Doc No. 1718-082/TRB/DPR/P4/S-5/REP-01

BUILDING INFRASTRUCTURE - BUILDING THE NATION

NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORTION LIMITED
(MINISTRY OF ROAD TRANSPORT & HIGHWAYS)
GOVT. OF INDIA

Consultancy Services for Preparation of DPR for Development of Economic Corridors, Inter Corridors and Feeder Routes to Improve the Efficiency of Freight Movement in India under Bharatmala Pariyojana

DETAILED PROJECT REPORT

Lot-1 : Package-IV

Section-5:Km 27+150 to 47+682 of NH-38

Volume-I
Main Report

March 2023, Rev. R1

VOYANTS
PARTNERING VISION

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EXECUTIVE SUMMARY

0.1 Project Background

The National Highways & Infrastructure Development Corporation Limited has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India. The National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the assignment of preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana.

In view of the above work NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. for Package IV under Lot-1 to carry out the Feasibility Studies including field investigations, road inventory, structure inventory, FWD test, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The letter of invitation (LOI) has been issued vide memo no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/2017, dated October 30, 2017, whereas, the letter of acceptance (LOA) has been issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package IV/2017/28, dated February 02, 2018. Letter of commencement (LOC) for the consultancy services was issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package IV/2017/79, dated April 13, 2018.

0.2 Project Road Description

The project road comprises 14 stretches as mentioned in the RFP as mentioned below in **Table 0.1**.

Table 0.1: Details of Major Road Segments

Stretches	Description
Strech-1	Dibrugarh Ghat/Bogibil Bridge (South Bank)-Bogibil Bridge (North Bank) (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=8 km)
Stretch-2	Bogibil Bridge (North Bank)-Kandulijan Gaon (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=11 km)
Stretch-3	Kandulijan Gaon-DimowCharali (Feeder Route-Inland Waterways) Section of NH-515 in Assam (L=21 km)
Stretch-4	DimowCharali-Sangajan (Feeder Route-Inland Waterways) Section of Majorbai Road in Assam (L=8.2 km)
Stretch-5	Kamar Gaon-Dibrugarh Ghat/Bogibil Bridge (South Bank) (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=15 km)
Stretch-6	Naltoli-Silghat (Feeder Route-Inland Waterways) Section of Silghat-Naltoli Road in Assam (L=4 km)
Strech-7	Jorhat-Neamati (Feeder Route-Inland Waterways) Section of NeamatiGhat-Jorhat Road in Assam (L=10.4 km)
Stretch-8	DimowCharali-Oriyamghat Road (Feeder Route-Inland Waterways) Section of NH-515 in Assam (L=62 km)

Stretches	Description
Stretch-9	Oriyamghat Road-Oriyamghat (Feeder Route-Inland Waterways) Section of Oriyamghat Road in Assam (L=6.7 km)
Stretch-10	Kamar Gaon-Lahowal (EC-Economic Corridor NER) Section of Dibrugarh Bypass in Assam (L=16 km)
Stretch-11	Lahowal-Tinsukia (EC-Economic Corridor NER) Section of NH-15 in Assam (L=38 km)
Stretch-12	Tinsukia-Makum (EC-Economic Corridor NER) Section of NH-15 in Assam (L=10 km)
Stretch-13	Makum-Digboi (EC-Economic Corridor NER) Section of NH-315 in Assam (L=25 km)
Stretch-14	Digboi-Margherita (EC-Economic Corridor NER) Section of NH-315 in Assam (L=13 km)

Project location on state and district maps are presented on **Figure 1.1** and **1.2** respectively.

Different road segments are schematically presented in **Figure 1.3**.

This report includes the road sections as mentