters at Dhubri district (January – December 2016)

Date	Temperature, deg C			Humidity, %			Pressure, hPa			Wind Speed, km/Hr	Predo-Minant Wind Direction	Rainfall mm
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Avg		
January	9.3	26.3	17.8	63	86	74.5	1009.7	1013.6	1011.65	4.8	NE	6.7
February	10.2	30.2	20.2	52	76	64	1007.1	1013.4	1010.25	5.6	N	6.6
March	13.4	35.8	24.6	48	68	58	1003.9	1011.2	1007.55	7.7	E	42.5
April	17.2	36.7	26.95	62	74	68	1000.9	1008.6	1004.75	11	NE	133.2
May	19.2	35.3	27.25	75	82	78.5	998.3	1005.7	1002	10.1	NE	340.4
June	21.7	35.2	28.45	83	89	86	995.2	1002.3	998.75	8.6	E	514.2
July	22.8	34.1	28.45	54	87	70.5	994.7	998.2	996.45	6.9	E	432.5
August	23.4	34.2	28.8	52	85	68.5	996.2	997.6	996.9	6.6	NE	368.2
September	22.3	24.5	23.4	86	83	84.5	999.5	1003.2	1001.35	6.4	NE	263.7
October	19.5	32.6	26.05	78	84	81	1004.5	1006.1	1005.3	6.9	NE	140.5
November	14.1	29.3	21.7	72	82	77	1007.5	1011.3	1009.4	7.4	NE	18.7
December	10.5	25.8	18.15	66	86	76	1008.6	1013.2	1010.9	5.7	NE	3.4

Source: IMD



Source: IMD

Figure 7-4: Wind Rose Diagram

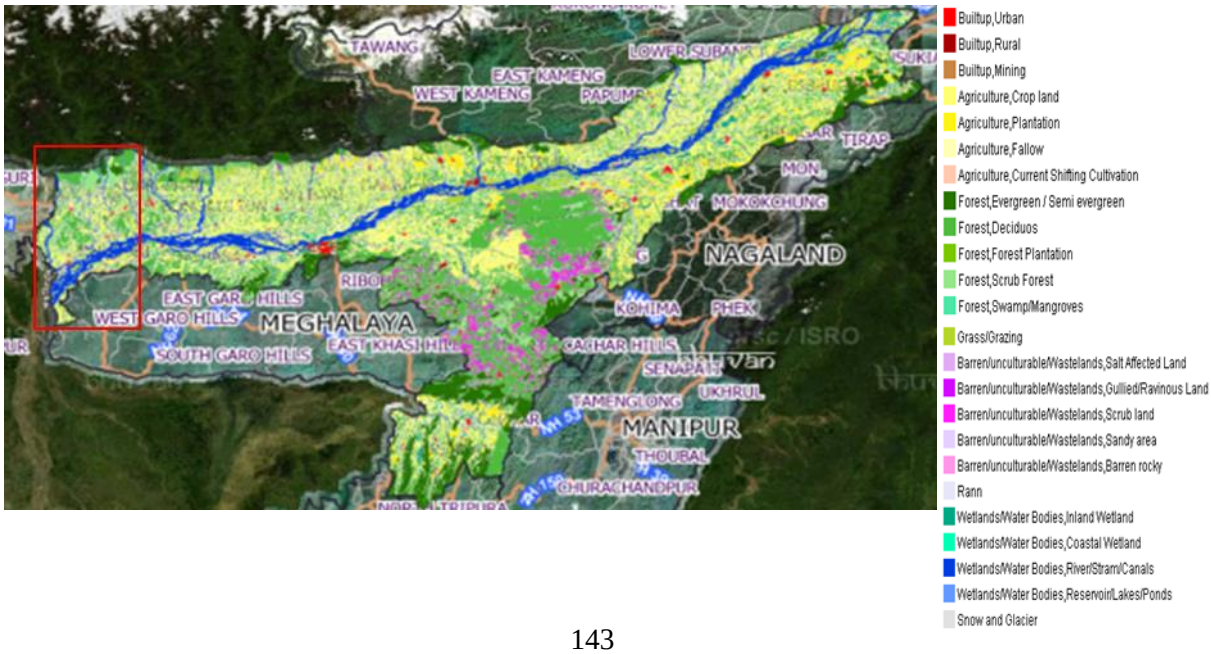
Table 7-2: Precipitation of West Garo Hills District in (mm)

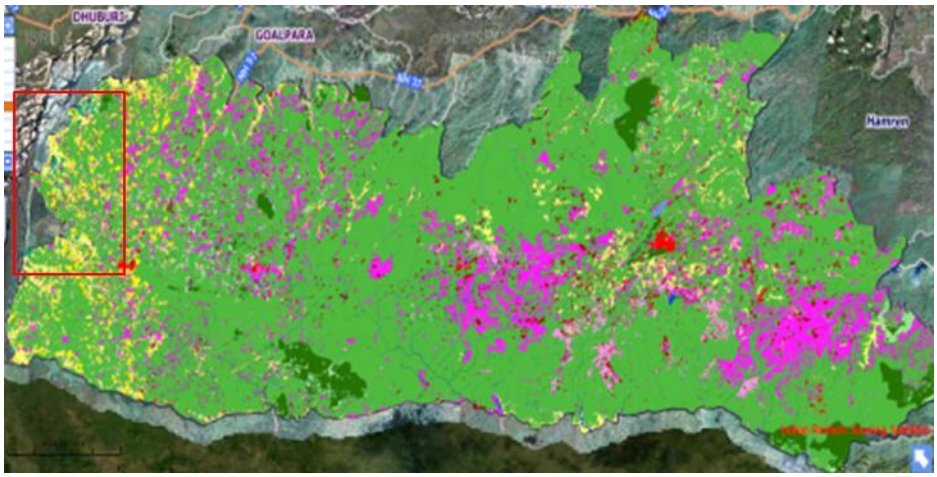
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
22.1	14.7	105	269	514	889	910	643	502	298	13.3	24.2	4203.8

Source: http://cgwb.gov.in/

(2) Land Use

Current land use of the project's surrounding areas in Assam and Megalaya State is shown in the following Figure. The majority of the areas in both Assam and Megalaya State are agriculture land (yellow), forest deciduous (light green) and wastelands/shrublands (pink).

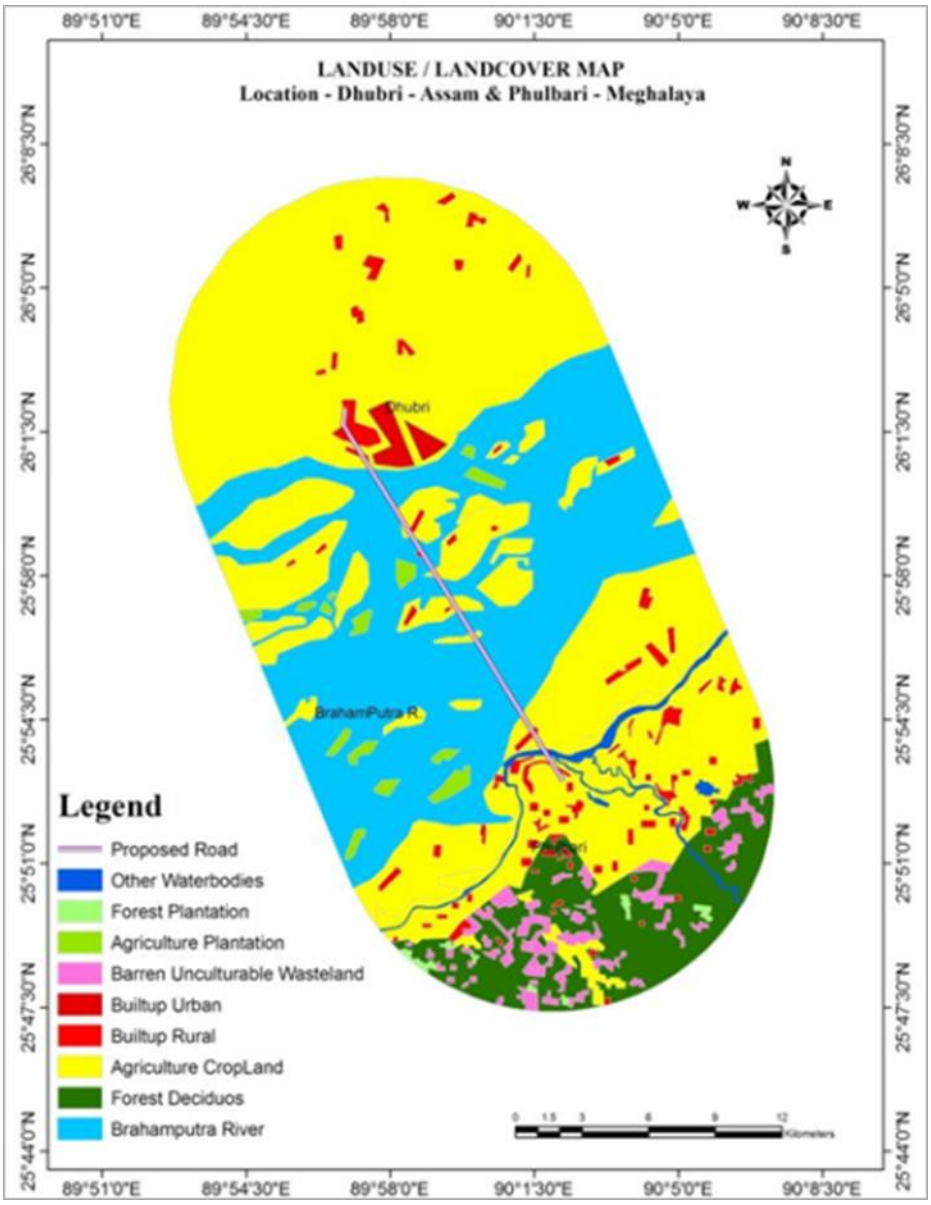




Source: bhuvan.nrsc.gov.in

Figure 7-5: Land Use of Assam and Meghalaya State

Figure 7-4 and Table 7-3 show the land use of a 5km radius of the project site. The area is composed of 45% agricultural land (yellow), 35% Brahmaputra River (light blue) and build up areas including residential structures (red) remains at 4%. The starting point of the approach road in the Dhubri District is planned to pass by the side of the residential area.



Source: Prepared by EIS based on Resourcesat I LISS-III

Figure 7-6: Land Use Pattern in 10km radius of the Project Area

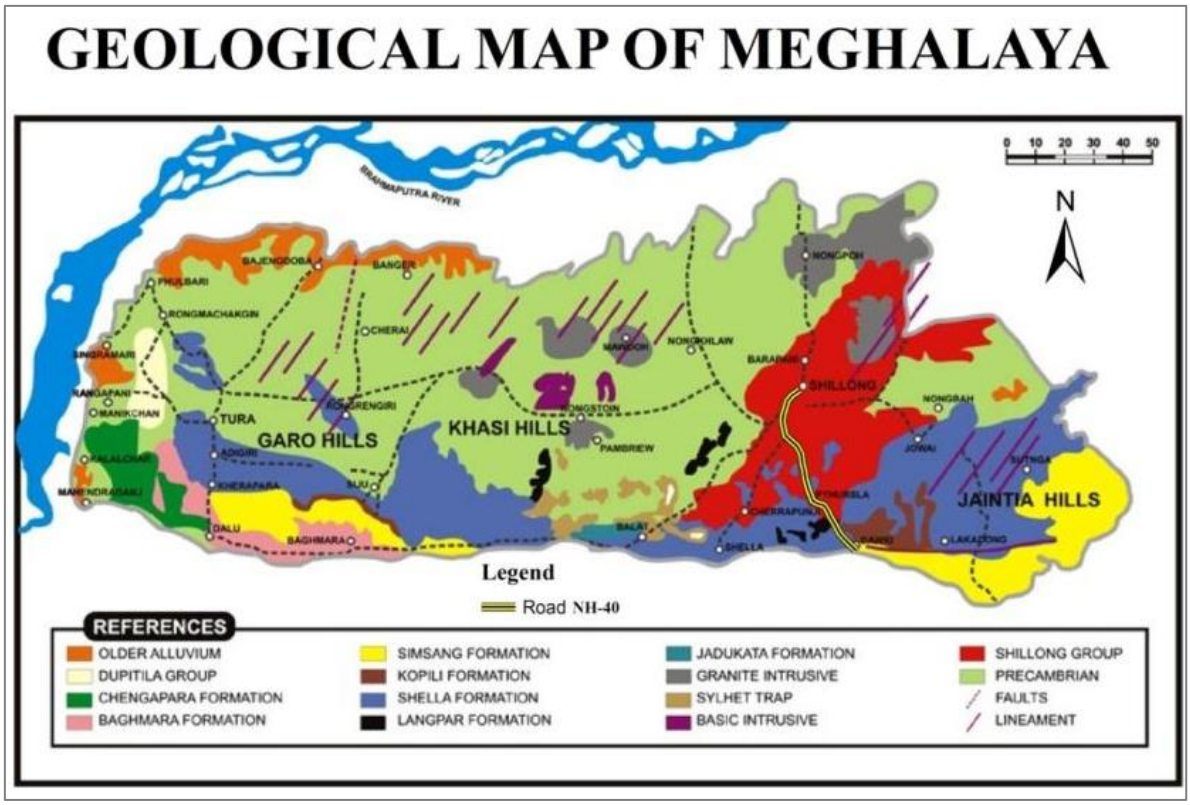
Table 7-3: Breakdown of the Land Use Pattern in 10km radius of the Project Area

Sl.No.	Land Use Class	% of Class
1	Proposed bridge	0.5%
2	Other Water bodies	1.5%
3	Forest Plantation	2.0%
4	Agriculture Plantation	2.0%
5	Barren Unculturable Wasteland	3.0%
6	Built up Urban	2.0%
7	Built up Rural	2.0%
8	Agriculture Crop Land	45.0%
9	Forest Deciduous	7.0%
10	Brahamputra River	35.0%

Source: Prepared by EIS based on Resourcesat I LISS-III

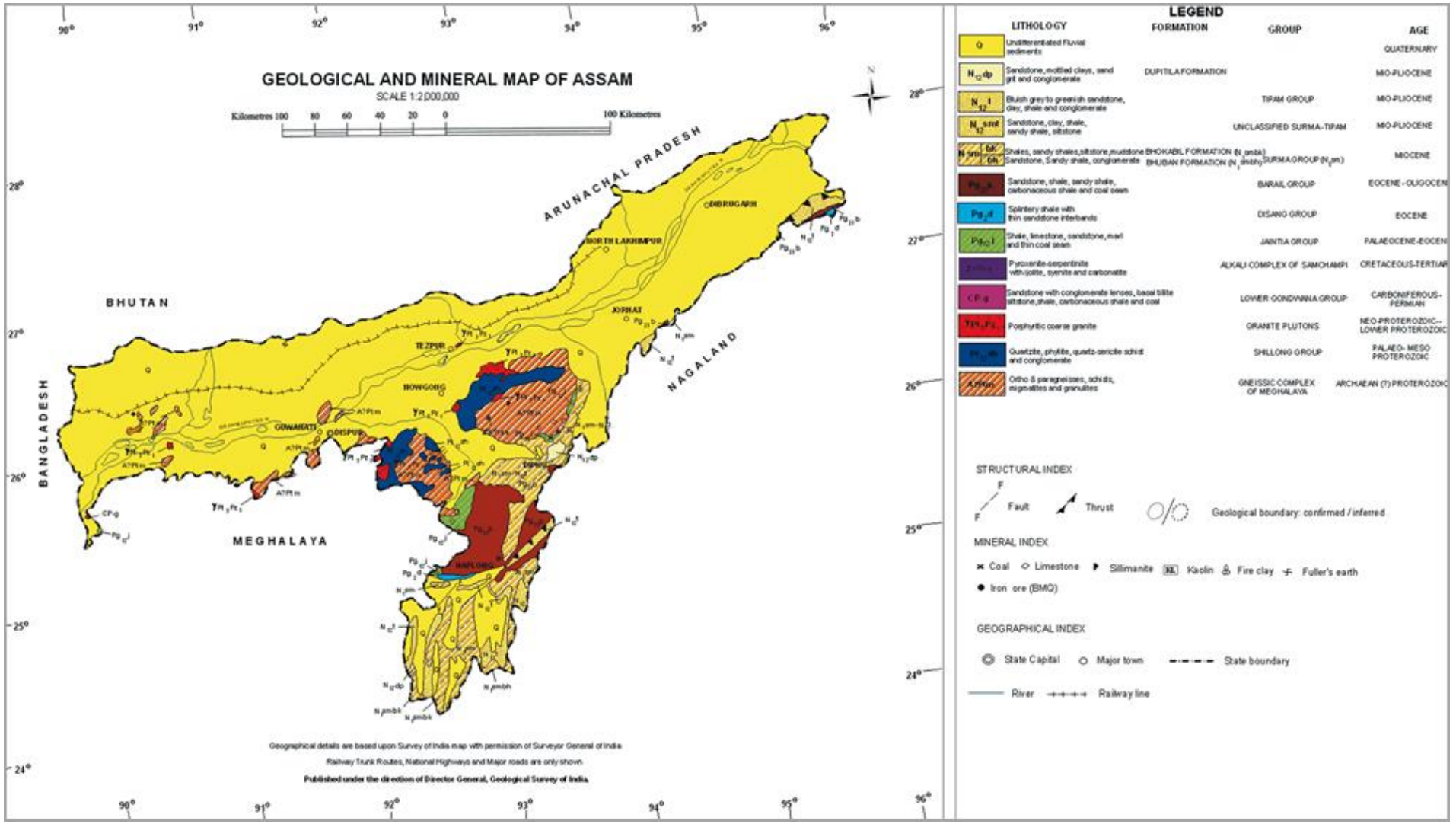
(3) Geology and Geography

The proposed bridge alignment passes over the river Brahamputra between Dhubri on the north bank and Phulbari on the south bank in the State of Assam and Meghalaya. The topography of the Dhubri/ South Salmara - Mankachar district is very peculiar. It has many rivers, small ranges of hillocks as well as several natural depressions. Physically, the greater part of the district is levelled plain land. Whereas in the West Garo Hills district with its undulating topography, the district constitutes the vast alluvial plains of the Brahmaputra River system. The monotony of the flat alluvial tract is interrupted by the presence of Archaean inliers in the form of disconnected hillocks referred to as inselbergs, and these occur especially in the eastern and southern parts of the district. Precambrian formation and fluvial sediment is dominant around the project area.



Source: Department of Mining & Geology, Government of Meghalaya

Figure 7-7: Geological map of Meghalaya



Source: Department of Mining & Geology, Government of Assam

Figure 7-8: Geological map of Assam

The Soil type of an area is dependent on factors like geology, relief, climate and vegetation. The soil of the Dhubri/South Salmara - Mankachar district has been found to be heterogenous in character. The majority of the places, particularly the riverine identifies that loamy to sandy-loam soil is predominant. In some areas, clay to heavy clay soil are also present. Soil reaction is acidic and found to vary from 5.6 to 6.5 in pH scale. Whereas in greater parts of West Garo Hills district Soils are sandy and silty loam, or clay loam. It is found to be highly acidic to slightly alkaline in nature, is moderately permeable and characterised by the presence of low organic carbon and low soluble salts. Soils restricted to inselberg areas are more clayey, lateritic, less permeable and are highly acidic in nature. From an agricultural point of view, the soils in major parts of the area are suitable for all sorts of crops cultivation.
In the proposed Dhubri – Phulbari bridge of the study area, loamy to sandy-loam soil is predominant. In some areas, clay to heavy clay soil also present.

(4) Geohydrology

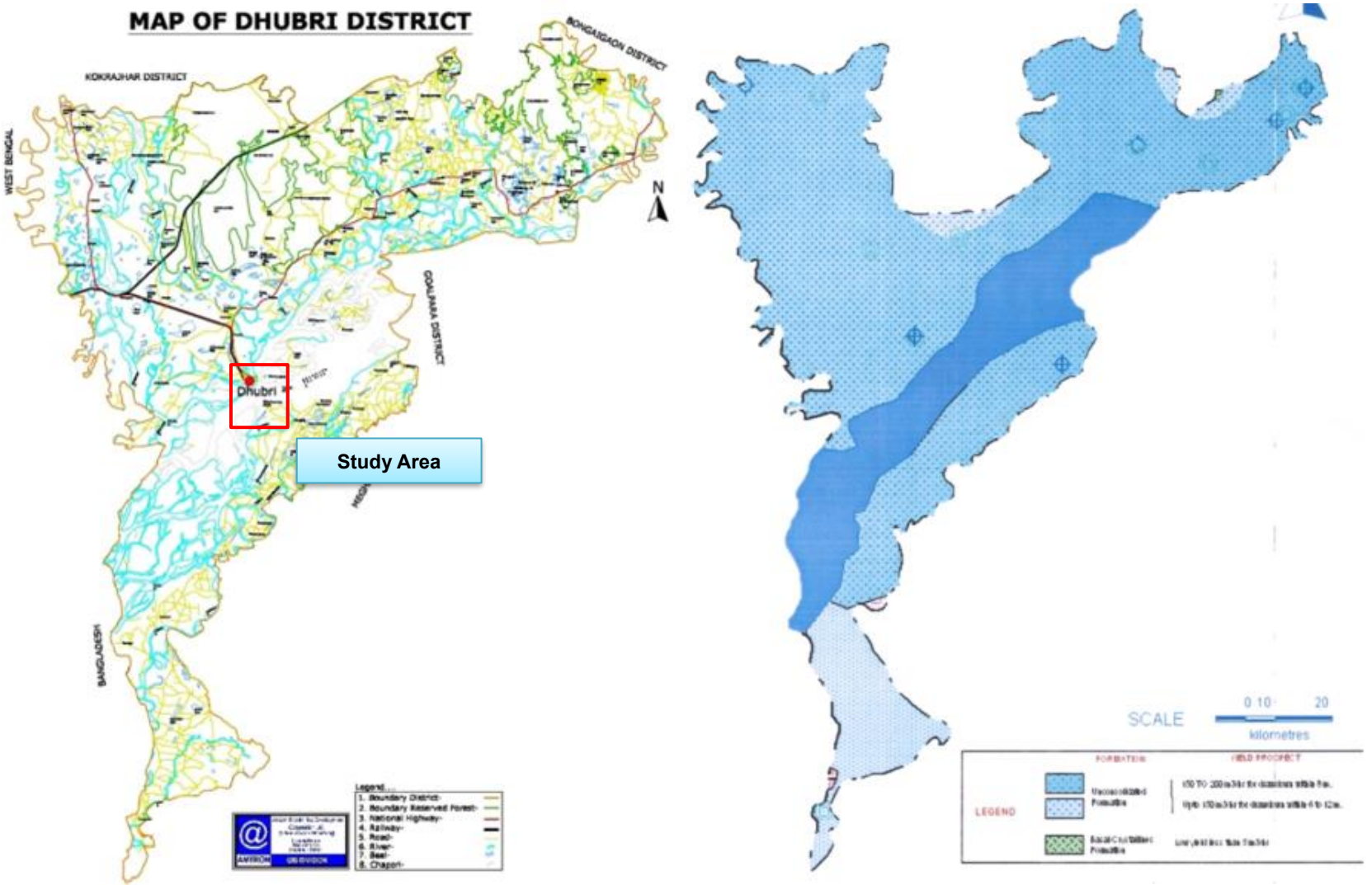
The Dhubri / South Salmara-Mankachar district covers an area of 1664.10 sq.km. It is situated in the extreme south-west corner of the state and has an international boundary with Bangladesh in the west and south west and is bounded by the Kokrajhar district in the north, Goalpara district in the east and north-east, the Garo Hills district of Meghalaya in the south and the Kochbehar and Jalpaiguri districts of West Bengal in the north-west.

Surface Water source in the Dhubri / South Salmara - Mankachar District:
The district spreads on both sides of the Brahmaputra River. A number of perennial streams flow through the district from north to south and join the Brahmaputra River. The major streams that drain the area are the Gadadhar, Sankosh, Silai and Gouranga Rivers. A River map showing the regions of Dhubri and South Salmara – Manakchar is given below in Figure. 7-7.

Ground Water source in the Dhubri / South Salmara - Mankachar District:
Ground water conditions in the district can be described using either of two distinct hydrogeological units, i.e. conditions prevailing in the consolidated formations, and the conditions prevailing in the unconsolidated formations. The net ground water availability estimated in the year 2009 is 1635.61 mcm. The existing gross ground water draft is 181.12 mcm and the stages of development are 11% only. Future provision for domestic and Industrial use is 65.35mcm and for Irrigation use is 1432.85 mcm. A Hydrogeological map showing the regions of Dhubri and South Salamara - Manakchar is given below in Figure. 7-7.

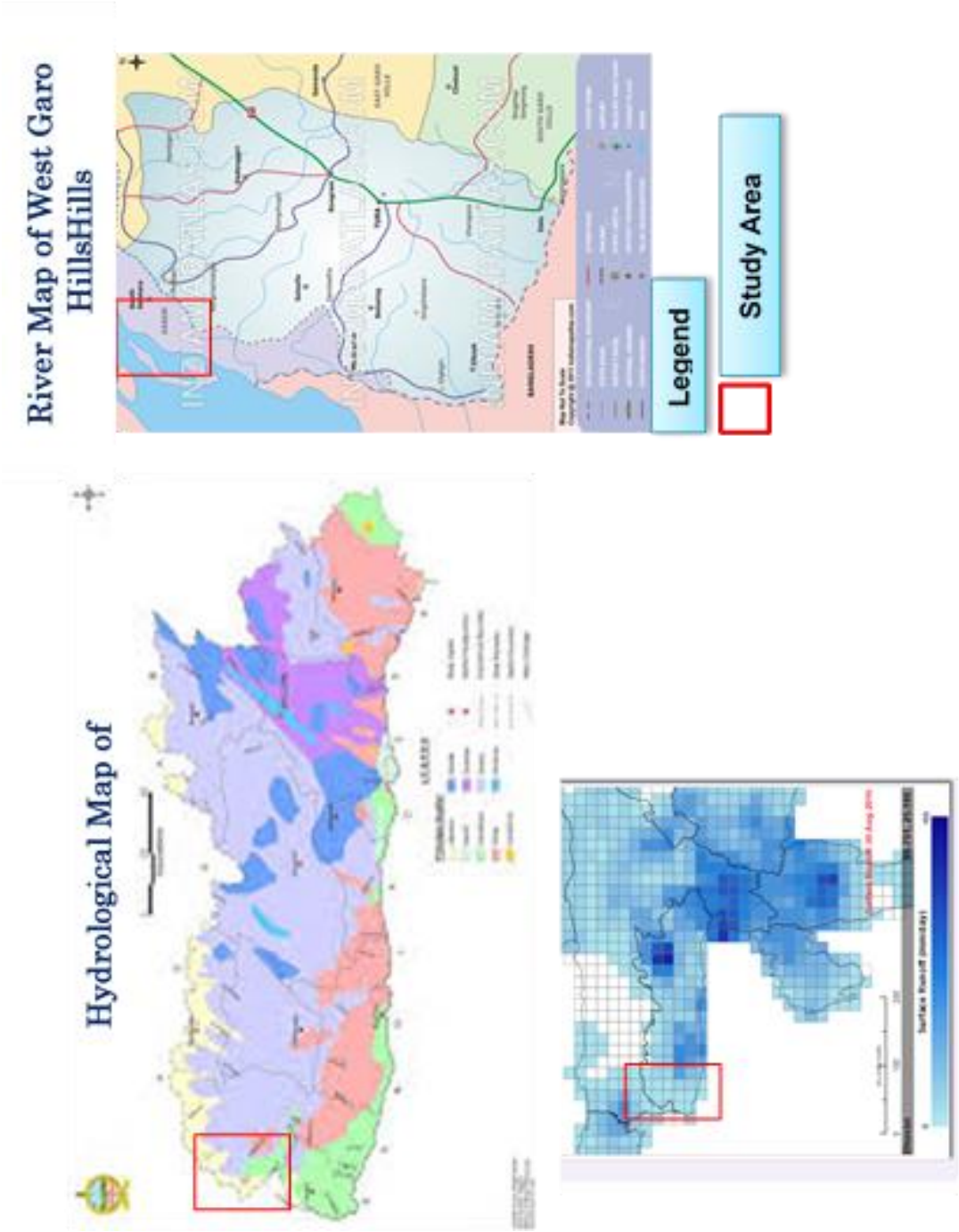
Surface Water source in the West Garo Hills District:
The topography controls the drainage system as it divides the state into two watersheds, namely the **Brahmaputra system** in the North and the Meghna /Surma system in the South. The Tura system range from watersheds in the West Garo Hills district, from which the rivers flow towards the Bangladesh plains in the south and the Brahmaputra valley in the north and west. A River map showing the regions of West Garo Hills district is given below in Figure. 7-8.

Ground Water source in the West Garo Hills District:
Hydro-geologically, the district can be divided into three units, namely, consolidated, semi consolidated and unconsolidated formations. The depth of the water level varies from 0.53 m bgl to 8.3 m bgl. The aquifer comprises sand and sand with gravel, while clay forms leaky aquitard. The maximum cumulative aquifer thickness is encountered around Ichaguri, Borkona, Barengapara and Betasing in alluvial areas of the West Garo Hills district. The granitic basement is encountered at a very shallow depth (less than 50 m.bgl) in the northern part of the district, while in the western and southern part of the district; basement has not even met a depth of 225 m.bgl. A Hydrogeological map showing the regions of the West Garo district is given below in Figure. 7-8.



Source: http://dhubri.gov.in/DMPLan & http://cgwb.gov.in

Figure 7-9: River Brahamputra and Geohydrological Map of Dhubri District in Assam



Source: http://cgwb.gov.in & http://bhuvan.nrsc.gov.in/

Figure 7-10: Geohydrological & River Map of West Garo Hills, Meghalaya

(5) Ecology

Interviews with the DPR Consultants and Dhubri District Forest Department have confirmed that there are no national parks, nature reserves or protected forests around the planned site of construction. The land portion of the Study area is mainly used as an agricultural land and residential area, so there is no primary forest or pristine ecosystem. However, the Brahmaputra River is a habitat for the Ganges river dolphins, and several of them were observed during the field survey.

The Ganges River dolphin belongs to the Platanistidae Family, and inhabits freshwater areas. Internationally it is a protected organism classified as Endangered in the IUCN Red List and further described in the CITES Appendix I. In India, it is designated as a protected species (Schedule I) by the Indian Wildlife Law (1972), and it is positioned as a National Aquatic Animal as a symbol of India. Its habitat extends to four countries- India, Bangladesh, Nepal and Bhutan; and lives only in limited areas of the Ganges River, Brahmaputra River, and its tributaries (the Meghna River, Karnaphuli River, Sangu River, etc.). The number of inhabitants in the whole world was estimated to be 4,000 to 5,000 in the 1980s, and 2000 in the 1990s; but it is estimated to have been about 1,200 in 2012, the decrease remarkable. The main reasons for the decrease in population are the loss of species that act as prey to the dolphins due to poaching, bycatch, over catching, water pollution, and division of habitat due to dam construction and topography modification of the river through inflow / extraction of sediment.

For the sake of aquatic organisms living in the Brahmaputra river including in the Ganges Dynasty, it is necessary to carefully examine the impact of the implementation of the project, especially after conducting detailed surveys in the future.

7.3.2 Living Environment

(1) Water Quality

There are many low wetlands around the planned construction site, and the Brahmaputra River which also boasts abundant water flow also flows. The turbidity of the Brahmaputra River was very high at the time of field survey in October 2016. As seen in other states in India, unprocessed domestic wastewater flows into the Brahmaputra River, and there are the residents who are bathing in the river and washing. As a result, some degree of artificial contamination (especially organic matter, etc.) is occurring. Sampling and analysis of the surface water and groundwater was conducted by the DPR survey in March 2016, and the results are shown below. The number of microorganisms exceeds the environmental standard, but others are within the reference value.

Table 7-4: Results of Water Quality Analysis

Sl. No.	Parameter	Unit	CPCB standard for drinking water (desirable limit/ permissible limit)	Chagalchora Bore Well (Ground Water)	Motichora Handpump (Ground Water)	Motichora Brahmaputra (Surface Water)	Savodari Handpump (Ground Water)	Chaitarchar Brahmaputra (Surface Water)
1	Temperature	C	-	22.0	22.6	23.8	23.0	23.0
2	pH value	-	6.5 – 8.5/no relaxation	7.38	7.20	7.56	7.52	7.72
3	Conductivity	µS/cm	-	571.47	593.23	185.09	559.80	182.26
4	Total dissolve solid (TDS)	mg/l	500/2000	371.45	385.60	120.31	363.87	118.26
5	Dissolve Oxygen	mg/l	-	4.3	4.2	6.1	4.8	6.8
6	Turbidity	NTU	5/10	<1.0	<1.0	1.0	<1.0	1.2
7	Salinity	ppt	-	4.8	4	3.8	4	4
8	Alkalinity	mg/l	-	212	221	68	203.90	66
9	Calcium as (CaCO3)	mg/l	75/200	162	192.84	50.3	173.60	48.8
10	Magnesium As (CaCO3)	mg/l	-	35.6	27.16	16.59	25.40	17.2
11	Total hardness as (CaCO3)	mg/l	200/600	197.60	220.0	66.89	199.0	66.0
12	Chloride as (Cl)	mg/l	250/1000	26.80	26.4	0.19	29.70	0.21
13	Iron (as Fe)	mg/l	0.3/1.0	0.238	0.261	0.258	0.252	0.261
14	Manganese (as Mn)	mg/l	0.1/0.3	BDL	BDL	BDL	BDL	BDL
15	Arsenic (as As)	mg/l	0.05/no relaxation	0.02	0.02	<0.01	0.01	<0.01
16	Fluoride (as F)	mg/l	1.0/1.5	0.85	0.98	0.34	0.71	0.38

Source: DPR Study

(2) Air Quality

Air quality analysis was conducted by DPR consultants in March 2016. The results of the analysis are shown below. At all sampling points the air quality was good and parameters were within the national environmental standards.

Table 7-5: Results of Air Quality Analysis

Ambient Air Quality Data March 2016				Location 1 : AQ1 (Village-Chagal Chora)		
S.No	Date	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NO_2 ,µg/m3	CO, µg/m3
		Gravimetric	IS:5182:Pt-23	IS:5182:Pt-2	IS:5182:Pt-6	IS:5182:Pt-10
1	01.03.2016	36.5	82.5	9.3	16.8	502
2	05.03.2016	32.3	80.6	8.6	15.9	460
3	09.03.2016	44.9	90.3	10.2	22.2	582
4	13.03.2016	39.8	84.5	9.8	18.9	516
	Min	32.3	80.6	8.6	15.9	460
	Max	44.9	90.3	10.2	22.2	582
	Average	38.4	84.5	9.5	18.5	515.0
	98 Percentile	44.6	90.0	10.2	22.0	578.0
NAAQS, For 24 hourly monitoring (except CO for One hour)		60	100	80	80	4000

Ambient Air Quality Data March 2016				Location 2: AQ2 (Village-Savodari)		
S.No	Date	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx µg/m3	CO, µg/m3
		Gravimetric	IS:5182:Pt-23	IS:5182:Pt-2	IS:5182:Pt-6	IS:5182:Pt-10
1	01.03.2016	22.3	73.3	6.8	12.3	312
2	05.03.2016	24.8	65.7	5.9	12.9	230
3	09.03.2016	23.6	69.8	6.4	14.2	345
4	13.03.2016	26.8	75.9	7.2	13.6	308
	Min	22.3	65.7	5.9	12.3	230
	Max	26.8	75.9	7.2	14.2	345
	Average	24.4	71.2	6.6	13.3	298.8
	98 Percentile	26.7	75.7	7.2	14.2	343.0
NAAQS, For 24 hourly monitoring (except CO for One hour)		60	100	80	80	4000

Ambient Air Quality Data March 2016				Location 3: AQ3(Village-Motichora)		
S.No	Date	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NO_2 ,µg/m3	CO, µg/m3
		Gravimetric	IS:5182:Pt-23	IS:5182:Pt-2	IS:5182:Pt-6	IS:5182:Pt-10
1	01.03.2016	37.8	83.7	9.7	17.3	527
2	05.03.2016	30.1	76.1	8.7	15.2	482
3	09.03.2016	41.3	88.6	10.1	20.8	561
4	13.03.2016	33.5	82.6	9.3	16.4	432
	Min	30.1	76.1	8.7	15.2	432
	Max	41.3	88.6	10.1	20.8	561
	Average	35.7	82.8	9.5	17.4	500.5
	98 Percentile	41.1	88.3	10.1	20.6	559.0
NAAQS, For 24 hourly monitoring (except CO for One hour)		60	100	80	80	4000

Ambient Air Quality Data March 2016				Location 4 : AQ4 (Village-Chaitarchar)		
S.No	Date	PM2.5,µg/m3	PM10,µg/m3	SO_2 µg/m3	NOx µg/m3	CO, µg/m3
		Gravimetric	IS:5182:Pt-23	IS:5182:Pt-2	IS:5182:Pt-6	IS:5182:Pt-10
1	01.03.2016	22.8	56.8	BDL	8.7	220
2	05.03.2016	23.2	60.5	BDL	9.8	283
3	09.03.2016	18.6	54.9	BDL	8.3	212
4	13.03.2016	21.8	58.8	BDL	9.2	249
	Min	18.6	54.9	BDL	8.3	212
	Max	23.2	60.5	BDL	9.8	283
	Average	21.6	57.8	BDL	9.0	241.0
	98 Percentile	23.2	60.4	BDL	9.8	281.0
NAAQS, For 24 hourly monitoring (except CO for One hour)		60	100	80	80	4000

Source: DPR Study

(3) Noise and Vibration

According to the DPR Study, the ambient noise level in the study area is below the national environmental standard. There is no data for vibration.

Table 7-6: Ambient Noise Level in the Study Area

Location	Eq. Noise levels dB(A) , Day.(Leq).	Eq. Noise levels dB(A), Night.(Leq)	National Ambient Air quality standard w.r.t. Noise, 2000 in dB(A) Day. (Leq)	National Ambient Air quality standard w.r.t. Noise, 2000 in dB(A) Night. (Leq)
Chagalchora (Residential)	53.2	38.8	55	45
Motichora (Commercial)	60.2	50.8	65	55
Savodari (Residential)	51.8	40.6	55	45
Chaitarchar (Residential)	48.9	36.7	55	45

Source: DPR Study

(4) Soil Quality

During the DPR Study, soil samples were collected from 4 locations and analyzed. The result is as follows.

Table 7-7: Results of Soil Quality Analysis

S.No	PARAMETERS	TEST METHOD	UNIT	Chagal chora	Moti chora	Savodari	Chaitarchar
1.	pH(1:5 suspension)	IS:2720(Part-26)	-	7.38	7.21	7.43	7.28
2.	Electrical Conductivity at 25^{O}C (1:5suspension.)	IS:2720(Part-21)	µS/cm	449	458	418	435
3.	Calcium Sulphate	STP/SOIL	mg/kg	BDL	BDL	BDL	BDL
4.	Magnesium(as Mg)	STP/SOIL	mg/kg	145.34	130.7	123.5	139.80
5.	Organic Matter	IS:2720(Part-22)	% by mass	6.28	5.25	4.61	5.65
6.	Potassium(as K)	STP/SOIL	mg/kg	133.15	127.6	123.5	119.83
7.	Water holding Capacity	STP/SOIL	% by mass	34.65	30.6	29.5	31.18
8.	Porosity	STP/SOIL	% by mass	29.40	25.1	23.8	26.46
9.	Sand	STP/SOIL	% by mass	42.40	38.59	43.70	40.16
10.	Clay	STP/SOIL	% by mass	50.32	54.27	46.82	53.32
11.	Silt	STP/SOIL	% by mass	7.28	7.14	9.48	6.52
12.	Sodium Sulphate	STP/SOIL	mg/kg	15.12	14.8	13.24	13.60
13.	Sodium Absorption Ratio	STP/SOIL	-	4.89	4.61	4.03	4.40
14.	Nitrogen	STP/SOIL	% by mass	0.064	0.060	0.051	0.057
15.	Phosphorus	STP/SOIL	mg/kg	23.4	25.4	20.5	21.06
16.	Bulk Density	STP/SOIL	gm /cc	1.32	1.46	1.26	1.18
17.	Texture	STP/SOIL	-	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay
18.	Moisture Retention Capacity	STP/SOIL	% by mass	22.0	20.5	24.6	19.8
19.	Infiltration Rate	STP/SOIL	mm/hr	24.0	26.4	20.3	21.6
20.	Moisture	STP/SOIL	%	16.20	15.64	13.81	14.58
21.	Sulphates	STP/SOIL	mg/1000g	14.24	15.2	13.64	12.81
22.	Sulphur(as S)	STP/SOIL	mg/kg	0.082	0.087	0.077	0.073
23.	Manganese (as Mn)	STP/SOIL	mg/kg	0.052	0.049	0.040	0.046
24.	Iron (as Fe)	STP/SOIL	mg/kg	0.70	0.75	0.67	0.63
25.	Exchangeable Sodium Percentage	STP/SOIL	mg/kg	0.062	0.066	0.051	0.055

Source: DPR Study

7.3.3 Socio-economic Environment

This project is located in the Dhubri District and South Salmara-Mankachar District of Assam State and the West Garo Hills District in Meghalaya State. The western end of the bridge is at Dhubri and it goes across the Brahmputra River and ends at Phulbari in the north of West Garo Hills. There are Char lands formed in the Brahmaputra River by the sand/silt from the upper stream. This Char land also belongs to the Dhubri and South Salmara-Mankachar Districts.

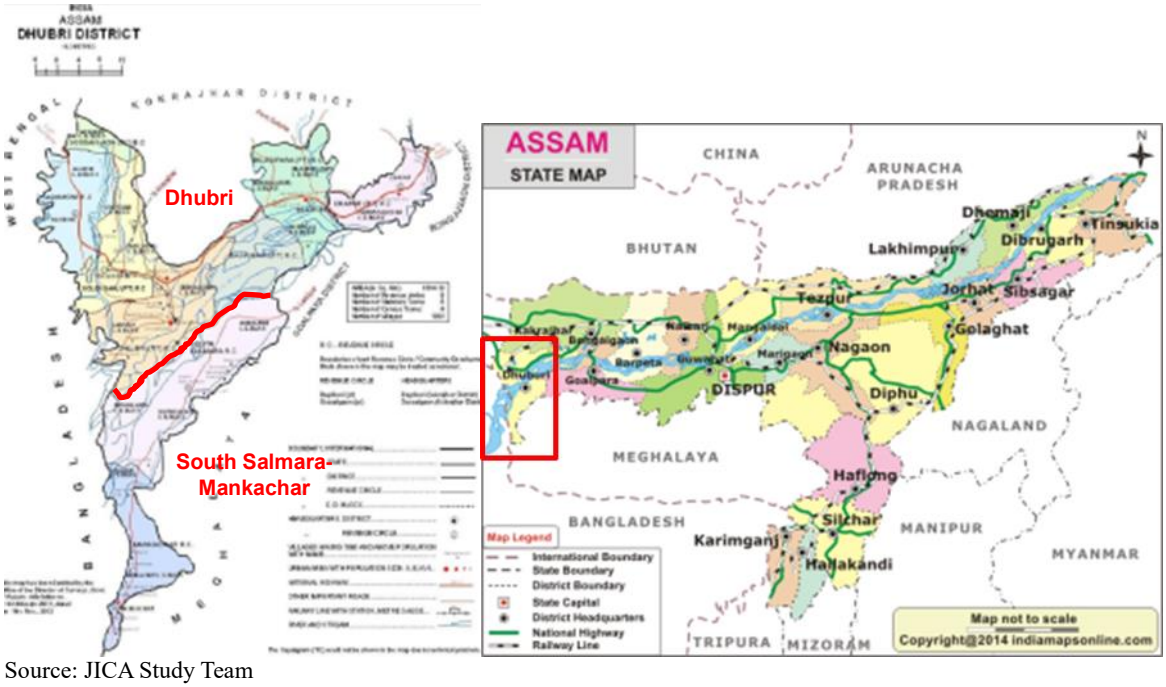
(1) Assam State

1) Administrative Division

Assam State is located in the northeastern part of India and is bounded on the north by Bhutan and the west by Bangladesh. The Dhubri and South Salmara-Mankachar Districts are situated in the extreme western corner of Assam State. Administratively, the Dhubri District has two sub-divisions namely Dhubri and Bilasipara along with eight revenue circles and seven tehsils. The South Salmara-Mankachar District is a newly formed district carved out from the Dhubri District in 2015

and officially became an administrative district in February 2016. It was formerly a sub-division of the Dhubri District. The South Salmara-Mankachar District has 2 revenue circles and 2 tehsils.

The distance from Dhubri town to the capital of Assam State, Dispur is approximately 290km. The distance between Hasingmari town, the capital of South Salmara-Mankachar District located across the Brahamputra River, and Dispur is approximately 245km by the route through Meghalaya State.



Source: JICA Study Team

Figure 7-11: Map of Assam State

2) Demographic Situation

The total area of the Dhubri District is 2,176km2 with the population of 1,949,258. The population density is 896 persons/km2, which is more than double compared to the Assam State average (398 people/km2). The population growth during 2001-2010 is 24.4% which is much higher than the Assam State average (17.1%). The literacy rate of the Dhubri District is 58.3% which shows quite a lower rate than that of the state average (72.2%).

The South Salmara-Mankachar District covers 568kmkm2, holding a population of 555,114. Out of which, rural population consists of around 95%. The population density of the district is 869 persons/km2, which is similar to the Dhubri District. The literacy rate is 39.9%, which is significantly low compared to the state average as mentioned above.

The following Table shows the demographic data of Assam State and two districts in the project sites.

Table 7-8: Demographics of Assam State and Districts in the Project Site

Item	Assam State	Dhubri District	South Salmara-Mankachar District
Area (km^2)	78,438	2,176	568
Population (no.)	31,205,576	1,949,258	555,114
Male-female ratio (no.) (1,000 men)	958	953	—
Population density (ppl/km^2)	398	896	869
Population growth rate (2001-2010)	17.1%	24.4%	—
Urban population	14.1%	10.5%	4.7%
Literacy rate	72.2%	58.3%	39.9%

Source: Census 2011

3) Ethnic Group and Religion

Assam State is home to the Assamese, Bodo and Ahom people. The official languages used in Assam State are Assamese and Bodo. Other than that, Bengali is also used in the project area which is similar to Assamese. The following Table shows the population ratio of the Scheduled Caste (SC)[19] and Scheduled Tribe (ST)[20] . The ratio is lower in the Dhubri District and South Salmara-Mankachar District compared to the Assam state average. Based on the survey, it is confirmed that minority groups, including the Bodo tribes[21], are not included in the project affected households.

Table 7-9: Scheduled Caste and Scheduled Tribe in Assam State

Item	India average	Assam State	Dhubri District	South Salmara-Mankachar District
SC population	16.2%	7.2%	3.6%	1.4%
ST population	8.2%	12.5%	0.3%	1.8%

Source: Census 2011

The Dhubri District has a large population of Muslims. Approximately 80% of the population is Muslim and the remaining 20% is Hindu. The South Salmara-Mankachar District is also Muslim dominant, composed of 95% Muslims and 5% Hindu.

4) Economy and Industry

The GSDP of Assam State in 2013-14 accounts for Rs. 885.4 billion and per capita GSDP is Rs. 50,558. The average annual growth rate during the past 10 years was approximately 6%. Industry wise ratio of GSDP in 2013-14 shows that service sector accounts for 60%, agriculture and industry sector shares 20% respectively. The shares of the agriculture and industry sectors have been decreasing over the past 10 years while the contribution of the service sector is increasing. Sector-wise annual growth rate is 3.8% for agriculture, 2.8% for the industry sector and growth of the service sector is the highest at 10.3%.

[19] Scheduled Caste (SC) refers to the group of people formerly known as Dalit (the lowest class in Hindu society) designated by the Indian Constitution.

[20] Scheduled Tribe (ST) is a group of tribes designated by the Indian Constitution who has a distinctive culture, are geographically isolated and are socio-economically lagging.

[21] For a reference, the Bodo tribe is one of the tribes designated in the sixth schedule in India having its roots in Tibeto-burman languages and call themselves “Bodosa”. A majority of the Bodo tribe are Hindu. The Bodo tribe continued armed conflict for their political independence, and Bodoland Autonomous Council was established in western Assam in 1993, and Bodoland Territorial Autonomous District was established in 2003.

Table 7-10: Economic Trend in Assam State

Item		2004-05	2008-09	2013-14	Annual growth (10year average)
GSDP (Rs. in billion)		534.0	640.3	885.4	6.6%
Ratio in GSDP	Agriculture (%)	25.6	23.4	21.3	3.8%
	Industry (%)	27.5	25.9	21.3	2.8%
	Service (%)	46.9	58.1	57.5	10.3%

Note: GSDP in Constant Price (2004-05)
Source: Planning Commission, Government of India

The composition of workers shows that majority of the workers in Assam State are engaged in agriculture related work accounts for 56.2% out of which 25.6% are the landless agriculture labours. At the project site, a majority of the population is cultivating paddies along with pulses and vegetables, in the Char land jute is also one of the major crops. In this area, animal husbandry, fishery and boat operation are also the income source for the population.

Table 7-11: Workers Ratio in Assam State

Item	Assam State	Dhubi District
Worker population (%)	38.4	34.4
Cultivator (%)	33.9	30.7
Agriculture worker (%)	15.4	25.6
Domestic worker (%)	4.1	4.2
Other worker (%)	46.6	39.7

Source: Directorate of Census Operations Assam, 2011

5) Char Lands

One of the peculiar features of the Brahmaputra River which flows in Assam State is the presence of riverine silt islands (the Char lands). The geographical spread of the Char lands is over 14 districts of Assam State and the major part of the project area falls under these Char lands.

The landform of the Char lands changes according to the erosion and deposition of silts and sands over the years. The areas also change in size and shape due to the changes of water level in the rainy season (May to October) and dry season (November to April). The origin of the populations in the Char lands dates back to the colonial period when the British administrators induced a large number of agriculture labours from East Bengal (former Bangladesh). Due to this historical background, the majority of the population in the Char lands is Muslim.

The official surveys focused on the Char lands were carried out in 1992-93 and 2003-04. According to the survey in 2003-04[22] , the total population of the Char lands is 2,490,097 and the population in Dhubri and the South Salmara-Mankachar District alone (former the Dhubri District) is 689,909. The result of those surveys shows that the Char lands represents one of the most backwards areas in the state showing high population growth, high poverty level and a low literacy rate. The population of Below Poverty Line (BPL) is 69% and a literacy level is 14.6%; both of which have worsened in 10 years.

[22] Socio-Economic Survey Report, 2003-04, Directorate of Char Areas Development, Govt. of Assam.

Table 7-12: Demographics of Char Area in Dhubri / South Salmara-Mankachar district

Year	Population	Population Growth	Household	BPL Household	Literacy
1992-93	233,206	—	—	54.2%	19.1%
2003-04	689,909	51.1%	109,748	69.0%	14.6%

Source: Socio-Economic Survey Report, 2003-04, Directorate of Char Areas Development, Govt. of Assam

In some areas, there are land registration records and private lands are allocated to villagers in the Char lands. However, the villagers in the Char lands are living in movable temporary structures so that they're able to shift their locations as necessary. Based on the interview survey conducted during the site visits, villagers who live on the land that will be under water during the rainy season will move their location to a neighboring area or other village in the Char land. During the dry season, some come back to the original place and others continue to stay in the shifted land.

Temporary residents in the Char Land

Erosion of the Char Land

Source: Socio-Economic Survey Report, 2003-04, Directorate of Char Areas Development, Govt. of Assam

In terms of basic amenities in the villages of the Char lands, hand pumps are introduced in some areas and some areas are sourcing the drinking water from the river. In a majority of the areas, electricity and sewage systems are unavailable. Lower primary and middle schools are established in the villages, however for higher education, the children must go to nearby towns. Medical sub-centres were provided in some areas, however, there are only visiting doctors available. The infrastructures and facilities are very much limited in those areas.

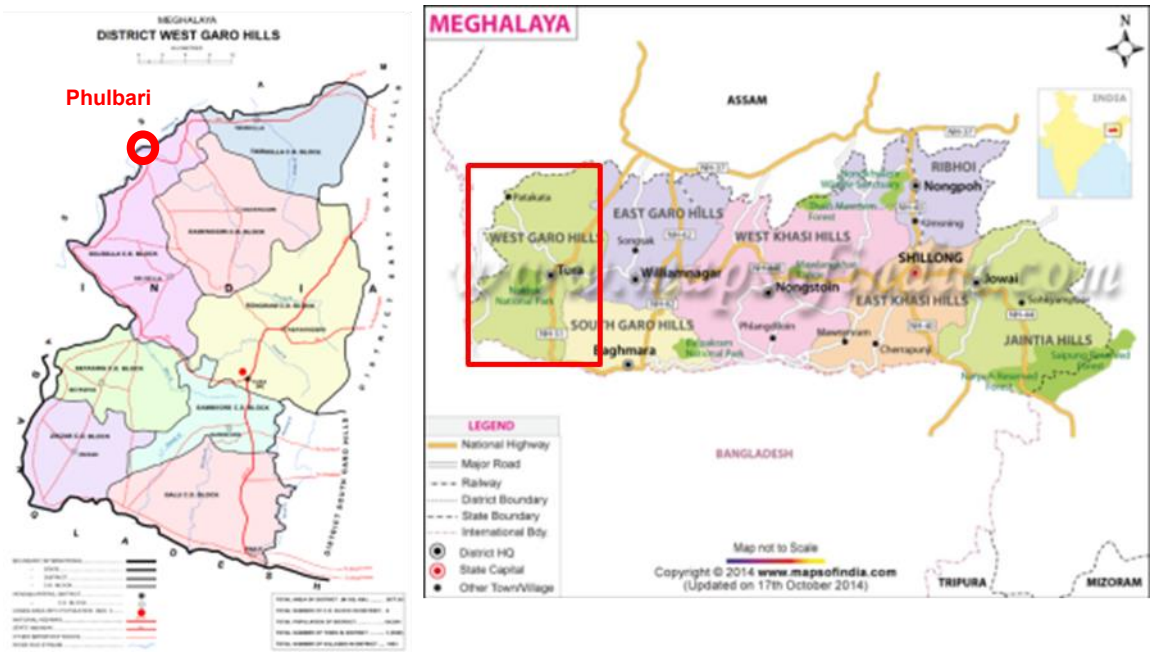
Hand pump in Char land

Primary School in Char land

(2) Meghalaya State

1) Administrative Division

Meghalaya State was a part of Assam State before 1970. It was founded as autonomous state in April 1970 and gained its status as an independent State in January 1972. The State shares the border with Assam State in the north and Bangladesh in the south and west. It is composed of 11 Districts. The West Garo Hills District is situated in the western corner of Meghalaya State. The state's capital, Tura, holds the second largest population in the State. The Phulbari village, at the end of the bridge, is located at the north end of the West Garo Hills District. The distance from Phulbari to Tura is approximately 80km, however, due to poor road conditions, it will take 3-4 hours to travel the distance by car.



Source: JICA Study Team

Figure 7-12: Map of West Garo Hills District

2) Demographic Situation

Total area of the West Garo Hills District is 1,650kmkm2, which is 7.4% of the total area of Meghalaya State. The district holds a population of 642,923, which is approximately 20% of the state population. The population growth rate of 2001-2010 was 26.7%, which is slightly lower than the state average (28.0%). The literacy rate of the West Garo Hills District is 67.6%, which is lower than the state average of 74.4%. The following Table shows the demographic situation of Meghalaya State and the West Garo Hills District.

Table 7-13: Demographic Situation of Meghalaya State

Item	Meghayala State	West Garo Hills District
Area (km^2)	22,429	1,650
Population (no.)	2,966,889	642,923
Male-female ratio (no.) (1,000 men)	28.0%	26.7%
Population density (ppl/km^2)	132	173
Population growth rate (2001-2010)	20.0%	11.6%
Urban population	74.4%	67.6%

Source: Census 2011

3) Ethnic Group and Religion

The main tribes in Meghalaya State are Kashi, Garo and Jaintia who reside in the hills of a different area. The official languages in the state are Kashi, Garo and English. Around the project area, Garo tribes are dominant in the hill area. However, since the end of the bridge locates at the border of Assam State and it is plain area along the Brahamputra River, Muslims are the main residents. Therefore, the common language used in the project area is Bangali.

Meghalaya State holds large populations of Scheduled Tribe (ST) which is a common feature of the states in North Eastern India. The population of ST in Meghalaya State is 86.2% while Scheduled Caste (SC) population is 0.6%, which is significantly low compared to the Indian average. In the case of the West Garo Hills District, ST accounts for 73.7%, out of which 71.2% is the Garo tribe. However, as described above, Garos are not included in the project affected people.

Table 7-14: Population Ratio of Scheduled Caste and Scheduled Tribes

Item	Phulbari Village	West Garo Hills District	Meghalaya State	India (average)
SC population (%)	11.2%	1.4%	0.6%	16.2%
ST population (%)	1.3%	73.7%	86.2%	8.2%

Source: Census 2011

Owing to the propagation of Christianity under the English colonial era, majority of the population in Meghalaya State is Christians. In the West Garo Hills District, 61% is Christian, 19% is Hindu, 17% is Muslim and other religions such as Buddhist and Shikh constitute 4%.

4) Economy and Industry

The GSDP of Meghalaya State in the 2013-14 accounts for Rs. 65.6 billion and the annual average growth rate in the past 10 years is 10.5%. The industry wise contribution to GSDP in 2013-14 shows that the service sector accounts for 54.1%, industry sector 31.4% and agriculture sector 14.6%. The trend over 10 years demonstrates that the contribution of agriculture sector in GSDP is decreasing while the ratio of the service and industry sectors is increasing.

Table 7-15: Economic Trend of Meghalaya State

Item		2004-05	2008-09	2013-14	Annual growth (10-year average)
GSDP (Rs. in billion)		65.6	90.0	134.7	10.5%
Ratio in GSDP	Agriculture (%)	23.3%	18.6%	14.6%	2.9%
	Industry (%)	26.1%	30.1%	31.4%	14.6%
	Service (%)	50.6%	55.6%	54.1%	11.9%

Note: GDP in Constant Price (2004-05)
Source: Planning Commission, Government of India

The composition of the working population in the West Garo Hills District is 39.8%, which is almost the same as Meghalaya the state average. 62.8% of the workers are engaged in agriculture related work. The agriculture in the West Garo Hills District is predominantly paddy cultivation and animal raring is the secondary occupation in the area.

Table 7-16: Workers Composition in Meghalaya State

Item	Meghalaya State	West Garo Hills District
Worker population (%)	40.0	39.8
Cultivator (%)	41.7	47.2
Agriculture worker (%)	16.7	15.5
Domestic worker (%)	1.7	3.0
Other worker (%)	39.8	34.3

Source: Directorate of Census Operations Meghalya, 2011

Since the project area is located at the north western end of Meghalaya state and is distant from the major cities, transportation infrastructures are not properly maintained and economic activities in this area are limited.

7.4 Legal Framework

7.4.1 Major Laws and Regulations Relevant to the Project

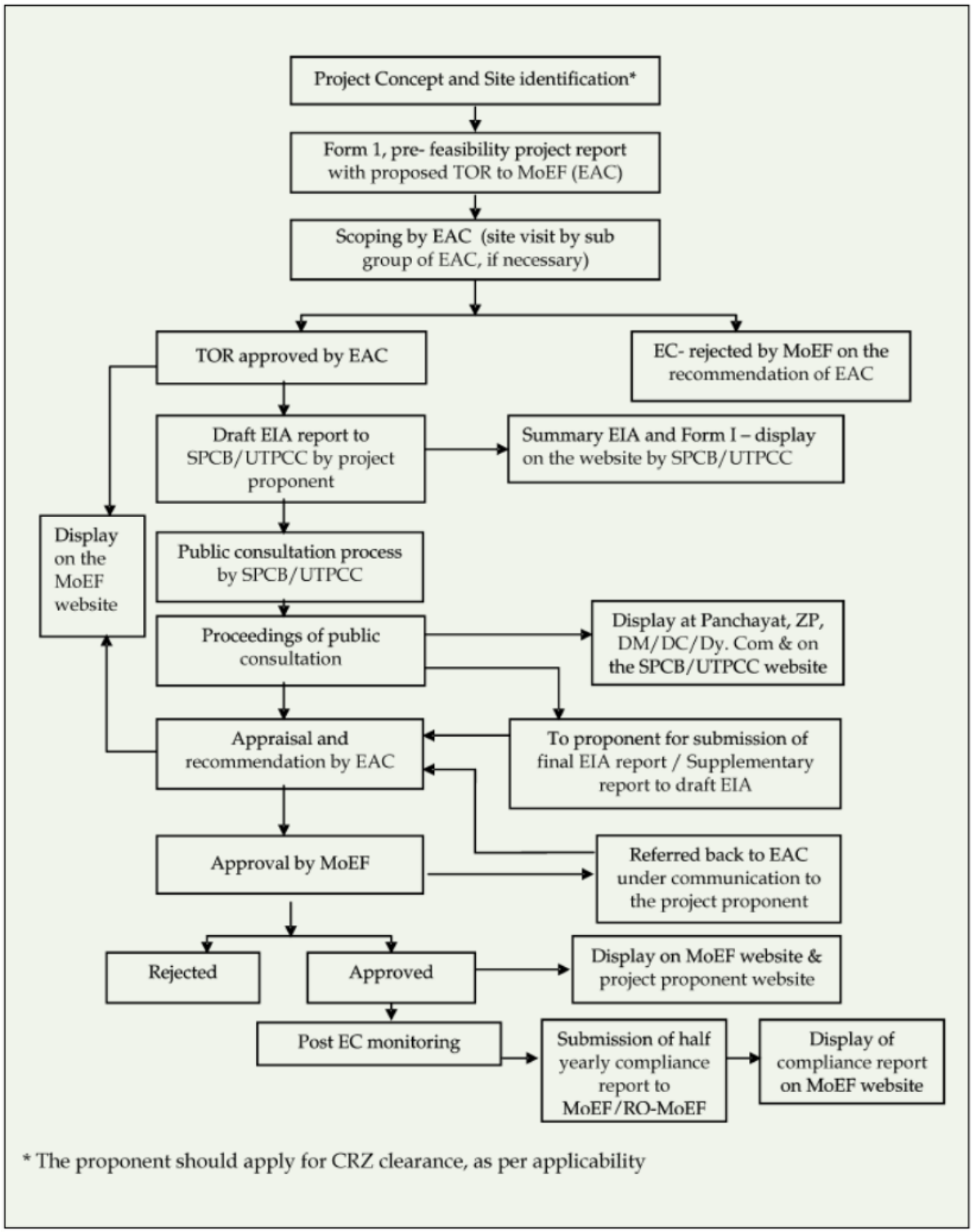
Within the framework of environmental laws of India, the Environmental (Protection) Act of 1986 and its enforcement rights have been given to the Ministry of Environment, Forest & Climate Change (MOEFCC). It has overall authority over the administration and implementation of the EIA related policies, laws and regulations, sustainable development and the pollution control in India. MOEFCC identifies the need to enact new laws and to issue amendment to the existing environmental legislations when required, in order to continue to conserve and protect the environment in India. The Central Pollution Control Board (CPCB) and respective State Pollution Control Board (SPCB) implement the acts. At state level, the Department of Environment and Forest of Assam / Meghalaya perform a role similar to that of MOEFCC.

(1) The Environment (Protection) Act, 1986

The Environment (Protection) Act, 1986 is the umbrella legislation which aims to protect the environment of India. Subject to the provisions of the Act, the Central Government has the power to take all measures as deemed necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.
The implementation of Environment (Protection) Rules, which was formulated in 1986, provides various standards for the emission and discharge of environmental pollutants (Schedule I to IV).
The central government has delegated the power vested on it under the Section 5 of the Act to the State Government. This law is applicable to this project for environment protection in general.

(2) Notification of the Environmental Impact Assessment of Development Projects

The Environmental Impact Assessment Notifications in 2006 have been subject to amendments in 2009, 2012, 2013, and 2014. The Expert Appraisal Committee or State Level Expert Appraisal Committee are given power to and are requested to establish recommendations for decision making at the central government level. The Expert Appraisal Committee of the central government and the State Level Expert Appraisal Committee are to meet once every month for screening, scoping and the appraisal of development projects.
Those projects intended to promote economic development at the national level as well as projects for each industrial sector in India are obliged to follow the EIA notification guidelines.



Source: Environmental Impact Assessment Guidance Manual for Highways, 2010

Figure 7-13: Environmental Clearance Process for Category A Projects

(3) Wildlife Protection Act, 1972

Amendments were made to the Wildlife Protection Act in 1982, 1986, 1991, 1993, 2002, 2006 and 2013 in order to protect wildlife in India. Code of conduct in terms of wildlife protection, trade of wildlife products, punishment for illegal hunting etc. have been amended from time to time. The protected areas are designated accreding to this act. The protected species are also categorized to Schedules I thorough IV under this act. Indian Board for Wildlife at central level and State Boards

for Wildlife at state level are organized under this act as advisory groups on the matters concerning wildlife conservation.

(4) The Biological Diversity Act, 2002

The Biological diversity Act is a law stipulated on the conservation, utilization, and benefit sharing of genetic resourcest and the Biodiversity Board has been established for each state based on this law. The main function of the Board is to give appropriate advice to the state government on issues concerning biodiversity conservation. The designation of Biodiversity Heritage Sites is also stipulated.

As a national policy for conserving biodiversity, the National Biodiversity Action Plan was formulated in 2008, which covers the conservation of biodiversity, its sustainable use, the equal distribution of profits arising from the use of biodiversity, the protected area networkfocused on the conservation of species, and so forth. Furthermore, itrecognize the importance of regulation on the introduction of alien species, eradication of alien species, and consideration on biodiversity in economic development projects.Assam State has formulated the state forest policy in 2004, among which, in addition to conservation and recovery of forests, strengthening of protected area network, conservation of wetlands, conservation of wetlands, conservation of wildlife as ways to preserve biodiversity preservation of habitats of living beings, promotion of research and research, etc. are listed.

(5) The Forest (Conservation) Act, 1980 (amended in 1988)

The Forest (Conservation) Act, 1980 amended in 1988, pertains to the cases of diversion of the use of forest area and the felling of roadside trees and those in the plantation areas. Depending on the size of the area subject to clearing, a license for felling trees should be obtained. The level of governments that is empowered to issue permission differs depending on the type of forest clearance:

- If the area of forests subject to clearing exceeds 20ha (or 10ha in the hilly area) then prior permission of the Central Government is required;
- If the area of forest clearance has a forest density of more than 40%, permission to undertake any work is needed from the Central Government, irrespective of the area to be cleared;
- If the area of forest subject to clearing is between 5ha to 20ha, the Regional Office of Chief Conservator of Forests is empowered to approve it; and
- If the area of forest subject to clearing is below or equal to 5ha, the State Government can issue permission.

(6) The Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act, 1974 resulted in the establishment of the central and state level Pollution Control Board (CPCB/SPCB). Their responsibilities include managing water quality and effluent standards as well as prosecuting offenders and issuing licenses for construction and the operation of certain facilities.

(7) The Air (Prevention and Control of Pollution) Act, 1981

The CPCB and the SPCB are empowered to set air quality standards, monitor and prosecute offenders under this Act. Powers have also been conferred to give instructions to the concerned authority in charge of vehicle registration under the Motor Vehicles Act, 1988, with regards to ensuring emission standards for automobiles.

(8) The Motor Vehicles Act, 1988

The Indian Motor Vehicles Act empowers the State Transport Authority to enforce standards for the control of vehicular pollution and prevention of air pollution. The authority also checks emission standards of registered vehicles, collects road taxes, and issues vehicular licenses. In August 1997, the Pollution under Control Certificate (PUC) program was launched in order to control vehicular emissions in all states of India.

(9) The Land Acquisition Act, Rehabilitation and Resettlement Act, 2013

The new "Rights to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR 2013)" replaced the Land Acquisition Act of 1894. It has so far served as the basic policy document on which the GOI passes resolution to acquire land for different projects, while traditionally it did not allow for compensation on a placement basis. The LARR 2013 came into force on January 1st, 2014, and the Assam/ Meghalaya States put the act into practice.

7.4.2 JICA's Guidelines for Environment and Social Considerations

Application of JICA's Guidelines for Environment and Social Considerations (ESCs) is required if a project is funded by JICA. If a significantly adverse impact on the environment or society has been identified during a JICA-assisted project, the following has to be thoroughly considered and studied.

(1) ESCs are Pre-Requisite

a. JICA will take necessary measures to ensure that the appropriate ESC is given;
b. When JICA reviews a project proposal and finds that the project could cause negative impacts on the environment or society, JICA advises that the project proponents provide appropriate ESC;
c. If the negative impact of the project cannot be avoided or mitigated to an acceptable level, JICA will not support its implementation.

(2) Respect Human Rights

a. Development project should aim for fair distribution of its benefits and must not burden or exclude certain stakeholders for the sake of others;
b. The project proponents must respect the rights of all people concerned, and pay special attention to vulnerable social groups such as women, elderly, the poor, people with disabilities, indigenous peoples, ethnic minorities, and other minority groups to ensure that they are involved in decision-making processes and that they benefit from the project;
c. JICA's ESC Guidelines define 'stakeholders' as local residents including non- titleholders who are affected by the project as well as local NGOs. By involving local stakeholders from the early stage of the project, the project proponents can receive their inputs and plan appropriate measures to address their concerns, avoid conflict, and achieve higher results with their support. For this reason, the project proponents should conduct a series of consultations with local stakeholders in an interactive and meaningful manner. During this process, appropriate consideration must be given to socially vulnerable people such as women, children, the elderly and ethnic minorities.

(3) Avoid Adverse Impacts

a. Priority should be given to the avoidance of adverse impacts on the environment or society when a project is planned;
b. Minimization or mitigation of impacts should be considered only if avoidance is not feasible and if the benefit of the project outweighs the cost of mitigation measures;
c. The project proponents must assess the environmental and social impacts at the earliest possible

stage of planning, and implement ESC measures in accordance with the ESC Guidelines 9.

(4) Information on ESC Must be Disclosed to the Public

a. Information disclosure is key in ESC. Project proponents must proactively release relevant information to the public;
b. Sharing information with a wide range of stakeholders from the early stage, the project proponents can utilize their feedback to improve the plan/project. In addition, the project proponents can ensure that unnecessary concerns and misunderstandings among the stakeholders are ameliorated.

(5) Host Country's Laws, Standards, Policies and Plans

a. A JICA-funded project must comply with the laws, standards, policies, and plans of the host country;
b. If the standard set by the host country differs from the international standard, the project proponents are advised to adopt an international standard that better serves the purpose of attaining a higher level of ESC.

(6) The World Bank's Safeguard Policies

ESC in a JICA project must be in line with the World Bank's Safeguard Policies including:

a) Operational Policy on Environmental Assessment (OP 4.01);
b) Natural Habitats (OP 4.04);
c) Involuntary Resettlement (OP 4.12);
d) Indigenous Peoples (OP 4.10), and other relevant policies.

7.4.3 World Bank's Environment Safeguard Policy

In respect to the Safe Guard Policies as listed above, the World Bank Performance Standards are imposed on the borrowers in terms of the requirement of the environmental impact assessment and resettlement action plan as guidelines for environmental study. It is a compulsory requirement for financing economic development projects that developing countries borrow funds from the World Bank. Major points of concern of its Performance Standards are summarized as follows:

a. PS 1: Assessment and Management of Environmental and Social Risks and Impacts

Performance Standard 1 underscores the importance of managing environmental and social performance throughout the life of the project.

b. PS 2: Labour and Working Conditions

The requirements labour and working conditions set out in part guided by a number of international conventions and instruments, including those of the International Labour Organization (ILO) and the United Nations (UN).

c. PS 3: Resource Efficiency and Pollution Prevention

This Performance Standard outlines a project-level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices. The Performance Standard promotes the ability of private companies to adopt such technologies and practices as far as their use is feasible in the context of a project that relies on commercially available skills and resources.

d. PS 4: Community Health, Safety, and Security

Performance Standard 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts due to project activities. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts on community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.

e. PS 5: Land Acquisition and Involuntary Resettlement

Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement as a result of project-related land acquisition and/or restrictions on land use. However, where involuntary resettlement is unavoidable, it should be minimized and appropriate measures to mitigate adverse impacts on displaced persons and host communities should be carefully planned and implemented.

f. PS 6: Biodiversity Conservation and Sustainable Management of Natural Resources

This Performance Standard recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and the sustainable management of living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity. This Performance Standard addresses how clients can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle.

g. PS 7: Indigenous Peoples

Performance Standard 7 recognizes that Indigenous Peoples are social groups with identities that are distinct from mainstream groups in national societies.

h. PS 8: Cultural Heritage

Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities.

7.4.4 Safeguard Policy of Asian Development Bank

(1) Latest Development of ADB Operations

The ADB's Environment Policy mandates the consideration of environment in all aspects of ADB's operations. The "Environment Policy and Operations Manual (OM) 20: Environmental Considerations in ADB Operations" outlines ADB's environmental assessment procedures and requirements. In 2003, ADB updated the old guidelines of 1993 and the contents are summarized as follows:

a. Introduced a check-list system of the Rapid Environmental Assessment (REA) for determining the environment category;
b. Introduction of the Country Environmental Analysis (CEA) as a requirement in preparation of

the Country Strategy and Program (CSP);
c. Introduction of the Strategic Environmental Assessment (SEA) as an optional tool for the environmental assessment for program loans, sector development program loans, and sector loans;
d. Establishing a new category FI for lending activities to financial intermediaries and other intermediaries and outlining the environmental assessment requirements to apply to this category;
e. Strengthening the requirements of Environmental Management Plans (EMP);
f. Recommending environmentally responsible procurement; and
g. Strengthening public consultation as an integral part of environmental assessment and management.

(2) General Contents of EIA Study

a. Coordinate with environment and government concerned agencies;
b. Prepare a project description, define the study area, collect environmental baseline data, prepare site maps, and other relevant maps for the study area;
c. Identify potential environmental impacts based on the information obtained on the proposed project and the baseline environmental conditions of the study area;
d. Identify alternatives and analyse the environmental impacts of each alternative and propose measures to avoid or prevent impacts;
e. Estimate the magnitudes of environmental impacts and assess the significance of the impacts;
f. Recommend environmental mitigation measures and estimate the mitigation costs;
g. Prepare an EMP to be implemented by the executing agency during project implementation, operation and abandonment;
h. Prepare the EIA and SEIA reports;
i. Conduct public consultation and ensure information disclosure; and develop plans for public consultation and information disclosure during project implementation;
j. Assess the executing agency's capacity to undertake an environmental review of the environmental assessment report and EMP recommendations, and recommend measures for capacity building if necessary; and
k. Ensure that the proposed project, with EIA and EMP implementation, conforms to the Government and ADB environmental assessment requirements, policies and regulations.
l. Economic assessment that should be carried out includes i) the costs and benefits of environmental impacts; ii) the costs, benefits, and cost effectiveness of mitigation measures; and iii) for environmental impacts that have not been expressed in monetary values, a discussion of such impacts, if possible, in quantitative terms.

7.4.5 Comparison of JICA/WB/ADB Guidelines and EIA Regulations of India

The JICA guidelines, World Bank and ADB Operational Manual and Environmental Safeguard policies, procedures & practices described in the Section 9.3.7 to 9.3.9 are compared to the following Government of India's guidelines in order to find the differences and elaborate on a way to fill in the gaps if any.

- "Environmental Guidelines for Selected Infrastructure Projects";
- "Project Terms of Reference (TOR)";
- "Environmental guidelines for Road/Rail/Highway Projects", Government of India, 1989
- "Handbook of environmental procedures and guidelines", 1994, Government of India
- "Guidelines for Environmental Impact Assessment of Highway Projects" (IRC:104-1988); and
- The Environmental (Protection) Act, 1986 and a series of its amendments as follows:
  S.O.695, [4/04/2011] - Amendment to EIA Notification, 2006,
  S.O.156, [25/01/2012] - Amendment to EIA Notification, 2006,

S.O.945, [11/06/2007] - Environmental Impact Assessment Notification-2007,
S.O.948, [12/06/2007] - Environmental Impact Assessment Notification-2007,
S.O.1105, [4/07/2007] - Environmental Impact Assessment Notification-2007,
S.O.1134, [12/07/2007] - Environmental Impact Assessment Notification-2007,
S.O.1203, [23/07/2007] - Environmental Impact Assessment Notification-2007,
S.O.1735, [11/10/2007] - Environmental Impact Assessment Notification-2007,
S.O.1736, [11/10/2007] - Environmental Impact Assessment Notification-2007,
S.O.1737, [11/10/2007] - Environmental Impact Assessment Notification-2007,
S.O.2674, [17/11/2008] - Environmental Impact Assessment Notification-2008,
S.O.2244, [22/11/2008] - Environmental Impact Assessment Notification-2008,
S.O.195, [19/01/2009] - Environmental Impact Assessment Notification-2009,
S.O.3067, [01/12/2009] - Environmental Impact Assessment Notification-2009
S.O.1850, [14/08/2012] - Environmental Impact Assessment Notification, 2012

Based on the above, a study on India's laws and regulations, and comparing them to the JICA/WB/ADB Guidelines is carried out in the following stages:

- The baseline environmental information in the study area such as; climate, physiographic features, drainage, geology, flora, fauna, ambient air, water and noise and socio-economic conditions.
- Reviews of the literature, laws and guidelines and discussions with concerned agencies and organizations, National/State Authorities
- A reconnaissance survey along with public consultation that occurred fromOctober 2016 to July 2017 and processes of public consultation continued until the completion of the study to inform the people about the project and collect the information/suggestions on environmental issues.
- The monitoring network with regard to air, water, soil and noise pollution.
- Assessment of the potential significant impacts and identification of the mitigate measures to address impacts adequately.
- Field observations including public consultation.
- Screening, testing and monitoring of environmental factors like air, water, soil and the noise level.
- Collection of secondary data from various departments.
- Compilation, analysis and presentation of the report.

Table 7-17: Comparison between JICA Guideline and Laws in India regarding EIA

No.	Items	JICA Guideline	Laws in India	Principle for this Project
1	Requirement of EIA	Environmental and social surveys at the EIA level (Category A projects) Proposed projects likely to have significant adverse impacts on the environment and society. Category A includes projects in sensitive sectors (ex. Roads, railways, and bridges), projects that have characteristics that are liable to cause adverse environmental impacts (ex. Large-scale involuntary resettlement),	Projects requiring EIA (Category A projects) i) New National Highways ii) Expansion of National Highways greater than 100km involving an additional right of way or land acquisition greater than 40m on the existing alignments and 60m on re-alignments and bypasses. Projects whose requirements of EIA are judged by the state level	EIA will be prepared as category A in accordance with JICA Guidelines though not required by Laws in India

No.	Items	JICA Guideline	Laws in India	Principle for this Project
		and projects located in or near sensitive areas. IEE level (Category B projects) Projects whose potential adverse impacts on the environment and society are less adverse than those of Category A projects.	Environment Impact Assessment Authority (Category B projects) i) State Highway ii) State highway Expansion projects in hilly terrain (above 1,000 m AMSL) and or ecologically sensitive areas	
2	Scope of Impacts to Be Assessed	In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent.	Factors which could lead to environmental effects or the potential for cumulative impacts shall be identified. Indirect impacts on the avifauna of the area shall be examined.	Derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined.
3	Stakeholder meetings/ Public consultation	Stakeholder meetings shall be held at the stages of the scoping draft and report draft.	Public consultation shall be conducted after submission of draft report.	To hold Stakeholder meetings at the stages of scoping draft and report draft.
4	Disclosure of EIA	EIA reports are required to be made available to local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents; and copying must be permitted.	MOEFCC shall display the Summary of the draft EIA report on its website, and also make the full draft EIA available for reference at a notified place during normal office hours at the Ministry in Delhi.	To disclose EIA in accordance with JICA Guidelines.
5	Certificate regarding the environment and society	If the project requires a certificate other than an EIA regarding the environment and society, indicate the title of said certificate and confirm the approval.	Forest Clearance will be required. The Contractor has to obtain permits from MSPCB for setting up hot-mix plants, batching plants, etc., under the Air and the Water Acts, whose results shall be reported to the Project proponents.	To confirm requirement of permits in accordance with the laws in India.
6	Monitoring	After projects begin, project proponents etc. monitor whether any unforeseeable situations occur and whether the performance and effectiveness of mitigation measures are consistent with the	Project proponents are required to submit environmental management plan & monitoring programme. It shall be mandatory for the project management to submit every half a year compliance reports	To implement environmental monitoring in accordance with the laws in India.

No.	Items	JICA Guideline	Laws in India	Principle for this Project
		assessment's prediction. They then take appropriate measures based on the results of such monitoring. In cases where sufficient monitoring is deemed essential, project proponents etc. must ensure that project plans include feasible monitoring plans. Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.	in respect to the stipulated prior environmental clearance terms and conditions.	

Source: JICA Study Team

7.4.6 Central Level Institutions

(1) National Highways Authority of India

The proposed Dhubri-Phulbari Bridge has been initiated and is being carried out by the National Highways and Infrastructure Development Corporation Limited (NHIDCL), under the auspice of the Ministry of Road Transport & Highways (MORTH). Though the primary responsibility of the Project rests with the NHIDCL, there are various institutions involved in the Project and their level of responsibilities in the project implementation are as follows:

The National Highway Authority of India (NHAI) and Regional Offices under the Ministry of Road Transport and Highway (MORTH) promote the national highway development project while the Border Roads Organization (BRO) under the Border Roads Development Board (BRDB) have control over roads in border regions. The NHIDCL was established for promoting the development of National Highways in North East and border areas of India, and started operation from January 1st , 2015.

The NHAI has been established under the National Highways Authority of India Act of 1988. It is the main nodal agency responsible for developing, managing and maintaining India's network of national highways. It became an autonomous body in 1995. NHAI maintains 70,934km of national highways and expressways across India.

The development of the Dhubri-Phulbari Bridge project has been promoted by NHIDCL, which is a company fully owned by the Ministry of Road Transport & Highways of the Government of India. The function of the NHIDCL is to promote the surveying, designing, building, operating, maintaining and upgrading of national highways and the development of strategic roads such as interconnecting roads in various parts of the country including those in areas with international boundaries with the neighboring countries.

The company also proposes to improve road connectivity and the efficiency of the international trade corridors by expanding about 500km of roads in the North Bengal and Northeastern Region of India.

(2) Ministry of Environment, Forest, and Climate Change (MOEFCC)

The primary responsibility for administration and implementation of the Government of India's (GOI) policy with respect to environmental management, conservation, ecologically sustainable development and pollution control rests with the Ministry of Environment, Forest and Climate Change (MOEFCC). Established in 1985, the MOEFCC is the agency primarily responsible for the review and approval of EIAs pursuant to GOI legislation.

(3) Central Pollution Control Board (CPCB)

Statutory authority attached to the MOEFCC, the main responsibilities of CPCB include the following:

- Planning and implementing water and air pollution control programs;
- Advising the central government on water and air pollution control programs;
- Setting air and water standards; and
- Coordinating the various State Pollution Control Boards.

The role of the CPCB for this Project will only be in an advisory capacity while the Project shall adhere to the norms and standards set up by the Meghalaya State Pollution Control Board (MSPCB).

7.4.7 State Level Institutions

(1) Public Works Department

The Public Works Department (PWD) is the premier agency of the state government engaged in planning, designing, construction, and maintenance of the government assets in the field of infrastructure development. Assets in infrastructure development include roads, bridges, urban centers, footpaths, new capital complexes, and airports. Assets such as hospitals, schools, colleges, technical institutes, police buildings, prisons, and courts among others are also under the PWD's jurisdiction. PWD Assam / Meghalaya also sustains and preserves these assets through a system of maintenance, which includes specialized services such as rehabilitation works, roads signage, and aesthetic treatments like interiors, landscaping etc.

(2) MOEFCC Regional Offices

MOEFCC has set up regional offices that cover the Northeastern Region including Assam / Meghalaya. It is located in Shillong, Meghalaya. This office is responsible for collecting and furnishing information relating to the EIA of various projects in respect to pollution control measures, methodology, and status, legal and enforcement measures and environmental protection in special conservation areas such as wetlands, mangroves and biosphere reserves.

(3) State Pollution Control Board, Assam / Meghalaya State Pollution Control Board

The State Pollution Control Boards have the mandate for environmental management at the state level, with emphasis on air and water quality. It is responsible for the planning and executing of state-level air and water initiatives, advising the state government on air, water and industry issues, establishing standards based on the National Minimum Standards, the enforcing and monitoring of all activities within the state under the Air Act, the Water Act and other relevant acts pertaining to pollution control.

They also conduct and organize public hearings for projects as defined by the various Acts and as stipulated by the amendment related to the EIA Act. It also issues No-objection Certificates (NOC) for environment clearance for industrial development defined in such a way as to include road projects' quarrying etc., which usually relate to water and soil contamination.

(4) Assam / Meghalaya State Forest and Environment Department

The Assam / Meghalaya Forest and Environment Department is responsible for the protection and management of the forest areas in the states that are designated for protection, conservation and production purposes. The Forest and Environment Department follows what is laid out in the Forest Working Plans for the various forest divisions to manage and protect the forest resources. These plans form the basis for managing the forest resources. is the department is responsible for granting licenses for clearances of the forest areas for various projects, according to the provisions of the

Forest (Conservation) Act, 1980. The State Forest and Environment Department performs functions similar to those of the MOEFCC at the state level but more specific to forestry activities including social forestry and production forestry development and licensing.

7.4.8 Requirements of Environmental Clearance

Environmental Clearance is not required for this project as per the MoEFCC notification, 2013.
Other clearances required are as follows:

1) The Contractor has to obtain permits from State Pollution Control Board for setting up hot-mix plants, batching plants, etc., under the Air and the Water Acts;
2) Clearance from the State Department of Mining is required for establishing quarries;
3) Clearance from the Water resource department/Authorities is required for establishment of new tube-wells/bore-holes in case they are required during construction work;
4) The provisions as laid down in the Factories Act, 1948, Labor Act, 1988 and the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 with respect to hygiene and health during the construction stage would apply to the project's implementation works; and
5) The provisions of the Hazardous Wastes (Management and Handling) Rules, 1989 and the Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996 may also be applied during the construction and the operation period.

Table 7-18: Applicable Environmental Clearance

No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
Pre-Construction Stage (Responsibility: MORTH)						
1	Road-side tree cutting and clearing forest	Forest Conservation Act1980 & MOEF Letter Dt.18.02.1998	Permission for Road-side tree cutting	State and Central Government	MORTH	2-3 months
2	Filling of Roadside water bodies (ponds and borrow pits)	State Fisheries Policy Draft Wetlands (Conservation & Management) Rules, 2008	Permission for filling of water bodies	State Irrigation Department State Fisheries Department State Wetlands Conservation Committee	MORTH	2-3 months
Construction Stage (Responsibility: Contractor)						
1	Establishing stone crusher, hot mix plant, wet mix plant and Diesel Generator Sets	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as Amended	Consent-forest abolishment	States Pollution Control Boards for respective section	Contractor	4-6 months
2	Operating stone crusher, hot mix plant, wet mix plant and Diesel Generator Sets	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as Amended	Consent-for operation	States Pollution Control Boards for respective section	Contractor	4-6 months
3	Use and storage of explosive for quarry blasting work	India Explosive Act 1984	Explosive license for use and storage	Chief Controller of Explosives	Contractor	2-3 months
4	Storage of fueloil, lubricants, diesel etc. at construction camp	Manufacture storage and Import of Hazardous Chemical Rules 1989	Permission for storage of hazardous chemical	States Pollution Control Boards for respective section and or Local Authority (DC)	Contractor	4-6 months
5	Quarry Operation	State Minor Mineral Concession Rules, The Mines Act of1952, Indian Explosive Act of1984, Air Act of1981 and Water Act of 1974	Quarry Lease Deed and Quarry License	State Department of Mines and Geology	Contractor	4-6 months
6	Extraction of ground water	Ground Water Rules of 2002	Permission for extraction of ground water for use in road construction activities	State Ground Water Board	Contractor	4-6 months
7	Engagement of labor	Labor Act	Labor license	Labor Commissioner	Contractor	2-3 months

Source: JICA Study Team

Regarding the procurement of sediment, quarry and other construction materials, the status of acquisition of licenses in terms of nature and social environment will be confirmed at the implementation stage.

7.5 Environmental Standards of India

Based on the Acts and Rules above, CPCB has set up various environmental standards as follows:

1) National Ambient Air Quality Standards
2) Water Quality Criteria
3) Vehicular Exhaust
4) Auto Fuel Quality
5) Noise and Emission Limits for Diesel Engines for Generators
6) Noise Standards

In addition to the above, there are a large number of environmental standards set up for each sector of the manufacturing industries. Since this is a road construction project consisting of the construction of a new bridge, during the construction period, construction debris, soil contamination, air and water pollution, noise and vibration are subject to monitoring in order to maintain emissions and discharges within the standards set up by the CPCB. During the operation and maintenance period, increasing traffic could cause noise and vibration. However, standards on the disposal of

construction debris, soil contamination, and vibration that could be caused by the Project are not clearly defined. The following is a set of environmental standards the Government of India has imposed to date.

Table 7-19: Standards for Ambient Air Quality

ıdian Ambient Air Quality Standards					WHO Ambient Air Quality Standards	
. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		Averaging Period	Guideline value in µg /m^3
			Industrial Residential, Rural and Other Areas	Ecologically Sensitive Area (notified by Central Government)		
(1)	(2)	(3)	(4)	(5)	(1)	(2)
1.	Sulphur Dioxide (SO_2), µg /m^3	Annual* 24 hours**	50 80	20 80	24 hours 10 minutes	125 (Interim target 1) 50 (Interim target 2) 20 (guideline) 500 (guideline)
2.	Nitrogen Dioxide (NO_2), µg /m^3	Annual* 24 hours**	40 80	30 80	1-year 1-hour	40 (guideline) 200 (guideline)
3.	Particular Matter (size less than 10µm) or PM_{10} µg /m^3	Annual* 24 hours**	60 100	60 100	1-year 24-hour	70(Interim target 1) 50 (Interim target 2) 30 (Interim target 3) 20 (guideline) 150(Interim target 1) 100 (Interim target 2) 75(Interim target 3) 50 (guideline)
4.	Particular Matter (size less than 2.5µm) or $PM_{2.5}$ µg /m^3	Annual* 24 hours**	40 60	40 60	1 – year 24-hour	35(Interim target 1) 25 (Interim target 2) 15 (Interim target 3) 10 (guideline) 75(Interim target 1) 50 (Interim target 2) 37.5 (Interim target 3) 25 (guideline)
5.	Ozone (O_3) µg/m^3	8 hours** 1 hour**	100 180	100 180	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

Source: Central Pollution Control Board, India, IFC

Table 7-20 Ambient Air Quality Standard by WHO

Table 1.1.1: WHO Ambient Air Quality Guidelines[7,8]		
	Averaging Period	Guideline value in µg/m³
Sulfur dioxide (SO_2)	24-hour 10 minute	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 24-hour	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline) 150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year 24-hour	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline) 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: IFC

Table 7-21: Vehicle Emission Standards (1991 to Date)

Norms	Passenger Car	Heavy Diesel Vehicles			
	CO (g/km)	CO (g/km)	HC (g.km.hr)	NOx (g.km.hr)	PM (g.km.hr)
1991Norms	14.3-27.1	14	3.5	18.0	-
1996 Norms	8.68-12.40	11.2	2.4	14.4	-
1998Norms	4.34-6.20	-	-	-	-
India stage 2000 norms	2.72	4.5	1.1	8.0	0.4
Bharat stage-II	2.2	4.0	1.1	7.0	0.2
Bharat Stage-III	2.3	2.1	1.6	5.0	0.1
Bharat Stage-IV	1.0	1.5	1.0	3.5	0.0

Source: Central Pollution Control Board, India
Note: Bharat indicates Indian nomenclature of vehicular emission which is the same as the Euro Stage.

Table 7-22: Water Quality

Designated best use	Class	Criteria
Drinking water source without conventional treatment but after disinfections	A	Total coliform organisms MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved oxygen 6 mg/l or more Biochemical oxygen demand 2 mg/l or Less
Outdoor bathing (organised)	B	Total coliform organisms MPN/100ml shall be 500 or less pH between 6.5 and 8.5 *Dissolved oxygen 5 mg/l or more Biochemical oxygen demand 3 mg/l or Less
Drinking water source with conventional treatment followed by disinfection	C	Total coliform organisms MPN/ 100ml shall be 5000 or less pH between 6 and 9 Dissolved oxygen 4 mg/l or more Biochemical oxygen demand 3 mg/l or less
Propagation of wild life, fisheries	D	pH between 6.5 and 8.5 Dissolved oxygen 4 mg/l or more *Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	pH between 6.0 and 8.5 Electrical conductivity less than 2250 micro mhos/cm Sodium absorption ratio less than 26 Boron less than 2mg/l

Source: Central Pollution Control Board, India

Compared to the EHS guideline set forth by the International Financial Corporation (IFC) shown in table below, the Class A Water Quality Standard of India is lacking a few items such as COD, Total Nitrogen, Total Phosphorus, Oil and Grease. Other parameters are set at equal level or below the EHS Guideline of IFC.

Table 7-23: Water quality standard for international EHS Guideline

Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges[a]		
Pollutants	**Units**	**Guideline Value**
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b] / 100 ml	400[a]
Notes: [a] Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation. [b] MPN = Most Probable Number		

Source: IFC

Table 7-24: Fuel Quality

Diesel Specification

Contents	1996	2000	2005	2010
Cetane No, Min	45	48	48	51
Sulphur % W/w, Max	0.5	0.25 0.25(metro)	0.05	0.035
Distillation T95	-	370	370	360
Polyaromatic	-	-	-	11

Gasoline Specification

Contents	1996	2000	2005	2010
RVP at 38 Deg.c,kpa	35-70	-	35-60	60
Benzine % by Vol.,Max	5	5.0 3.0(metro)	3.0 (all) 1.0 (metro)	1
Lead G/m3, Max	0.15% (low Pb) 0.013% (unleaded)	0.013	0.013	0.005
Sulphur % by mass, Max	0.10 (low Pb) 0.20 (unleaded)	0.1	0.05	0.015
Aromatics % v/v., Max	-	-	45	42
Oxygen %by Vol., Max	-	-	2	2.7

Source: Central Pollution Control Board, India

Table 7-25: Noise Standard for Diesel Generator

No.	**Description**
1	The maximum permissible sound pressure level for new diesel generator (DG) sets with rated capacity upto 1000 KVA, manufactured on or after the 1st January, 2005 shall be 75 dB(A) at 1 metre from the enclosure surface.
2	Noise limits for diesel generator sets not covered by 1, shall be as follows:-
	2.1 Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the users end.
	2.2 The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/ room, then averaged.
	2.3 The DG set shall be provided with proper exhaust muffler with insertion loss of minimum 25 dB (A).
	2.4 Guidelines for the manufacturers/ users of Diesel Generator sets shall be as under:-
	2.4 (1) The manufacturer shall offer to the user a standard acoustic enclosure of 25 dB (A) insertion loss and also a suitable exhaust muffler with insertion loss of 25 dB(A).
	2.4 (2) The user shall make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper citing and control measures.
	2.4 (3) Installation of DG set must be strictly in compliance with the recommendations of the DG set manufacturer.
	2.4 (4) A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Source: Central Pollution Control Board, India

Table 7-26: Noise Emission Standards

S. No.	Type of vehicle	Noise Limits from 1st January, 2003, dB(A)
1.0	**Two wheeler**	
1.1	Displacement upto 80 cc	75
1.2	Displacement more than 80 cc but upto 175 cc	77
1.3	Displacement more than 175 cc	80
2.0	**Three wheeler**	
2.1	Displacement upto 175 cc	77
2.2	Displacement more than 175 cc	80
3.0	**Vehicles used for carriage of passengers and capable of having not more than nine seats, including the driver's seat**	74
4.0	**Vehicles used for carriage of passengers having more than nine seats, including the driver's seat, and a maximum gross Vehicle Weight(GVW) of more than 3.5 tonnes**	
4.1	With an engine power less than150 KW	78
4.2	With an engine power of 150 KW or above	80
5.0	**Vehicles used for carriage of passengers having more than nine seats, including the driver's seat: Vehicles used for carriage goods.**	
5.1	With maximum GVW not exceeding 2 tonnes	76
5.2	With maximum GVW greater than 3 tonnes but not exceeding 3.5 tonnes	77
6.0	**Vehicles used for transport of goods with a maximum GVW exceeding 3.5 tonnes.**	
6.1	With an engine power less than 75 KW	77
6.2	With an engine power of 75 KW or above but less than 150 KW	78
6.3	With an engine power of 150 KW or above,	80"

Source: Central Pollution Control Board, India

Table 7-27: Ambient Noise Standards

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:- 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time 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: Central Pollution Control Board, India

Indian noise standards are at the same level as the EHS guideline of IFC.

7.6 Analysis of Alternatives

7.6.1 Alternatives Subject to Analysis

There are four options that must be considered in terms of impact mitigation measures and are as follows:

(1) Zero Option

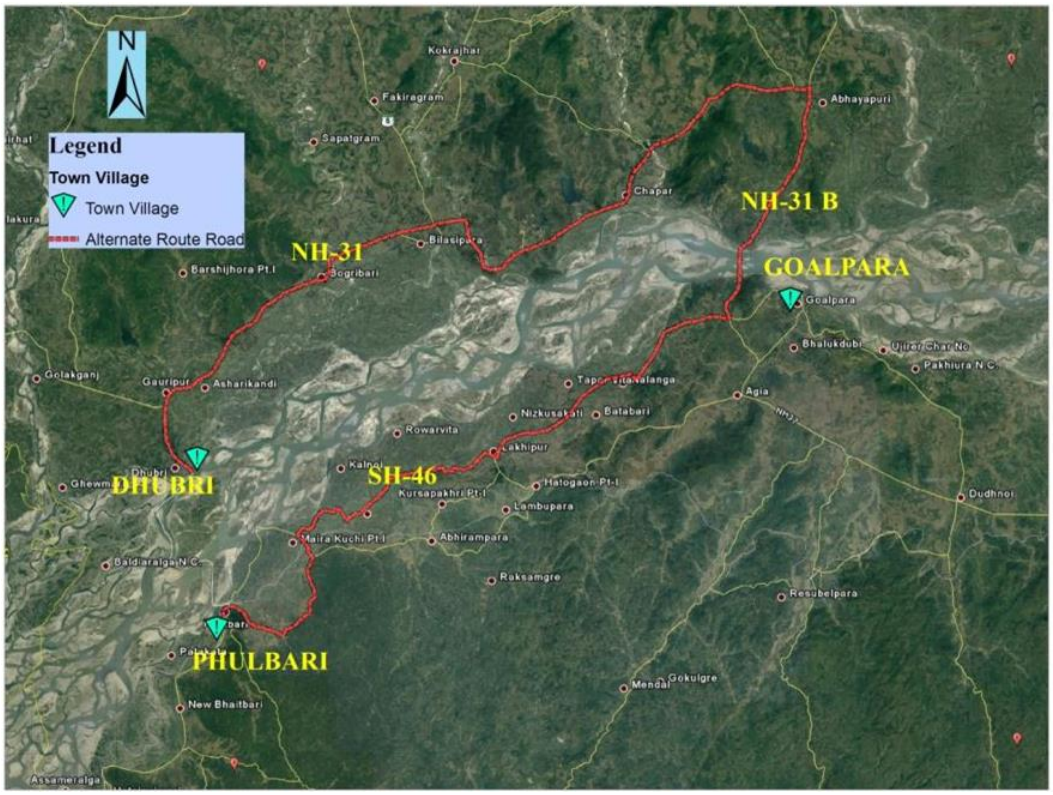
No project intervention is implemented, i.e. present status i.e. transportation by boats, is to be continued to be used;

(2) Alternative mode of transportation such as ferry

As an alternative to the construction of a new bridge, capacity by boat transportation across Brahmaputra River can be increased by constructing ferry terminals at Dhubri and Phulbari.

(3) The Alternative Route connects Dhubri and Phulbari by widening of existing NH-31 B and SH-46 through existing bridge near Goalpara

The Alternative Routes to connect Dhubri and Phulbari through NH-31 B and SH-46 and utilize the existing bridge near Goalpara would have approximately 200km length,

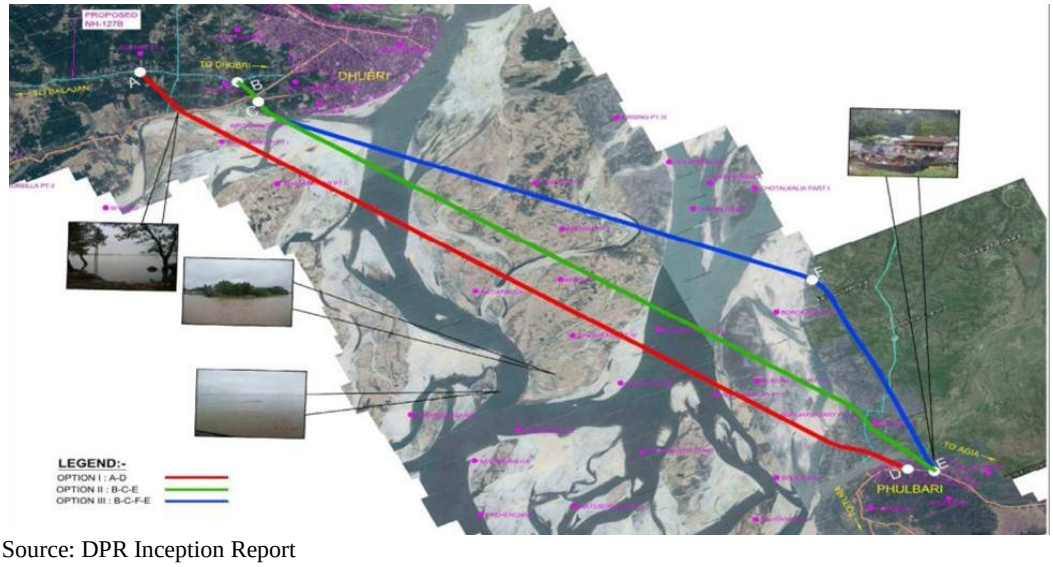


Source: JICA Study Team

Figure 7-14: The Alternative Route connects Dhubri and Phulbari by widening of existing NH-31 B and SH-46 through existing bridge near Goalpara

(4) The Proposed Bridge Option – DPR Design

The proposed Bridge is the construction of two Four-lane bridges including approaches over River Brahamputra between Dhubri on the North Bank and Phulbari on the South Bank in the state of Assam/Meghalaya on NH-127B (Length: 20km) with minimum PAPs. In this option, three alternative alignments were compared in order to minimize the social and environmental impacts.



Source: DPR Inception Report

Figure 7-15: Alignment of Two / Four lane bridge between Dhubri and Phulbari

7.6.2 Criteria for Analysis of the Alternatives

Criteria for the analysis of the selected four alternatives are shown in the following Table. These criteria are based on the importance of the Project being a bridge project running through the Dhubri, South Salmara-Mankachar districts in Assam State and Phulbari in Meghalaya State.

Table 7-28: Criteria for the Evaluation of the Alternatives

No.	Alternative Models	Criteria of Evaluation
1	Zero Option (No project is implemented)	Connectivity - Road Connectivity as a means of infrastructure for communication or transportation of goods - If current connectivity should be improved - Contribution to the development of local/state economy Environmental Pollution - CO2 emission could increase/decrease with the road - Noise and vibration - Health conditions could be improved/worsened Socio-economic Conditions - Contribution to road accidents - Contribution to improve/worsen living standard - If resettlement was involved - If land acquisition is involved Natural Environment - impacts on fisheries and other aquatic life - Effects on the ecological conditions Others - If it is worth implementing the project despite effects on the natural/social environment, or economic conditions - Technical viability of the bridge construction
2	Alternative mode of transportation such as a ferry	
3	The Alternative Route connects Dhubri and Phulbari by widening of existing NH-31 B and SH-46 through existing bridge near Goalpara	
4	The Proposed Bridge Option – DPR Design alignment AD	
5	The Proposed Bridge Option – DPR Design alignment BE	
6	The Proposed Bridge Option – DPR Design alignment BFE	

Source: JICA Study Team

7.6.3 Results of the Analysis of Alternatives

(1) Zero Option

The Zero option of the project is to take no project intervention. This option is assessed as follows:

a. Advantages

- There will be no involuntary resettlement involved in the Zero Option
- No tree cutting and agricultural areas lost to the road / bridge construction works
- No construction works and no pollution
- No impact on Aquatic Fauna

b. Disadvantages

- No road network between Dhubri and Phulbari
- Existence boat transportation takes more time and inconveniences the people
- No local area development
- No Economic development in project districts

(2) Alternative mode of transportation such as ferry

Alternative to the construction of a new bridge, capacity by boat transportation across Brahmaputra River can be increased by constructing ferry terminals at Dhubri and Phulbari. However constructing ferry terminals will require large-scale change in geology, toropgraphy and hydrology of the existing revier banks of the Brahmaputra which may cause negative impacts on the habitat of the endangered river dolphins.

a. Advantage

- Provide transport connectivity to Dhubri and Phulbari
- Land acquisition and involuntary resettlement will be incurred but on a smaller scale

b. Disadvantage

- Significant negative impacts on the ecosystem of the Brahmaputra River by the dredging of ferry terminals
- High maintenance and operation cost for ferry boats
- Susceptible to natural disasters such as flooding
- Travel time is dependent on ferry time schedule

(3) The Alternative Route connect Dhubri and Phulbari by widening of existing NH-31 B and SH-46 through existing bridge near Goalpara

The Alternative Routes to connect Dhubri and Phulbari through NH-31 B and SH-46 and utilize the existing bridge near Goalpara will have approximately 200km length.

a. Advantages

- Better connectivity to villages / towns falling in the 200km alignment
- Overall economic development of the project area
- No impact on Aquatic ecology of Brahmaputra River

b. Disadvantage

- Very high resettlement as settlements are all along the existing highway
- Acquisition of land and cutting of large numbers of trees
- Construction works likely to cause significant traffic jams throughout the construction period, dust during dry season and muddy roads during rainy season.
- Very high construction cost due to long length

(4) The Proposed Bridge Option – DPR Design

The proposed Bridge is the construction of two Four-lane bridges including approaches over Brahamputra River between Dhubri on the North Bank and Phulbari on the South Bank in the state of Assam/Meghalaya on NH-127B (Length: 20km) with minimum PAPs, This option is assessed as follows:

a. Advantage

- Provide easy and short distance connectivity to Dhubri and Phulbari
- Less number of PAPs
- Overall infrastructure development and economic development of the area.
- Negative ecological impacts on Brahnmaputra are smaller compared to other options.
- No need for deforestation

b. Disadvantage

- Involuntary resettlement of the local residents will be reduced, however, in acquisition of approximate 65 Ha of land and significant number of PAPs.
- Construction works should cause significant traffic jams throughout the construction period, dust during dry season and muddy roads during rainy season.
- Increase of traffic volume including heavy load vehicles likely to cause noise, air pollution, and increase in traffic accidents along the road while some traffic is diverted to bypasses.

- Impact on aquatic fauna in Brahmaputra River during construction phase.

Given the above analysis results, the results of comparing and examining each option were ranked and are shown in the table below. Furthermore, the score was allocated according to the rank, and the option with the highest total score was selected as the best. The main objective of this project is to bring positive influence on the regional economy, so the "impact on local economy" was given a double score. As a result, **The Proposed Bridge Option** is recommended.

Table 7-29: Analysis of alternatives

Sr. No	Factors	Without Project Impacts	With Project Impacts		
			Alternative mode of transportation such as ferry	**The Alternative Route connect Dhubri and Phulbari by widening of existing NH-31 B and SH-46 through existing bridge near Goalpara**	**With Proposed bridge**
1	Involuntary resettlement	+++ No involuntary resettlement is incurred.	++ Land acquisition and involuntary resettlement will be incurred around ferry terminal area but on smaller scale.	-- Large scale of involuntary resettlement is expected due to upgrading of 200km of existing road.	+ Middle scale of involuntary resettlement is incurred along the alignment of the proposed bridge.
	Score	**4**	**1**	**3**	**2**
	Weighted score	**4**	**1**	**3**	**2**
2	Impact on natural ecosystem	+++ No direct impacts on natural ecosystem.	- Significant negative impacts are caused on the ecosystem of the Brahmaputra River by dredging of ferry terminals and navigation channels.	+ Natural environment is altered along the existing road for 200km, but no impacts on the Brahmaputra River.	++ Some impacts are caused on Brahmaputra River ecosystem during construction phase, but there will be little impact during operation phase.
	Score	**4**	**2**	**1**	**3**
	Weighted score	**4**	**2**	**1**	**3**
3	Pollution	+ Present status is continued.	- Possibility of water pollution such as oil leak from ferries.	++ Air pollution and CO2 emission may decrease due to improved road conditions.	+++ Overall air pollution and CO2 emission will be greatly reduced because travel distance between Dhubri and Phulbari is shortened by the bridge.
	Score	**2**	**3**	**1**	**4**
	Weighted score	**2**	**3**	**1**	**4**
4	Impact on local economy	- No positive or negative impact on local economy.	+ Connectivity between Dhubri and Phulbari is improved by the ferry, but it is susceptible to natural disasters such as flooding.	++ Connectivity between Dhubri and Phulbari is improved to some extent.	+++ Transport between Dhubri and Phulbari takes less time and becomes efficient, and it will enhance the local economy.
	Score	**1**	**3**	**2**	**4**
	Weighted score	**2**	**6**	**4**	**8**
	Total score	12	12	9	17
	Rank	2	2	4	1

Sr. No	Factors	Without Project Impacts	With Project Impacts		
			Alternative mode of transportation such as ferry	**The Alternative Route connect Dhubri and Phulbari by widening of existing NH-31 B and SH-46 through existing bridge near Goalpara**	**With Proposed bridge**
	Evaluation	Local economic development is obstructed by the lack of road connectivity.	Expected positive impact is small while significant negative social and environmental impact is anticipated.	Scale of involuntary resettlement can be kept relatively small, but serious negative impacts on natural environment are anticipated.	Involuntary resettlement and impact on natural environment is anticipated. However, improvement of transportation will contribute to the development of local socioeconomic development.

Legend
+++ : best (most desirable) option; score 4 points
++: second-best option; score 3 points
+ : third-best option; score 2 points
-: worst (least desirable) option; score1 point
Source: JICA Study Team

7.6.4 Comparison of bridge alignment options

In order to minimize the social and environmental impacts, three alignment options were compared. The three options were set as follows. Each line is a line connecting the following combinations of the six points in the table below.

i) Option 1 represented by line AD: This option is designed to avoid residential areas in the Dhubri town and the islands as much as possible. The total length of the bridge and approach road will be longer, but the negative social impacts can be minimized.
ii) Option 2 represented by line BE: This option is designed to connect Dhubri and Pulbari in the shortest distance. The total length of the bridge and approach road can be minimized, but the start point of the bridge falls on the dense residential area of Dhubri town, alignment passes through residential area of the islands.
iii) Option 3 represented by line BFE: This option is designed to cross Brahmaputra River at a right angle. The navigable section of the bridge can be shortened and residential area on the islands can be avoided, but but the start point of the bridge falls on the dense residential area of Dhubri town and the alighment is composed of more curves.

The proposed alignment option was finalized based on a desk study of satellite imageries available from "Google Earth" and a reconnaissance survey at site. The alignment options are detailed, node-wise in Figure 7-12 and the nodes are described below.

Table 7-30: Location of Nodes for the Bridge Alignment Alternatives

NODE	LOCATION
Node-A	At km 55+200 on proposed NH-127B, near Adabari Junction
Node-B	At Balajan Dhubri road, near Choto Bashjani (1.3km east of Adabari Junction)
Node-C	At College Road Junction with the bund road, near Bidyapara
Node-D	At agia-Tura NEC Road, 400 m from Phulbari Ghat towards Agia
Node-E	At Agia-Tura NEC Road, 1km from Phulbari Ghat towards Agia
Node-F	On Southern Bank of Brahmaputra, near Borokalia Surjyamara

Source: DPR Inception Report

The methodology is adopted to review these three alignments by covering the following aspects.

Table 7-31 Evaluation Criteria

	Parameter	Evaluation	Data collection
Social Aspects	Affected structures	Larger number will cause larger impact	Satellaite image and land survey
	Land to be acquired	Larger number will cause larger impact	Satellaite image and land survey
	Permanent Char Land	Larger number will cause larger impact	Satellaite image and land survey
Environmental Aspects	Total Length	Larger number will cause larger impact	Construction design by DPR cosultants
	Agriculture Land	Larger number will cause larger impact	Construction design by DPR cosultants
	Total Length over Brahmaputra River	Larger number will cause larger impact	Satellite image
Engineering Aspects	Total Length	Smaller number is more preferable	Construction design by DPR cosultants
	Length of bridge approach	Smaller number is more preferable	Construction design by DPR cosultants
	Horizontal Geometry : Total no. of curves	Smaller number is more preferable	Construction design by DPR cosultants
	Horizontal Geometry: Total length of curves	Smaller number is more preferable	Construction design by DPR cosultants
Indicative Cost Aspects	Total Approximate Civil Construction Cost	Smaller number is more preferable	Construction design by DPR cosultants

Social Aspects

The number of affected structures is considered as an equivalent to the scale of resettlement expected from the Project. Size of Land to be acquired is indicative of the scale of possible losses of livelihood considering that the population in the area is largely dependent on their land. The length of alignment passing through Permanent Char Land is also included in the parameters to evaluate the impact on Char people whose socio-economic status is lower than that of the inland communities.

Environmental Aspects

Total length is indicative of negative impacts such as noise, vibration, and air pollution at operation phase. As the total length increases, vehicles need to travel longer distances and larger negative impacts are anticipated.

Agriculture Land that overlaps with the alignment will be lost due to the construction of the bridge and cause negative environmental impacts such as loss of environmental services. Total Length over the Brahmaputra River is indicative of negative impacts of the project on the river ecosystem and endangered aquatic species such as Gangas river dolphins. The longer the length over Brahmaputra River is, the larger the damage on the river ecosystem will be.

Engineering Aspects

With regard to the total length of the bridge, because of higher construction technologies and costs of bridges compared with embankments, a shorter bridge length is rated favorable. With regard to the length of the approach, because of the necessity of new road constructions of approaches to connect the bridge and the existing roads, a shorter approach length is rated favorable. With regard to the number of curves, because of easier drivability of roads with fewer curves, the fewer is rated favorable. With regard to the total length of curves, because of the requirement of complex structures and higher construction technologies, a shorter length is rated favorable.

Based on the above aspects, the parameter scores for various aspects and options are as follows. The numerical score was calculated by the following equation:

Score for Option X = 10 * value of Option X / Max value for 3 options

Table 7-32 Evaluaiion and Comparison of the Alternatives

Item	Unit	Max. Score	Option 1		Option 2		Option 3	
			Qty	Score	Qty	Score	Qty	Score
Socail Aspects								
Affected structures	No.	10.0	122	6.52	170	9.09	187	10.00
Land to be acquired	ha	10.0	55.20	7.69	63.00	8.77	71.76	10.00
Permanent Char Land	km	10.0	6.30	9.40	6.70	10.00	5.10	7.61
Total Score		30.0		23.61		27.86		27.61
Evaluation				++		+		+
Environmental Aspects								
Total Length	km	10.0	19.282	10	17.847	9.26	18.797	9.75
Agriculture Land	ha	10.0	0.012	3.42	0.018	5.14	0.035	10
Total Length over Brahmaputra River	km	10.0	2.85	10	2.67	9.36	2.20	7.72
Total Score		30.0		23.42		27.76		37.47
Evaluation				++		+		-
Engineering Aspects								
Total Length	km	10.0	18.360	10.00	17.01	9.26	17.995	9.80
Length of bridge approach	km	10.0	0.471	10.00	0.465	9.87	0.430	9.13
Horizontal Geometry : Total no. of curves	no.	10.0	3	6.00	5	10.00	5	10.00
Horizontal Geometry: Total length of curves	M	10.0	983.2	3.24	2054.15	6.77	3035.09	10.00
Total Score		40.0		29.24		35.90		38.93
Evaluation				++		+		-
Indicative Cost Aspects								
Total Approximate Civil Construction Cost	Cr.	10.0	2858	9.47	3018	10.00	2889	9.57
Total Score		10.0		9.47		10.00		9.57
Evaluation				++		+		++
Total Rank			1		2		3	

As for the social aspects, Option 1 has less impact with respect to the number of affected structures and the size of the land to be acquired. Although Option 3 has less impact on the poor, the total score shows Option 1 as the most favorable option.

As for the environmental aspects, differences among the three options were relatively small for the total length and the total length over Brahmaputra, but impacts on agriculture land were most significant for Option 3.

As for the engineering aspects, although Option 1 is unfavorable with respect to a longer bridge length and approaches, it has a fewer curves and a shorter curve length deemed to be favorable. The comprehensive rating gives Option 1 the highest score.

Based on the above, Option 1, i.e. proposed bridge over river Brahmaputra between Dhubri on North Bank and Phulbari on South Bank in the state of Assam/Meghalaya on NH-127B, alignment AD (Length: 20km), is recommended.

7.7 Scoping Analysis

7.7.1 Procedures of Scoping Analysis

Depending on the scale and nature of works during the various stages of the project, there are positive and negative impacts to the natural and social environment. These impacts are different in the intensity, in the spatial reach, and in whether it is irrevocable or temporary.

The scoping matrix highlights anticipated impacts that occur on various environmental and social components during the scoping stage of the project. The project may affect the aquatic ecosystem in terms of the impacts to the natural environment. Also, the ROW for this project is 60m in width, and social impacts such as land acquisition and resettlement are anticipated.

7.7.2 Scoping Matrix: Preliminary Analysis of the Environmental Impacts

The scoping matrix is shown in the table below. According to the JICA Guideline (2010), the impacts are rated as follows:

"A" denotes that severe/irrevocable impact is expected (+: Positive impact, -: Negative impact)

"B" denotes that significant impact is expected (+: Positive impact, -: Negative impact)

"C" denotes that impact is relatively small (+: Positive impact, -: Negative impact)

"D" denotes that impact with little significance occurs (+: Positive impact, -: Negative impact)

Table 7-33: Scoping Matrix for the Proposed Bridge Option

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation Stage	Rational of the Impact Assessment
Pollution				
Air Pollution	D	B-	B-	P: No impact is expected. C: Some negative impacts are expected due to the operation of construction equipment and vehicles. One example is dust incidental to earthwork especially during the dry season. O: Air pollution is expected to increase due to increase traffic volume on the road.
Water Pollution	D	B-	D	P: No impact is expected. C: Turbid water due to the earthworks, bridge pier construction work and wastewater effluents from construction workers' camps / yards are expected to pollute the Brahmaputra river to some extent. O: No impact is expected.
Wastes / Hazardous Materials	D	B-	D	P: No impact is expected. C: Waste will be generated from construction workers' camps. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal. O: No impact is expected.
Soil Contamination	D	B-	D	P: No impact is expected. C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the road is already polluted. O: No impact is expected.
Noise and Vibration	D	B-	B-	P: No impact is expected. C: Noise and vibration generated by the operation of construction equipment and vehicles, although they are temporary. Construction schedule should take into account the location of schools, hospitals and religious facilities that require silence during parts of the day. O: Noise and vibration level are likely to increase due to greater traffic volume along the road. Specific measures may be required to minimize impacts on schools, hospitals and religious facilities.
Ground Subsidence	D	D	D	P/C/O: No impact is expected.
Offensive Odor	D	D	D	P/C/O: No impact is expected.
Bottom sediment	D	C	C	P: No impact is expected. C/O: The piers may cause slight change in the hydrodynamics and cause erosion of bottom sediment.
Natural Environment				
Wildlife Reserve/ protected area	D	D	D	P: No impact is expected. C: No protected area exists within 10km radius of project area. O: No protected area exists within 10km radius of project area.
Eco-system/Bio-diversity	D	A-	B-	P: No impact is expected. C: During the construction period, ecosystem in the project area including local flora and fauna will be damaged to some extent, such as the impact of water pollution on Gangatic river dolphins. O: Increase of traffic volume will cause negative impacts on the ecosystem including fauna and flora along the project road.
Topography/ Geology	D	B-	D	P: No impact is expected. C: Changes in topographic conditions over the project area takes place due to

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	**Construction Stage**	**Operation Stage**	**Rational of the Impact Assessment**
				the need for cutting and filling work.
				O: No impact is expected.
Hydrology	D	B-	B-	P: No impact is expected.
				C: Construction work may cause minor and temporary impacts on hydrology because of pier construction, or the local use of water.
				O: Cutting and / or filling should result in minor changes of local hydrology.
Social Environment				
Involuntary Resettlement	A-	D	D	P: The project will likely affect over 700 families.
				C: Resettlement will be completed before construction begins and thus no resettlement is expected during operation.
				O: No impact is expected, as relocation will be completed before construction begins.
Local Economy and Livelihood	A-	B+/-	B+/-	P: Loss of income sources and livelihood due to involuntary resettlement are expected to negatively affect the local economy and livelihood.
				C: Economic activity of fishermen may have negative impact during construction period. On the other hand, employment opportunities of various skill levels will be created by the project.
				O: Economic activity of boat operators may be affected. On the other hand, by improving transportation network, access to market and public facilities will be improved and positive impact on regional development can be expected.
Land Use	B-	B-	D	P: Land acquisition and involuntary resettlement are likely to cause changes in the existing land use patterns.
				C: Land use is expected to change for the construction of construction yards and workers' camps, however the impact is temporary.
				O: Land usage along the alignment will be permanently changed, however a negative impact is not expected. Construction yard will be restored to their original conditions by the contractors.
Utilization of Local Resources	D	B-	D	P: No impact is expected.
				C: The use of local resources such as sand, crushed stone, etc. for the construction activities may have negative impact on the local use.
				O: No impact is expected as use of local resources is not expected during operation.
Water Usage	D	D	D	P: No impact is expected.
				C: There is a possibility that the residents who use river as domestic water may be affected during construction.
				O: No impact is expected.
Social Infrastructure and Services	B-	D	B+/-	P: One school playground will be affected.
				C: No impact is expected.
				O: In case of the relocation of school, commuting distance may increase depends on the location. In the long run, improved connectivity contributes to better accessibility to social infrastructure and services.
Social Institutions and Local Decision-making Institutions	D	D	D	P/C/O: Land acquisition and involuntary resettlement will be implemented based on existing social and local decision-making institutions so no impact will be expected.
Unequal Distribution of Benefit and Damage	B-	B-	B+/-	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damage between those who are directly affected by the project and those who are not. However, the impact can be mitigated with adequate resettlement plan with compensation packages.
				C: Those who are affected by Land acquisition and resettlement should have preference in access to employment opportunities by the construction work.

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	**Construction Stage**	**Operation Stage**	**Rational of the Impact Assessment**
				O: There is a possibility of uneven distribution of benefits between bridge connection site and Char land. In the long term, the project is expected to have a positive impact on the local economy through an improved transportation network.
Local Conflicts of Interests	B-	B-	B-	P/C/O: It is possible that unequal distribution of benefits and damage will result in local conflicts on intrests
Cultural and Historical Heritage	D	D	D	P/C/O: The proposed bridge does not traverse or run near major cultural or historical heritage sites.
Landscape	D	D	D	P/C/O: No impact is expected.
Poor People	A-	B+	B+/-	P: Given the limited coping capacity of the poor, it is necessary to assess their vulnerability and develop appropriate mitigation measures.
				C: The poor can benefit from employment opportunities during construction work.
				P: In the long-term, economic development in the region is likely to benefit the poor. However, the poor may not be able to receive benefits from the project due to the lack of skills and coping capacity.
Ethnic Minorities/ Indigenous People	C	C	C	P/C/O: According to initial site survey, there are no ST/SCs in the project area. However, the presence of ethnic minorities will be confirmed during the census survey.
Gender	B-	B-	D	P: Involvement of women should be ensured during the course of the land acquisition and resettlement process.
				C: Equal opportunity should be sought for employment during construction work.
				O: No impact is expected.
Children's Rights	B-	C	D	P: One school playground will be affected by land acquisition.
				C: The impact will be evaluated after the study.
				O: Child labor is unlawful according to Article 24 of the Indian Constitution. Only adults are eligible for potential employment opportunities created by the project.
Public Health (sanitation and infectious diseases)	D	B-	D	P: No impact is expected.
				C: Influx of construction workers is likely to increase the health risk, particularly that of STD / STI and HIV / AIDS.
				O: No impact is expected.
Occupational Health and Safety (OHS)	D	B-	B-	P: No impact is expected.
				C: Occupational health and safety of construction work should be properly managed through adequate EMP.
				O: Maintenance and repair work should take into account the occupational health and safety of the workers.
Others				
Accidents	D	B-	B-	P: No impact is expected.
				C: Increased risk of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles.
				O: Risks of accidents is expected to increase due to greater traffic volume and speed.
Climate Change	D	D	D	P: No impact is expected.
				C: The use of construction machines and operation of vehicles will result in an increase of GHG emissions, though the impact is small and short-term.
				O: The new bridge will shorten the truck transportation distance which reduces GHG emission. On the other hand, traffic volume is expected to increase. However, it is not significant enough to have impact on climate change and transboundary effects.

Source: JICA Study Team

7.7.3 TOR of Natural and Socio-economic Environment Survey

TOR of the Natural Environment and Socio-economic Survey is shown in the table below.

Table 7-34: TOR of Natural and Socio-economic Environment Survey

Item	Locations	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
Air Quality	3-4 locations along the bridge alignment (approximately every 10km)	• PM2.5, PM10, NOx, SO2	• Review of DPR environmental study • Continuous 24 hours per location (1 weekday) • Accordance with environmental standards in India • General trend of increase in traffic and vehicles is taken into account and CO_2 increase is qualitatively analysed.
Water Quality	3-4 locations along the bridge alignment	• Water temperature, turbidity (NTU), pH、 BOD5, COD	• Review of DPR environmental study • Accordance with environmental standards in India • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Solid Waste		• Solid waste production and disposal during the construction period • Solid waste produced during the maintenance works of the Project	• Review of DPR environmental study • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Soil Contamination	3-4 locations along the bridge alignment	• pH, Manganese, Iron, etc.	• Review of DPR environmental study • Soil sampling and laboratory analysis • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Noise and Vibration	3-4 locations along the bridge alignment	• Noise level	• Review of DPR environmental study • Accordance with environmental standards in India • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Bottom Sediment		• Hydrodynamic analysis	• Review of DPR environmental study • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Ecosystem/ Biological Diversity	Entire Project Area	• Presence/absence of rare species	• Field Survey • Document survey • Hearing Survey on local NGO/ experts. • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Hydrogeography	Entire Project Area	• Existing waterways such as rivers, streams and agricultural canals as well as sewage channels	• Review of DPR environmental study • Document survey • Field survey, map location study of the disaster-prone areas • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Geography/ Geomorphology	Entire Project Area	• Areas subject to cut and fill slope creation	• Review of DPR environmental study • Document survey • Field survey • Impacts during the construction period and operation and maintenance period are qualitatively analysed based on construction plan and similar projects
Involuntary Resettlement	Within ROW	• Population, asset inventory, livelihood • Resettlement and rehabilitation	• Census Survey • Focused Group Discussion • Estimate the quantitative impact of affected households, land and properties.

Item	Locations	Items Subject to Investigation	Method of Assessment and Estimation of Impacts
		cost	• Estimate the cost of resettlement and rehabilitation, restoration program
Local Economy and Livelihood	Within ROW and area surrounding the proposed alignment	• Regional economic situation • Social structure • Income and livelihood	• Census Survey • Socio-economic Survey • Focused Group Discussion • Estimate likely impacts on the local economy based on Review of Document plus Similar Examples • Estimate the impact on livelihoods based on the quantitative data of the socioeconomic status of PAPs
Land Use	Within ROW	• Land utilization • Extent of Impact by the project	• Socio-economic Survey • Review project content • Estimate the impacts based on result of Field Survey, Review of Document plus Similar Examples
Utilization of Local Resources	Area surrounding the proposed alignment	• Volume of local resource use • Extent of Impact by the project	• Socio-economic Survey • Review project content • Estimate the impacts based on result of Field Survey and Review of Document
Water Usage	Area surrounding the proposed alignment	• Water usage of residents	• Socio-economic Surve • Census Survey • Estimate the impacts based on result of Field Survey
Social Infrastructure and Services	Area surrounding the proposed alignment	• Target facilities • Distant from ROW, location • Accessibility	• Socio-economic Survey • Estimate the impacts based on information of utility infrastructure and public facilities (medical, school, religious facilities)
Unequal Distribution of Benefit and Damage	Within ROW and area surrounding the proposed alignment	• Livelihood of PAP and surrounding area • Utilization of Affected Land	• Census Survey • Focused Group Discussion • Estimate the impacts based on result of income sources of PAPs and other villagers plus Similar Examples
Poor People	Within ROW	• Livelihood and employment status • Literacy	• Census Survey • Socio-economic Survey • Estimate the impacts based on result of Field Survey, Review of Document plus Similar Examples
Ethnic Minorities/ Indigenous People	Within ROW	• Ethnicity, Language • Livelihood	• Census Survey • Socio-economic Survey • Estimate the impacts based on result of Field Survey, Review of Document
Gender	Within ROW and area surrounding the proposed alignment	• Social Structure • Livelihood and employment status • Literacy	• Socio-economic Survey • Focused Group Discussion • Documents and reports of similar projects in the neighbouring areas. • Estimate the impacts based on result of Field Survey, Review of Document plus Similar Examples
Children's Rights	Within ROW and area surrounding the proposed alignment	• Number of students • Facilities nearby	• Socio-economic Survey • Estimate the impacts based on result of Field Survey plus Similar Examples
Public Health (sanitation and infectious diseases)	100m from the proposed alignment	• Rate of disease, epidemic and tendency	• Review of documents of the similar projects. • Estimate the epidemic of diseases and tendency through Review of Document plus Similar Examples
Occupational Health and Safety (OHS)	Area surrounding the proposed alignment	• Risk of Safety and Health, countermeasure	• Review of documents including EMP of the similar projects. • Estimate the impacts based on Similar Examples
Accidents	Area surrounding the proposed alignment	• Traffic demand • Accident risk and measures	• Review of documents including EMP of the similar projects. • Estimate accident risk, tendency and measures based on Review of Plan plus Similar Examples

Source: JICA Study Team

7.8 Anticipated Environmental Impacts

7.8.1 Impacts on the living environment

(1) Survey Results

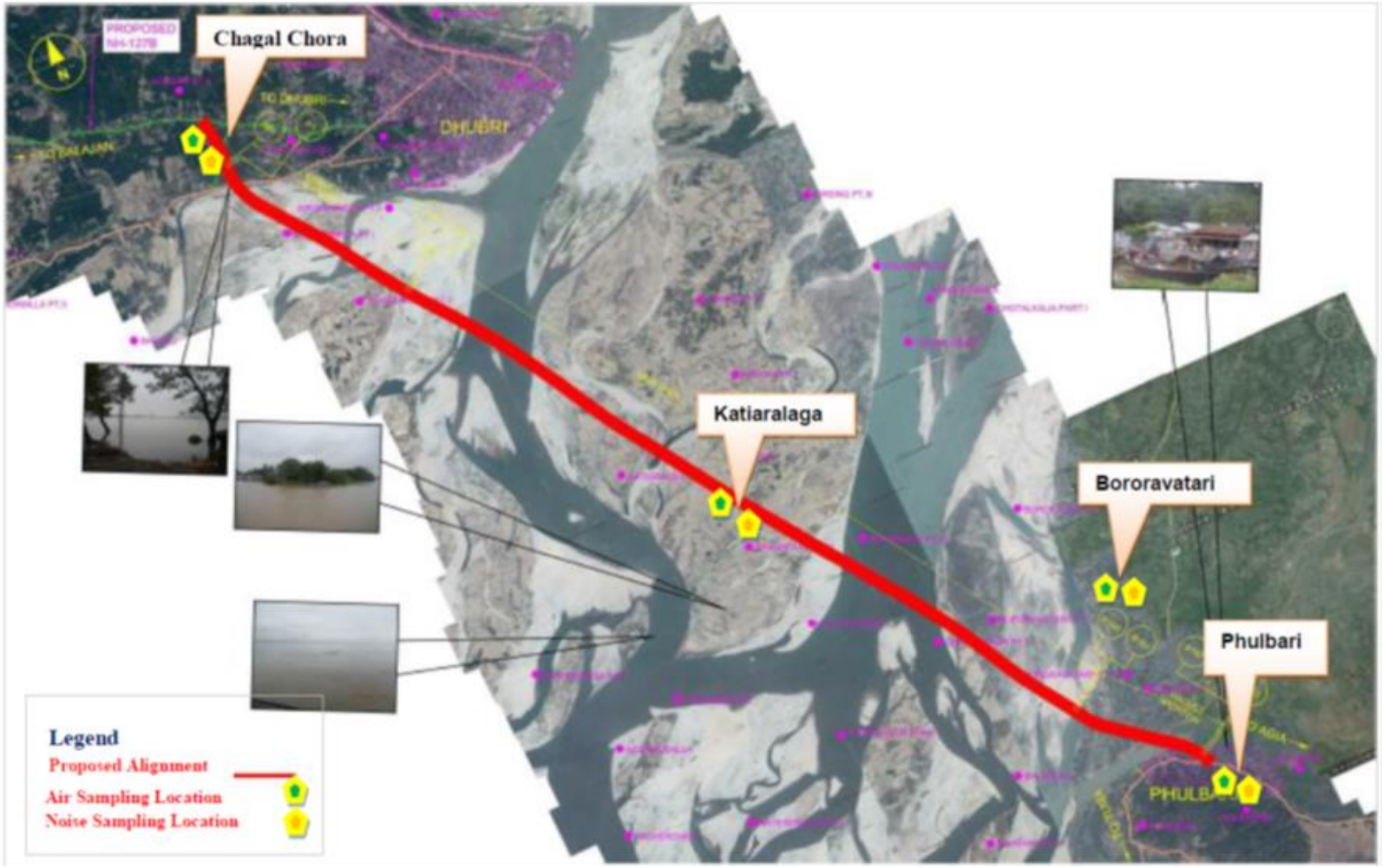
1) Air Quality

Ambient air samples were collected and analyzed at 4 locations along the proposed alignment of the bridge in October 2016. The results are shown below. At all sampling locations, the concentrations of air pollutants were below the national environmental standards. When compared with WHO guidelines,only at two locations of Chagal Chora and Phulbari, the measured value exceeded the guideline value, but within Interrim target 2 value.

Table 7-35: Ambient Air Quality along proposed Dhubri – Phulbari bridge

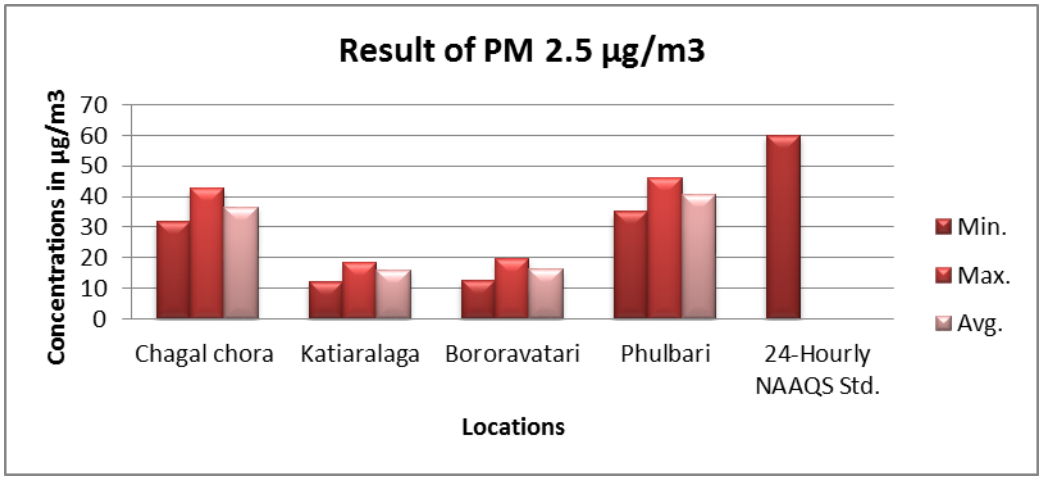
Chagal chora (Latitude 26°02'0.32"N & Longitude 89°56'15.67"E)					
	$PM_{2.5}$,µg/m3	PM_{10},µg/m3	SO_2 µg/m3 ,	NOx ,µg/m3	CO, µg/m3
Min	31.7	78.6	8.2	15.2	450
Max	42.6	86.3	10.2	22.4	750
Average	36.6	81.8	9.0	18.6	567.1
Katiaralaga (Latitude 25^0 57' 49.90" N & Longitude 89^0 58'38.26" E)					
	$PM_{2.5}$,µg/m3	PM_{10},µg/m3	SO_2 µg/m3 ,	NOx ,µg/m3	CO, µg/m3
Min	12.2	45.2	BDL	8.2	220
Max	18.3	56.4	BDL	10.4	290
Average	16.0	50.8	BDL	9.2	251.3
Bororavatari (Latitude 25^0 55' 03.91" N & Longitude 90^0 00' 53.50" E)					
	$PM_{2.5}$,µg/m3	PM_{10},µg/m3	SO_2 µg/m3 ,	NOx ,µg/m3	CO, µg/m3
Min	12.8	47.2	BDL	8.8	230
Max	19.6	59.4	BDL	11.6	310
Average	16.2	54.2	BDL	9.9	270.0
Phulbari (Latitude 25^0 53' 21.04" N & Longitude 90^0 02' 13.40" E)					
	$PM_{2.5}$,µg/m3	PM_{10},µg/m3	SO_2 µg/m3 ,	NOx ,µg/m3	CO, µg/m3
Min	35.2	79.6	8.9	16.2	460
Max	46.2	88.7	11.5	23.7	780
Average	40.7	83.2	10.1	19.6	576.3

Source: JICA Study Team



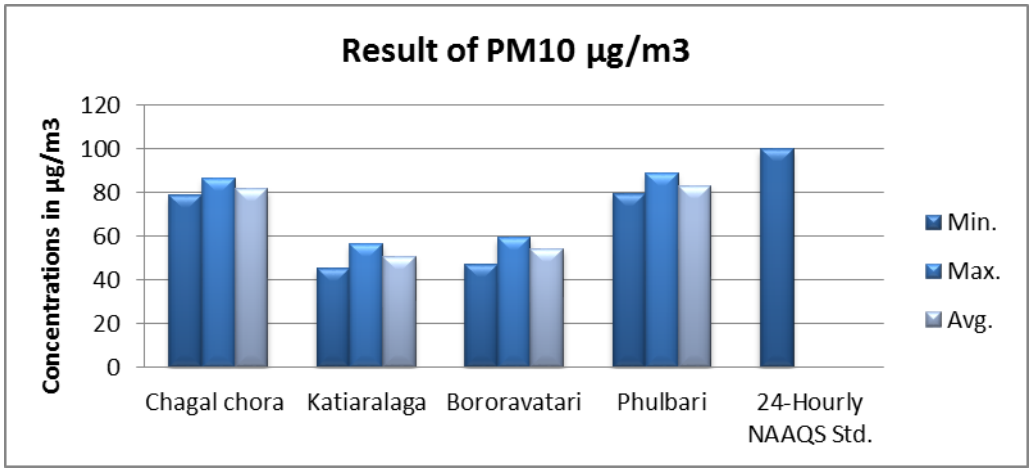
Source: JICA Study Team

Figure 7-16: Sampling locations for ambient air quality and noise level



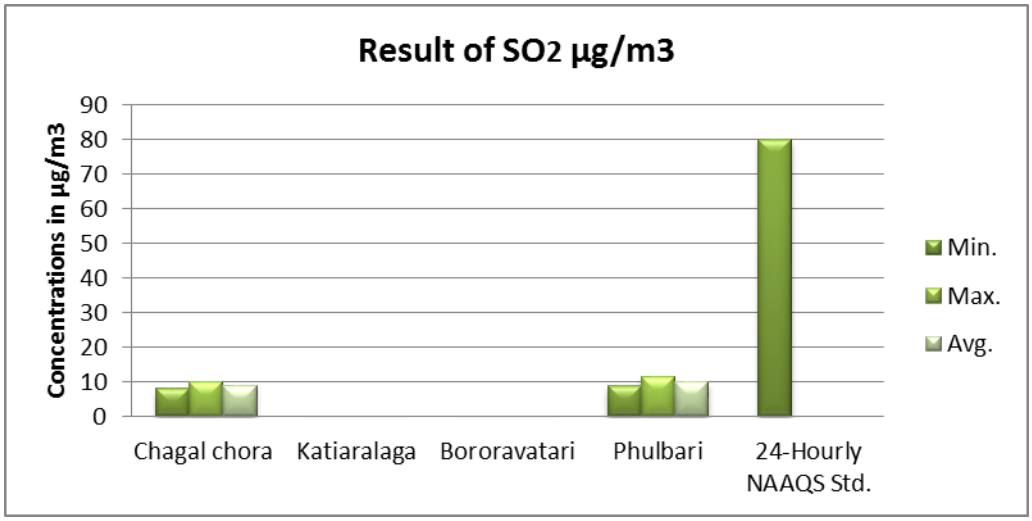
Source: JICA Study Team

Figure 7-17: Concentration of PM2.5 at locations along proposed Dhubri – Phulbari bridge on NH-127B



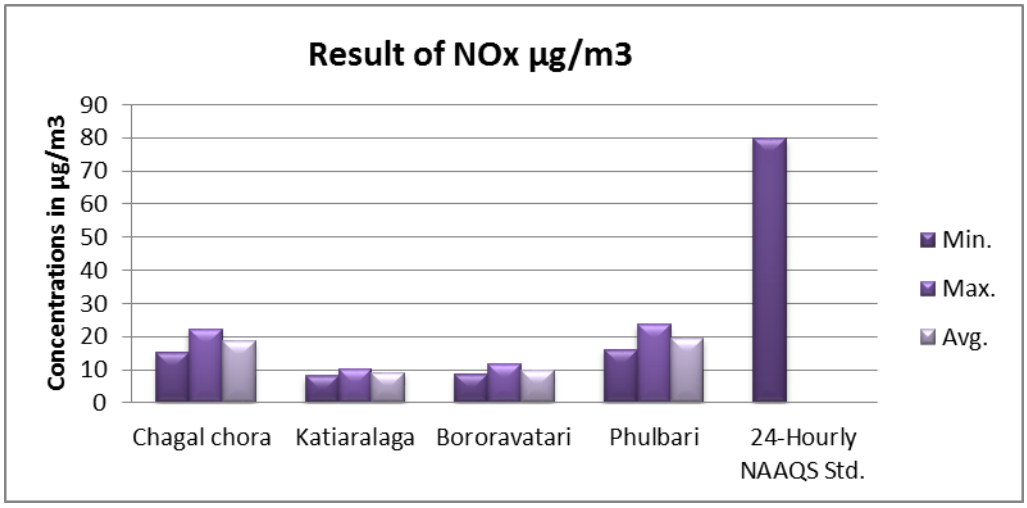
Source: JICA Study Team

Figure 7-18: Concentration of PM10 at locations along proposed Dhubri – Phulbari bridge on NH-127B



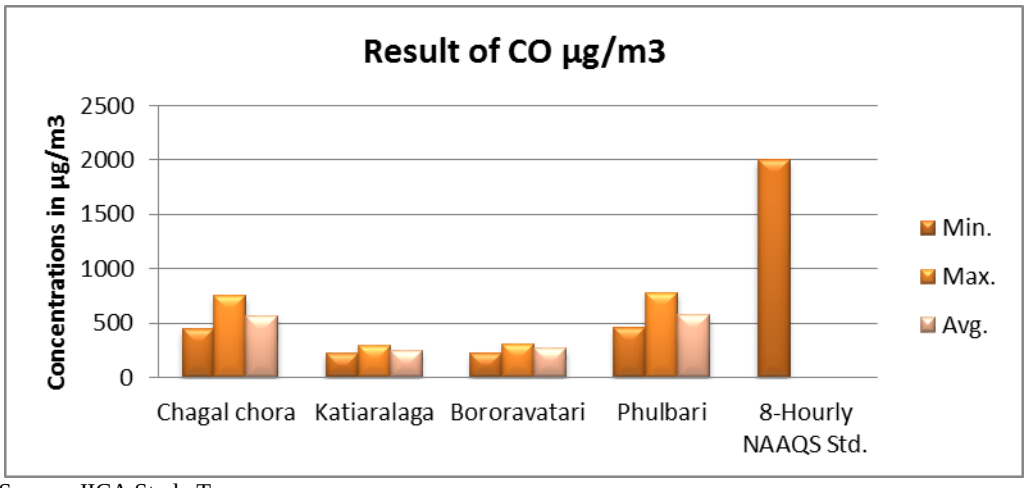
Source: JICA Study Team

Figure 7-19: Concentration of SO_2 at locations along proposed Dhubri – Phulbari bridge on NH-127B



Source: JICA Study Team

Figure 7-20: Concentration of NO_X at locations along proposed Dhubri – Phulbari bridge on NH-127B

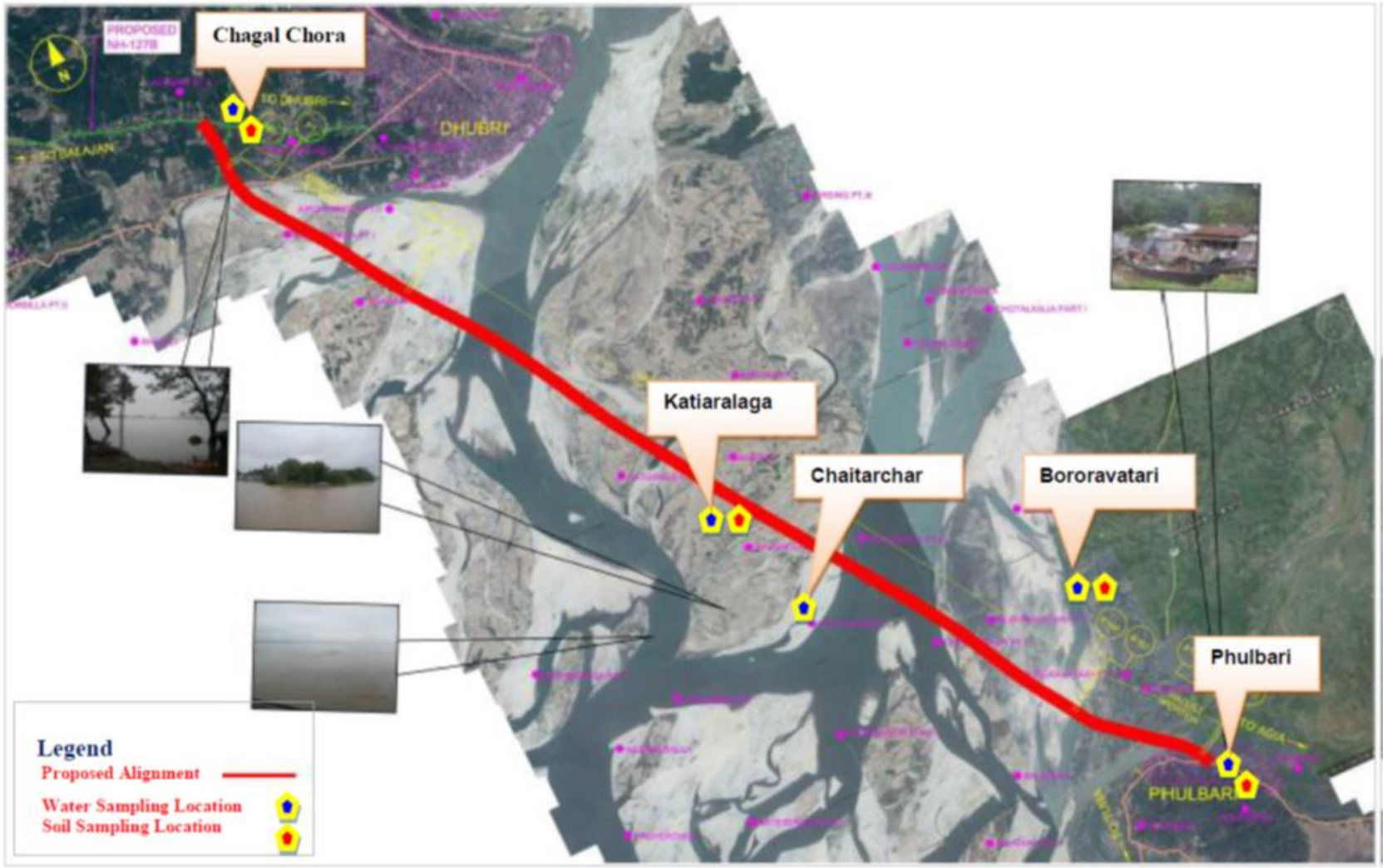


Source: JICA Study Team

Figure 7-21: Concentration of CO at locations along proposed Dhubri – Phulbari bridge on NH-127B

2) Water and Soil Quality

The monitoring of the water quality (surface and ground water) was performed at five identified locations in October 2016, in accordance to the Indian Standard Drinking Water Specification – IS 10500: 2012 and the quality met the IS Standards and the EHS guideline except for the pH, which is mildly acidic in Phulbari (dug well) and found to be 6.2 in pH scale. The bacteriological parameters are well within the standard limit except at Bororavatari perhaps due to waste from human intervention in the form of release of untreated waste. As for the soil quality, Since India does not have any environmental standards for soil contamination, the results were compared with Japanese stanrdards, and the results indicate no contamination.



Source: JICA Study Team

Figure 7-22: Sampling locations for water and soil quality

Table 7-36: Water quality (Surface and Ground water) along proposed Dhubri – Phulbari Bridge on NH-127B

Sl. No.	Parameters	Unit	Limit (as per IS:10500-2012)		Chagal chora (Latitude 26°02'0.58"N & Longitude 89°56'15.22"E) (Bore well)	Chaitarchar (Latitude 25°55'49.65"N& Longitude 89°59'30.77"E) (Brahmaputra River)	Katiaralaga (Latitude 25^0 57' 48.71" N & Longitude 89^0 58'34.52" E) (Hand pump)	Bororavatari (Latitude 25^0 55' 00.77" N & Longitude 90^0 01' 45.56" E) (Jinger River)	Phulbari (Latitude 25^0 53' 21.04" N & Longitude 90^0 02' 13.40" E) (Dug well)
			Desirable Limit	Permissible Limit					
1	pH	-	6.5-8.5	No Relaxation	6.56	7.54	7.29	6.63	6.02
2	Colour	Hazen	5	25	<5	<5	<5	<5	<5
3.	Turbidity	NTU	5	10	BDL	5.5	BDL	6.5	BDL
3	Dissolved Oxygen	% By Mass	5	10	7.2	6.5	6.5	7.0	6.0
4	BOD (at 27^0C 3-Days)	mg/l	-	-	<2.0	3.8	<2.0	4.2	<2.0
5	COD	mg/l	-	-	BDL	10.6	BDL	16.0	BDL
6	TKN	mg/l	-	-	3.1	3.2	2.5	3.5	2.0
7	Total Hardness (as $CaCO_3$)	mg/l	200	600	204.30	60.4	186.60	45.6	120
8	Calcium (as $CaCO_3$)	mg/l	75	200	168	44.40	153	34.6	94
9	Magnesium (as $CaCO_3$)	mg/l	30	100	38.3	16.0	33.6	11	26
10	Ammonia (NH_3)	mg/l			BDL	BDL	BDL	BDL	BDL
11	Electrical Conductivity	Microm/hos/cm	-	-	649.87	184.17	660.99	177.91	598.06
12	Chloride (as Cl)	mg/l	250	1000	23.99	0.5	27.3	4.49	50.99
13	Sulphate (as SO_4)	mg/l	200	400	46.52	8.4	38.4	19.6	41.0
14	Phosphates	mg/l	-	-	BDL	BDL	BDL	BDL	BDL
15	Nitrate (as NO_3)	mg/l	45	No Relaxation	10.68	3.8	8.32	2.6	9.6
16	Fluoride (as F)	mg/l	1	1.5	0.45	0.32	0.31	0.28	0.23
17	Arsenic (As)	mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
18	Lead (as Pb)	mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01

Sl. No.	Parameters	Unit	Limit (as per IS:10500-2012)		Chagal chora (Latitude 26°02'0.58"N & Longitude 89°56'15.22"E) (Bore well)	Chaitarchar (Latitude 25°55'49.65"N& Longitude 89°59'30.77"E) (Brahmaputra River)	Katiaralaga (Latitude 25^0 57' 48.71" N & Longitude 89^0 58'34.52" E) (Hand pump)	Bororavatari (Latitude 25^0 55' 00.77" N & Longitude 90^0 01' 45.56" E) (Jinger River)	Phulbari (Latitude 25^0 53' 21.04" N & Longitude 90^0 02' 13.40" E) (Dug well)
			Desirable Limit	Permissible Limit					
19	Mercury(as Hg)	mg/l	-	-	<0.001	<0.0001	<0.001	<0.001	<0.001
20	Phenols	mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
21	Cyanides	mg/l	-	-	BDL	BDL	BDL	BDL	BDL
22	TDS	mg/l	500	2000	422.41	119.71	429.64	115.64	388.74
23	Iron (as Fe)	mg/l	0.3	1.0	0.165	0.24	0.18	0.54	0.14
24	Alkalinity as ($CaCO_3$)	mg/l	200	600	221	68	216	51	168
25	Sodium (as Na)	mg/l	-	-	32.6	12	56.7	16.30	62.5
26	Potassium (as K)	mg/l	-	-	1.8	1.33	3.5	2.2	3.8
27	Total Organic Carbon (TOC)	mg/l	-	-	3.2	0.092	2.7	1.9	2.6
28	Zinc	mg/l	5	15	<0.05	0.044	<0.05	<0.05	0.208
29	Cadmium	mg/l	0.003	No Relaxation	<0.001	<0.01	<0.001	<0.001	<0.001
30	Chromium	mg/l	0.05	No Relaxation	<0.05	<0.01	<0.05	<0.05	<0.05
31	Manganese (as Mn)	mg/l	0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
32	Nitrite (as No_2)	mg/l	<0.01	No Relaxation	<0.01	<0.01	<0.01	<0.01	<0.01
Bacteriological Parameters									
1.	Faecal Coliform	MPN/100 ml	Shall Not be Detectable		Absent	168	Absent	210	Absent
2.	Total Coliform	MPN/100 ml	Shall Not be Detectable		Absent	655	Absent	740	Absent

Source: JICA Study Team

Table 7-37: Soil quality (Surface and Ground water) along proposed Dhubri – Phulbari Bridge on NH-127B

S.No.	PARAMETERTS	TEST METHOD	UNIT	Chagal chora (Latitude 26°01'59.13"N & Longitude 89°56'16.42"E)	Katiaralaga (Latitude 25^0 57' 48.75" N & Longitude 89^0 58'34.64" E)	Bororavatari (Latitude 25^0 55' 07.21" N & Longitude 90^0 00' 56.29" E)	Phulbari (Latitude 25^0 53' 20.24" N & Longitude 90^0 02' 14.60" E)	Legal standards in Japan (reference)
1.	pH(1:5 suspension)	IS:2720(Part-26)	-	6.2	5.9	5.4	6.5	—
2.	Electrical Conductivity at 25^OC (1:2suspension.)	IS:2720(Part-21)	µS/cm	449	490	378	461	—
3.	Calcium Sulphates	STP/SOIL	mg/kg	BDL	BDL	BDL	BDL	—
4.	Magnesium (as Mg)	STP/SOIL	mg/kg	132.85	123.4	145.6	115.0	—
5.	Organic Matter	IS:2720(Part-22)	% by mass	6.36	5.12	5.76	6.67	—
6.	Potassium (as K)	STP/SOIL	mg/kg	128.5	114.3	122.7	137.9	—
7.	Water Holding Capacity	STP/SOIL	% by mass	31.1	22.8	29.36	26.71	—
8.	Porosity	STP/SOIL	% by mass	23.3	17.3	22.82	32.7	—
9.	Sand	STP/SOIL	% by mass	38.0	37.8	39.3	36.4	—
10.	Clay	STP/SOIL	% by mass	54.6	55.2	52.7	54.4	—
11.	Silt	STP/SOIL	% by mass	7.4	7.0	8.0	9.2	—
12.	Sodium Sulphates	STP/SOIL	mg/kg	13.9	12.20	15.76	12.5	—
13.	Sodium Absorption Ratio	STP/SOIL	-	4.12	4.49	4.51	5.23	—
14.	Nitrogen	STP/SOIL	% by mass	0.062	0.057	0.051	0.076	—
15.	Phosphorus	STP/SOIL	mg/kg	22.7	18.4	16.20	21.93	—
16.	Bulk Density	STP/SOIL	gm/cc	1.30	1.37	1.52	1.45	—

S.No.	PARAMETERTS	TEST METHOD	UNIT	Chagal chora (Latitude 26°01'59.13"N & Longitude 89°56'16.42"E)	Katiaralaga (Latitude 25^0 57' 48.75" N & Longitude 89^0 58'34.64" E)	Bororavatari (Latitude 25^0 55' 07.21" N & Longitude 90^0 00' 56.29" E)	Phulbari (Latitude 25^0 53' 20.24" N & Longitude 90^0 02' 14.60" E)	Legal standards in Japan (reference)
17.	Texture	STP/SOIL	-	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	—
18.	Moisture Retention capacity	STP/SOIL	%by mass	20.6	18.9	22.3	19.6	—
19.	Infiltration Rate	STP/SOIL	mm/hr	23.4	21.0	19.66	24.2	—
20.	Moisture	STP/SOIL	%	16.82	14.3	13.28	15.6	—
21.	Sulphates	STP/SOIL	mg/1000g	13.4	15.7	17.9	14.62	—
22.	Available Sulphur (as S)	STP/SOIL	mg/kg	0.081	0.072	0.060	0.078	—
23.	Available Manganese (as Mn)	STP/SOIL	mg/kg	0.048	0.040	0.051	0.059	—
24.	Available Iron(as Fe)	STP/SOIL	mg/kg	0.63	0.71	0.68	0.076	—
25.	Exchangeable Sodium Percentage	STP/SOIL	mg/kg	0.076	0.052	0.067	0.059	—
26.	Mercury (as Hg)	STP/SOIL	mg/kg	ND	ND	ND	ND	15
27.	Lead (as Pb)	STP/SOIL	mg/kg	ND	ND	ND	ND	150
28.	Cadmium (as Cd)	STP/SOIL	mg/kg	ND	ND	ND	ND	150
29.	Zinc (as Zn)	STP/SOIL	mg/kg	0.02	0.3	0.2	0.2	—
30.	Total Chromium	STP/SOIL	mg/kg	ND	ND	ND	ND	250

Source: JICA Study Team

3) Noise Levels

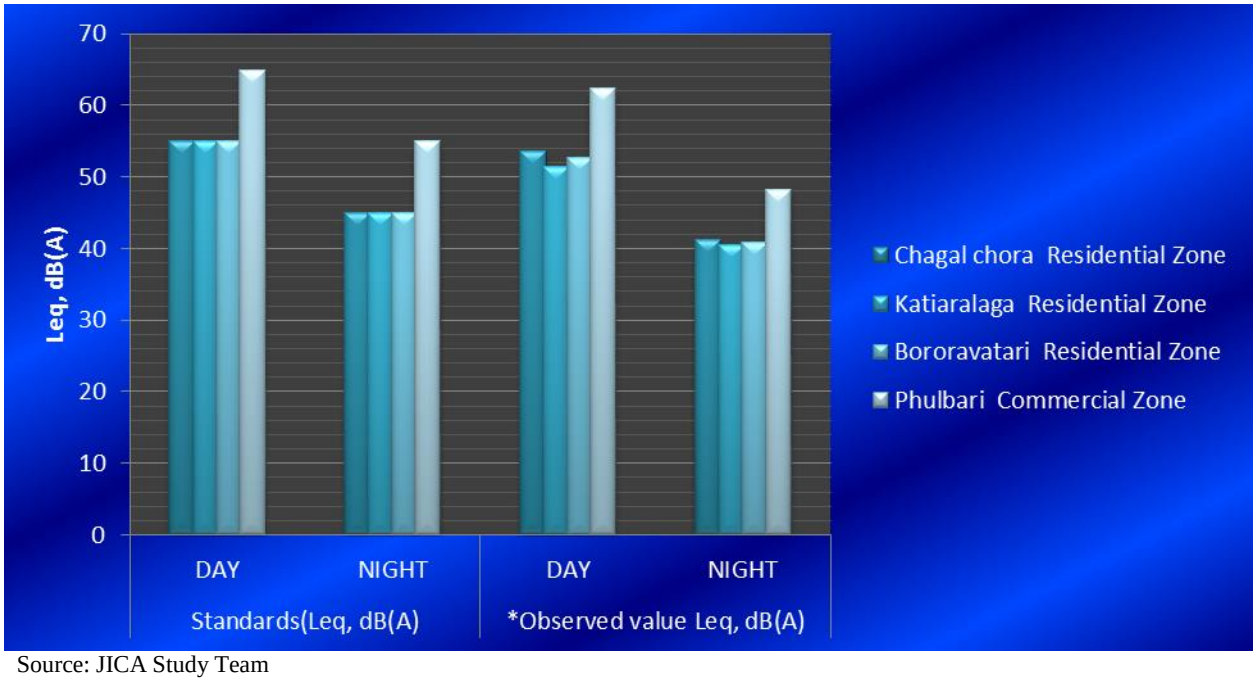
Monitoring of the noise levels were done at four identified locations along the proposed Dhubri – Phulbari bridge on NH-127B during October 2016, as per Ambient Air Quality standards with respect to noise, (2000). Results of noise levels are presented in Table 7-35, a map of ambient noise locations is presented in Figure 7-21 and a location wise comparative chart for noise levels is presented in Figure 7-21.

Currently there is no source of vibration in the project area. Therefore vibration data was not measured.

Table 7-38: Noise Levels along proposed Dhubri – Phulbari Bridge on NH-127B

Sl. No	Date of Monitoring	Location	ZONE	Standards (Leq, dB(A)		*Observed value Leq, dB(A)	
				DAY	NIGHT	DAY	NIGHT
1	04.10.2016	Chagal chora (Latitude 26°02'0.58"N & Longitude 89°56'15.22"E)	Residential Zone	55	45	53.6	41.2
2	04.10.2016	Katiaralaga (Latitude 25^0 57' 48.75" N & Longitude 89^0 58'34.64" E)	Residential Zone	55	45	51.4	40.5
3	05.10.2016	Bororavatari (Latitude 25^0 55' 05.21 N & Longitude 90^0 00' 54.81" E)	Residential Zone	55	45	52.7	40.8
4	05.10.2016	Phulbari (Latitude 25^0 53' 20.91" N & Longitude 90^0 02' 15.30" E)	Commercial Zone	65	55	62.4	48.2

Source: JICA Study Team



Source: JICA Study Team

Figure 7-23: Ambient Noise Quality Results at locations along proposed Dhubri – Phulbari bridge on NH-127B

(2) Anticipated Impacts and Mitigation Measures

1) Air Quality

Impacts

During the construction phase, the short-term and localized degradation of air quality will occur from dust generation due to the procurement and transportation of raw materials from quarries and borrow pits, site clearance, use of heavy vehicles, machinery/ equipment, stone crushing handling and the storage of aggregates and generation of fine particulate matter (smoke) in asphalt processing. Dust would be generated from the haulage of materials and detouring of traffic on non-permanent, temporary pavement etc. Hot mix plants contribute substantially to the deterioration of air quality due to emissions of oxides of Sulphur, Hydrocarbons and particulate matter. During the construction period, temporary impacts include the generation of Odor from construction activities as well as from construction camps. During the construction of the road, the movement of different types of construction machinery and vehicle will increase. This in another way increases the fuel consumption. From the results of the ambient air quality monitoring conducted along the road, it is noted that the monitoring parameters are within the standards as prescribed by the Central Pollution Control Board. The concentration of the air pollutants will further increase during construction period but for a limited period only. The impacts on the air quality during construction will be mostly localized and concentrated within the ROW. The impacts due to dust generation may be felt downwind of the site rather than the site itself due to local wind patterns.

During the operation phase, the project road is mostly passing through the rural areas with alluvial soil. Dust generation due to the movement of vehicles is envisaged along the project road, but not in significant amount. Due to increase in speed and volumes of vehicular traffic on the project corridor, marginal increase in the air pollutant levels is expected but not significant. Construction of the bridge will attract larger communities to use this corridor which in-turn increases the fuel consumption and can have direct impact on the national economy and local ecosystem.

Mitigation Measures

The hot mix plants, crushers and the batching plants will be sited at least 500m in the downwind direction from the nearest settlements and forest areas. All precautions to reduce the level of dust emissions from the hot mix plants, crushers and batching plants will be taken. The hot mix plant will be fitted with a dust extraction system. Asphalt and concrete plants will be operated in conformity with government pollution control legislation, and located away from the settlements as far as possible. All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. Regular monitoring of particulate matter at crusher sites, during the construction, will be conducted. Regular water sprinkling will be done on the cement and earth mixing sites, asphalt mixing site and temporary service and access roads. After compacting the earthwork, water will be sprayed to prevent dust emission. The vehicles delivering construction material will be covered to avoid spilling. Planting of trees/vegetation on the periphery of the construction site will be taken.

During the operation stage of the project, vehicular emissions of critical pollutants (PM2.5, PM10, CO, HC, SO2, and NOx) will be monitored and roadside tree plantation will be maintained. Over the long-term, projected increase in traffic volume, particularly ones of heavy trucks, may pose health threat to roadside community. The peak hourly estimated traffic volumes for the years 2020 and 2035 have been considered to project future air quality scenarios to provide an indication of long-term variations in air quality. The future level of air pollution, modeled based on the projected increase in traffic volume indicates that the level of pollution (CO and NOx levels) will remain below the standard during the projected period (2035). Nevertheless, mitigation measures such as introducing speed limit and other measures to control congestion in built-up area may be necessary in the longer term. The RSPM values may increase as the traffic volume increases, however implementation of new Euro Norms in vehicle & Air Pollution control measures will ensure that values do not exceed the limit during operation stages.

Also, local communities should be well informed of the risk of air pollution. Awareness raising campaigns may include distribution of facemask to mitigate risk of air pollution and other information kits. Finally, relevant data (e.g. actual/projected traffic volume and likely emissions) shall be shared with relevant State authorities so that mitigation measures can be developed.

2) Water Quality

Impacts

Bridge projects may marginally lead to increased run-off during construction stages, which will increase sediment accumulation in nearby water bodies, the impacts due to the increased run-off would be negligible due to the project road. During construction, the disposal of solid and liquid waste from labor camps, fuel and lubricant spills, or leaks from construction vehicles, pollution from fuel storage and distribution sites and that from hot-mix plants is likely to affect water quality unless adequate mitigation measures are designed. Hence, change in natural drainage pattern is very insignificant to the present state of the project. No chemical pollution is expected since no hazardous materials will be used during the construction phase.

Use of water for construction activities such as compaction, suppression, concrete work may pose pressure on local water supplies; the demand would be met from surface water bodies like ponds, canal and rivers. Municipal water supply will be used only for drinking purposes (for construction camps), if available, and if permitted by the local municipal authority. No local/municipal water supply would be used for construction purposes.

Road and bridge projects may marginally lead to increased run-off during operational stages due to increases in impervious surfaces and sediment will accumulate in water bodies.

In the operation stage, pollutants from vehicles, and accidental fuel spills may make their way into the receiving environment. The major pollutants of concern are suspended solids, oil and grease, lead etc. No adverse direct impact on the water quality (both underground and surface water bodies) is expected during the operation period. The change in natural drainage pattern is expected to be very insignificant from the present state of the project.

Mitigation Measures

To avoid contamination of the various water bodies and drainage channels, construction work close to the watercourses or other water bodies will be avoided, especially during monsoon period. All necessary precautions will be taken to construct temporary or permanent devices to prevent water pollution due to increased siltation and turbidity. All wastes arising from the project will be disposed of, as per the State Pollution Control Board/Central Pollution Control Board norms, so as not to block the flow of water in the channels. The wastes will be collected, stored and taken to approve disposal sites.

To avoid contamination of the water body and drainage channels from fuel and lubricants, the vehicles and equipment will be properly maintained and refueled only at designated places. The slopes of embankment leading to water bodies will be modified and re-canalized so that contaminants do not enter the water body. Oil and grease traps will be provided at fueling locations, to prevent contamination of water.

Discharge of oil and grease is most likely from construction vehicle parking areas, vehicle repair areas and workshops. An oil interceptor shall be provided to ensure that all wastewater flows into the interceptor prior to its discharge. The device has a chamber for separation of oil and water and can handle 200 L/hour of wastewater. The oil float appearing on the surface is removed by periodic cleaning once a week by skimming off the oil film from the surface.

The sewage system (including septic tanks and soak pits) for construction camps will be properly designed and built so that no water pollution takes place in any water body or watercourse. The workplace will have proper medical approval by local medical, health or municipal authorities. The

contractor will make arrangements for water required for construction in such a way that the water availability and supply to nearby communities remains unaffected. Due to the non-availability of water required for construction, if a new tube-well is to be bored, prior sanction and approval by the Central Ground Water Board (CGWB) will be obtained. Wastage of water during the construction will be minimized.

3) Wastes/Hazardous Materials

Types of construction waste which are expected to be generated include asphalt chunks, chunks of concrete, surplus soil, construction scrap materials and organic waste generated by construction workers. The amount and percentage composition of construction waste will depend on the final design and the schedule of the construction, and thus generic mitigation measures proposed in EMP should be updated once the final ROW drawing is completed. All other construction wastes are also planned to comply with relevant central or State laws pertaining to waste management.

To minimize the transportation of surplus soil, spoil banks should be located using the following conditions:

- Ground shape with concavity topography
- Ground gradient less than 22 degrees which is assumed as an average angle for spoil banks slope with necessary steps
- Not in built-up area
- Not in protected forest/private forest

4) Soil

Impacts

The contamination of soil during construction stage is primarily due to construction and allied activities. The soil contamination may take place due to solid waste from the labor camps set-up during the construction stage. This impact is significant at locations of construction camps; stockyards, hot mix plants, etc. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. The contamination of soils can also occur at the site of hot-mix plants from leakage or spillage of asphalt or bitumen. At the site of batching plants, because of spillage of cement and leakage of curing agents, soil contamination can occur. The contamination of soil may take place due to dumping of solid waste in an unscientific manner, leaching of fuel/oil & grease from workshops, or petrol stations and DG sets.

During the operation stage, soil pollution due to accidental vehicle spills or leaks is a low probability but potentially disastrous to the receiving environment, should they occur. These impacts can be long term and irreversible depending upon the extent of the spill.

Mitigation Measures

At construction yards, the vehicles/equipment will be maintained and refueled in such a fashion that oil/diesel spillage does not occur and contaminate the surrounding soil. It will be ensured that the fuel storage and refueling sites are kept away from drainage channels and important water bodies. At wash-down and refueling areas, "Oil Water Separators" shall be provided. All spills and discarded petroleum products shall be disposed of in accordance to the Hazardous Waste Management and Handling Rules. Fuel storage and re-fueling areas will be located at least 500m away from all water bodies near the road alignment. The fuel storage and refueling areas shall not be located on agricultural lands or productive lands to avoid topsoil contamination. The earthwork will be carried out strictly in accordance with the design so that no excess earth is borrowed. The construction waste generated will be reused in the construction of the highway.

Bituminous waste will be used after milling and in the case of bituminous waste being required to be disposed of it shall be disposed in a secured way by providing a 50mm thick layer of clay. The solid waste generated during the construction phase, which includes municipal waste both organic

and inorganic in nature, shall be stored/treated/disposed of in accordance with Municipal Solid Waste (Management & Handling) Rules. The hazardous waste may include oil waste, biomedical waste, E-waste etc. This shall be disposed of in accordance with the Hazardous Waste (Management, Handling & Trans boundary Movement) Rules, Biomedical Waste (Management and Handling) Rules and E-Waste (Management and Handling) Rules respectively.

In the operation stage, the petrol pumps and vehicle washing area located along the ROW will be monitored regularly for any spillage, and corrective remedial measures like the spread of sand, and the provision of oil and grease separators for the passing of wash water from petrol pumps and vehicle washing areas, before diverting it to water bodies. The solid waste generated from the way side amenities will include Municipal Waste both organic and inorganic, hazardous waste (like used batteries), will be treated in accordance with Municipal Solid Waste (Management & Handling) Rule and Hazardous Waste (Management, Handling & Trans boundary Movement) Rules.

5) Noise and vibration

Impacts

During the construction, the major sources of noise pollution is the movement of vehicles transporting the construction material to the construction yard and the noise generating activities at the yard itself. Mixing, casting and material movement are primary noise generating activities in the yard and will be uniformly distributed over the entire construction period. Construction activities are expected to produce noise levels in the range of 80 - 95 dB (A). The major work will be carried out during the daytime. The noise levels in the project area during the construction stage will be intermittent and temporary in nature. Typical noise levels associated with the various construction activities and construction equipment are presented in the table below.

Table 7-39: Typical Noise Levels of Construction Equipment

Construction Equipment	Noise Level dB(A)
Bulldozer	80
Front end loader	72-84
Jack hammer	81-98
Crane with ball	75-87
Crane	75-77
Bulldozer	80
Backhoe	72-93
Front end loader	72-84
Cement & Dump trucks	83-94
Jack hammer	81-98
Scraper	80-93
Welding generator	71-82
Grader	80-93
Roller	73-75
Concrete mixer	74-88
Concrete pump	81-84
Concrete vibrator	76
Paver	86-88
Truck	83-94
Tamper	74-77
Air compressor	74-87
Pneumatic tools	81-98

Source: U.S. Environmental Protection Agency, noise from Construction Equipment and Operations. Building, Equipment and Home Appliance.NJID. 300.1. December 31, 1971

At the moment, the noise level is within the desired level. The noise level will increase during the construction period, which may have significant impact for a limited period on the surrounding

environment. The noise levels in the working environment are compared with the standards prescribed by the Occupational Safety and Health Administration (OSHA-USA) which in-turn are being enforced by the Government of India through Model rules framed under the Factories Act. The acceptable limits for each shift being of 8 hours in duration, the equivalent noise level exposure during the shift is 90 dB(A). Hence, noise generated due to various activities in the construction camps may affect workers, if an equivalent 8-hour exposure is more than the safety limit. ACGIH (American Conference of Government Industrial Hygienists) proposed an 8-hour Leq limit of 85 dB(A). Exposure to impulses or impact noise should not exceed 140 dB(A). The workers in general are likely to be exposed to an equivalent noise level of 80-90 dB(A) in an 8-hour shift for which all statutory precautions as per the law should be taken into consideration.

During the operation stage of the project, reduction of vehicular engine noise (as a result of reduced congestion from the earlier, smoother flow of traffic due to 2 separate lanes), vehicular body noise (as a result of reduced development roughness) and the reduction of blowing of horns will bring the noise levels down, but as the volume of traffic, mainly heavy duty traffic, will increase in the future due to rapid development and industrialization along the road corridor, the noise may increase slightly.

Mitigation Measures

The high noise levels may cause discomfort for local residents and workers. Following mitigation measures shall be adopted to keep the noise and vibration levels under control.

- The plants and equipment used for construction will strictly conform to Central Pollution Control Board (CPCB) noise standards. Vehicles, equipment and construction machinery shall be monitored regularly with particular attention to silencers and mufflers to maintain noise levels to a minimum;
- Workers in the vicinity of high noise levels must wear ear plugs and helmets and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90 dB(A);
- In construction sites within 150 m of human settlements, noisy construction will be stopped between 10 PM and 6 AM except in the case of laying of cement concrete pavement for which a lower working temperature is a requirement;
- Hot mix plants, batching or aggregate plants shall not be located within 500m of sensitive land use for schools and hospitals;
- For places close to the sensitive receptors such as hospitals and schools, noise barriers such as earth, concrete, wood, metal or double-glazing of windows for façade insulation shall be used;
- Phase demolition, earthmoving, and ground-impacting operations are not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately;
- Avoid neighborhoods of residential areas and facilities susceptible to noise such as schools and hospitals as much as possible in the transportation route of construction vehicles.
- Construction machinery will be located away from the settlements;
- Careful planning of machinery operation and scheduling of operations can reduce the noise levels. Use of equipment, emitting noise not greater than 90 dB(A) for the eight-hour operations shift, and the locating of construction yards at a distance of at least 500m from any residential areas can be adhered to;
- Use of noise shields to construction machinery and provision of earplugs to the heavy machine operators are some of the mitigation measures, which should be followed by the contractors during the civil works;
- The noise control measures include limitations on allowable grades. Open-graded asphalt and avoidance of surface dressings to reduce tire noise in sensitive areas. Maintenance of proper road surface repairs will also help in reducing noise levels;

- Use of air horns should be minimized on the highway during nighttime. During daytime hours, use of horns should be restricted to the sensitive locations. This can be achieved through the use of sign boards along the roadside;
- Future development along the road should follow correct land use norms so that sensitive receptors are not located along the road, specifically along the bypasses; and
- The development of greenbelt along the main road can also bring about a considerable reduction in noise levels. The area available on both sides of the road should be used to develop greenbelt, comprised of selected species of trees with high canopies to provide added attenuation of noise.

6) Bottom Sediment

Impacts

During the pre-construction phase, surveying of the riverbed during pre-construction activity could affect the bottom sediment quality. However, the expected level of impact is low, temporary, and limited.

During construction activity, when foundations and piers of the bridge are constructed, there may be mobilization of the bottom sediments causing high, temporary, yet localized environmental impacts. Constructed foundations and piers may produce scour around them when the velocity of water becomes high due to flooding during and after construction. However, the expected level of impact is low, temporary, and limited.

Mitigation Measures

Mobilization of bottom sediments will require the EPC Contractor to install turbidity curtains around the foundation and pier under construction. Minimization of scour will require the EPC Contractor to suspend construction during flooding. Those scours will naturally be filled up and stabilize after the flooding. The EPC Contractor will monitor the velocity of water flow for a flood warning.

7.8.2 Natural Environment

(1) Survey Results

1) Ecology

The survey was conducted in October 2016. Primary information was collected by geo-spatial survey using GPS for land use and land cover in the area and visual survey during site visit of the floral and faunal biodiversity both in land and water, and threats to biodiversity.

The secondary source of data collection included on-site discussion with local people, boatmen, fishermen, knowledgeable people, local NGO, the faculty of Department of Zoology, Guwahati University, Guwahati, Assam, as well as information collection from published studies available as research and development publications, reports and bulletin of individual faculty and research institutions like Forest Department, BSI, ZSI, IUCN, CPCB, etc..

The area includes predominantly the flood plain or riparian ecosystem of the river Brahmaputra. In certain places, island habitation or small villages, e.g., Armari, Balughat, etc., are evident in the region.

Local people (rural inhabitants) practice conventional, natural living based on resources. Agriculture of subsistence nature, and fishing are the major economic activities of these people.

Habitation towards Dhubri and South Salmara-Mankachar consists of land based plantation of plantation crops and forest species, buildup areas and water bodies; while the area towards Phubari includes scattered patches of barren land or waste land, forestry plantations of sal, sagaun or teak and occasionally eucalyptus. Natural forest is totally obscured in the bridge impact area. Deciduous

forest (Champion and Seth 1968) is recorded only in the West Garo Hills near Phulbari (beyond 15km distance).

Biodiversity of agricultural species of plants is enumerated in the following Table. A total of 37 species of diverse economic use were recorded in the island habitations predominantly including vegetable crops (16 species). The Animal husbandry includes rearing of goats, cows and buffalo, rarely pigs or ducks. Backyard poultry is also practiced on a small scale by some inhabitants. The practice of aquaculture (rearing fishes and prawn) is altogether absent.

Table 7-40: Domesticated agro-biodiversity in the Study Area

Scientific Name	Family	Crop Type	Local/ English Name
Allium cepa	Amaryllidaceae	Vegetable	Piyaj
Allium sativum	Amaryllidaceae	Spice	Lahsun
Amaranthus sp.	Amaranthaceae	Vegetable	Lalsag
Anacardium occidentalis	Anacardiaceae	Plantation Crop	Kaju
Ananas comosus	Bromeliaceae	Fruit	Pineapple
Areca catechu	Arecaceae	Plantation Crop	Tambul
Artocarpus hetrophyllus	Moraceae	Vegetable	Kathal
Brassica spp.	Brassicaceae	Oilseed	Sarson
Capsicum annuum	Solanaceae	Vegetable	Mirch
Carica papaya	Caricaceae	Fruit	Papita
Cier aeriatinum	Fabaceae	Pulse	Chana
Citrus media	Rutaceae	Fruit	Nimbu
Cocos nucifera	Arecaceae	Fruit	Narikol
Colocasia antiquoram	Aracea	Vegetable	Kachchu
Corchorus capsularis	Malvaceae	Fibre	Jute
Coriandrum sativum	Apiaceae	Condiment & Spice	Dhania
Cucumis sativa	Cucurbitaceae	Fruit	Kheera
Cucurbita pepo	Cucurbitaceae	Vegetable	Kaddu
Daucus carrota	Apiaceae	Vegetable	Gajar
Hevia brasiliensis	Euphorbiaceae	Plantation Crop	Ruber
Lens esculenta	Fabaceae	Pulse	Masur
Luffa spp.	Cucurbitaceae	Vegetable	Lauki
Lycopersicon esculentum	Solanaceae	Vegetable	Tamatar
Momordica charantia	Cucurbitaceae	Vegetable	Karela
Musa indica	Musaceae	Fruit	Kela
Oryza sativa	Poaceae	Cereal	Dhan
Phaseolus mungo	Fabaceae	Pulse	Urd
Psidum guajava	Myrtaceae	Fruit	Amrud
Raphanus sativa	Brassicaceae	Vegetable	Muli
Sesamum indicum	Pedaliaceae	Oilseed	Til
Solanum melongena	Solanaceae	Vegetable	Began
Solanum tuberosum	Solanaceae	Vegetable	Aalu
Spinach oleracea	Amaranthaceae	Vegetable	Palak
Trigonella foenium graecum	Fabaceae	Vegetable	Methi
Triticum aestivum	Poaceae	Cereal	Gehu
Zea mays	Poaceae	Cereal	Makka
Zingiber officinalis	Zingiberaceae	Rhizome	Adrakh

Source: JICA Study Team

The diversity of flora (macrophytes) of terrestrial and aquatic ecosystems, in the wild, is listed in Table 7-38. A total of 75 plant species were recorded, including herbs (34 species), shrubs (06 species), trees (21 species) and climbers (04 species). The area included 27 plant species as invasive alien species, comprising of herbs (22), shrubs (03), small trees (01) and climbers (01) (Table 7-39). The flood plain areas are occupied by native Saccharum spontaneum grass, which was well established in the riparian ecosystem on account of the availability of a suitable habitat.

Table 7-41: Plant Biodiversity in the Study Area

Scientific Name	Family	Habit	Local Availability	IUCN * Status
(A) ANGIOSPERMS				
Acacia pennata	Mimosaceae	Herb	Common	LC
Ageratum conyzoides	Asteraceae	Herb	Very Common	NA
Albizzia procera	Mimosaceae	Tree	Rare	NA
Anthocephalus chinensis	Rubiaceae	Tree	Common	NA
Artocarpus integrifolia	Moraceae	Small Tree	Common	NA
Arundinella nepalensis	Poaceae	Herb	Common	NA
Arundo donax	Poaceae	Herb	Common	LC
Asparagus racemosus	Liliaceae	Trailing Herb	Rare	NA
Bauhinia acuminata	Caesalpiniaceae	Small Tree	Common	LC
Bombax ceiba	Bambacaceae	Tree	Very Common	NA
Cardamine impatiens	Brassicaceae	Herb	Common	NA
Cassia fistula	Caesalpiniaceae	Small Tree	Common	NA
Cassia tora	Caesalpiniaceae	Shrub	Common	NA
Chrysopogon fulvus	Poaceae	Herb	Common	NA
Cissampelos pariera	Manispermaceae	Herb	Rare	NANIC
Commelina bengalensis	Commelinaceae	Herb	Very Common	NANIC
Cyperus rotundus	Cyperaceae	Herb	Abundant	NANIC
Dendrocalamus hamiltonii	Poaceae	Herb	Common	NA
Dioscorea bulbifera	Dioscoreaceae	Climber	Common	NA
Erythrina variegata	Papilionaceae	Small Tree	Rare	NA
*Eucalyptus tereticornis***	Myrtaceae	Tree	Rare	NA
Euphorbia emodi	Euphorbiaceae	Herb	Common	LC
E. hirta	Euphorbiaceae	Herb	Common	NA
Ficus hispida	Moraceae	Tree	Common	NA
Galium sp.	Rubiaceae	Herb	Common	NA
Gmelina arborea	Verbenaceae	Tree	Common	NA
Imperata cylindrica	Poaceae	Herb	Common	LC
Ipomoea aquatica	Convolvulaceae	Herb	Common	NA
I. cairica	Convolvulaceae	Creeper	Very common	NA
Justicia adhatoda	Acanthaceae	Shrub	Common	NA
*Lagerstroemia parviflora***	Lytharaceae	Tree	Rare	NA
Lathyrus aphaca	Fabaceae	Herb	Common	NA
Lemna minor	Lemnaceae	Herb	Common	LC
Lepidium virginicum	Brassicaceae	Herb	Common	NA

Scientific Name	Family	Habit	Local Availability	IUCN * Status
Litsea glutinosa	Lauraceae	Tree	Rare	NA
Mallotus philippensis	Euphorbiaceae	Small Tree	Common	NA
Mimosa pudica	Mimosaceae	Herb	Rare	NA
Phragmites karka	Poaceae	Herb	Common	LC
Phyllanthus emblica	Euphorbiaceae	Tree	Common	NA
Poa annua	Poaceae	Herb	Common	LC
Potamogeton pectinatus	Potomogetonaceae	Herb	Common	LC
Pycrius spp.	Cyperaceae	Herb	Abundant	NA
Ranunculus arvensis	Ranunculaceae	Herb	Common	NA
Saccharum spontaneum	Poaceae	Herb	Abundant	LC
Sapium baccatum	Euphorbiaceae	Tree	Common	NA
Scripus spp.	Cyperaceae	Herb	Common	NA
Shorea robusta	Dipterocarpaceae	tree	Rare	NA
Smilex zylanica	Smilaceae	Climber	Rare	LR
Solanum erianthum	Solanaceae	Herb	Common	NANIC
Sonchus spp.	Asteraceae	Herb	Common	NA
Stellaria media	Caryophylaceae	Herb	Common	NA
Syzygium cumini	Myrtaceae	Tree	Common	NA
*Tectona grandis***	Verbenaceae	Tree	Common	NA
Thysanolaena maxima	Poaceae	Herb	Common	NA
Tinospora cordifolia	Manispermaceae	Climber	Rare	NA
Toona ciliata	Meliaceae	Tree	Common	NA
Trewia nudiflora	Euphorbiaceae	Tree	Rare	LR
Vitex peduncularis	Verbenaceae	Tree	Rare	NA
Zizyphus mauritiana	Rhamnaceae	Tall Shrub	Abundant	NANIC
(B) FERNS AND FERN ALLIES				
Adiantum caudatum	Adiantaceae	Herb	Common	NA
Equisetum diffusum	Equisetaceae	Herb	Common	NA
Marselia minuta	Marseliaceae	Herb	Common	NANIC
Pteris biaurita	Pterideae	Herb	Rare	NA
Seleginella helferi	Selaginellaceae	Herb	Common	NANIC

*Based on the IUCN Red List of the Species Version 2016-3, downloaded on Dec. 28, 2016.
** Planted / Cultivated
Abbreviations: VU = Vulnerable, NA = Not assessed but present in the catalogue of Life, NANIC = Not assessed and not present in the catalogue of Life, LC = Least concern, LR = Low risk
Source: JICA Study Team

Table 7-42: Invasive Alien Plants in the Study Area

Species	Family	Habit	Nativity
Aerva javanica	Amaranthaceae	Herb	Tropical America
Ageratum conyzoides	Asteraceae	Herb	Brazil
Amaranthus spinosus	Amaranthaceae	Herb	Tropical America
Anagallis arvensis	Primulaceae	Herb	Europe
Argemone mexicana	Papaveraceae	Herb	Tropical South America
Calotropis procera	Asclapiadaceae	Shrub	Tropical America
Cannabis sativa	Cannabaceae	Herb	Tropical America
Chenopodium album	Chenopodiaceae	Herb	Tropical America
Cleome viscosa	Capparaceae	Herb	Tropical America
Cuscuta reflexa	Cuscutaceae	Climber	Mediterranean region
Datura metal	Solanaceae	Shrub	Tropical America

Species	Family	Habit	Nativity
Eichhornia crassipes	Pontederiaceae	Herb	Tropical America
Euphobia hirta	Euphorbiaceae	Herb	Tropical America
E. thymifolia	Euphorbiaceae	Hurb	Tropical America
Galinsoga paviflora	Asteraceae	Herb	Tropical America
Lantana camara	Verbenaceae	Shrub	Tropical America
Oxalis corniculata	Oxalidaceae	Herb	Europe
Parthenium hysterophorus	Asteraceae	Herb	Tropical America
Physalis minima	Solanaceae	Herb	Tropical America
Portulaca oleracea	Portulacaceae	Herb	Tropical South America
Prosopis juliflora	Mimosaceae	Small Tree	Mexico
Saccharum spontaneum	Poaceae	Herb	Tropical America
Side acuta	Malvaceae	Herb	Tropical America
Solanum nigrum	Solanaceae	Herb	Tropical America
Tridex procumbens	Asteraceae	Herb	Tropical America
Typha angustifolia	Typhaceae	Herb	Tropical America
Xanthium strumarium	Asteraceae	Herb	Tropical America

Source: JICA Study Team

The faunal diversity as recorded for the bridge influenced area is listed in Table 7-40. Evidently, 40 animal species belonging to mammals (11), avifauna (13), reptiles (05) amphibians (04), butterflies (03) and anthropods (04) are recorded for the study site. The status of occurrence of these species based on the field study and following the Wildlife Act (amended in 2013) as well as the IUCN status are also in the Tables. The diversity of fish fauna as recorded for the area along with the IUCN status and local availability is enlisted in Table 7-41. Some migratory species were found in the study area and indicated in bold letter in the table below. Ganges river dolphins are known to have local migration pattern due to water level change between wet and dry season, but they are seen in Dhubri area all year around, All of the other migratory species were birds, and no seasonal variation was found in reptiles, amphibians, fish and invertebrate according to interview and literature surveys.

Table 7-43: Animal biodiversity in the Study Area

Scientific Name	Local /English Name	Status* WLA	IUCN** Status
Mammals			
Canis aureus	Jackal		LC
Cnnomys badius	Bay Bamboo rat		NANIC
Lepus nigricollis	Hare	Sch.III	LC
Macaca mulatta	Monkey		LC
Mus musculus	House mouse		LC
Platanista gangetica ssp. gangetica	Dolphin	Sch. I	EN
Pteropus giganteus	Flying fox	Sch. I	LC
Trachypithecus pileatus	Capped Langur	Sch. I	VU
Sus scrofa	Wild Boar		LC
Vulpes bengalensis	Fox	Sch. III	LC
Alcedo atthis	Common Kingfisher		LC
Birds			
Babulus ibis	Bagula		NANIC
Corvus splendens	House Crow		LC
Cuculus micropeterus	Indian Cuckoo		NANIC
Dendrocopus mahrattensis	Woodpecker		NANIC

Scientific Name	Local /English Name	Status* WLA	IUCN** Status
Gracula religiosa	Hill Myna	Sch. II	LC
Gyps indicus	Vulture	Sch. I	CR
Otus spilocephalus	Mountain Scops Owl	Sch. I	LC
Passer domesticus	House Sparrow		LC
Perdicula asiatica	Jungle Bush Quail		LC
Ploceus philippinus	Baya		LC
Psittacula krameri manillensis	Parrot	Sch. I	NA
Sturnus contra	Grey-headed Myna	Sch.I	NA
Reptiles			
Bungarus fasciatus	Common Indian Krait	Sch. II	LC
Crotalus sp.	Viper		LC
Hemidactylus flaviviridis	House Geeko		NA
Naja naja	Cobra	Sch. II	DB
Varanus bengalensis	Common Indian Monitor	Sch. I	LC
Amphibians			
Bufo melanostictus	Common Asian Toad		LC
Hoplobatrachus tigerinus	Indian Bull Frog	Sch. I	LC
Polypedates sp.	Frog		LC
Spaerotheca brericeps	Burrowing Frog		NANIC
Fish			
Apistogramma borelli	Bareli		NA
Aspidoparia moror	Boreala		NANIC
Barillus bendalisis	Barilius		NANIC
B.barna	Barilius		NANIC
Batasio sp.	Tengra		NA
Catla catla	Catla		NA
C.striatus	Sal		NANIC
Channa marulius	Sal		LC
C. orientalis	Chengeli		NA
Cirrhinus mrigala	Mrigal		LC
Clarias butrachus	Magur		NANIC
*Cyprinus carpio**	Common carp/Chinese carp		VU
Labeo rohita	Rohu/Rau		NANIC
Mastacembelus armatus	Common Spiny Eal		LC
Mystus cavasius	Dwarf Tengra		LC
M. tengara	Tingorah		LC
Neolissocheilus hexagonolepis	Mahseer		NA
Noemachilus beavani	Botia		NANIC
N. botia	Striped Louch		NANIC
Punctius chola	Puthi/Punti		NANIC
P. sarana	Fire fin barb		NANIC
Tenualosa ilisha (Hilsa ilisha)	Ilis/Ilisha		LC
Invertebrates			
Macrobrachium choprai	Prawn		NA
M. rosenbergii	Prawn		LC
Macrognathus aral	Toru		LC
Chilades laius	Lime blue		NA
Graphium sarpedon sarpedon	Common Bluebottle		NA
Mycalensis perseus blasius	Common Bushbown		NANIC
Anopheles stepnensi	Anepheles Mosquito		NANIC
Culex quingquefaeciatus	Culex Mosquito		NANIC

Scientific Name	Local /English Name	Status* WLA	IUCN** Status
Hippasa lycosina	Grassland spider		NA
Pholcus phalangiodes	House Spider		NANIC

*According to Wildlife Act, 1972 amended in 2013.
**Based on the IUCN Red List of the Species Version 2016-3, downloaded on Dec. 29, 2016.
Bold: Migratory species
Abbreviations: VU = Vulnerable, NA = Not assessed but present in the catalogue of Life, NANIC = Not assessed and not present in the catalogue of Life, LC = Least concern, LR = Low risk, NT = Near Threatened, EN = Endangered, CR = Critically Endangered, DD = Data Deficient
Source: JICA Study Team

Dr. Abdul Wakid, a Project Scientist at the Wildlife Institute of India and Head (honorary) of the Gangetic Dolphin Research and Conservation Division (GDRCD) of Aaranyak, an Assam based leading environmental NGO, has 17 years of experience in the scientific study and conservation activities of the Ganges River Dolphins in Assam State. He conducted a series of dolphin surveys in the Brahmaputra river system, starting from 2005. In the last census conducted in 2012, Dr. Wakid and his team estimated dolphin population in Brahmaputra river system as follows.

Brahmaputra river system (including 2 tributaries): 635 dolphins
Brahmaputra River (not including tributaries): 583 dolphins
Brahmaputra River between the Golpara Bridge and Bangradesh border: 92-96 dolphins

During the 2012 bsurvey, Dr. Wakid recorded the highest density of the dolphin population in the section between the Goalpara Bridge and the Bangladesh border, including the river stretches within the proposed bridge construction site of the Dhubri District. Highest density of dolphin population was recorded in the dolphin survey conducted in 2005. The breeding season for the Gangetic dolphins of Brahmaputra River is recorded asFebruary to June. Dolphins are found in and around Dhubri area throughout the year but aggregate in the deep section of the river in the winter and more spread to the side channels during the summer. The population has had an upward trend since 2008 because of the lot of community engagement and awareness activities conducted since 2008.

2) Hydrology/geology/geography

A riverbed topographic map of the Brahmaputra River was created for the area of the 20km width including the Bridge crossing section by the riverbed configuration survey. The survey included the Gandadhar River on the north bank and the Jinjiram River on the south bank, and tributaries of the Brahmaptra River, to consider any influence from those rivers.

Existing data and materials were collected from all available resources including the observation data from the Brahmaputra and Barak Basin organization (B&BBO), Shillong of the Central Water Commission (CWC), available literature to assess the catchment areas and hydraulic parameters, interviews of local people, DPR of Naranarayan Bridge, and physical model studies conducted by NEHARI (North Eastern Hydraulic and Allied Research Institute) on behalf of the Brahmaputra Board. These data and materials were studied and analyzed to determine the HFL (High Flood Level), LWL (Low Water Level), Maximum discharge, and other necessary parameters. Various simulations were carried out using the US Army Corps of Engineers (USACE) Hydraulic Engineering Centre's River Analysis System (HEC-RAS).

Source: DPR

Figure 7-24: Riverbed Topography around the Dhubri Bridge

Building structures in a river may cause erosion of the bank and riverbed. There are two kinds of erosions: contraction scour and local sour. The contraction scour occurs due to a reduction in the flow area of the river when it approaches a bridge. Reduction in flow area is followed by an increase in flow velocity which results in the removal of sediments and rocks. The local scour is caused by increased velocity of water around a bridge pier and abutment and due to the formation of vortices and wakes. The contraction scour and the local scour together constitute the total scour around piers. Hydraulic parameters used for the analysis are shown in the table below.

Table 7-44: Hydraulic Parameters

Parameters	Values
High Flood Level（HFL）	30.36 m
Low Water Level（LWL）	23.00 m
Average Riverbed Slope	1/14,700
Maximum discharge for 100 years return period	100,306 m3/s
Maximum discharge for 10 years return period	71,225 m3/s
Maximum water velocity at HFL	4.5 m/s

Source: DPR

The analysis of the impact of the contrition was conducted. The interval of the substructures of the Project Bridge is 125m and there will be no impact due to the contraction of the river width.

(2) Anticipated Impacts and Mitigation Measures

1) Ecology

Impacts

The main impact on flora involves the removal of trees and the grubbing of vegetative cover for construction and a clear zone within theROW (inlcluding crops and fruit-bearing trees and for spoil bank. The types of impacts on ecosystem and biodiversity can be as follows:

- Loss of trees;
- Compaction of vegetation, and
- Pollution and dust accumulation on vegetation.
- The construction phase of the bridge will lead to the release of some amount of debris which needs be managed judiciously in order to maintain ecology of the area and aquatic life.
- During the construction of the proposed dam, there is a high possibility of dolphins and their habitats impacts due to high underwater noise, water quality change, habitat geomorphology changes, prey-base depletion etc.
- The existing Gangas river dolphin population suffers from habitat fragmentation by the development activities such as the construction of dam. It is estimated to be one of the causes of population decrease. In the case of this project, the dolphins and other aquatic species can pass under the bridge and no habitat fragmentation will be caused.
- No direct negative impact is anticipated on other species, but care should be taken to prevent indirect negative impact such as the deterioration of habitat. There will be some temporary physical disturbance to the aquatic environment during construction, but no chemical pollution will be caused and therefore no irreversible damage will be caused for the aquatic species.

Mitigation Measures

The following mitigation measures are recommended.

<Pre-Construction phase>

- No detailed survey has been done on the population of the dolphins in the Dhubri area, so it is suggested that a scientific study is done before the construction begins as a baseline for monitoring.

<Construction phase>

- Land clearing activities at the construction site should be kept at an absolute minimum. Construction vehicles, machinery and equipment will be moved or stationed in the (ROW) to prevent compaction of vegetation. While operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activities, it will be ensured that the trampling of soil is avoided.
- Anti-poaching measures during the construction phase should be strengthened to check for any violation of existing regulations. Awareness campaign to be made among the workers to aware them on the endangered and other important species.
- When rare birds of prey nesting are found in the vicinity, avoid large-scale construction during breeding period.
- Regular monitoring of the impacts of construction activities on the Gangetic dolphins and other important species should be done by dedicated wildlife experts and forest officials, so that immediate prevention activities can be undertaken.

- Channels will be kept free at all times for free movement of dolphins.
- To minimize impacts, noisy operations should be avoided during winter (Nov-Feb; when dolphin congregates into the deeper channel and pre-monsoon season (Mar-Jun; dolphin breeding time), thus from November to June..
- Construction activities should be carried out in close supervision of the dolphin ecologist.
- Measures such as the creation and monitoring of an exclusion zone of a 500m radius for at least 30 minutes before the start of construction activities shall be followed. If dolphins are observed in the exclusion zone, construction works should be delayed until they have left the area. If dolphins enter the exclusion zone after construction has commenced, construction works should cease until they have left. The contractors are recommended to adopt these mitigation measures during construction works inside the river. Acoustic deterrents can be tested to keep the dolphin away during from construction zone under the supervision of dolphin ecologist.
- Relevant information (e.g. encounter with vulnerable species during engineering work) shall be shared with the State Environment and Forest Department and concerned regional environmental experts with which the project authority will discuss potential measures to promote conservation and monitoring of the ecosystem.
- If trees are cut down for the labor camps and materials storage sites,the trees shall be re-planted after construction. Also, when trees in the ROW are cut down, alternative tree planting should be considered using local native tree species.

During the construction, the following endangered species may be encountered in the following locations.

Table 7-45: Distribution of vulnerable and other important species in the project area

Scientific Name	Local /English Name	Local Availability	Location
(A) MAMMALS			
Trachpithecus pileatus	Capped Langur	Common	Forest, agricultural field, residential area
Platanista gangetica ssp. gangetica	Dolphin	Rare	Whole section of Brahmaputra River
Pteropus giganteus	Flying fox	Common	Forest, agricultural field, residential area
Semnopithecus *entellus*.	Langoor	Rare	Forest, agricultural field, residential area
Vulpes bengalensis	Fox	Common	Grassland
(B) BIRDS(AVIFAUNA)			
Gracula religiosa	Hill Myna	Abundant	Forest
Gyps indicus	Vulture	Rare	Agricultural field
Otus spilocephalus	Mountain Scops Owl	Rare	Forest
Psittacula krameri manillensis	Parrot	Common	Forest, residential area
Sturnus contra	Grey-headed Myna	Abundant	Grassland, agricultural field, residential area
(C) REPTILES			
Bungarus fasciatus	Common Indian Krait	Common	River bank, grassland, agricultural field
Naja naja	Cobra	Common	River bank, grassland, agricultural field
Varanus bengalensis	Common Indian Monitor	Common	River bank, grassland, agricultural field
(D) AMPHIBIANS			
Hoplobatrachus tigerinus	Indian Bull Frog	Common	Wetland

Source: JICA Study Team

<Operation phase>

- It is suggested that regular monitoring by the forest department and relevant environment and wildlife experts should be done. In keeping view of a likely increase in vehicular emissions in the future, the monitoring should include the assessment of impact due to increased air pollution;
- A suitable landscaping plan for the project road shall be prepared to enhance the ecological status of the area. It was noticed, that the project road did not have tree cover at a few locations. Tree plantation at these locations will enhance the aesthetics as well as reduce the pollution level of the area. Local native tree species should be used for plantation.
- It is recommended that the lost trees be compensated at a 1:3 ratio.
- Awareness programmes as training, workshops, seminars, brainstorming, etc., need to be organized to promote responsible consumerism, sustainable economic practices and the protection of endangered species for all the stakeholders.Research on Ganges River Dolphins

needs be conducted to study in details the abundance, distribution, ecology and threats of the Ganges River Dolphin in and around the construction sites. Community engagement and awareness activities regarding the conservation of Gangetic dolphin also need to be done.

2) Hydrology

Impacts

Potential impact on hydrology will be minor, as the project does not involve the diversion or re-routing of existing watercourses. However, the river flows in Brahmatupta and its tributary Jhinjer will be slightly obstructed during the construction of piers of bridge, but for a limited period. There is no other pond/canal that will be affected by the Project. Hence, a change in natural drainage pattern will be very insignificant to the present state of the project.
During the operation stage, no impact is envisaged.

Mitigation Measures

The new bridge design is based on hydrological calculation results. Based on the obtained location of water crossings and water discharge, the dimension and locations for drainage system are determined. For cross drainage structure, the appropriate culvert type is selected by taking into account the economy, construction workability, and maintenance ability.

3) Topography and Geology

Impacts

Change in topography (that of the existing) is envisaged to some extent at various places along the entire length of the bridge and approach road while developing a 4-lane standard. The riverbed will be excavated for the construction of substructures. The impact is temporary because the excavation will be filled in after the construction of substructures. The change in topography will also happen due to the operation of borrow areas. The construction of material handling yards and labor camps will also alter the existing topography temporarily.

Mitigation Measures

During construction phase, the existing vegetation including shrubs and grasses along the route (except within the strip directly under embankment or cutting) will be properly maintained. The borrow areas shall be operated and closed as per the specifications for road and bridge construction manual of MORTH. The borrow areas shall be filled with the rejected waste/material, spoil and then finally a layer of topsoil shall be spread over it before carrying out plantation and turfing. For turfing, plant species that are native to the area will be used. Temporary structures such as borrow areas, material handling yards, and labor camps should be returned to their original states after construction finishes. During the operation phase, maintenance of the embankment will be carried out to avoid soil erosion. The slope protection/ retaining wall, if damaged due to land slide, will be repaired promptly. The slope protection will also be established / strengthened regularly through the plantation of shrubs and vegetation.

7.8.3 Major Impacts on Social Environment

(1) Involuntary Resettlement

As per the ROW design, the project will affect 761 households and 3,043 people. Out of which, 633 households (2,538 people) will be affected by their land only, and 127 households (500 people) will be affected by the structure, meaning physically displaced households. One commercial shop will

be affected and one public structure (the government office) will be affected. No schools or religious facilities will be affected.

Table 7-46: Summary of Households Affected

Item	PAHs	PAPs
Total project-affected household	761	3,043
Household whose residential land will be affected (physically displaced)	127	500
Household whose agricultural land will be affected	633	2,538
Household whose commercial land will be affected	1	5

Source: JICA Study Team

Mitigation Measures

Affected households will be provided with adequate compensation and assistance. Based on the census survey, the majority of affected households requested cash compensation and self-relocation. However, if they request land compensation, the respective DCs in consultation with local communities shall secure the land in the vicinity of the original place of residence to the extent possible.

(2)

(3) Local Economy and Livelihood

Economic activities and livelihoods in the project area are mainly agriculture, animal rearing, fishing and boat operation. People whose livelihoods that are likely to be affected by the project are as follows.

1) Agriculture labours

In the project area, major crops are paddy and pulses and vegetables are the second crop. In Char land, jute is also a common crop along with paddy and pulses. The land acquisition will not only affect land owners but also agriculture laborers who are hired by the land owners on a temporary basis during cultivation and harvest season. Those labourers are either relatives of the land owners or villagers in the same or neighboring villages. Due to the land acquisition, loss of livelihood associated with those agricultural lands is expected.

2) Boat operators

Based on the information provided by the boat operators association, a total of 2,000 boat operators are registered in the Dhubri District and out of which around 250-300 operators are directly serving between Dhubri and Phulbari. Others are operating to and from others parts of the district and islands (Char lands) in the Brahmaputra River. According to Inland Waterway Transportation (IWT), daily operations of direct boat services between Dhubri to Phulbari are 20 passenger boats and 30-50 goods transportation boats.

Boat operators who are providing the service between Dhubri and Phulbari may experience loss of business opportunities by the project. Considering that the continued demand is expected for the passengers and goods transportation to and between the Char lands, boat operators servicing those routes will not have a negative impact from the project. The impact on the loss of assets was also pointed out by the boat owners. The project will consider compensation for those boats.

3) Fishermen

According to the meeting with fishermen in the project area, normally households engaging in fishery also have agricultural land and their primary income source is agriculture. On the other hand, there are around 100 fishermen along the alighnment whose livelihood depends primarily on fishery activities. Fishing activities usually take place at night and they sell them to licensed traders in the area. Fishermen are having their own boats without engines and their fishing ranges are normally 4-5km radius upstream, downstream and across the Brahamputra River, and thus fishing locations are not fixed. Most fishermen are from the villages along the Brahamputra River and Char land and only during the rainy season when the river becomes wider, will the people from other villages also come for fishing.

Since there is no particular fishing ground mentioned along the alignment, permanent impact will not be anticipated. During the construction stage, based on the fact that the fishermen move freely in the Brahamputra River and that their activities take place at night when the construction work is finished, the impact may not be significant. However, during the construction stage, considering there will be vibration around pier construction areas and that the construction section will be restricted during the construction period, travel distance may increase for fishermen and they may face difficulty compared to during the pre-construction stage.

Mitigation Measures

In R&R, a combination of compensation and assistance will be prepared for those likely affected. Since the project entails large scale construction, significant job opportunities will be generated. Especially for the affected people in the project area, necessary trainings will be provided to meet the eligibility of employment criteria. Moreover, the improvement of the transportation network is expected to enhance accessibility to market, goods, increase employment opportunities and bring a positive impact to the local economy. Necessary training will be also included in R&R to take advantage of those opportunities.

(4) Land Use

Change of the land use will be expected along the alignment, most of which is agricultural land. Although most of PAPs requested cash compensation over land compensation, if requested, DC shall be responsible for identifying land for relocation. In this case, the development of a resettlement site is required, which causes changes in land use pattern. In the case of the construction of workers' camp, land use will change in the short term.

Mitigation Measures

If land compensation were requested as a resettlement option, a resettlement site should be identified by the DC as close to the existing village area as possible, and should ensure a proper supply of basic utilities. As for the workers' camp, the contractor should make lease agreements with the land owners in consultation with the local community assisted by the DC. Prior to the development of such sites, EIA should be carried out.

(5) Utilization of Local Resources

Excessive use of local resources especially the construction materials is expected. Assam and Meghalaya State produces large amount of construction materials including crushed stones. In this

project, those materials will be procured from the existing public and private quarries. Aggregate and landfill sand are also available from the surrounding areas of the project site. Local resources should be procured in consultation and in agreement with the owners.

Mitigation Measures

If the excessive use of construction materials causes a price hike for local usage, although the impact will be short-term, the source of construction materials should be coordinated accordingly.

(6) Water Use

The Brahmaputra River has low transparency throughout the year due to the mixture with high silt content. In the target area, the Brahmaputra River s are used as domestic water along the rivers and in the char land. Since it is assumed that the turbidity of the river will increase during the construction period, mitigation measures shall be proposed.

Mitigation Measures
At locations close to the residential area, mitigation measures such as installing silt fences shall be included to minimize the impact on river water quality,.

(7) Social Infrastructure and Service / Sensitive Facilities

With the change of the starting point in the Dhubri District, there will be no impact on schools that were initially a subject for relocation.

(8) Unequal Distribution of Benefits and Damages

Land acquisition and involuntary resettlement may lead unequal distribution of benefits between those who are directly affected by the project and those who are not. Due to the nature of the bridge, there is a possibility of an uneven distribution of benefits between the bridge connection site and Char lands.

On the other hand, the agricultural products from the Char land are currently sold by the traders to the Dhubri side. Therefore, by improving the logistics network, it is expected that the market of the product will expand to a wider area via traders and selling price will also improve. The same can be expected to goods and daily necessities in terms of improvement of access to the goods and markets.

Mitigation Measures

R&R will be designed and implemented to mitigate unequal distribution of benefits by providing preferential opportunities to those who are directly affected. The project will pay special attention to the people in Char lands to ensure that they will get benefits from the project. For this purpose, an income restoration program will be prepared by taking into consideration their socio-economic condition assisted by the external expert.

(9) Local Conflict of Interest

Due to the uneven distribution of damage and benefits, conflicts of interest within the region may occur. During the survey, people in the target area had a good understanding and high expectation towards the project so the risk of serious conflict of interests seems to be low. However, it will be important that appropriated information sharing and explanation is given to affected and non-affected people from the project.

Mitigation Measures

It is necessary to adequately explain the affected people, content of impact, compensation and support measures with its basis and gain their understanding. For this reason, the same explanation shall be given to the residents of the target area, not limited to the affected people. For the people in Char land, there should be a consideration that the benefits of this project can be received by them and the plan should be included to realize it.

(10) The Poor

It should be noted that the poor are less exposed to big development projects and hence may feel intimidated and unable to voice concerns, grievances and suggestions. The baseline survey has identified the gap between official poverty level and poverty level as reported by the people. Their income level is low and illiteracy rate is high, especially in Char land. Therefore, impact mitigation measures and assistances shall be well considered recognizing the local situation.

Mitigation Measures

During the course of land acquisition and resettlement activities, adequate information sharing is a must to include the poor in the process and it should be ensured that their grievances are heard and redressed. A resettlement and restoration plan should be prepared considering their limited coping capacity, as well as develop measures that lead to sustainable income generation for the affected people rather than a one-off payment of compensation and assistance. Skill development shall be also planned and implemented in a livelihood restoration program.

(11) Gender

There are a number of women headed households identified in the project site. Considering that the target areas are Muslim communities, women may not be able to articulate their issues and demands in the same way that the men can. It is also possible that participation in economic activities and travelling distances may be limited for women.

Mitigation Measures

In order to reflect women's needs, which may be different from those of men, the involvement of women should be ensured in various stages of the project. Therefore, during RAP implementation, a women representative should be invited and consulted with necessary assistance from village chiefs and NGOs. If required, assistance would be provided to open accounts and receiving compensation under their names. During the construction period, equal employment opportunities should be sought for women and also preference should be given to women in choosing light loaded work and day time work, if necessary.

(12) Children's Rights

Although child labor is unlawful according to Article 24 of the Indian Constitution, it should be ensured that child labor will be strictly prohibited.

Mitigation Measures

In order to ensure that only adults are eligible for potential employment opportunities created by the project, the contract agreement with contractor should include the condition in its clause.

(13) Public Health and Occupational Health and Safety (OHS)

The health and safety measures at the design, construction, and operation phases are outlined in Table below.

Table 7-47: Health and Safety Measures

Stage	Health and Safety Measures
Construction Stage	
Health hazards at workplace	• Good and sufficient potable water (as per Indian Standard (IS) codes) shall be provided to avoid water-borne diseases and to ensure the health of workers. • Adequate provision for drainage, sanitation and waste disposal shall be provided. • Preventive medical care shall be provided to workers.
Hygiene at construction camps	• The contractor will provide and maintain temporary accommodation and ancillary facilities for workers that meet standards and scales approved by the resident engineer. • Drinking water, latrines and urinals shall be provided within the precincts of accommodation, as per standards set by the Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act. • Garbage bins must be provided, regularly emptied and disposed of at landfill sites.
Health/social hazards	• Provide training on transmitted diseases to workers and villagers. • Segregation of male and female areas in the construction camp.
Risk from operations	• The contractor is required to comply with all the precautions as required for the safety of the workmen as far as those applicable to this project. • The contractor shall supply all necessary safety appliances such as safety goggles, gloves, helmets, masks, etc., to the workers and staff. • The contractor must comply with all regulations regarding safe scaffolding, ladders, working platforms, gangways, stairwells, excavations, trenches and safe means of entry and egress. • Fences are recommended between the road and quarry places.
Malaria risks	• The contractor shall, at their own expense, conform to all anti-malarial instructions given to them by the engineer including filling up any borrow pits that may have been dug.
Operation Phase	
Traffic accidents	• Establish traffic signs and enforce traffic control measures including speed limits in the vicinity of schools and residential area。 • A traffic management plan shall be developed especially along congested locations. • Sidewalks and shoulders will be constructed at the congested locations to ensure safety of pedestrians • Conduct traffic safety education by giving guidance to neighbors and schools for the safe way of walking along the roads, crossing the roads and consider safe route to school • To ensure the above, the physical facilities will be installed by contractors. Safety education shall be continued in coordination with the schools and the police in the neighborhood. These conditions will be included in the TOR of contractors.

Source: JICA Study Team

7.8.4 Others

(1) Accidents

During the construction stage, traffic volume of heavy equipment and construction vehicles will increase. During the operation stage, increase of traffic volume and speed might increase the risk of accidents.

Mitigation Measures

During the construction stage, the construction section should be properly demarcated and signages should be placed. Notice and necessary information shall be shared amongst surrounding villagers prior to the construction activities. During the operation stage, traffic signs shall be installed, especially in the built-up areas as well as at the junction of the existing road and approach road to avoid traffic accidents. Sidewalks and pedestrian crossings will be equipped to ensure the safety and movement of pedestrians.

7.9 Impact Analysis

Comparison between the scoping and survey results is shown below.

Table 7-48: Scoping and Survey Result

Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rational of the Impact Assessment
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
Pollution							
Air Pollution	D	B-	B-	D	B-	B-	P: No impact is expected. C: Some negative impacts are expected due to the operation of construction equipment and vehicles. One example is dust incidental to earthwork especially during the dry season. O: Air pollution is expected to increase due to increase in traffic volume on the road.
Water Pollution	D	B-	D	D	B-	D	P: No impact is expected. C: Turbid water due to the earthworks, bridge pier construction work and wastewater effluents from construction workers' camps / yards are expected to pollute the Brahmaputra river to some extent. O: No impact is expected.
Wastes / Hazardous Materials	D	B-	D	D	B-	D	P: No impact is expected. C: Waste will be generated from construction workers' camps. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal. O: No impact is expected.
Soil Contamination	D	B-	D	D	B-	D	P: No impact is expected. C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the road is already polluted. O: No impact is expected.
Noise and Vibration	D	B-	B-	D	B-	B-	P: No impact is expected. C: Noise and vibration are expected to be generated by the operation of construction equipment and vehicles, although temporary. Construction schedule should take into account the location of schools, hospitals and religious facilities that require silence during parts of the day. O: Noise and vibration levels are likely to increase due to greater traffic volume along the road. Specific measures may be required to minimize impacts on schools, hospitals and

Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rational of the Impact Assessment
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
							religious facilities.
Bottom sediment	D	C	C	D	D	D	P: No impact is expected. C/O: The piers may cause slight changes in the hydrodynamics and cause erosion of the bottom sediment.
Natural Environment							
Eco-system/Bio-diversity	D	A-	B-	D	B-	B-	P: No impact is expected. C: During the construction period, ecosystems in the project area, including local flora and fauna, are damaged to some extent. O: Increase of traffic volume will cause negative impacts on the ecosystem including fauna and flora along the project road.
Topography/ Geology	D	B-	D	D	B-	D	P: No impact is expected. C: Changes in topographic conditions over the project area takes place due to the need for cutting and filling work. O: No impact is expected.
Hydrology	D	B-	B-	D	B-	D	P: No impact is expected. C: Construction work may cause minor and temporary impacts on hydrology because of pier construction, or the local use of water. O: No impact is expected.
Social Environment							
Involuntary Resettlement	A-	D	D	A-	D	D	P: The project requires approximately 94ha land and a Total of 761 PAHs will be affected by the project, out of which 30% need to be resettled. C/O: Resettlement will be completed before construction begins and thus no resettlement is expected during construction and operation.
Local Economy and Livelihood	A-	B+/-	B+/-	A-	B+/-	B+/-	P: Loss of income source and livelihood due to involuntary resettlement and change in land usage are expected to negatively affect the local economy and livelihood. C: Construction work may have a negative impact on the fishery activities to some extent. On the other hand, construction work will have a positive impact on local economy by creating employment and business opportunities in the project area. Due to the increase of construction workers, business opportunities such as small shops are expected to increase in the area. O: The bridge will have impacts on the boat operators who operate directly between Dhubri and Phulbari. On the other hand, improvement of logistic network will increase accessibility to market, goods and generate employment

Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rational of the Impact Assessment
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
							opportunities and bring positive effect on regional economy. Although the Char area will not be directly connected by the bridge, accessibility to the markets and other necessities is expected to be improved.
Land Use	B-	B-	D	B-	B-	D	P: Land acquisition and involuntary resettlement are likely to cause changes in the existing land use patterns along the alignment. C: Construction yards and workers' camps will have an impact on the land use, however the impact will be short term. O: Land usage of the approach road section will be permanently changed, however no significant negative impact is expected. Construction yard will be restored to its original condition by the contractors.
Utilization of Local Resources	D	B-	D	D	B-	D	P: No impact is expected. C: Procurement of large quantities of local resources for the construction materials may have impact on the price hike. O: No impact is expected as use of local resources is not expected during operation.
Water Usage, Water Rights and Communal Rights	D	B-	D	D	B-	D	P: No impact is expected. C: There is a possibility that the residents who use rivers as living water may be affected in the short term. O: No impact is expected.
Social Infrastructure and Services	B-	B-	B+/-	D	D	B+	P/C: Due to the change of the alignment, there will be no impact on school which was assumed in the beginning O: Improved connectivity contributes to better accessibility to social infrastructure and services.
Social Institutions and Local Decision-making Institutions	D	D	D	D	D	D	P/C/O: Land acquisition and involuntary resettlement will be implemented based on existing social and local decision-making institutions so no impact will be expected.
Unequal Distribution of Benefit and Damage	B-	B+/-	B+/-	B-	B+/-	B+/-	P: Land acquisition and involuntary resettlement will lead to an unequal distribution of benefits and damage between those who are directly affected by the project and those who are not. C: Those who are affected by Land acquisition and resettlement should have preference in access to employment opportunities in the construction work. O: There is a possibility of uneven distribution of benefits between the bridge connection site and Char land. In the long term, the whole area is expected to have economic benefits from

Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rational of the Impact Assessment
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
							improved logistics networks including access to markets as well as employment opportunities.
Local Conflict of Interest	B-	B-	B-	B-	B-	B-	P/C/O: There is a possibility that unequal distribution of benefits and loss will cause local conflict of interests
Sensitive Facilities (e.g. hospital, school)	B-	D	B-	D	D	D	P/C/O: Due to the change of the alignment, there will be no impact on school which was assumed in the beginning
Poor People	A-	B+	B+/-	A-	B+/-	B+/-	P: The ratio of illiterates and the poor is high in the Char area. Given the limited coping capacity of the poor, appropriate mitigation measures will be considered in the RAP.
							C: The poor may bear a higher burden due to their limited capacity to cope. However, they can benefit from employment opportunities during construction work.
							P: The poor may fail to benefit from the project due to lack of skills and coping capacity, therefore assistance to improve their skills and capacity will be considered in the RAP. With that assistance, the poor can also gain benefit from improved market access and business opportunities in the long run.
Ethnic Minorities/ Indigenous People	C	C	C	D	D	D	P/C/O: Ethnic minority and Scheduled Tribes were not identified in PAH/PAPs.
Gender	B-	B-	D	B-	B+/-	D	P: Numbers of women-headed households were identified. Involvement of women should be ensured during the course of the land acquisition and resettlement process.
							C: Equal opportunity in construction work should be sought for women and job training should be provided as necessary.
							O: No impact is expected
Children's Rights	B-	C	D	D	D	D	P: Due to the change of the alignment, there will be no impact on school which was assumed in the beginning
							C: Child labor is unlawful according to Article 24 of the Indian Constitution. Only adults are eligible for potential employment opportunities created by the project. As for the precaution, the contract with the contractors should include the clause to prohibit hiring children for the construction works.

Item	Impact Assessments of Scoping			Impact Assessments of Study Result			Rational of the Impact Assessment
	Pre-construction	Construction Stage	Operation Stage	Pre-construction	Construction Stage	Operation Stage	
							O: No impact is expected
Public Health (sanitation and infectious diseases)	D	B-	D	D	B-	D	P: No impact is expected.
							C: Influx of construction workers is likely to increase the health risk, particularly that of STD / STI and HIV / AIDS.
							O: No impact is expected
Occupational Health and Safety (OHS)	D	B-	B-	D	B-	B-	P: No impact is expected.
							C: Occupational health and safety of construction work should be properly managed through adequate EMP.
							O: Hygiene and safety of workers should be considered for those in charge of maintenance and repair work.
Others							
Accidents	D	B-	B-	D	B-	B-	P: No impact is expected.
							C: An increased risk of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles.
							O: Risks of accidents is expected to increase due to greater traffic volume and speed. Traffic measures shall be taken especially in the village area.

Source: JICA Study Team

7.10 Environmental Management Plan and Monitoring Plan

Descriptions of the environment management measures during different stages of the project are provided in the tables below. Regarding measures to mitigate impacts on aquatic organisms such as Ganges dolphins, reference was made to experts on the ecology of Ganges dolphin and other similar projects.

Table 7-49: Environmental Management Plan for Pre-Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
P1	Bottom sediment	• Mobilization of bottom sediments will require Contractor to install turbidity curtains.	Brahmaputra River	During boring survey	Contrcator	Project Implementation Unit (PIU)
P2	Resettlement of Project Affected Persons (PAP) / local economy and livelihoods	• All requirements of the RAP as applicable shall be complete before start of construction stage. The activities broadly include acquisition of land and structures, rebuilding of common properties, payment of compensation and provision of assistance • Survey on loss of assets and livelihood of PAP will be conducted to calculate replacement cost and consider appropriate assistance in cooperation with NGO.	All areas	Before construction begins	Government of Assam / Meghalaya, District Revenue authorities and District Authorities, NGO/Consultant	PIU, SC
P3	Land use / Identify and prepare relocation sites	• Upon the requests from PAPs, the identification and selection of land shall be carried out with the assistance from respective DCs and in consultation with local residents. • In case of preparing relocation sites, necessary utilities such as water and electricity shall be provided.	Near the original villages	Before construction stage	District Authorities/ Contractor	PIU
P4	Unequal distribution of benefit and damage	• Support measures shall be implemented based on RAP including the preferential provision of employment opportunities to those directly affected. • Support measures for the char people will be planned with the assistance from NGO and other experts so that they can receive maximum benefit from the project.	Within ROW	Before construction stage	District Authorities, NHIDCL, NGO	PIU
P5	Local conflicts of interest	• Carry out close monitoring of RAP process to detect and resolve the local conflicts at earlier stage.	All areas	Before construction stage	District Authorities, NHIDCL, NGO	PIU

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
P6	Poor people / Gender	• Ensure the participation of the poor and women in the process of land acquisition and resettlement. • Livelihood restoration plan will be considered taking in to account the limited skills of the poor people (including illiterate population and different needs of women). • Information shall be shared to women and representatives of women with the assistance from the village heads and NGOs.	Within ROW	Before construction stage	District Authorities, NHIDCL, NGO	PIU

Source: JICA Study Team

Table 7-50: Environmental Management Plan for Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementatio	Supervision
Soil						
C1	Soil Erosion in Borrow Pits (Impact on topography/ geology)	• The depth of borrow pits shall be Restricted so that sides of the excavation shall have a slope not steeper than 1:4, from the edge of the final section of the bank. After construction, excavated land shall be filled back to the original condition.	On approved locations of borrow pits.	Construction Stage	Contractor Supervision Consultant	Project Implementation Unit (PIU)
C2	Loss of top soil in Borrow pits (Impact on topography/ geology)	• Agricultural fields or productive land shall be avoided for borrowing earth. • Top soil shall be preserved as instructed by the state government and used for tree plantation.	On approved locations of borrow pits.	Construction Stage	Contractor Supervision Consultant	PIU
C3	Compaction of Soil (Impact on topography/ geology)	• Construction equipment and vehicles shall be restricted to move only within designated area to avoid compaction of productive soil.	Throughout corridor.	Construction Stage	Contractor Supervision Consultant	PIU
C4	Soil erosion in embankments (Impact on	• Pitching shall be done for slope stabilization as per the IRC guidelines	At the embankments	Construction Stage	Contractor Supervision Consultant	PIU

C5	Soil Pollution	• Construction vehicles and equipment shall be operated and maintained in such a manner so that soil contamination due to its spillage shall be at a minimum. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies. • All spills and discharged petroleum products shall be disposed of in accordance to the Hazardous Waste Management and Handling Rules.	Near Labor camp and Sites of installation of Construction machineries.	Construction Stage	Contractor Supervision Consultant	PIU
C6	Soil Pollution from construction waste	• Debris generated due to unused / waste material shall be suitably reused in the proposed construction, such as for filling materials for embankments. . All spoils shall be disposed of as desired and the site shall be fully cleaned before handing over. • Construction waste including non-bituminous and bituminous waste shall be dumped in an approved landfill site identified by State Pollution Control Board (SPCB) or competent authority. All spoils shall be disposed of as desired and the site shall be fully cleaned before handing over.	Solid waste dump identified and by SPCB or competent authority.	Construction Stage	Contractor Supervision Consultant	PIU
		•				
C7	Loss of top soil	• Topsoil shall be stripped, stored and laid on ground for landscaping purposes.	Throughout the area	Construction Stage	Contractor and Supervision Consultant	PIU
Water						

C8	Water pollution	• Construction vehicles / equipment shall be operated and maintained in such a manner to avoid contamination of water bodies due to oil spillage. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies. • Oil and grease traps will be provided at fueling locations	Near labor camp and sites of the installation of Construction machineries.	Construction Stage	Contractor and Supervision Consultant	PIU
C9	Water pollution from labor camp.	• Labor camp shall not be allowed near any of the water bodies. • The proper sanitation facilities shall be provided.	Preapproved away from the	Construction Stage	Contractor and Supervision	PIU
C10	Deposition of dust in open wells near construction site	• The mouth/opening of the well shall be covered with suitable material duringany of the construction activity so as to prevent dust from entering in the well.	All the wells along the project	Construction Stage	Contractor and Supervision	PIU
C11	Impact on Surface water quality due to eroded soils	• Construction work close to the watercourses or other water bodies will be avoided, especially during the monsoon period. • Increase coverage of open surface area by planting grass and creepers so that the washing away of materials from sloped surfaces would be reduced by a significant extent. • Silt curtain should be used for all underwater works.	All the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
Air						
C12	Emission from construction vehicles and machinery.	• All vehicles, equipment and machinery shall be selected to meet recognized international and national standards for emissions and shall be maintained and operated in a manner that ensures relevant air, noise and discharge rules. • Only unleaded petrol and low sulphur diesel or sulphur-free diesel shall be used as fuel for vehicles, equipment and machinery. • Air quality monitoring shall be conducted.	Wherever the hot mix plant and batching plant is setup.	Construction Stage	Contractor and Supervision Consultant	PIU
C13	Air pollution from various plants	• The asphalt plants, crushers and batching plants shall not be sited within at least 500m in leeward direction from the nearest human settlement. • Particulate Filters shall be installed.	Locations near Settlement	Construction Stage	Contractor and Supervision Consultant	PIU

C14	Dust	• The dust generated by vehicles on site shall be arrested using a water tanker fitted with a sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. • Trucks shall be covered by the sheet.	Wherever the plants are Set up and locations as suggested in the monitoring plan.	Construction Stage	Contractor and Supervision Consultant	PIU
Waste						
C15	Waste disposal	• Debris generated due to unused / waste material shall be suitably reused in the proposed construction, such as for filling materials for embankments. • Construction waste including non-bituminous and bituminous waste shall be dumped in an approved landfill site identified by State Pollution Control Board (SPCB) or competent authority. All spoils shall be disposed of as desired and the site shall be fully cleaned	Solid waste dump identified and by SPCB or competent authority. Throughout the	Construction Stage	Contractor Supervision Consultant	PIU
Noise						

C16	Noise levels from vehicles. Asphalt plants and equipment	• The plants and equipment used for construction will strictly conform to Central Pollution Control Board (CPCB) noise standards. Vehicles, equipment and construction machinery shall be monitored regularly with particular attention to silencers and mufflers to maintain noise levels to a minimum; • Workers in the vicinity of high noise levels must wear ear plugs and helmets and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90 dB(A); • In construction sites within 150 m of human settlements, noisy construction will be stopped between 10 PM and 6 AM. • Hot mix plants, batching or aggregate plants shall not be located within 500m of sensitive land use for schools and hospitals; • For places close to the sensitive receptors such as hospitals and schools, noise barriers such as earth, concrete, wood, metal or double-glazing of windows for façade insulation shall be used; • Phase demolition, earthmoving, and ground-impacting operations are not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately; • Construction machinery will be located away from the settlements; • Careful planning of machinery operation and scheduling of operations can reduce the noise levels. • Noise monitoring shall be conducted to check if the noise level is within the environmental standards.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
Bottom Sediment						
C17		• Slit curtain shall be installed to prevent move of the sediment. • Construction works shall be suspendeed when flood warning is issued.				
Ecology						

C18	Tree cutting in ROW	• Land clearing activities at the construction site should be kept at an absolute minimum. • Construction vehicles, machinery and equipment will be moved or stationed in the (ROW) to prevent compaction of vegetation. • Water shall be sprinkled to prevent dust generation.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant Forest Dept.	PIU

C19	Endangered species	• Relevant information (e.g. encounter with vulnerable species during engineering work) shall be shared with the State Environment and Forest Department and concerned regional environmental experts. • Anti-poaching measures during the construction phase should be strengthened to check for any violation of existing regulations. Awareness campaign to be made among the workers to aware them on the endangered and other important species. • Construction vehicles must be operated at safe speed to avoid collision with wildlife. Training should be provided for the vehicle operators and warining signs should be insrtalled. • Change of geology and topography should be kept minimum. Avoid construction labor camps and construction yard near the river banks. • To minimize impacts, noisy operations should be avoided during breeding season of the dolphins (February-July). • River flow should not be blocked at all times for free movement of dolphins. • Measures such as the creation and monitoring of an exclusion zone of a 500m radius for at least 30 minutes before the start of construction activities shall be followed. If dolphins are observed in the exclusion zone, construction works should be delayed until they have left the area. If dolphins enter the exclusion zone after construction has commenced, construction works should cease until they have left. • All activities that increase soil erosion or contribute to nutrients and pollutants to water need be minimized both on-site and off-site by using measures such as silt curtain. • • Construction works should be avoided or kept minimum in vicinity of the dolphins' favorable microhabitats (downstream of shallow areas/sandbars, tributary junctions) • Dolphins are likely to prefer water depth range between 4.1 to 6 m. Therefore, movement of sediment and influx of soil/silt etc. should be avoided to keep the favorable depth range. • In case rare birds of prey are observed near the construction area, the construction work will be avoided during their breeding season.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU

C20	Underwater noise impacts on aquatic species.	• Use vibratory hammer. Under conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer. • Monitor sound levels during pile driving to ensure that they do not exceed the NOAA (National Oceanic and Atmospheric Administration, USA) or any other international recognized criteria. • Implement measures to attenuate the sound when sound pressure levels exceed the NOAA or any other international recognized criteria. Methods to reduce the sound pressure levels include but are not limited to: Installation of underwater enclosures to minimize sound Surrounding the pile with an air bubble curtain system or air-filled coffer dam. Using a smaller hammer to reduce the sound pressure. The sound produced in pile driving has a direct relationship to the force used to drive the pile. A smaller hammer will have less force on the pile therefore producing less sound. • Construction works should be ceased when the dolphins are observed near the work area.				
Social Environment						
C23	Local Economy and Livelihood / Unequal Distribution of Benefit and Damage / Local Conflict of Interest	• PAP (including women and the poor) will be given priority to be employed in the construction work. Information will be widely shared to local residents for them to understand and take advantages of the employment opportunities. • Provide vocational training that allows local residents to satisfy the conditions to become workers.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant, NHIDCL, NGO	PIU
C21	Land Use	• When the workers' camp was to be developed, the contractor should make lease agreements with the land owners in consultation with the local community assisted by the DC. Prior to the development of such sites, EIA should be carried out as necessary.	At respective planned constructio n sites	Construction Stage	Contractor and Supervision Consultant	PIU

C22	Utilization of Local Resources	• If the excessive use of construction materials causes a price hike for local usage, the source of construction materials should be coordinated accordingly.	At respective planned constructio	Construction Stage	Contractor and Supervision Consultant	PIU
C24	Water Usage	• To minimize the river pollution during construction, mitigation measures will be applied such as installing a silt fence in places close to the residential area.	At respective planned constructio	Construction Stage	Contractor and Supervision Consultant	PIU
C25	Gender	• Equal employment opportunities should be sought for women and also preference should be given to women in choosing light loaded work and day time work, if necessary.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
Health and Hygiene						
C20	Health hazard at Construction work sites	• At every workplace, good and sufficient potable water (as per IS 10500) supply shall be ensured to avoid water-borne diseases and to secure the health of workers. • Adequate drainage, sanitation and waste disposal shall be provided at workplaces. • Preventive Medical care shall be provided to workers.	Wherever labor camp is set up	Construction Stage	Contractor and Supervision Consultant	PIU
C21	Health hazard during construction work	• Personal protective equipment shall be provided to workers as per the Factories Act.	Construction work	Construction Stage	Contractor and Supervision Consultant	PIU

C22	Hygiene at Construction Camps	• The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labor to appropriate standards and scale approved by the resident engineer • These shall be provided within the precincts of every workplace, latrines and urinals in an accessible place, and the accommodation, separately for each for these, as per standards set by the Building and other Construction Workers (regulation of Employment and Conditionsof Service) Act, 1996. There shall be adequate supply of water, close to latrines and urinals. • All temporary accommodation shall be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be properly designed, built and operated. • Compliance withthe relevant legislation must be strictly adhered to. Garbage bins shall be provided in the camp and regularly emptied and the garbage disposed of in a lined landfill sites.	Wherever labor camp is set up	Construction Stage	Contractor Supervision Consultant	PIU
C23	Health/ social hazard, sexual harassment to female workers	• Segregation of male and female areas in labor camp shall be executed.	Wherever labor camp is set up	Construction Stage	Contractor and Supervision Consultant	PIU
C24	Construction Camps	• Upon completion of the works, the entirety of such temporary structures shall be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off and the entirety of the site left clean and tidy, a the Contractor's expense, to the entire satisfaction of the Engineer.	Wherever labor camp is set up	Construction Stage	Contractor and Supervision Consultant	PIU
C25	Quarry site will accumulate water and act as a breeding ground for disease vectors.	• Reclamation measures shall be adopted with a garland of trees around the periphery. The quarry dust and waste shall be used for refilling. The remaining portion should be covered with trees.	All quarry locations	Construction Stage	Contractor and Supervision Consultant	PIU

Safety						
C26	Workers' safety	• The contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, etc. to the workers and staff. Especially all workers employed in mixing Asphaltic material, welding works, stone breakers, and paint should be provided with appropriate personal protected equipment. • The contractor has to comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and a safe means of entry and egress. • All necessary fencing and lights will be provided to protect the public. All machines to be used in the construction will conform to the relevant Indian Standards' (IS) codes, will be free from patent defect, will be kept in good working order, will be regularly inspected and properly maintained as per IS provisions and to the satisfaction of the Engineer.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C27	Unexpected disasters and accidents	• All reasonable precautions will be taken to prevent danger for the workers and the public such as fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work. • At every workplace, a readily available first aid unit including an adequate supply ofsterilized dressing material and appliances will be provided.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C28	Workers' health	• The Contractor shall, at his own expense, conform to all anti-malarial instructions given to him by the Engineer, including filling up any borrow pits which may have been dug by him	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C29	Accidents	• The construction section should be properly demarcated and signage, flag and light should be placed. Signage, barricade and road marking shall be in line with the speficiation of MORTH. • Carry out traffic safety awareness program for road side communities. • Check and approve the Contractor's method of work, including site organization, quality assurance system, safety plan, method statements of safety and environmental monitoring plan.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU

Source: JICA Study Team

Table 7-51 Environmental Management Plan for Operation Stage

	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
O1	Water Pollution	• Silt fencing, oil & grease traps, etc. shall be provided at sensitive water bodies to ensure that the water quality is not impaired due to contaminants from road run-off Monitoring shall be carried out as specified in the monitoring plan • Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals	As specified in the Monitoring plan	As per monitoring plan	PIU, SPCB	Project Implementation Unit (PIU)
O2	Soil contamination	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals • Monitoring shall be carried out as specified in the Monitoring Plan	All area and as specified in the monitoring plan	Plan to be developed at state/district level By early operation stage	PIU, SPCB, Local Government Bodies	PIU
O3	Air quality degradation due to increases in traffic volume	• Monitoring shall be carried out as specified in the Monitoring plan • Share air quality data with SPBC and relevant agencies and discuss options for mitigate air quality degradation associated with greater traffic volume.	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU
O4	Increases in noise and vibration due to greater traffic volume	• Monitoring shall be carried out as specified in the Monitoring plan • Install noise barrier (wall etc.) in sensitive areas, if necessary • Carry out proper road maintainance to reduce noise and vibration.	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU
O5	Ecology	• Monitor the poplutaion of endangered species. • Enhance research and conservation of Gangatic river dolphins. • Littering from the bridge into the river must be prohibited. • Roadside greenbelt should be mainteained to enhance ecological landscape, using native local tree species.	As specified in the monitoring plan	As per monitoring plan	PIU, NGO	PIU

O6	Local economy and livelihoods/ Poor people	• Change of income source and income of PAPs shall be monitored and modify the assistance measures as necessary.	Within ROW	As per monitoring plan	PIU, NGO	PIU
O7	Unequal Distribution of Benefit and Damage / Local Conflict of Interest	• Conduct interviews to DCs and village heads about dissatisfaction or conflict of residents of the target area and explain and take measures as necessary.	All area	When issues are identified	District Authorities, PIU, NGO	PIU
O8	Public Health / Occupational Health and Safety (OHS)	• Ensure the safety of the workers by providing safety guidance to the maintenance and repair workers.	Area of maintenance / repair work	At the time of maintenance / repair work	PIU	PIU
O9	Accidents	• Ensure the safety through traffic rules such as speed limit. • Traffic signs shall be installed, especially in the built-up areas as well as at the junction of the existing road and approach road to avoid traffic accidents. • Sidewalks and pedestrian crossings will be equipped to ensure the safety and movement of pedestrians.	All area	As per monitoring plan	PIU	PIU

Source: JICA Study Team

7.10.1 Environment Monitoring Program

(1) Ambient Air Quality

Ambient air quality parameters recommended for monitoring road transportation developments are PM10, PM2.5, Carbon Monoxide (CO), Oxides of Nitrogen (NOX), and Sulphur Dioxide (SO2). These will be monitored at designated locations starting from the commencement of construction activity. Data should be generated at all identified locations in accordance with the National Ambient Air Quality Standards, 2009. The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed in the Monitoring Plan.

(2) Water Quality

The physical and chemical parameters recommended for the analysis of water quality relevant to road / bridge development projects are: pH, turbidity, total solids, total dissolved solids, total suspended solids, oil and grease, COD, chloride, lead, zinc and cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan. The monitoring of the water quality is to be carried out at all identified locations in accordance with the Indian Standard Drinking Water Specification – IS 10500: 2012.

(3) Noise

The measurements for monitoring noise levels would be carried out at all designated locations in accordance with the Ambient Noise Standards formulated by the Central Pollution Control Board (CPCB) in 1989. Noise should be recorded at an "A" weighted frequency using a "slow time response mode" of the measuring instrument. The location, duration and the noise pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan.
The monitoring plan for the various performance indicators of the project in the construction and operation stages is summarized in the table below.

(4) Biodiversity

The monitoring of ecosystem including the Ganges River Dolphins shall be carried out by subcontracting a competent environmental NGO led by a qualified expert. A detailed dolphin census survey shall be carried out before the onset of construction works, in which the estimated number of the dolphins, demography, geographical distribution, and their behavioral pattern will be studied in the project affected area. Using the data from the initial assessment as a baseline, the monitoring of the dolphin population will be carried out thrice a year following the same survey protocol. At the time of each survey, visual observation of the ecosystem will be also carried out for presence/absence of other rare/endangered species.

The monitoring plan for the various performance indicators of the project in the construction and operation stages is summarized in the table below.

Table 7-52: Environmental Monitoring Plan

Sl. No	Item	Project Stage	Parameters	Guidance	Standards	Location	Frequency	Responsibility	
								Implementation	Supervision
M1	Air	Construction	PM_{10}, SO_2,NOx, CO	• Dust sampler to be located 50m from the plan in the downwind direction. • Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Hot mix plant/ batching plant, Sampling locations specified in EIA report	Thrice a year For 6 years	Contractor through approved monitoring agency	PIU
M2		Operation	PM_{10}, SO_2,NOx, CO	• Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Sampling locations specified in EIA report	Twice a year for two years	PIU	PIU
M3	Water	Construction	pH, Turbidity, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Sample collected from source and analyzed as per Standard Methods for Examinationof Water and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Thrice a year For 6 years	Contractor through approved monitoring agency	PIU
M4	Noise	Construction	Noise levels on dB (A) scale	• Free field 1m from the equipment whose noise levels are being determined.	Noise Standards by CPCB	At equipment yard / construction site.	Thrice a year For 6 years	Contractor through approved monitoring agency	PIU
M5		Operation	Noise levels on dB (A) scale	• Equivalent Noise levels using an integrated noise level meter kept at a distance of 15m from edge of Pavement	Noise standards by CPCB	At maximum 4 sites listed in EIA	Twice a year for 2 years	PIU	PIU
M6	Topography and geology	Construction	Conditions in embankment area	• Visual survey about stability of embankment		At equipment yard/ construction site.	Thrice a year For 6 years	Contractor	PIU
M7	Soil contamination	Construction	Presence/absence of oil spillage	• Visual inspection		At equipment yard/ construction site.	Thrice a year For 6 years	Contractor	PIU

Sl. No	Item	Project Stage	Parameters	Guidance	Standards	Location	Frequency	Responsibility	
								Implementation	Supervision
M9	Ecology	Construction and operation	Frequency of dolphin sightings, Observation of Vulnerable Species (name and location of the observed species)	• Observation from river bank (from sunrise to sunset, 10 days), visual observation, hearing to construction workers/local residents	Baseline survey will be carried out before contruction	Dhubri, Phulbari	Thrice a year for 6 years during construction and twice a yeaer for 2 years during operation	NGO, PIU	PIU
M10	Livelihood	Construction and operation	Change of livelihood	• Evaluate based on the RAP monitoring results	Census survey carried out during the RAP preparation	Within ROW	Twice a year	NGO	PIU
M11	Land Use	Construction	Change of land use	• Visual inspection	Land use before construction	At construction yard and labour camp	Twice a year	Contractor	PIU
M12	Utilization of Local Resources	Construction	Price of construction materials	• Interview with local construction company	NA	Dhubri, Phulbari	Twice a year	Contractor	PIU
M13	Unequal Distribution of Benefit and Damage	Construction and operation	Satisfactory level	• Evaluate based on the RAP monitoring results	NA	Dhubri, Phulbari	Twice a year	NGO	PIU
M14	Water use	Construction	Use of silt fence	• Site inspection	NA	At the construction site near residential area	During construction near residential area	Contractor	PIU

Sl. No	Item	Project Stage	Parameters	Guidance	Standards	Location	Frequency	Responsibility	
								Implementation	Supervision
M14	Gender	Construction	Number of women employed	• Employment record • Evaluate based on the RAP monitoring results	NA	Within ROW and surrounding villages	Twice a year	NGO, Contractor	PIU
M15	Public Health	Construction and operation	Adequate equipment and facilities Number of health issue reported	• Site inspection • Record on health	NA	At labour camp and construction site.	Twice a year	Contractor	PIU
M16	Occupational Health and Safety	Construction	Adequate equipment and facilities Number of work related accidents	• Site inspection • Accident records	Factories Act.	At labour camp and construction site.	Twice a year	Contractor	PIU
M17	Accidents	Construction and operation	Number of traffic accidents	• Accident records	NA	Within ROW	Twice a year	Contractor	PIU

Source: JICA Study Team

7.10.2 Institutional Arrangement

The detailed measures adopted and/or to be adopted during different stages of the project to mitigate negative impacts and enhance positive aspects are shown in Tables below. The responsibility for the implementation and supervision of EMPs are vested with three agencies, namely, Contractors, PIU, and Supervision consultants (SC). The Contractors herein mean the agency hired for the execution of the construction works for the respective contract packages. PIU would be the implementation agency with the support of PWD. Figure 7-23 indicates the implementation structure of the EMP.

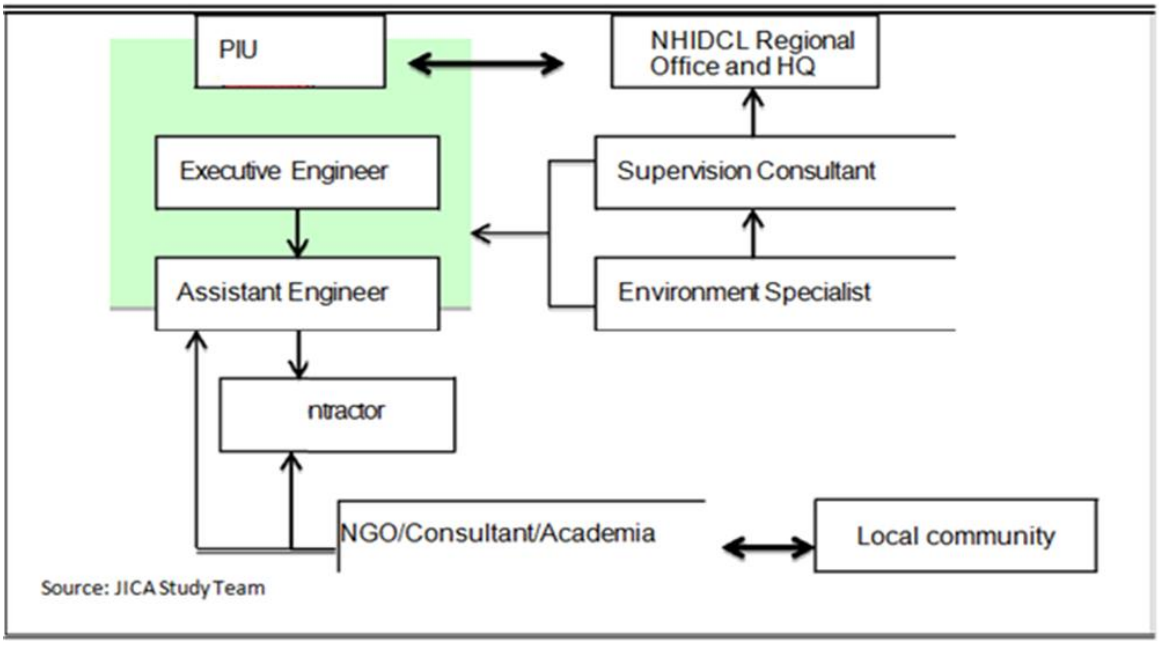


Figure 7-25: Riverbed Topography around the Dhubri Bridge

It has been proposed that the Executive Engineer (environment) based in Dhubri will be in charge of the implementation of EIA and EMP for this project. Such an engineer will be assisted by the Assistant Engineer (Environment), who will be assisted by a Junior Engineer as well as a Supervision consultant (and Environment Specialist) and contractor.

The construction supervision consultants are expected to have in-house capacity to advise on and supervise the implementation of the EMP including suggesting enhancement design options and modifications, as necessary. For this purpose, the supervision consultant will employ a full-time environmental specialist.

Compensatory plantation, maintenance and protection of vegetation will be required as part of environmental mitigation and enhancement works. Likewise, spoiled soil shall be used, where possible, to create community assets such as playgrounds, as per request of the community. In these types of works, the project may engage NGO, Consultant or experts from local universities to liaise with the local community for effective implementation of the project.

7.10.3 Grievance Redress Mechanism

An integrated grievance and redress mechanism (GRM) for environmental and social action plans is needed to be established for the project. The GRM provides a system for receiving, evaluating and facilitating the resolution of affected people's concerns, complaints, and grievances about the project's social and environmental performance. Due to the scale of the project with one end of the bridge located in an urbanized section of Dhubri and adverse impacts are anticipated, issues like poor legal records, voluminous titles and sometimes conflicting holdings, intensive construction

activities located near communities, traffic from construction vehicles, and conflict between migrant and host communities are to be expected.
Grievances related to the implementation of the project, will be acknowledged, evaluated, and responded to with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken and their outcomes will be properly maintained.
The nature and significance will be evaluated by the receiving party. Any complaint which concerns project construction activity, poses imminent serious risk to life and property, or will result to irreversible damage to wildlife (dolphin) will be immediately forwarded to the PIU- for action within 24-hours from receipt of complaint.

7.10.4 Monitoring Forms

The following Tables indicate JICA's standardized monitoring form. Monitoring works should be carried out every six months unless otherwise specifically noted. Monitoring forms for land acquisition and resettlement are indicated in 7.12.9.

Table 7-53: Environmental Clearance

During Construction

Monitoring Item	Conditions During the Reporting Period
Response to State Department's Comments/Guidance for Obtaining Environmental Clearance	

Source: JICA Study Team

Table 7-54: Air Quality

During Construction

Item (Unit)	Measured Value of Baseline Data (Max.)	Measured Value of Monitoring (Max. Value)	Indian Standard	Referred International Standard	Remarks (Location、Frequency and Method of Measurement)
SO_2	11.5 µg/m^3		80µg/m^3	20µg/m^3	Chagal chora (Latitude 26°02'0.32"N & Longitude 89°56'15.67"E) Katiaralaga (Latitude 250 57' 49.90" N & Longitude 890 58'38.26" E) Bororavatari (Latitude 250 55' 03.91" N & Longitude 900 00' 53.50" E) Phulbari (Latitude 250 53' 21.04" N & Longitude 900 02' 13.40" E) Thrice a year, Based on the National Ambient Air Quality Standard: NAAQS
NO_2	23.7 µg/m^3		80µg/m^3	200µg/m^3	
CO	780 µg/m^3		2000µg/m^3	-	
PM10	88.7		100µg/m^3	50µg/m^3	

During Operation

Item (Unit)	Measured Value of Baseline Data (Max.)	Measured Value of Monitoring (Max. Value)	Indian Standard	Referred International Standard	Remarks (Location、Frequency and Method of Measurement)
SO_2	11.5 µg/m^3		80µg/m^3	20µg/m^3	Chagal chora (Latitude 26°02'0.32"N & Longitude 89°56'15.67"E) Katiaralaga (Latitude 250 57' 49.90" N & Longitude 890 58'38.26" E) Bororavatari (Latitude 250 55' 03.91" N & Longitude 900 00' 53.50" E) Phulbari (Latitude 250 53' 21.04" N & Longitude 900 02' 13.40" E) Twice a year, Based on the National Ambient
NO_2	23.7 µg/m^3		80µg/m^3	200µg/m^3	
CO	780 µg/m^3		2000µg/m^3	-	
PM10	88.7		100µg/m^3	50µg/m^3	

Air Quality Standard: NAAQS

Source: JICA Study Team

Table 7-55: Water Quality

During Construction

During Construction

Item (Unit)	Measured Value	Indian Standard	International Standard	Remarks (Location、Frequency and Method of Measurement)
pH	6.02-7.54	6.5-8.5	6-9	Chagal Chora (Latitude 26°02'0.58"N & Longitude 89°56'15.22"E) (Bore well) Chaitarchar (Latitude 25°55'49.65"N& Longitude 89°59'30.77"E)(Brahmaputra River) Katiaralaga (Latitude 250 57' 48.71" N & Longitude 890 58'34.52" E) (Hand pump) Bororavatari (Latitude 250 55' 00.77" N & Longitude 900 01' 45.56" E) (Jinger River) P hulbari (Latitude 250 53' 21.04" N & Longitude 900 02' 13.40" E) (Dug well) Thrice a year, Based on the Indian Standard Drinking Water Specification – IS 10500: 1991
Turbidity (NTU)	6.5	10NTU	50mg/L	
BOD/COD (mg/L)	4.2/16.0	-	30/125	
DO (% by mass)	6.0-7.2	10	-	
Heavy Metal	<0.05	-	-	
Phenol	<0.01	-	-	
Cyanide	BDL	-	-	

Source: JICA Study Team

Table 7-56: Solid Waste

During Construction

Monitoring Item	Types and amount of generated waste
Reused Debris	
Disposed Debris	

Source: JICA Study Team

Table 7-57: Noise and Vibration

During Construction

Item (Unit)	Measured Value (Min. Value)	Measured Value (Max. Value)	Indian Standard	Referred International Standard	Remarks (Location、Frequency and Method of Measurement)
Noise Level (dB)	40.5	62.4	Noise Standard of India 2000		Chagal Chora (Latitude 26°02'0.58"N & Longitude 89°56'15.22"E) Katiaralaga (Latitude 250 57' 48.75" N & Longitude 890 58'34.64" E) Bororavatari (Latitude 250 55' 05.21 N & Longitude 900 00' 54.81" E) Phulbari (Latitude 250 53' 20.91" N & Longitude 900 02' 15.30" E),、 Thrice a year, , Based on Noise Standard of India 2000
Vibration Level					

Source: JICA Study Team

During Operation

Item (Unit)	Measured Value (Min. Value)	Measured Value (Max. Value)	Indian Standard	Referred International Standard	Remarks (Location、Frequency and Method of Measurement)
Noise Level (dB)	40.5	62.4	Noise Standard of India 2000		Chagal chora (Latitude 26°02'0.58"N & Longitude 89°56'15.22"E) Katiaralaga (Latitude 250 57' 48.75" N &

Vibration Level	Longitude 890 58'34.64" E) Bororavatari (Latitude 250 55' 05.21 N & Longitude 900 00' 54.81" E) Phulbari (Latitude 250 53' 20.91" N & Longitude 900 02' 15.30" E) Twice a year, Based on Noise Standard of India 2000

Source: JICA Study Team

Table 7-58: Topography and Geology

During Conctruction

Monitoring Location	Condition of embankment, presence/absence of erosion
Construction Camp	
Equipment Yard	
Construction Site	
Others	

Source: JICA Study Team

Table 7-59: Soil Contamination

During Construction

Monitoring Item	Conditions During the Reporting Period
Presence/absence of oil spillage	

Source: JICA Study Team

Table 7-60: Biodiversity

During Construction

Monitoring Item/Parameter	Conditions During the Reporting Period	Remarks
Observation of Ganges River Dolphin (number of dolphins/hour)		At least 6 locations (2 locations in Dhubri, 2 locations in Phulbari, 2 locations on the sandbar), Thrice a year, 10 days
Observation of Vulnerable Species		Visual observation and hearing to construction workers/local residents
Name of the Species:		
Location of the Observation		

Source: JICA Study Team

During Operation

Monitoring Item/Parameter	Conditions During the Reporting Period	Remarks
Observation of Ganges River Dolphin (number of dolphins/hour)		At least 6 locations (2 locations in Dhubri, 2 locations in Phulbari, 2 locations on the sandbar), Twice a year, 10 days
Observation of Vulnerable Species		Visual observation and hearing to local residents
Name of the Species:		
Location of the Observation		

Source: JICA Study Team

Table 7-61: Resettlement

Major items of action	Specific action steps (sub-items)	Progress in quantity	Progress in %	Expected Date of Completion
Recruitment, training and deployment	Deployment of consultants and resettlement workers (MM)			
	Training and mobilization (No. of trained personnel)			
Review of Resettlement Action Plan	Review of RAP (%)			
	Finalization of PAPs (%)			
	Approval of RP with corrections (%)			
Socioeconomic Survey	Field Survey and collection of data, Data analysis (%)			
	Valuation of affected property and collection of data (%)			
	Produce data for comparison/evaluation (%)			
Information campaign	Distribute information brochure (No. distributed)			
	Public consultation meetings/FGD (Times)			
Identification of PAPs	Assigning ID numbers (No. of Person)			
Payment	Opening bank account (No. of Person)			
	Assist PAPs in collecting of cash compensation (No. of Persons)			
	Confirm payment of transfer (No. of Persons)			
Resettlement	Coordination with DC on the new site (No. of Households)			
	Assist PAH for the resettlement (No. of Households)			
Income restoration program	Training program, Assistant activities (No. of cases)			
	Field Survey and collection of socio-economic data after 5 years (%)			
Grievance Redress	Formation of GRC (%)			
	Receiving complaints / claims from PAPs (No. of cases)			
	Resolved complaints / claims from PAPs (No. of cases)			
Supervision and Management	Supply of manpower (MM)			
	Number of meetings with relevant agencies (No. of meetings)			
Performance Reporting	Inception / Monthly progress / Draft final report			

Source: JICA Study Team

Table 7-62: Land Use

Monitoring Item	Land use (Before/After)	Size	Agreed with land owner (Yes/No)	Land acquired / Lease / returned
Location				

Source: JICA Study Team

Table 7-63: Utilization of Local Resources

Monitoring Item	Price hike (Yes/No)	If yes, description
Name of Construction materials		

Source: JICA Study Team

Table 7-64: Unequal Distribution of Benefit and Damage

Monitoring Item	No. of samples	No. of unsatisfied PAPs	If unsatisfied, reasons
Satisfaction level			

*Based on RAP monitoring

Source: JICA Study Team

Table 7-65: Water Use

Monitoring Item	Use of silt fence	Turbidity
Location		

Source: JICA Study Team

Table 7-66: Gender

Monitoring Item	Description
Number of women employed	

Source: JICA Study Team

Table 7-67: Public Health

Monitoring Item	Description
Equipment and facilities	Adequate/Not adequate. If no, describe.
Number and nature of health issue reported	

Source: JICA Study Team

Table 7-68: Occupational Health and Safety

Monitoring Item	Description
Equipment and facilities	Adequate/Not adequate. If no, describe.
Number and causes of work related accidents	

Source: JICA Study Team

Table 7-69: Accident

Monitoring Item	Remark
Number of Injury/Fatalities	
Location of the accident	
Type and cause of the accident	

Source: JICA Study Team

7.10.5 Environmental Management Budget

The Proposed Budget for implementation of EMP is estimated below.

Table 7-70: Budget for EMP Implementation

No.	Cost of Environmental / Mitigation Plan Description	Unit	Qty	Unit Rate (Rs.)	Amount (Rs.)
A.	**Cost During Construction Phase**				
1	**Environmental Monitoring**				
	Air quality monitoring at 5 locations for 3 seasons for 6 consecutive years	Nos.	90	8,000.00	720,000.00
	Surface water quality monitoring at 5 locations for 4 seasons for 6 consecutive years	Nos.	120	6,000.00	720,000.00
	Noise quality monitoring at 10 locations for 3 seasons for 6 consecutive years	Nos.	180	3,000.00	540,000.00
	Flora and Fauna Study at 2 locations for 6 consecutive years	Nos.	18	1,00,000.00	1,800,000.00
2	**Dust suppression at site (2 trips/day for 300 days/year for 6 years)**	Nos.	3600	1,500.00	5400,000.00
3	**Development of river funding near bridge area, providing toilets etc.**			10,00,000.00	1,000,000.00

No.	Cost of Environmental / Mitigation Plan Description	Unit	Qty	Unit Rate (Rs.)	Amount (Rs.)
	Total cost during construction phase				**10,180,000.00**
B	**Institutional Cost**				
1.	**Expert Fees**	L.S			6,00,000.00
2.	**Staff Training**	L.S			4.00,000.00
3.	**Information Disclosure**	L.S			4,00,000.00
	Total				**14,00,000.00**
C.	**Annual cost During Operation Phase**				
1	**Environmental Monitoring**				
	Air quality monitoring at 5 locations for 3 seasons for 2 years	Nos.	30	8,000.00	2,40,000.00
	Noise quality monitoring at 4 locations twice a year for 2 years	Nos.	16	3,000.00	48,000.00
	Flora and Fauna Study at 2 locations for 2 consecutive years	Nos.	4	1,00,000.00	4,00,000.00
	Monitoring and maintenance efforts for ensuring survival of planted trees for 2 years	Nos.	1000	5,00.00	5,00,000.00
Total Cost During Operation Phase					**11,88,000.00**
Total Cost (A + B + C)					99,54,000.00
Contingency (10%)					9,95,400.00
Total (Rs.)					**10,949,400.00**

Source: JICA Study Team

7.11 Stakeholder Consultation

7.11.1 1st Round Consultation with Communities

Stakeholder consultation is important to carry out from the project preparation stage. The purpose of the consultation is to inform the nature of the project and possible impacts expected from the project, and invite comments and concerns from the relevant stakeholders to reflect them in the project design. This exercise is also useful for building concent from the stakeholders.

Throughout the series of consultation, general perceptions of the participants were positive and they welcomed the project itself. They especially understand that the improved transportation network and connectivity will bring better access to many facilities, businesses and employment opportunities, transportation of their agricultural produce, appreciation of land value etc. The main issues raised during the consultation are the possible loss of land and structure and the fair compensation.

The following is the basic information from the stakeholder meetings and community discussions carried out in this survey. The details of discussion will be explained in "7.12 Stakeholders Consultation".

7.12 Land Acquisition and Resettlement

7.12.1 Requirements for Land Acquisition and Resettlement

The project is a 19,282km bridge with approach road that stretches over the Bramaphtra River from the Dhubri and South Salmara-Manchakar District in Assam State, to the West Garo Hills District in Meghalaya State. The proposed alignment of this bridge will be a part of newly designated highway (NH-127B) connecting Dhubri to Phulbari. This NH-127B will continue on to connect Srirampur in Assam state and Nongstoin in Meghalaya state. The bridge will have four lanes.

According to Indian standard and specification (IRC:SP:84-2014), the ROW for four lane highway is set as 60m as shown below. Thus, ROW for this project is planned as 60m.

IRC:SP:84-2014 A minimum Right of Way of 60m should be available for development of 4-lane highway. The authority would acquire the additional land required, if any.

This ROW along the bridge and approach road passes 18 villages in total. There are title holding and non-title holding land owners who will be affected by the land acquisition and will require involuntary resettlement. In this survey, a Resettlement Action Plan (RAP) was prepared with the assistance from district land acquisition officers and village chiefs of the target area, and the district autonomous council in the West Garo Hills in accordance with Indian laws and regulations, as well as the JICA Guideline.

(1) Project Component and Area

The project component and area encompassing the land acquisition and resettlement will be the entire alignment of bridges, including approaches over the Brahmaputra between Dhubri and Phulbari. The Project affected area is the whole stretch of the bridge under 60m ROW which includes land and structures, such as residential and common properties.

Table 7-71: Project Component and Area

Length	19.282km
ROW	60 m (four lane)
Affected Areas	18 villages (Dhubri-13, South Salmara-Mankachar-4, West Garo Hills-1)

Source: JICA Study Team

Land use and land acquisition required during the construction work will be under the responsibility of contractors. The identification and selection of the land will be carried out with the assistance from respective DCs and in consultation with local residents. The land will be leased out or acquired at market rates. Land that is leased shall be returned in the same condition it was before the use. Those conditions will be included in the contract agreement between the contractors. The actual process should be included in the resettlement monitoring plan.

(2) Alternatives of Initial Design

Alternatives to minimize the resettlement at the initial design stage are described in section 7.4. the following table shows social components, including land acquisition and resettlement considered in the alternative analysis. The affected structures were estimated from the site survey. Option 1, the alignment selected in DPR, is the option with minimum number of affected structures, impact on agricultural/ Char land, and area necessary for the land acquisition. The following three options were analysed in section "7.4.3 Result of the Analysis of Alternatives".

Table 7-72: Alternatives of Initial Design

	Option 1 (DPR, recommended)	Option 2	Option 3
Structures affected (no.)	122	170	187
Agricultural land affected (km)	2.00	2.95	5.86
Built up area affected (km)	0.90	0.85	1.00
Char land affected (km)	6.30	6.70	5.10
Land to be acquired (ha)	55.20	63.00	71.76

Source: JICA Study Team based on Inception Report, July 2015 prepared by AECOM

(3) Method for Minimizing Resettlement

The original alignment was planned to connect to the existing road where residential structures are concentrated. However, in order to minimize the scale of resettlement, the connection point was changed to connect to another road upgrading project NH-27 (old NH31C); connecting to Srirampur, which is now in preparation by the Public Works Department of Assam State. The alighment was modified to bypass existing roads, and the starting point (connection point) of the bridge at Dhubri District was shifted about 300m south as indicated in Figure below. Due to this shift, a number of physically displaced households were reduced and the displacement of 1 school facility was avoided.

Source: JICA Study Team

Figure 7-26: Change of Starting Point of Dhubri-Phulbari Bridge Approach Road

7.12.2 Legal Framework for Land Acquisition and Resettlement

(1) Acts / Policies / Notifications for Land Acquisition and Resettlement

The development projects are mandated to be consistent with the existing acts and policies of the respective national, state, local governments, and also the guidelines and policies of JICA. An outline of the various acts and policies that are in place in the country are as follows:

Table 7-73: Acts / Policies / Notifications & Their Relevance to the Project

No	Acts and Policies	Relevance to the project
1	The Right to Fair Compensation and Transparency in Land Acquisition Rehabilitation and Resettlement Act, 2013	This Act came into force on 1 January, 2014, and extends to the whole of India except the state of Jammu and Kashmir. The provisions of this Act relating to land acquisition, compensation, rehabilitation and resettlement, shall apply when the appropriate government acquires land for its own use, hold and control, including for public sector undertakings and for public purposes.
2	The Assam Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Rules, 2015	This Rule came into force on 31 July, 2015, and extends to the whole state of Assam. This Rule is based on the basic provision of the LARR Act (2013), and detailed descriptions covering requirement of consent, condition of compensations, etc. are provided.
3	National Highway Act 1956	It extends countrywide. If the Central Government deems any land required for the building, maintenance, management or operation of a national highway; the intension to acquire such land will be declared by notification in the official Gazette.
4	Meghalaya Transfer of Land (Regulation) Act, 1971.	It extends to the tribal areas within the state of Meghalaya. Providing the government of Meghalaya may prohibit any transfer of land by notifications issued by the competent authority under the provision of this Act. However, this act is only applicable mainly for land transfers from government to private companies or between private individuals, and is not applicable for land acquisition by public sectors.
5	Right to Information Act 2005	Provided for the citizens to have access to information under the control of public authorities, in order to promote transparency and accountability in every public authority.
6	World Bank OP 4.12 – Involuntary Resettlement	Provided that all affected lands or structures under the project, irrespective of valid certificates or legal documents, shall be supported under the project to improve their quality of life, or at least restore to pre-project standards.
7	JICA Guidelines for Environmental and Social Considerations 2010	See (3) below.

Source: JICA Study Team

(2) Main Laws and Provisions Applicable for the Project

1) Right to fair compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act (LARR), 2013

The LARR Act (2013) was passed by the Parliament on 5 September, 2013, and came into force on 1 January, 2014, replacing the previous Land Acquisition Act (1984). The aim and objectives of this Act are:

- To ensure, in consultation with local institutions established under the Constitution, a humane, participative, informed and transparent process for land acquisition.
- To provide just and fair compensation to the families whose land has been acquired, or affected by such acquisition.
- To make adequate provisions for such affected persons, and their rehabilitation and resettlement.
- To ensure that the outcome of acquisition should be that affected persons become partners in development leading to an improvement in their post-acquisition social and economic status, and for matters connected therewith or incidental thereto.

At the beginning of the enforcement of the LARR Act (2013), the National Highway Act 1956 was included in the 13 enactments under Fourth Schedule, which exempted the application of the LARR Act (2013). However, under Order from Ministry of Road Development dated 28 August, 2015,

named as "Removal of Difficulties" extended the provisions of compensation and rehabilitation & resettlement to the Fourth Schedule. The LARR Act 2013 provision will apply when:

- Government acquires land for its own use, hold and control for strategic purposes and infrastructure development
- Government acquires land with the ultimate purpose to transfer it for use of private companies for stated public purpose (including PPP projects, but excluding state or national highway projects)
- Government acquires land for immediate and declared use by private companies for public purpose

In Meghalaya, this Act was challenged on grounds that the State falls under the Sixth Schedule of the Constitution, since Land in the State belongs to individuals and not the Government. Nevertheless, the provisions of this Act relating to land acquisition, compensation, rehabilitation and resettlement, shall apply when the appropriate Government acquires land for its own use, hold and control, including for public sector undertakings, and for public purposes.

2) The Assam Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Rules, 2015

The Assam Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Rules, 2015 (Assam LARR Rules 2015) has been in effect since 31 July, 2015. This Rule extends to the whole state of Assam. LARR 2013 allows states to set detailed procedures and specifications based on the Act. Basic provisions of LARR 2013 applies to Assam LARR 2015, and detailed descriptions are provided including the following sections.

- Requirement of consent from the affected persons
- Update of government's land records before the acquisition
- Details in compensation amount (multiplier, etc.)

3) National Highway Act 1956 by Ministry of Shipping, Transport and Highways

The National Highway Act (1956) extends to the whole of India where the central government deems for public purpose that land is required for the building, maintenance, management or operation of a national highway. The definition of highway includes the following.

- All lands appurtenant thereto, whether demarcated or not
- All bridges, culverts, tunnels, causeways, carriageways and other structures constructed on or across such highways
- All fences, trees, posts and boundary, furlong and milestones of such highways or any land appurtenant to such highways

The act provides the process of land acquisition for highway projects. The local government appointed by the central government will be the implementation agency for land acquisition. The amount of compensation will be calculated at market value based on the tax record of land transaction owned by the concerned agency. The final decision will be made upon confirmation from the land owner, and subsequent compensation and land acquisition will follow.

4) Right to Information Act 2005

The basic objective of the Right to Information Act is to empower the citizens, promote transparency and accountability in the workings of the Government. The Right to Information Act (2005) mandates timely response to citizen requests for government information. It was enacted on 15 June, 2005, and came into force on 12 October, 2005. The Act extends to the whole of India except Jammu and Kashmir, and is non-applicable to Intelligence and Security organizations.

5) World Bank Safeguard Policy OP 4.12 Involuntary Resettlement

The overall objectives of the Bank's policy on involuntary resettlement are that it should be avoided where feasible, or minimized, exploring all viable alternative project designs. When resettlement is not avoidable, the project should assist displaced persons to improve their livelihoods and standards of living, or at least to restore them to the prior state. It also states that displaced persons should be consulted and should have opportunities to participate in planning and implementing resettlement programs.

Definition of displaced persons in this policy is categorized as followings (including those who have no legal rights).

- Those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country);
- Those who do not have formal legal rights to land at the time the census begins, but have a claim to such land or assets, provided that such claims are recognized under the laws of the country or become recognized through a process identified in the resettlement plan;
- Those who have no recognizable legal right or claim to the land they are occupying.

This policy covers direct economic and social impacts from the projects such as (i) relocation or loss of shelter; (ii) loss of assets or access to assets; or (iii) loss of income sources or means of livelihood, irregardless if the affected persons must move to another location.

6) JICA Guidelines for Environmental and Social Considerations

The key principles of JICA policies on involuntary resettlement are summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

II. When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

IV. Compensation must be based on the full replacement cost as much as possible.

V. Compensation and other kinds of assistance must be provided prior to displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan includes elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

The above principles are complemented by World Bank OP 4.12. Since it is stated in the JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principles based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers or others who wish to take advantage of such benefits.

XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who do not have formal legal rights to land at the time of census but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period between displacement and livelihood restoration.

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

In addition to the above core principles in the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed financial plan etc.

(3) Applicable Acts and Guidelines

1) Assam State

According to the DCs of Dhubri District and South Salmara-Mankachar District of Assam State, the land acquisition process will follow the National Highway Act (1956). The compensation and resettlement procedures, including the calculation of the R&R budget, as well as the consideration of livelihood restoration programme will follow Assam LARR Rules (2015), which is based on LARR Act (2013).

The main gaps between NH Act 1956 and Assam LARR Rule 2015 in the land acquisition process are as follows.

- Implementation of SIA by the agency appointed by the district government. In practice, DRP consultants prepare SIA/RAP report together with DPR, which is in line with an international donor agency in the case of a donor funded project.
- Public consultation duration is 21 days, which is shorter than the Assam LARR 2015/LARR 2013 of 60 days.

The land acquisition procedure for this project will be as follows. The status as of 4 July, 2017, was at the draft 3A Notification stage.

Table 7-74: Land Acquisition Procedure in Assam

Procedures	Responsible Agencies
Submission of requisition for land acquisition	Project proponent
Notification of affected area (3A) (target village and land area)	District government (DC)
Hearing of objections	District government (Land acquisition officer)
Census survey for valuation	District government (Land acquisition officer)
Compensation budget calculation	District government (DC)
Preparation of R&R Scheme	District government (Land acquisition officer)
Notification of compensation (3D) (affected people, compensation amount)	District government (DC)
Hearing of objections	District government (DC)
Declaration of final award	District government (DC)
Payment of full amount of compensation	Project proponent to affected families through State and District government
Land transfer	District government (DC)
Displacement of affected families	District government (DC)

Source: JICA Study Team

2) Meghalaya State

In the West Garo Hills District of Meghalaya State, according to the DC, the LARR Act 2013 will be applied in the process of land acquisition, compensation and resettlement. However, since Meghalaya state falls under the Sixth Schedule of the Constitution, the land belongs to communities and not the government. Therefore, an additional step in the process is required to obtain a NOC (No Objection Certificate) from the district autonomous council, which is essentially the approval of the project itself before the land acquisition process.

The process for land acquisition in this project will be as follows. As of 4 July, 2017, the NOC was already obtained and undergoing SIA notification.

Procedures	Responsible Agencies
Submission of requisition for land acquisition	Project proponent
No objection certificate (NOC)	West Garo Hills Autonomous Council
SIA notification	District government (DC)
SIA implementation	Assigned agency (MIG)
SIA appraisal	Assigned experts group (District level)
Preliminary notification	State government
Hearing objections	District government (DC)
Compensation budget calculation	District government (DC)
Preparation of R&R Scheme	District government (DC)
Hearing of objections	District government (DC)
Declaration of final award	District government (DC)
Payment of full amount of compensation	Project proponent to affected families through State and District government
Land transfer	District government (DC) / State government
Displacement of affected families	District government (DC)

Table 7-75: Land Acquisition Procedure in Meghalaya

Source: JICA Study Team

(4) Key Gap between Indian Acts and JICA Guidelines Applied to This Project

Table 7-68 summarizes the key differences between JICA guideline and Indian LARR Act 2013, Assam LARR Rules 2015 and NH Act 1956 relevant to this project. The recommendations for measures to fill the gaps, and policy applied for this project are also given in the table.

Table 7-76: Key Gap between JICA and Indian Regulations

SL. No.	JICA Guidelines (2010)	India LARR 2013/ Assam LARR 2015	India NH Act 1956	Gaps Identified	Proposed Gap Filling Measures
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	The government shall ensure minimum displacement of people, disturbance to the infrastructure, ecology and minimum adverse impact on the individuals affected. (Ch.2)	No specific provision	LARR: N/A NH: Yes	Conduct alternative analysis
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	When the government intends to acquire land for public purposes, it shall consult with the people concerned and carry out a Social Impact Assessment (SIA). (Ch.2)	No specific provision	LARR: N/A NH: Yes	Include an appropriate compensation and livelihood restoration policy to RAP
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost, must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	RAP will be prepared based on the census survey (including compensation and livelihood restoration assistance. (Ch.4, The 2nd Schedule)	Amount of compensation shall be determined with consideration on the damages caused by the loss of the land, change of residence, earnings, etc. (3G)	LARR: No NH: No provision for the livelihood restoration assistance	Same as above
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL) Valuation and compensation for losses shall be determined by the replacement cost. (WB OP4.12 Para 10)	Amount of compensation shall be determined by the competent authority based on the market value of the land (2x the market price in urban areas and up to 4x in rural areas). Building shall also be based on the market value. Stamp duty and other fees payable for registration of the land or house will borne by the government. (Ch.4,8, The 1st Schedule)	Amount of compensation shall be determined by the competent authority based on the market value of the land (3G)	LARR: Replacement cost for land will be 2-4 times of the market price which satisfies WB guideline (land price, cost for land preparation). Likewise, replacement cost for structure will be 2 times of the market price which also satisfies WB guideline (materials, transportation of materials, cost of labour and transfer tax). However, depreciation of the asset will be considered NH: The amount determined by the competent authority may be lower than the actual market price.	Amount of compensation shall be determined based on the replacement cost identified through market value survey. Also, the calculation of the replacement cost should not take into account the depreciation of the assets.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	The Collector shall take possession of land after ensuring that full payment of compensation, rehabilitation and resettlement are paid to entitled persons (Ch.5)	The amount of compensation shall be deposited by the government before taking possession of the land. (3H)	LARR: No NH: No	N/A
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	SIA report and SIA management plan will be prepared by the concerned government, and made available to local institutions in local languages (Ch.2)	Concerned government shall have newspapers publish information of the land to be acquired. (3A,3G)	LARR: No NH: No	N/A
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	The government shall give adequate publicity of date and venue of the public hearing, and results of discussions shall be indicated in the SIA. SIA shall be made available to local institutions. (Ch.2)	Public hearings will be conducted in two stages, intention of land acquisition and the information of land owner list and compensation amount (3A, 3C,3G)	LARR: No NH: Possibility of insufficient information disclosure	Need consideration for information disclosure. Stakeholder consultation shall be conducted with the participation of residents, and the result shall be incorporated in the project.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	Same as above	Same as above	LARR: No NH: Possibility of insufficient information disclosure	Same as above
9	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Monitoring committee in the central and provincial level shall be established. Experts in the concerned field can be employed to implement the monitoring (Ch.7)	No specific provision	LARR: No NH: Yes	Establish an appropriate monitoring system to ensure participation of the community
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	An objection hearing will be conducted within 60 days from the date of the notification indicating the information of the land to be acquired (Ch.4)	Public hearing will be conducted after the information of land owner list and compensation amount are made available (3C,3G)	LARR: Yes NH: Yes	Establishment of grievance redress mechanism shall be mentioned in the RAP and district gov't shall be responsible for its implementation.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey, preferably at the project identification stage, to prevent a subsequent influx of encroachers who wish to take advance of such benefits. (WB OP4.12 Para.6)	Affected households, land and property will be identified through site investigation (Ch.2)	Affected households, land and property will be identified through site investigation (3B)	LARR: No NH: No	N/A
12	Eligibility of benefits includes; the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Title holders include those who have the legal rights and those who do not have legal rights but whose primary source of livelihood for three years prior to the acquisition of the land. (Ch.1)	Land users shall receive 10% of the amount determined by the competent authority (3G)	LARR: Non-titleholders need to be residing continuously or drawing livelihood from the affected area for a period of not less than 3 years. NH: Non-titleholders are not entitled for compensation	Recognize claims of non-titleholders (irrespective of their residing period status).
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	In case of an irrigation project, land-based resettlement will be considered. SC/ST shall be provided land equivalent to the land acquired (The 2nd Schedule)	No specific provision	LARR: No NH: Yes	If land compensation is requested, advise will be provided to the district collector to give priority for possible land compensation.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	The government shall provide the choice of 1) suitable training for the jobs created through the project, 2) a one-time payment per affected family, 3) certain amount of monthly payment for 20 years (The 2nd Schedule)	Amount of compensation shall be determined with consideration of the damages caused by the loss of the land, change of residence, earnings, etc.(3G)	LARR: No NH: No provision for the livelihood restoration assistance	Livelihood restoration programme shall be included in the RAP.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	Additional assistances to vulnerable groups, SC/ST are mentioned in the provision (Ch.5, The 2nd Schedule)	No specific provision	LARR: No NH: Yes	Vulnerable groups, SC/ST shall be identified during the census survey and special assistance shall be included in the RAP.

Source: JICA study team

7.12.3 Scale and Scope for Land Acquisition and Resettlement

(1) Methodology

The census survey was carried out along the proposed alignment to understand the impact of land acquisition and scale of resettlement from this project. In this survey, questionnaire sheets were used to develop the profiles of Project Affected Households (PAHs) and to prepare an inventory of the affected assets including land and structures. The components of the survey include a population census, asset survey and livelihood survey, and estimate budget for compensation and assistance for rehabilitation as well as livelihood restoration. Duration and target of the census survey is as follows.

- Duration: November 2016 to February 2017
- Target: PAHs whose structure (residential, shops, etc.) and/or land (agricultural, residential, etc.) will be affected

The census survey used the list of villages and land plots under the alignment produced by land acquisition officers in Dhubri and South Salmara-Mankachar Districts based on the land acquisition map produced by DPR consultant (AECOM). The list of land plots indicates land owners, land types and land areas. Since a similar list has not been prepared for the West Garo Hills District, likely PAHs were identified via map and site observation.

Although the survey aimed to cover all the affected areas, 31.4% of the total land plots remained un-surveyed, since the owners could not be identified during the course of the survey period. In the census survey, the survey team sought assistance from village heads and villagers to inform the land owners prior to and during the survey, the owners were contacted by phone calls from relatives and neighbors.

Following table shows the list of villages, number of plots under the alignment and number of plots un-surveyed. The section marked in gray are the villages in the Char lands.

Table 7-77: List of Surveyed Villages and Land Pieces

District		Village	No. of Dag under alignment	No. of Dag not surveyed
Dhubri	1	Adabari Part-II	62	25
	2	Chagal chora Part-I	19	5
	3	Chagal chora Part-II	67	24
	4	Chagal chora Part-III	70	24
	5	Airanjangla Part-I	85	20
	6	Airanjangle Part-II	80	17
	7	Bhassanir char Part-I	41	14
	8	Kathiar Alga	66	14
	9*	Bauskata IV	1	-
	10*	Bauskata VI	1	-
	11	Bororawatre Part-I	9	4
	12	Bororawatre Part-II	5	2
	13	Aminerchar	13	1
South Salmara-Mankachar	14*	Basir Char	1	-
	15	Chaiter Chor Part-I	168	75
	16	Baladoba	47	6
	17*	Sebaltari	1	-
West Garo	18	Phulbari	1	0
		Total	736	231

Source: JICA study team
Note: Grey section indicates villages of Char land
Note: Villages with * mark are government land so land plots are not allocated to individual owners.

(2) Census Survey

The survey components include basic information of the PAH including composition of households, ethnicity and religion. Inventory of the loss of assets of lands, structures and other assets, livelihood survey including source of income were also surveyed.

1) Summary of Project Affected Households

Out of 761 PAHs, 633 PAHs (2,538 PAPs) are affected by land only, 127 PAHs (500 PAPs) are affected by structures and lands, while 1 PAH (5 PAPs) is affected by commercial structure. In addition, the Project has impact on the livelihoods of 495 PAHs: 95 agriculture labours, approximately 300 boat operators and 100 fishermen.

Table 7-78: Summary of the Survey

Impacts	PAHs		PAPs	
	Legal	Illegal	Legal	Illegal
Total PAHs	671	90	2706	337
Structure to be affected (Physically displaced)	124	3	491	9
Only land to be affected	546	87	2,210	328
Commercial structure to be affected	1	0	5	0
PAHs whose livelihoods to be affected	495	-	-	-
Agriculture labours	95	-	-	-
Boat operators	300	-	-	-
Fishermen	100	-	-	-

Source: JICA study team

Detailed results of the census survey are described in the following sections.

2) Project Affected Household and Affected People

District wise PAHs and PAPs identified in this census survey are shown in Table 7-70. The total PAHs are 761 and PAPs are 3,042. The composition of PAPs in the project area is 59.2% in Dhubri, 40.6% in South Salmara-Mankachar and 0.1% in West Garo Hills. Out of the total PAPs, 54.1% are residents in the Char land.

Table 7-79: Number of PAH and PAP

District	PAHs	PAPs	PAPs in Char land
Dhubri	621	2,550	1,109
South Salmara	138	485	485
West Garo Hills	2	8	0
Total	761	3,042	1,858

Source: JICA study team

Village wise number of PAHs and PAPs are shown in Table 7-71.

Table 7-80: Village wise PAHs and PAPs

District	No.	Village	PAHs	PAPs
Dhubri	1	Adabari Part-II	46	171
	2	Chagal chora Part-I	14	60
	3	Chagal chora Part-II	63	290
	4	Chagal chora Part-III	69	279
	5	Airanjangla Part-I	17	87
	6	Airanjangle Part-II	168	701
	7	Bhassanir char Part-I	56	213
	8	Kathiar Alga	93	360
	9	Bauskata IV	58	252

District	No.	Village	PAHs	PAPs
	10	Bauskata VI	2	8
	11	Bororawatre Part-I	16	65
	12	Bororawatre Part-II	5	20
	13	Aminerchar	14	44
South Salmara Mankachar	14	Basir Char	0	0
	15	Chaiter Chor Part-I	63	212
	16	Baladoba	52	196
	17	Sebaltari	23	77
West Garo	18	Phulbari	2	8
		Total	761	3,043

Note: Grey lines indicate villages of Char land
Source: JICA study team

3) Movement of Locations

During the rainy season, due to the rise of water level, Char lands near the river will be submerged. According to the census survey, 18.7% of the total PAH (142 households) shift their location during rainy season and out of which, half resides in Dhubri and half in South Salmara-Mankachar District. Out of those who shift their locations, 26.1% (18 households) in Dhubri and 72.6% (20 households) in South Salmara-Mankachar District answered that they do not return to the original places. Mobile households are more prominent in the South Salmara-Mankachar District. In relation to the land ownership which will be described later, it was reported from DCs that those who have the ownership or land use rights (Patta) of the original land will be entitled to compensation.

Table 7-81: Movement of Location

District	No. of PAH	Move the location during rainy season	Come back to the same location in dry season
Dhubri	621	69	18
South Salmara	138	73	53
West Garo Hills	2	0	0
Total	761	142	71
Percentage	-	18.7%	9.3%

Note: Households who answered that they do not come back to the same location in dry season were in four villages such as; Bororawatre Part-1, Part-2, Baladoba and Chaiter Chor Part-1.
Source: JICA Study Team

4) Population

The census survey identified that the majority of PAHs were male-headed households, while female-headed households were 51 (6.7%). Out of total PAPs, 69.0% are male and 31.0% are female.

Table 7-82: Socio-Demographic profile

PAHs			PAPs		
Male-headed	Female-headed	Total	Male	Female	Total
710	51	761	2,099	944	3,043
93.3%	6.7%	-	69.0%	31.0%	-

Source: JICA Study Team

5) Composition of Households

The average family size of PAHs is 4. In Dhubri, 3 to 5 family members are the majority, and 3 to 4 are the majority in the South Salmara-Manchakar District.

Table 7-83: Composition of Affected Households

	1	2	3	4	5	6	7+	Total
Dhubri	13	62	145	177	131	63	30	621
South Salmara	1	15	59	45	13	3	2	138
West Garo Hills	0	0	0	2	0	0	0	2
Total	14	77	204	224	144	66	32	761
Percentage	1.8%	10.1%	26.8%	29.4%	18.9%	8.7%	4.2%	-

Source: JICA Study Team

6) Social category

All PAHs identified themselves as a general caste. No scheduled castes or scheduled tribes were identified during the census survey.

7) Ethnicity and Language

The ethnicity of PAHs in the survey area were mixed between Assamese and Bengali due to the historical background mentioned in 7.3.3 (5). Therefore, all the PAHs in the project area use Assamese and Bengali languages[23].

8) Religion

The religious breakdown of the surveyed PAHs is shown in Table 7-75. Most of the PAHs are Muslims consisting of 99.3% of the total PAH, and the other 0.7% (5 PAHs) are Hindus. No PAHs maintain special cultural and social traditions outside of the mainstream.

Table 7-84: Religious Composition

	Muslim	Hindu	Others
Dhubri	619	2	0
South Salmara	137	1	0
West Garo Hills	0	2	0
Total	756	5	0
Percentage	99.3%	0.7%	-

Source: JICA Study Team

(3) Asset and Land Survey

1) Land Ownership Status of PAHs

During the census survey, it was observed that the government records do not match with the current land owners since the records have not been updated. Therefore, those having land registration are classified as (1) Tile holder, those who do not have land registration but have documents showing that they have succeeded the land or they had land purchase agreements are classified as (2) Non-title holder but can claim rights. For those who reside on government land without any documents / certificateswill be categorized as (3) Non-title holder and cannot confirm rights. Based on the information of land ownership provided during the interview survey, titleholders and non-titleholders in this project are classified as follows.

In this project, (1) Tile holder and (2) Non-title holder but can claim rights are considered as “Legal” and (3) Non-title holder and cannot confirm rights as “Illegal”.

[23] As Assamese is a language derived from Bengali, there are high similarity between both languages. In the project area, government officials mainly use Assamese language and schoold education is done in Assamese as well so written documents are usually in Assamese. On the other hand, daily communication and spoken languages are mostly in Bengali.

Table 7-85: Classification of Titleholders and Non-titleholders

Titleholder as per gov't record	Current Status	Classification	Entitlement
Original owner is the same as current owner	Current owner is the same as in the land record	(1) Title holder	Compensation & Assistance
Original owner is different from current owner	Current owner is son/daughter of the original owner or having purchase record but not registered	(2) Non-title holder but can claim rights	Compensation & Assistance
Government land	Current owner does not have documents and not registered	(3) Non-title holder and cannot confirm rights	Assistance

Source: JICA Study Team

Titleholders and non-titleholders were counted based on the above mentioned classification. Out of 761 respondents, 449 households are legal titleholders (59.0%), whereas 222 respondents are non-titleholders but can claim rights (29.1%). There are 90 respondents who do not have any legal right (non-title holder) and cannot claim rights (11.8%). The majority of non-title holders were identified in Char lands, 71 households (11.4%) in Dhubri and 19 households (13.8%) in South Salmara-Mankachar. Assistance for those non-titleholders shall be adequately provided by the project.

Table 7-86: Land ownership status of PAHs

District	Titleholder	Non-titleholder can claim rights	Non-titleholder cannot claim rights
Dhubri	365	185	71
South Salmara	82	37	19
West Garo Hills	2	0	0
Total	449	222	90
Percentage	59.0%	29.2%	11.8%

Source: JICA Study Team

Legal and illegal status of PAHs of each construction section (bridge and approach road) is shown as follows.

Table 7-87: Legal status of PAHs of each construction section

Items	Title holder & Non-titleholder can claim rights	Non-titleholder
Bridge section	332	81
Access road section	339	9
Total	671	90

Source: JICA Study Team

2) Loss of Private Land

The majority of land in the project area is agricultural land. PAHs with affected agricultural land are 633 PAHs (83.2%), residential land are 102 PAHs (13.4%), both agricultural and residential land are 25 PAHs (3.3%) and only 1 household uses it for commercial purposes. A total of 127 households (16.7%) will have their structure affected and will be displaced from their original residential land. Table 7-88 presents the number of PAH/PAPs by different use of land and Table 7-89 indicates a district-wise breakdown of the land usage.

Table 7-88: Loss of Land by Usage and Number of PAH/PAPs

Use of Land	PAHs	PAPs	PAP (%)
Agricultural	633	2,538	83.4%
Residential	102	406	13.3%
Agricultural and Residential	25	94	3.1%
Commercial shop	1	5	0.2%
Total	761	3,043	-

Source: JICA Study Team

Table 7-89: Loss of Land by District and Usage

District	Agriculture	Residential	Agricultural & Residential	Commercial
Dhubri	527	69	24	1
South Salmara	106	31	1	0
West Garo Hills	0	2	0	0
Total	633	102	25	1
Percentage	83.2%	13.4%	3.3%	0.1%

Source: JICA Study Team

3) Severeness of Impact on Land Owners

The intensity of their land loss is shown in the Table 7-80. Out of 393 PAHs who responded, 46.1% are losing less than 25% of their land and 30.3% are losing more than 50% of their land. Others who were not aware of the total land area were not included in the figures.

Table 7-90: Severeness of Land Impact

Scale of Impact	PAHs	PAH %
Up to 10%	73	18.6%
Above 10% and Below 25%	108	27.5%
Above 25% and Below 50%	93	23.7%
Above 50% and Below 75%	58	14.8%
Above 75%	61	15.5%
Total	**393**	**-**

Note: Other respondents do not have information about their total area.
Source: JICA Study Team

4) Loss of Structures

Due to the project, 273 structures are going to be affected and 127 PAHs and 500 PAPs will be displaced. 72.3% of structures and 71.4% of displaced PAPs are in the Dhubri District.

Table 7-91: Loss of Private Structures in the Project

District	No. of Structure	Displaced PAHs	Displaced PAPs	% of PAPs
Dhubri	200	93	357	71.4%
South Salmara	65	32	135	27.0%
West Garo Hills	8	2	8	1.6%
Total	273	127	500	-

Source: JICA Study Team

5) Type of Affected Structures

The structures to be affected by the project are categorized as temporary, semi-permanent, and permanent structures. Out of 273 affected structures, 32 (11.7%) structures are of permanent nature, 78 (28.6%) are of semi-permanent nature and 163 (59.7%) are of temporary nature. The district-wise breakdown of the affected structures is summarized in Table 7-82.

Table 7-92: Type of Affected Private Structures

District	Permanent	Semi-Permanent	Temporary
Dhubri	23	55	122
South Salmara	1	23	41
West Garo Hills	8	0	0
Total	32	78	163
Percentage	11.7%	28.6%	59.7%

Source: JICA Study Team

6) Loss of Common Property Resources

In terms of common property resources, one forest office in Phulbari will be affected from the project. The relocation of the office will be discussed between DC of West Garo Hills and the forest department. No other education or religious facilities will be affected.

7) Loss of Trees and Crops

Along the path, a total of 2,559 trees may be impacted due to the land acquisition. Out of which 1,897 trees (74.1%) are fruit bearing trees and 662 trees (25.9%) are other trees. Major fruit bearing trees observed were bananas, jackfruits and groundnut, etc. and other trees were bamboo trees.

Table 7-93: Affected Trees

District	Fruit Tree	Other Trees
Dhubri	1,796	594
South Salmara	62	29
West Garo Hills	39	39
Total	1,897	662
Percentage	74.1%	25.9%

Source: JICA Study Team

Major crops cultivated in the areas were a combination of rice paddies (dominant source), pulses, jute and vegetables including tomatoes, potatoes and chili etc. During the census survey, the exact size of cultivated area and areas of each crop could not be identified. Table 7-85 shows the types of crops cultivated by the PAHs. Second and third crops, if any, were counted multiple times. PAHs in Dhubri District cultivate rice (99.6%) together with dal/lentils (74.9%), jute (40.7%) and vegetables (31.4%). In South Salmara-Mankachar District, dal/lentils (84.9%), paddy (49.1%) and jute (3.8%) are cultivated. At the time of the official assessment survey by the valuation committee, the areas and types of standing crops will be assessed in detail.

Table 7-94: Crops Cultivated by PAHs

District	No. of PAH	Paddy	Dal/Lentils	Jute	Vegetables
Dhubri	526	99.6%	74.9%	40.7%	31.4%
South Salmara	106	49.1%	84.9%	3.8%	0.1%
West Garo Hills	0	0	0	0	0

Source: JICA Study Team

8) Loss of Livelihood

Apart from those whose assets are to be affected, agriculture labourers who are employed by the land owners will also negatively impacted from the project. During the census survey, 95 agriculture labourers were identified, a majority which were in the Dhubri District. Most of them are engaged as temporary labours during sowing and harvesting seasons. These agriculture labourers will also be entitled to assistance and participation in the income restoration program.

In addition, current boat operators who are providing the services between Dhubri and Phulbari will also be affected by the project. According to the Inland Waterway Transportation (IWT), 20 passenger boats and 30-50 goods transportation boats per day are in direct operation between

Dhubri and Phulbari. Based on the information from the boat operators association in Dhubri and Phulbari, a total of 2,000 boat operators are registered in the area, out of which 250-300 boat operators are directly serving the target area. Their loss of business opportunities will be considered in this project. For the other operators, since demand for boat transportation between Char lands are still expected, their business will not be affected by the project. During the survey, it was also requested that boat owners who have invested in their boat, be compensated for their boat under this project which shall be considered as a loss of asset.

Furthermore, based on meetings with fishermen, there are around 100 households engaging in fishing activities along the alignment as their primary income source. Even though they can move freely in and around the river which means that they can continue their activities outside of the alignment during the construction, considering they operate hand-rowing boats, long distance travel may be difficult and there may be a possible reduction of catch during the construction period. Therefore, fishermen shall also be provided with the option to be employed in the construction work.

(4) Livelihood Survey

1) Education Level of PAHs

The education Level of PAHs is as shown in Table 7-85. Out of total PAHs, 60.7% have had no education at all. 12.2% have lower primary and 9.8% have upper primary education, 9.0% have junior high, 4.1% have high school education and 4.8% have completed collage.

Table 7-95: Education Level of PAPs

	No education	Lower Primary	Upper Primary	Junior High	High School	College	Total
Dhubri	348	78	69	62	30	33	620
South Salmara	111	13	5	6	1	2	138
West Garo Hills	0	1	0	0	0	1	2
Total	**459**	**92**	**74**	**68**	**31**	**36**	**760**
Percentage	60.7%	12.2%	9.8%	9.0%	4.1%	4.8%	-

Source: JICA Study Team

2) Literacy

Table 7-86 indicates the literacy rate of the head of households of PAHs. If no education is considered as an illiterate household, then literacy rates of Dhubri and South Salmara-Mankachar District are 43.9% and 19.6% respectively. Those figures are lower than the average district rates which are 58.3% and 40.0% respectively, especially the rate in South Salmara-Mankachar District is significantly low. In Phulbari, out of 2 PAHs in Phulbari, one has primary education and the other has college education.

Table 7-96: Literacy Rate of PAPs

	Literacy Rate	Baseline Data
Dhubri	43.9%	58.3%
South Salmara	19.6%	40.0%
West Garo Hills	-	67.6%

Source: JICA Study Team

3) Occupation

Table 7-87 presents income source of the responded PAHs. All the respondents are engaged in agriculture followed by unskilled labour (46.3%). Some are self-employed (7.6%) and some are engaged in private services (3.0%) and government services (4.5%). It clearly indicates that the agriculture is the main occupation and unskilled labour is the secondary income source in the project area.

Table 7-97: Occupation

	Agriculture	Dairy	Unskilled Labour	Self Employed	Skilled	Private Service	Government Service	Others	Total
Dhubri	554	11	273	40	4	19	25	68	994
South Salmara	117	1	38	11	3	0	5	5	180
West Garo Hills	0	0	0	0	0	1	0	1	2
Total	**671**	**12**	**311**	**51**	**7**	**20**	**30**	**74**	**1176**
Percentage	100%	1.8%	46.3%	7.6%	1.0%	3.0%	4.5%	11.0%	-

Note: Multiple answers were given
Source: JICA Study Team

4) Monthly household income of households

Monthly household incomes were surveyed between the ranges of below Rs. 1,000 to above 21,000. Only 0.8% earn below Rs. 1,000. The majority 42.2% are earning between Rs. 1,001 to 5,000, followed by 36.8% who earn between Rs. 5,001 to 9,000. Around 3.7% are earning between Rs. 13,001 to 21,000 per month, and 6.1% have a household income that is above Rs. 23,000. Table 7-88 indicates the district-wise total monthly income of the PAHs.

Although it is important to note that the cash income may not reflect the real well-being of PAHs engaged in subsistence agriculture, the figure indicates that people have significantly less capital for savings and investments.

Table 7-98: Total Monthly Household Income (Rs/Month)

	Below 1,000	1,001-5,000	5,001-9,000	9,001-13,000	13,001-17,000	17,001-21,000	Above 21,001	Total
Dhubri	6	260	207	72	14	11	42	612
South Salmara	0	57	70	5	1	1	4	138
West Garo Hills	0	0	0	1	1	0	0	2
Total	6	317	277	78	16	12	46	752
Percentage (%)	0.8%	42.2%	36.8%	10.4%	2.1%	1.6%	6.1%	-

Source: JICA Study Team

(5) Vulnerability

The census survey has identified 51 female-headed households (6.7%), 8 household with physically challenged members (1.1%), 1 elderly household with no immediate support member (0.1%) and 414 households who consider themselves as a BPL household (54.4%). Although this number of BPL households is self-reported without cross-checking with actual income data, this shows that those households may have low coping ability against possible negative impacts.

Table 7-99: Vulnerability

	Female-headed HH	HH with physically challenged member	Elderly with no immediate support member	Below Poverty Line*	Total HHs
Dhubri	47	8	1	363	419
South Salmara	4	0	0	51	55
West Garo Hills	0	0	0	0	0
Total	51	8	1	414	474
Percentage	6.7%	1.1%	0.1%	54.4%	

*The figure shows results from self-reported interviews without cross checking actual income.
Source: JICA Study Team

7.12.4 Compensation and Assistance Policy

(1) Cut-off-date

At the time of this survey, the cut-off-date has not been declared in Assam and Meghalaya State. Therefore, in this survey the cut-off-date is set as the starting date of the census survey. As per respective provisions, Assam State will follow the NH Act 1956, and Meghalaya State the LARR Act 2013. The cut-off-date in Assam State will be the issue date of 3A notification indicating the target villages and land areas which will be prepared by respective DCs approved by NHIDCL. As for Meghalaya State, the issue date of SIA notification from the state government will be recognized as the cut-off-date.

- This Survey: 24 November, 2016
- Dhubri, South Salmara-Mankachar District: expected in July, 2017
- West Garo Hills District: not yet decided

The cut-off date will be officially declared by the respective DCs along with the disclosure of the RAP report, and will be disclosed in the project area through local newspapers. For the purpose of preventing an influx of people into the project area, PAPs who settle in the affected areas after the cut-off date will not be eligible for compensation.

(2) Eligibility

The status of title holder / non-title holder in the target area can be categorized as follows.

- Private land with periodic patta[24] (Titleholders)
- Private land with periodic patta or purchase record but not yet registered (Non-titleholder can claim rights)
- Government land without any certificates (Non-titleholder cannot claim rights)

(3) Compensation Policy

Despite that efforts are made to minimize resettlement impacts, the proposed project will affect land and structures. As a result of which physical displacement will arise and resettlement will be required. The resettlement plan shall furnish fair compensation for displaced households.

1) Land compensation

In case of land compensation, the DC is responsible for identifying land for providing adequate and appropriate replacement land for PAHs who requests land compensation, rather than cash compensation. If PAHs request land compensation, the DC shall secure land as close to the original location as possible. The condition for the relocation site shall be better housing at resettlement sites, with comparable access to employment and production opportunities, and infrastructure with utility and community services.

2) Cash compensation

According to the census survey, most of the PAHs preferred cash compensation and self-relocation over land compensation. Therefore, cash compensation at market rate along with relocation assistance is considered a more practical solution in this case. In case of cash compensation, only titleholders are eligible for compensation for the land. Non-title holders are eligible for structures and crops, if any, excluding the land. Details are given in the entitlement matrix.

[24] A certificate of land use rights which is considered as a land title in the Assam State.

3) Basic compensation and assistance

The PAPs will be entitled to the following six types of compensation and assistance packages:

a) Compensation for the loss of land at replacement cost
b) Compensation for structures (residential/commercial) at their replacement cost without depreciation
c) Crops/ trees at their market cost
d) Assistance in lieu of the loss of business/ wage income and income restoration assistance. In case of boat operators, compensation will be provided if the needs are confirmed.
e) Assistance for shifting and provision for the relocation site, if required
f) Rebuilding and/ or restoration of community resources/facilities

(4) Income Restoration Program

The purpose of restoration of livelihoods is to ensure that the PAPs are able to at least regain their standard of living. In this project, the eligible people for the restoration program include the following;

- PAPs whose assets are affected (land, residential and commercial structures)
- PAPs whose livelihoods associated with loss of assets are affected (agriculture labourers)
- PAPs whose livelihoods are affected from the Project (boat operators, boat owners, fishermen etc.)

Table 7-100: Summary of Assistance (Whose livelihood are affected)

Eligible people	No. of people	Nature of the impact	Assistance
Agriculture Labours	95	There are temporary agriculture labours (during harvest season) hired on the land to be acquired. Therefore, their income generation opportunities will be reduced and will have impact on their livelihood due to this project.	a) Agriculture Labours: Provision of 200 days of minimum wage b) Provision of preference in employment opportunities from construction work c) Provision of preference in vocational training
Boat Operators	250-300	The livelihoods of boat operators operating direct service between Dhubri and Phulbari are expected to be affected as business opportunities will be reduced due to this project. (Since there will be continuous demands for the transportation service even after this project, no particular impact will be expected.)	a) Compensation for the boat if necessary (only for the direct service between Dhubri and Phulbari) b) Provision of preference in employment opportunities from construction work c) Provision of preference in vocational training
Fishermen	100	During the construction, it is assumed that vibration around the bridge piers and restriction of access to the construction section. Althrough local fishing areas are within 4-5 km radius (including upstream and downstream), there is a possibility of conducting	a) Provision of preference in employment opportunities from construction work b) Provision of preference in vocational training

		fishing activities far away from the usual fishing location. Considering that they are using rowing boat without an engine, it may be difficult to travel in the distance.	

Source: JICA Survey Team

To restore and enhance the economic conditions of the PAPs, their present socio-economic status and potential opportunities in and around the affected communities should be considered. An income restoration program will be developed and implemented by the district government, with the assistance from RAP implementation NGO in order to identify suitable options. Inputs and feedbacks from relevant stakeholders and communities must be also incorporated in the program through a series of discussions and workshops.

Possible income restoration programs considered at this stage are as follows.

1) Preference in employment in the Project

Employment opportunities shall be provided to the local community including all the PAPs. Agriculture labourers, boat operators and fishermen whose livelihoods are likely to be affected from the project are also provided with the opportunities to engage in the construction work of the project. The vulnerable PAPs and women should have equal opportunities to be employed in the project, taking into account their needs, competence and social situation of the area. For those who do not have the skills in construction work and other related works, job training shall be provided prior to the employment in the project in order to provide equal opportunities to other potential candidates.

The NHIDCL local office, with the assistance from NGO will liaise with the contractor to seek employment opportunities in construction related activities for PAPs. Especially with regard to women's employment, it is considered necessary for NGOs to confirm the needs of women who need to take care of children and elderly. Based on the identified needs, NHIDCL shall propose the contractor to consider employment method for women, such as working palces and time zones. In addition, preferably a mandatory clause in the contract with the contractor should be added to give preference to local labour, as a measure of corporate responsibility of the contractor.

2) Skill improvement training

Contents of job training will be considered based on the current local economic activities and occupational opportunities in the target area. Interviews with the applicants on their interest, and the demand for those occupations and skill improvement are necessary to identify the training contents. At the same time, possible collaboration with vocational training centers, and programs in the surrounding area and with existing training courses should also be explored.

Vocational training programs that could be considered at this stage are as follows.

- Considering that agriculture is the major source of income, it may be useful to provide guidance from Krishi Vigyan Kendras (KVK[25]) for increasing productivity and introducing suitable breeds of crops.
- Based on the fact that land transportation needs will increase in addition to river transportation, driver training on tricycles and trucks together with the support for their license registration may be useful.

[25] Krishi Vigyan Kendras (KVK) is the Agricultural Technology Dissemination center of the India Agricultural Research Council (ICAR) and has several regional centers in each state. The trainings provided by KVK Dhubri include provision of technical information and trainings on agriculture, livestock and fisheries.

- Improved distribution network will increase access to the (local) market, so guidance on the trading and marketing of produce is considered to be effective.

3) Assistance for starting up new businesses

New business opportunities shall be surveyed with the assistance from experts by reviewing the market situation in the target area. Assistance should be provided to get access to local banks with lower interest rates. More specifically, introduce local banking programs, coordinate with banks for the relaxation of conditions, and provide training on how to utilize microfinance which can be done through NGOs.

The following new business initiative can be supported.

- The launch of small stores and establishment of bases for selling products and trading goods may be new business opportunities.
- Credit schemes can be applied to procure funding for the initial investments, including purchasing new means of transportation as described above.

4) Additional Support from On-going Poverty Reduction Programs

In India, governments at the village and district levels are now responsible for the planning and implementation of all anti-poverty programs funded by the central and state governments. The National Skill Development Program, the initiative of the central government and Swarnjayanti Gram Swarojgar Yojna (SGSY[26]), specially catered for those below the poverty line are examples. The implementing NGO will work with the panchayat governments to make those programs available to PAPs, and also play a proactive role to mobilize PAPs to get benefits from various ongoing pro-poor programs.

5) Provision of subsistance allowance to PAHs in Char area

People living in the project area are having low literacy rate and low income level and considered to be vulnerable to the change of environment. Therefore, all PAHs should be entitled for monthly allowance regardless of their displacement requirements (according to Acts and Rules of India, monthly allowance is only for displaced families).

Table 7-101: Entitlement Matrix

Type	Affected People	Entitlement	Details
Loss of land	Title holder	Compensation, Assistance	a) Minimum 60 days advance notice b) Compensation at replacement cost (*2) c) One-time resettlement allowance Rs. 50,000/PAH d) Monthly subsistence allowance Rs.3,000/PAH×12months (*1)
	Non-title holder	Assistance	a) Minimum 60 days advance notice b) One-time resettlement allowance Rs. 50,000/PAH c) Monthly subsistence allowance Rs.3,000/PAH×12months (*1)
Loss of structure[27]	All PAH	Compensation, Assistance	a) Minimum 60 days advance notice b) Compensation based on replacement cost (*2) c) Right to salvage materials d) One-time resettlement allowance Rs.50,000/PAH e) One time shifting allowance Rs.50,000/PAH f) Monthly subsistence allowance Rs.3,000/PAH×12months (*1)
Loss of	All PAH	Compensatio	a) Minimum 60 days advance notice

[26] Swarnjayanti Gram Swarojgar Yojna (SGSY) is a program that provides support for private entrepreneurs with the aim of improving livelihoods for the poor. The support includes organizing self-help group, providing training, loan and marketing support, etc.

[27] During the census survey, there were no HHs renting houses. Therefore, HH losing structures equals displaced HHs

tree and crops		n	b) Harvest before acquisition. Compensation based on market price for standing crop, if advanced notice was not provided
Loss of shops	Title holder	Compensation, Assistance	a) Minimum 60 days advance notice b) Compensation based on market price (*1) c) Right to salvage materials
Loss of livelihood	All PAHs	Assistance	a) Financial assistance Rs. 25,000/PAH b) Preference in employment under the project (*3) c) Training and assistance for business opportunity (*3)
	Agriculture Labourer	Assistance	a) Minimum wage for 200 days b) Preference in employment under the project (*3) c) Training and assistance for business opportunity (*3)
	Boat operator	Assistance	a) Compensation of boats at replacement cost (direct service from Dhubri – Phulbari) b) Preference in employment under the project (*3) c) Training and assistance for business opportunity (*3)
	Fishermen	Assistance	a) Preference in employment under the project (*3) b) Training and assistance for business opportunity (*3)
Vulnerable people	Vulnerable people[28]	Assistance	a) Additional assistance of Rs.25,000/PAH over above b) Preference in employment under the project c) Training and assistance for business opportunity
Loss of public property	District government	Replacement or Restoration	a) Based on the request of affected villages or districts
Impact during construction	Title holder	Compensation, Assistance	a) Land: Rental based on market price during occupied period. Hand back the land in the original condition b) Structure: Compensation based on market price c) Livelihood: Rs.3,000/PAH /month during occupied period
	Non-title holder	Assistance	a) Livelihood: Rs.3,000/PAH /month during occupied period

Source: JICA Study Team

(*1) Amounts of allowances are based on the LARR Act 2013. For agriculture labours, the Assam LARR Rule 2015 will be applied having more detailed regulation. The conditions of recieints of financial support are as follows. Also, since the people living in the project area are considered to be vulnerable to the changes of environment, all PAHs will be included as beneficiaries of the subsistence allowance. The conditions of recipients of financial support are as follows.

- Resettlement allowance (Rs.50,000): All PAHs
- Shifting allowance (Rs. 50,000): Displaced family
- Subsistance allowance (Rs. 3,000×12 months): All PAHs
- Assistance for loss of livelihoods (Rs. 25,000): All PAHs whose livelihoods are lost
- Assistance for vulnerable HH (Rs. 25,000) PAHs with vulnerable people

(*2) As per Assam LARR Rule 2015 and LARR Act 2013, replacement cost for land and structures will be calculated as follows, based on the market price notified by the district government. Also, stamp duty and other fees payable for registration of the land or house will borne by the government.

- Land price will be calculated by multiplier (depends on rural or urban) and solatium.
  - Rural areas = A(Market price×Multiplier(1.5-2.0))+A×100%Solatium+A×12%
  - Urban areas = A(Market price×Multiplier(1.0))+A×100%Solatium+A×12%
- Structure price will be based on market price without depreciation
  - Market price×100%Solatium

The definition of the replacement cost by World Bank Guideline (WB OP4.12) indicates that calculation of the replacement cost should not take into account depreciation of the asset. The same provision shall be followed to determine the cost.

(*3) According to LARR Act 2013, the appropriate Government shall ensure that all PAHs are provided with the following options. At this stage, provision of the option for the employment opportunities and appropriate trainings will be assumed.

- Provision of employment oportunities and appropriate trainings
- Rs. 5,00,000/family

[28] Vulnerable HH includes; Women headed HH, HH with physically challenged member, Eldery with no immediate support member, and HH below the Poverty Line.

- Rs. 2,000/family×20years

7.12.5 Grievance Redress Mechanism

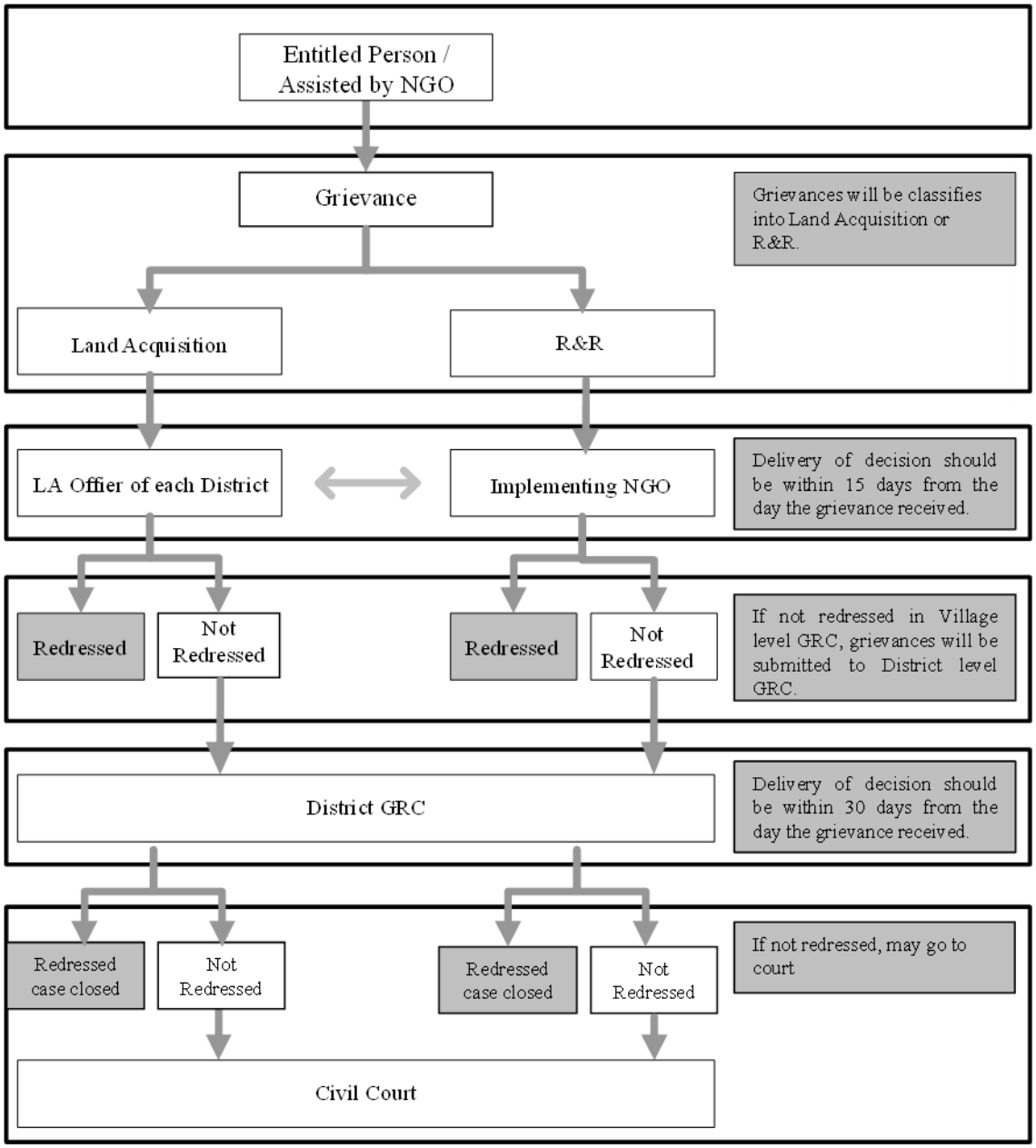
In the RAP implementation, there is a need for an efficient grievance redress mechanism (GRM) that will assist the PAPs in raising their issues and concerns, and resolving queries and complaints. For this purpose, a Grievance Redress Committee (GRC) will be established to resolve most grievances, if not all in the project.

Grievances will be redressed at the local and district level for this project. At the local level, PAPs, NGO, and land acquisition officers of respective districts will be involved and if needed, village leaders will also be invited for resolving issues. At the district level, the GRC will be headed by the DC or his designated representative; while representatives from NHIDCL local office, representatives of PAPs, village leaders, and NGOs will be the members. In the West Garo Hills District, the Autonomous District Council will also join in the GRC. Representatives of PAPs should include representatives from women groups, non-titleholders and vulnerable PAPs.

It is proposed that GRC will meet regularly, at least twice a month, on a pre-fixed date. The committee will look into grievances of the PAPs, assign responsibilities to resolve the issues, and deliver decisions within the due date. The claims will be reviewed and resolved within 15 days at the village level and 30 days at the district level, from the date of submission to the committee. PAPs can call upon the support of the NGO to assist them in presenting their grievances or queries to the GRC.

PAPs, who would not be satisfied with the decision of the GRC, will have the right to take the grievance to the EA head office for its redress. Failing the redressal of grievance at NHIDCL, the PAPs may take the case to Judiciary. Taking grievances to Judiciary will be avoided as much as possible and the NGO will make utmost efforts at reconciliation at the GRC level. All grievances received (written or oral) and their redress will be recorded and documented properly. The NHIDCL will ensure that such records will be made available to the external monitor.

The procedure and role of the GRM is as shown below;



Source: JICA Study Team

Figure 7-27: Grievance Redress Mechanism

7.12.6 Institutional arrangement

For the implementation of RAP, there will be a set of institutions involved at various levels and stages of the project. As per Indian acts and regulations, land acquisition, resettlement and rehabilitation activities must be executed by the state government. In practice, the state government entrusts tasks to the district government headed by the DC. Therefore, all activities will be implemented by the district government and the decision-making power lies within the DC. For Meghalaya state, being under jurisdiction of the sixth schedule of the constitution, Autonomous District Councils (ADC) will also be involved in the approval of project.

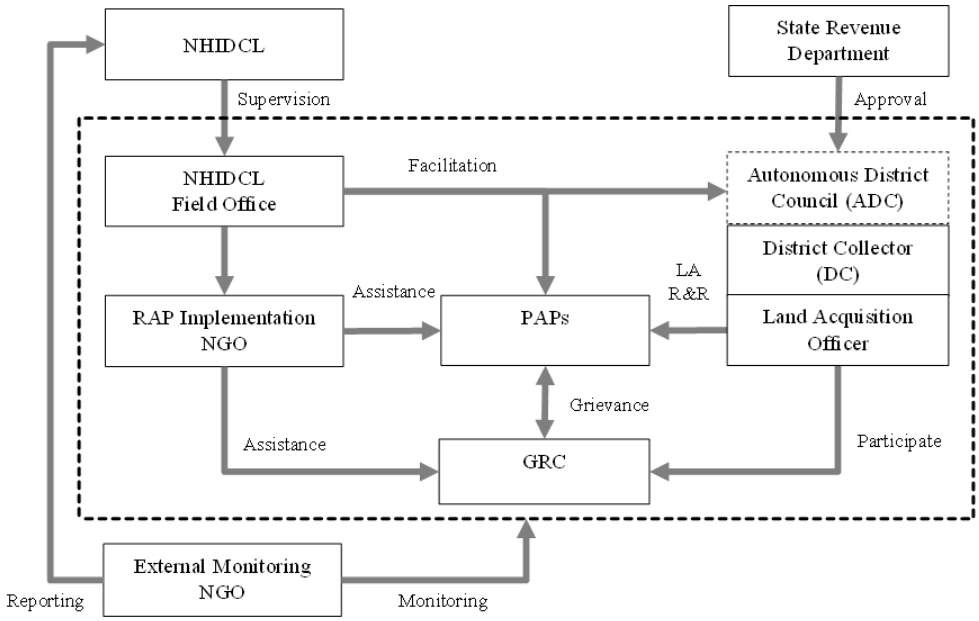
The primary institutions who will be involved in this implementation process are follows. The proposed institutional arrangement with their roles and responsibilities are shown in Table 7-92.

- National Highway and Infrastructure Development Corporation Ltd (NHIDCL)
- NHIDCL Regional Office
- Autonomous District Councils (ADC)
- Deputy Commissioner / District Collector (DC)
- Non-Government Organization (NGO)
- Grievance Redress Committee (GRC)

Table 7-102: Implementation Institute and Their Roles

Name	Members and Roles
Central Level Institution	
NHIDCL	• Project Implementation Agency • Ensure availability of budget for R&R activities • Responsible for coordination and monitoring of overall processes
State Government	
Revenue and Disaster Management Department	• Confirm notification of procedure for Land Acquisition
Meghalaya Institute of Governance (MIG)	• SIA Implementation agency for Meghalaya
District Government	
West Garo Hills Autonomous District Council (ADC)	• Issue No Objection Certificate for Land Acquisition
District Collector / Deputy Commissioner (DC) of each District	• Responsible for Land Acquisition, Resettlement and Rehabilitation
Land Acquisition Officers of each District	• Implementation land acquisition and resettlement
Other Implementation Agencies	
NHIDCL Local Office	• Oversee and monitor R&R activities implemented by district governments, assisted by NGO • Conduct internal monitoring
Non-Governmental Organization (NGO)	• Act as a representative of PAPs in communicating with district governments and NHIDCL local office • Assist PAPs through Land Acquisition, Resettlement and Rehabilitation activities • Conduct external monitoring
Grievance Redress Committee (GRC)	• Coordinate and resolve grievances submitted by PAPs
Project affected persons (PAP)	• Participation in the process of PAP activities
Contractor	• Consult with DC and community regarding location of construction camps • Restore the land to equal or better condition upon completion

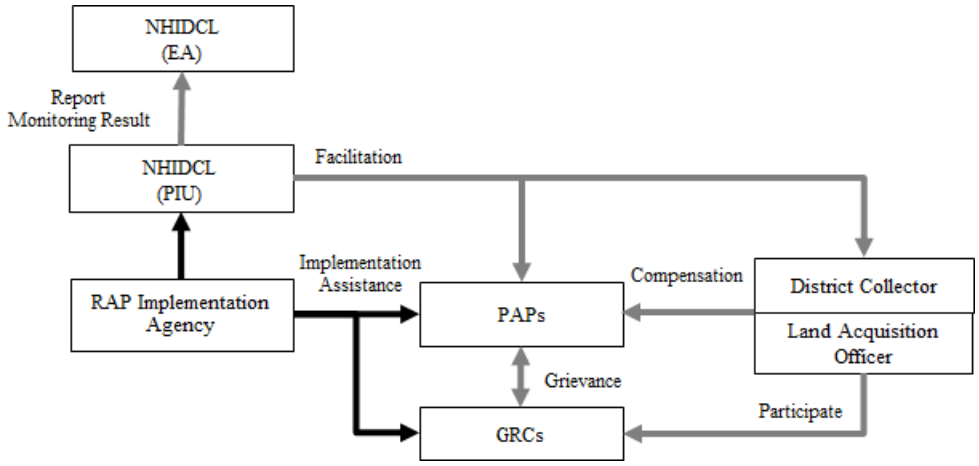
Source: JICA Study Team



Source: JICA Study Team

Figure 7-28: Institutional Arrangements for RAP Implementation

Implementation of RAP will be supported by RAP Implementation agency as shown below.



Source: JICA Study Team

Figure 7-29: Support Arrangement for RAP Implementation

7.12.7 Resettlement Schedule

The proposed land acquisition and resettlement and rehabilitation activities are divided into three broad categories based on the stages of work, and process of implementation. The details of activities involved in these three phases are discussed below.

(1) Preparation phase

The major activities to be performed in this period include preparation of RAP, submission of RAP for a government approval, appointment of NGO, establishment of NHIDCL Field Office and GRC etc. The information campaign and community consultation will be initiated from this stage, and will continue until the end of the project. Information will be disseminated using brochures and leaflets that will inform the community about the resettlement policy, entitlements, and any other necessary information deemed relevant for the effective implementation of the project.

(2) Implementation phase

In the RAP implementation phase, land acquisition, payment of compensation and provision of all eligible assistances will be carried out by the DCs, assisted by NGOs using the GRM, and in consultation with PAPs wherever necessary. Activities including relocation of PAPs and initiation of income restoration program will follow. After the acquisition of lands, notice for the start of civil work will be issued.

(3) Monitoring phase

The monitoring will be under the responsibility of the NHIDCL field office, and carried out by the RAP implementing NGO from project start to complementation. Recognizing that the project will have an impact on a relatively large number of PAPs, an external monitoring and reporting expert will be hired for the project.

The Resettlement Schedule is shown below. It will be implemented in accordance with principal activities as below, however, the sequence may change or delays may occur due to circumstances beyond the control of the project, and accordingly, the time shall be adjusted for the implementation of the plan.

Table 7-103: Resettlement Schedule

No.	Activity	2015		2016				2017				2018				2019				Responsible Agency	
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	Management	Implementation
Preparation Stage																					
1	Preparation, finalization of alignment	■	■	■	■	■	■													NHIDCL	AECOM
2	Issue No Objection Certificate (NOC)						■													NHIDCL	ADC
3	Conduct census survey						■	■												NHIDCL	AECOM
4	Preparation of RAP							■	■											NHIDCL	AECOM
5	Declaration of cut-off-date									■										DC	DC
6	Identification of PAP and compensation										■									DC	DC
7	Disclosure of RAP										■									NHIDCL/DC	DC
8	Consultations with PAPs						■	■	■	■	■									NHIDCL	DC
9	Procurement of NGO										■									NHIDCL	NHIDCL local
10	Review RAP										■									NHIDCL	NGO
11	Establishment of GRC											■								NHIDCL	DC/NGO
Implementation Stage																					
12	Land Acquisition											■	■	■	■					DC	DC
13	Payment of Compensation											■	■	■	■					NHIDCL	DC
14	Relocate houses, shops, businesses														■					DC	DC
15	Grievance Redressing											■	■	■	■	■	■	■	■	DC	NGO
16	Consultations with PAPs											■	■	■	■	■	■	■	■	DC	NGO
17	Clear the ROW													■	■					DC	DC
18	Income Restoration													■	■	■	■	■	■	NHIDCL	NGO
19	Issue notice for start of civil works																■			NHIDCL	DC
20	Civil works																■	■	■	NHIDCL	Contractor
Monitoring Stage																					
21	Management Information System											■								NHIDCL	NGO
22	Internal Monitoring (*1)											■	■	■	■	■	■	■	■	NHIDCL	NHIDCL local
23	External Monitoring (*2)											■						■		NHIDCL	NGO

NHIDCL: National Highways and Infrastructure Development Corporation Limited, AECOM: DPR Consultant, ADC: Autonomous District Councils,
DC: Deputy Commissioner and/or District Collector
(*1) Internal monitoring will be carried out every month
(*2) External monitoring will be carried out every 6 months
Source: JICA Study Team

7.12.8 Budget and its Source

The cost estimation for land acquisition and resettlement includes the cost for affected lands, structures, trees, resettlement assistances and support cost for RAP implementation. In this survey, the budget estimation is only limited to those covered in the census survey which is around 70% of the total land plot numbers. Thus, the budget shall be revised at the time of land acquisition. Tentative budget calculated in this survey comes out to be Rs. 57 crores, 31 Lakhs and 82 thousands. The budget will be secured by MORTH from the national budget based on an application from NHIDCL. The budget will be transferred from MORTH to DC through NHIDCL, and disbursed to entitled households.

Table 7-104: R&R Budget

Item	Unit	Unit Cost (Rs. In Lakh)	Quantity	Total (Rs. In Lakh)
I. Compensation				
Land (Rural)*	Acre	7.73	95.13	735.15
Land (Urban)*	Acre	36.06	42.30	1,525.63
Structure (Permanent)	Sq. m	0.15	1,296	194.40
Structure (Semi Permanent)	Sq. m	0.1	3,024	302.40
Structure (Temporary)	Sq. m	0.05	4,100	205.00
Public / Govt. building	No.	Lump sum	1	12.00
Trees (Fruit)	No.	0.15	1,897	284.55
Trees (Other)	No.	0.1	662	66.20
Crops		Lump sum		22.00
Boat		25	20	500.00
Sub-Total (I)				**3,847.34**
II. Allowance				
Resettlement allowance	Household	0.5	761	380.50
Shifting assistance	Household	0.5	127	63.50
Subsistence allowance	Household	0.36	761	273.96
Assistance for loss of livelihoods	Household	0.25	761	190.25
Assistance to agriculture labours	Household	0.5	95	47.50
Assistance to vulnerable HH	Household	0.25	474	118.50
Training fee	Household	0.2	1256	251.20
Sub-Total (II)				**1,325.41**
III. Implementation				
NGO fees	Per year	3	5 years	15.00
Staff training	Lump sum			3.00
Information disclosure / GRM	Lump sum	2	5 years	10.00
Livelihood restoration	Lump sum			10.00
Sub-Total (III)				**38.00**
Sub-Total (I+II+III)				**5,210.75**
Contingency (10%)				521.07
Total				**5,731.82**

Note: Villages in Char lands are considered "Rural", and villages elsewhere are considered "Urban".
Note: The details of the receipients of the allowances and assistances under the items of "II.Allowance" are as follows.

- Resettlement allowance: All PAHs
- Shifting allowance: Displaced family
- Subsistance allowance: All PAHs
- Assistance for loss of livelihoods: All PAHs
- Assistance to vulnerable HH: PAHs with vulnerable people
- Training fees: All PAHs

Source: JICA Study Team

7.12.9 Monitoring and Evaluation

Monitoring is a periodic assessment of planned activities providing midway inputs, and gives necessary feedback of activities and the directions on which they are going. Whereas evaluation is a summing up activity at the end of the project, assessing whether the activities actually achieved their intended goals and purposes or not. The Project will adopt a two-tier monitoring system; internal monitoring and external monitoring and evaluation.

(1) Internal Monitoring

Internal monitoring will be carried out by the NHIDCL field office with the assistance from a RAP Implementation NGO. RAP implementation agency will submit monthly report to the NHIDCL field office. The NHIDCL field office will review and assess the progress and results of RAP implementation. The NHIDCL field office will visit the project site biannually to monitor the current status and adjust the work program where necessary.

The objectives of internal monitoring are as follows.

(i) To measure progress against the RAP implementation plan.

(ii) To confirm if all entitlements agreed upon are delivered to PAPs.

(iii) To identify critical issues that impedes the project or people, and suggests measures.

(iv) To monitor the efficiency of the GRM.

(v) To appraise the satisfaction of PAPs with the activities of the project.

The design of the Monitoring Form is shown below:

Table 7-105: Internal Monitoring Form

Major items of action	Specific action steps (sub-items)	Progress in quantity	Progress in %	Expected Date of Completion
Recruitment, training and deployment	Deployment of consultants and resettlement workers (MM)			
	Training and mobilization (No. of trained personnel)			
Review of Resettlement Action Plan	Review of RAP (%)			
	Finalization of PAPs (%)			
	Approval of RP with corrections (%)			
Socio-economic Survey	Field Survey, data collection, data analysis (%)			
	Valuation of affected property and collection of data (%)			
	Produce data for comparison/evaluation (%)			
Information campaign	Distribute information brochure (No. distributed)			
	Public consultation meetings/FGD (Times)			
Identification of PAPs	Assigning ID numbers (No. of Person)			
Payment	Opening bank account (No. of Person)			
	Assist PAPs to collect cash compensation (No. of Person)			
	Confirm payment transfers (No. of Person)			
Resettlement	Coordinate resettlement site with DC (No. of HH)			
	Assist relocation and resettlement (No. of HH)			
Income restoration program	Training program, Assistant activities (No. of case)			
	Field Survey, data collection, data comparison (%)			
Grievance Redress	Formation of GRC (%)			
	Receiving complaints / claims from PAPs (No. of case)			

	Resolved complaints / claims from PAPs (No. of case)			
Supervision and Management	Supply of manpower (MM)			
	Number of meetings with relevant agencies (No. of meetings)			
Reporting	Inception / Monthly progress / Draft final report			

Source: JICA Study Team

(2) External Monitoring

External monitoring of RAP will be undertaken by the independent agency, a third party, to assess the implementation of resettlement, assistances and their impacts, and suggest any adjustments of delivery mechanisms and procedures as required. A post-resettlement evaluation will be carried out to confirm the effectiveness of the resettlement and assistance programmes in comparison with the baseline data.

The fundamental objectives of external monitoring are as follows.

(i) To monitor the overall compliance of RAP in the project

(ii) To monitor delivery of entitlement according to RAP

(iii) To assess the resettlement outcomes in comparison with the baseline conditions

(iv) To assess whether the livelihoods and living standards have been restored

Table 7-106: External Monitoring Form

Major Items in Actions	Details (Sub-items)	Answer	Remark
Review RAP	• Is the content of the RAP efficient and entitlements sufficient?	Yes/No	
	• Is the time frame and budget sufficient to meet objectives?	Yes/No	
Monitor operational process	• Has the census and asset verification/quantification procedures been implemented?	Yes/No	
	• Is the timing and duration of the hearing objections procedures adequate?	Yes/No	
	• Is the coordination between NGO, NHIDCL, and other line agencies effective in addressing the issues identified?	Yes/No	
Stakeholder consultation and participation	• Implementation of adequate information dissemination	No. of cases	
	• Consultations and meetings with community, PAPs, vulnerable people, women, etc. are implemented.	No. of cases	
	• Number of GRC conducted, and participation of appropriate stakeholders including government officials, NHIDCL, PAPs.	No. of cases	
	• Types of complaints/grievances raised and resolved and time taken for the resolution of complaints/grievances	Describe	
Land and asset acquisition	• Agreement and consent received before the acquisition and change of official registration after the acquisition.	Progress	
	• Land acquired (private and government owned land, land use by agricultural, residential, commercial etc.);	Progress	
	• Structures acquired (private buildings, government buildings and infrastructure etc.);	Progress	
	• Trees and crops acquired	Progress	
Delivery of entitlements	• Payment of compensation and assistance including the timing.	Progress	
	• Has the resettlement sites adequately prepared, when required?	Yes/No	

Major Items in Actions	Details (Sub-items)	Answer	Remark
	• Has the compensation paid for temporary impact and has the site restored after construction?	Yes/No	
	• Level of satisfaction	Positive %	
Restoration of livelihoods	• Has the employment been provided to compensate the loss of earnings?	Yes/No	
	• Has job trainings and other assistance programs been provided and are they adequate to restore livelihoods?	Yes/No	
	• Were monetary and technical assistances sufficient for livelihood restoration?	Yes/No	
	• Level of satisfaction	Positive %	
Economic activities of PAPs	• Employment status	Positive %	
	• Change in occupation and stability of income source	Positive %	
	• Change in income of households	Positive %	
	• Change in skill levels	Positive %	
Access to Infrastructure and networks	• Change in access to transport and mode of transportation	Positive %	
	• Change in access to markets	Positive %	
	• Change in access to health care, education facilities and other community facilities etc.	Positive %	

Source: JICA Study Team

7.13 Stakeholder Consultation

Public consultations were arranged at the scoping phase and draft final report phase to ensure the participation of the community in the planning process, and to gather issues, comments and suggestions from the relevant stakeholders.

Consultation with the first stakeholder was held in two locations and followed by five community meetings and three focus group discussions, in order to cover project area and to have a comprehensive view on the project. Consultation with the second stakeholder was held in four locations where a majority of the PAPs have easy access.

Information for those who remained un-surveyed due to absence during the census survey period, information of stakeholder meeting and the summary of draft report, was shared by the land acquisition officers of respective districts and assistance from the village chiefs and neighboring residents. The same method will be employed for the information dissemination during the hearing objection period.

7.13.1 1st Round Consultation

(1) 1st Round Consultation

The purpose of the stakeholders meeting at the scoping stage is to explain the project objective, a summary of the project and scoping results of environmental and social impact from the project in order to obtain comments and concerns from the likely affected communities. The meetings were held in two locations, at the starting point on the Dhubri and Phulbari side.

The main discussion points were as follows.

1) Outline and purpose of the Project
2) Explanation on the alignment
3) Anticipated positive and negative impacts from the project
4) Conveyed that the results of the meeting (especially comments and concerns) will be reflected in the project as necessary

The announcements of stakeholder meetings were informed by visiting land acquisition officers, publishing in a local newspaper and distributing pamphlets through village chiefs and local consultants (Enviro Infra Solutions Pvt. Ltd.: EIS). Stakeholder meetings were conducted with the approval from the NHIDCL. Participants include land acquisition officers, village chief, villagers, DPR consultant (AECOM), PWD officers etc. Assamese and Bengali were used in the meeting which are the languages used in the target area. The details are shown below.
The details of 1st Round Consultations with Communities are summarized in Table 7-97 and Table 7-98.

Table 7-107: Location and Dates of Stakeholder meetings

No.	Date	Location	Total	Male	Female	From Char	Coverage
1	24/10/2016	Irrigation IB, Dept. Of Water Resources, Phulbari	68	68	0	2	Phulbari and South Salmara-Mankachar District
2	25/10/2016	EQRA Academy School, Adabari Chomor, Dhubri	119	119	0	23	Dhubri District

Source: JICA Study Team

Table 7-108: Discussion in Stakeholder Meetings

No.	Comments	Answers
1	• Compensation of land should be given on the basis of current market price and not by the price that is fixed by the government • Community meetings shall be conducted separately involving all the affected villages and affected families. • Request compensation and income generation method for boat owners and boat operators • Provide proper connectivity of the bridge to National Highway with minimal disturbance in nearby villages	• Amount of compensation will be calculated based on the current market value • Community meetings will be conducted to cover affected villages • Employment opportunities in other modes of transportation (tuktuk, truck etc.) may increase after the project. Thus, income generation method with the provision of trainings will be considered in an income restoration program. • Multiple alignments were considered and the alignment with the least disturbance in the villages was selected. Adequate compensation package will be designed for those affected by the project.
2	• Start point of bridge shall be shifted to minimize the impact on local residences. • Local people preferred compensation in terms of land for their acquired land • Community meetings shall be conducted to cover affected villages • Request separate compensation and generation of alternative employment to boat owners and boat operators as proposed bridge will have a major impact on their livelihood.	• The proposed alignment was selected considering the future connection to national roads. However, the proposed starting point is still under discussion and minimization of the impact will be considered. • DC is responsible for finding alternative land, in consultation with the target community • Community meetings will be conducted to cover affected villages • Alternative employment may be expected in other modes of transportation. Assistance for the transition of occupation will be considered in an income restoration program.

Source: JICA Study Team

(2) Community Meeting

For the purpose of gathering comments from the communities in concerned areas, five community meetings were organized. The locations of the meetings were identified based on the concentration of PAPs along the alignment. Participants in the meetings were village chiefs and villagers, including displaced persons and vulnerable groups.

The main points explained and discussed in the meetings were as follows:

1) Outline and Purpose of the Project
2) Recommended alignment
3) Anticipated positive and negative impact from the project
4) Socio-economic status of the concerned community

During the community meetings, the comments from local communities regarding the location of starting point and ending point were confirmed. As a result, the starting point was shifted to minimize the impact. As for the ending point, the reason for the selection of the point was explained to the local community which was helpful to gain understanding from the local people.
Summary of the results are shown in Table 7-99 and Table 7-100.

Table 7-109: Location and Dates of Community meeting

No.	Date	Location	Total	Male	Female	From Char	Coverage
1	26/10/2016 @12.00	M. E. School, Adabari, Dhubri	22	16	6	15	Starting point of Dhubri
2	26/10/2016 @16:00	Ponchu Ghat in Dhubri	17	17	0	9	Ferry point in Dhubri
3	27/10/2016 @11:00	Phulbari	20	10	10	3	Lower Phulbari
4	27/10/2016 @13:30	South Salmara	15	15	0	5	South Salmara
5	27/10/2016 @16:30	Bauskata and Bororavatari	22	22	0	20	Bauskata, Bororavatari, Phulbari

Source: JICA Study Team

Table 7-110: Discussion in Community meetings

No.	Comments	Answers
1	• Local people should be informed about compensation packages, valuation methods prior to land acquisition. • Preference shall be given to local people to be employed in the construction works. • Suggested that the location of start point of the bridge should be shifted to Chandachal Bridge, which is 500m away from the present point to minimize the impact.	• Amount of compensation will be determined by DC based on market value (details of the compensation package and the amount will be explained in separate meetings at the end of the survey). • Mechanism for employing local people will be proposed for the construction work which requires unskilled labours. • The proposed alignment was selected considering the future connection to national roads. However, the proposed starting point is still under discussion and minimization of the impact will be considered.
2	• Concern that the aquatic biodiversity will be deteriorated and whether fishing environment will be disturbed. • Concern that boat operators will become unemployed after completion of the project. • New means of livelihood shall be considered for affected people. Preference shall be given to local people for construction work.	• The impact on the fishery activities will be assessed and mitigation measures will be implemented if negative impact is to be expected. • Boat operation service to Char islands will continue. Regarding the loss of business opportunities, an adequate income restoration program will be considered with input from boat operator communities. • Employment in construction work and income restoration program for affected people will be considered and proposed.
3	• Suggested that end point of the bridge be shifted to Bangshidua Bridge, which is 300m north from the present point for better connection to existing road. • Will there be a possible interruption of river corridor isolating habitats with potential decrease in species numbers and local biodiversity.	• Affected people will increase as the alignment moves closer to towns. The end point of the bridge was well considered among several alternative alignments and the one with least impact on villages was selected. • Impacts on the river flow during the construction period will be well considered and specific construction method will be employed to minimize the disturbance.
4	• Do not have full information about project affected persons and would like to have clarification about the alignment. • Fair and timely compensation shall be paid to the affected people.	• Clarification about the alignment will be explained, and affected persons will be identified during census survey. • Amount of compensation will be determined based on market value. The consideration will be given to avoid the delay of payment.
5	• Concern that construction activities could damage their crops. • Compensation shall be paid for standing crops if the land will be acquired before harvesting. • Ensure that individuals and groups have opportunities to participate in the construction of the bridge.	• The land acquisition will be completed before the construction so no damage to crops are expected during construction work. • Standing crops will be subject to compensation. • Mechanism to give preference of employing affected people and local people on construction works will be considered.

Source: JICA Study Team

Starting and ending points, which were pointed out in the stakeholder meetings are as shown in the map below. As for the starting point, the suggested location is the connection point to the proposed NH-27. Final alignment was decided to connect to NH-27 without connecting existing roads which was originally planned. The point mentioned for the ending point is the location where a new bridge was recently built. However, it was explained that it is more reasonable to connect to the existing

road, considering the better connectivity.

Source: JICA Study Team

Figure 7-30: Starting location mentioned in the meeting

Source: JICA Study Team

Figure 7-31: Ending location mentioned in the meeting

(3) Focus Group Discussion

In order to understand the issues from women's perspective and concerns from boat operators and fishermen, three focus group discussions were carried out. Participants in the meetings were women in surrounding villages, boat operators from boat operators association, and fishermen in the target area.

The main points explained and discussed in the meetings were as follows.

1) Outline and Purpose of the Project
2) Recommended alignment
3) Anticipated positive and negative impacts from the project
4) Socio-economic status of the concerned groups

As a result, the area of activities, means of livelihoods of boat operators and fishermen and their requests were identified. Based on the findings, they were included in the beneficiaries of compensation and assistance.

The details are shown below.

Table 7-111: Location and Dates of Focus Group Discussions

No.	Date	Location	Total	Male	Female	From Char	Coverage
1	26/10/2016 @10.00	M.E. School, Adabari Chomor, Dhubri	9	0	9	2	Womens group
2	26/10/2016 @14.00	Panchu Ghat, Dhubri	13	13	0	7	Boat operators
3	30/06/2017 @10.00	M.E. School, Adabari Chomor, Dhubri	50	50	0	18	Fishermen

Source: JICA Study Team

Table 7-112: Topics in Focus Group Discussions

No.	Comment	Response
1	• Amount of compensation for land acquisition and resettlement shall be sufficient for the family, even during the transition period. • Payment shall be made on time. • Preference shall be given to women to be employed in the construction work.	• Amount of compensation will be calculated considering that the affected people will be able to retain their livelihood after the project. • The process will be considered to coordinate with NHIDCL, DC, etc. that payment will not be delayed. • Equal employment opportunities will be sought for women to engage in construction work taking into account their needs, competence and social situations in the area.
2	• Preference shall be given to boat operators for construction work. • Request assistance for alternative employments (road transport etc.) after completion of the bridge construction. • Request some form of livelihood programs.	• Mechanism to give preference of employing affected people on construction works will be considered. • Boat operation service to Char lands will continue and demand for the movement of goods and people may increase. Regarding the loss of business opportunities, in addition to the construction work during construction periods, an adequate income restoration program will be considered with input from boat operator communities.
3	• Whether the fishing activity will be affected by the project and the impact on the volume of catches expected during the construction stage. • If there are employment opportunities in the project, people will be very much interested.	• During the construction work, vibration may have some impact on fish at the location of pier construction. However, vibration it expected during the construction (day-time) and long-term impact is not anticipated. In case catch volume is impacted, employment options will be provided for fishermen to engage in construction works. • Mechanism to give preference of employing affected people on construction work will be considered.

Source: JICA Study Team

7.13.2 2nd Round Consultation

The purpose of second round stakeholder meetings was to inform the results of EIA, and explain anticipated impacts as well as mitigation measures to confirm the consent from stakeholders. Main discussion points are as follows.

1) Outline and objective of the project
2) Reason of recommended alignment
3) Result of Environmental Assessment (anticipated positive and negative impacts)

4) Mitigation measures and monitoring plan

As for RAP, the result of the census survey and compensation policy, as well as rehabilitation and income restoration program were explained to gain concent from PAPs.
Main discussion items are as follows.

1) Scale of impact based on result of census survey
2) Compensation policy
3) Rehabilitation and income restoration program

Information disclosure for the 2nd stakeholder meeting was carried out by visiting land acquisition officers, publishing in a local newspaper, and distributing pamphlets through village chiefs and local consultants (Enviro Infra Solutions Pvt. Ltd.: EIS). The participants include NHIDCL, DPR consultant (AECOM), land acquisition officers from each DC offices, village chiefs, villagers including PAPs, boat operators, fishermen, etc. Assamese and Bengali were used in meetings which are the common languages in the target area.

Summary of the meetings is shown in the table below.

Table 7-113: Details of the Second Round Consultation Meetings

No.	Date	Location	Total	Male	Female	From Char	Coverage
1	2017/7/4 @11:00	M.E. School, Chagalchora II, Dhubri	121	113	8	47	Adabari Part-II, Airanjangla Part-I&II, Bhassanir char Part-I, Chagal chora Part-I&II&III
2	2017/7/4 @15:00	Boat operator office, Jogmaya ghat, Dhubri	56	53	3	18	Kathiar Alga, Bauskata Part-IV&VI, Basir Char, Aminerchar, Chaiter Chor Part-I
3	2017/7/5 @11:00	Phulbari Youth Club, Phulbari	100	94	6	34	Phulbari, Baladoba, Bauskata, Saboratary, Chaiter Chor Part-I, Hatsingwari
4	2017/7/5 @14:00	M.V. School, Bororawatre part-I, Dhubri	28	16	12	21	Bororawatre Part-I&II

Source: JICA Study Team

Table 7-114: Participation Details of the Second Round Consultations

No.	Comment	Answer
1	• What kind of compensation and assistance will be provided to agriculture labourers? • How will the rate for land be calculated? • What will be the process of land acquisition and how to identify the land owner? • If the new owner's name is not listed, will they get compensation • Will non-title holders get compensation for land, structure	• Agriculture labours will get at least minimum wage of 200 days. Employment opportunities will also be provided during construction and will be entitled to get training for business opportunity • Rate of the land will be calculated as per the latest land revenue records in the area. • First, 3A notification will be issued and field verification will be followed based on the government land record. After the 3D notification, there will be a hearing objection period before finalization. • Non-title holders will get compensation for structures and standing crops, as well as are entitled for assistance.

No.	Comment	Answer
	and employment opportunities? • Are there employment opportunities for graduate students?	Training will be provided and possibly issue certificates for employment opportunities. • For graduates, there are National Skill Development Programs where they can get special training. Even in the construction work, they may get employed in a position considering their capacity.
2	• What kind of assistance will be provided to the boat operators and whether boat operators will get employment opportunities? • One boat cost nearly Rs. 25-30 Lakh, after completion of this project there will be no use of these boats, will boat owners get any compensation? • Will fisherman be affected by this project? • Will fisherman get any compensation?	• Boat operators are also provided with opportunities to engage in construction work. During the period, vocational training opportunities will be offered to prepare for the transition to new occupations. • The construction period is around six years. During this period, the boat can be used for transportation of goods and workers in addition to normal services. However, considering that usage opportunities decrease after the project, the boat will also be considered for compensation. • During construction work, there will be impact on fishermen in the project area, but fishing can continue upstream and downstream of the river. • Employment opportunities will be provided to fishermen during the construction work.
3	• When and to whom will employment opportunities be offered. How should I apply? • Is there any plan to develop bridge cum railway? • When and how will compensation be provided? • What is the market rate of the land and buildings to be decided based on? • What should I do if there is a problem with land ownership? • What kind of compensation can be taken if leasing the land and holding the building on that land?	• Employment opportunities will be offered to residents of the target area when construction work will be carried out. NHIDCL will contract with contractors so the application shall be submitted to the contractors. NHIDCL is considering to state in the contract that priority should be given to local employment as a condition. • In this project, railway is not included in the plan. • First of all, DC will conduct a field survey and confirm the affected land, affected people and the price. After the compensation is paid to the affected people, land acquisition will start. • Market rate for the land will be based on the zonal valuation which is set by the land sale price. Buildings are also calculated at market prices. The amount will be decided based on a site investigation. • If there is a land ownership problem, DC office will be the window agency. The land ownership will be reviewed with documents and records. • There will be no compensation for the land, but structures and crops will be compensated and assistances will be provided. If you have been paying the lease fee of land for a long time, the amount after land acquisition will be refunded.
4	• In the case the land has been submerged and became government land in the past, can the former owner with the previous land documents claim compensation? • Do residents of affected villages have access to employment opportunities for construction work?	• In principle, land that became government land will not be subject to compensation, but compensation for standing crops and financial support and support for livelihood restoration will be provided. However, during the site verification stage, the current and past land ownership will be properly reviewed. • It is assumed that employment opportunities for construction work will also be provided to residents of target villages.

Source: JICA Study Team

	
1st SHM in Dhubri	1st SHM in Phulbari
	
Meeting with boat operators	Meeitng with fishermen
	
2nd SHM in Dhubri	2nd SHM in Boat point in Dhubri
	
2nd SHM in Phulbari	2nd SHM in Char land

Source: JICA Study Team

Figure 7-32: Stakeholders/Community Meetings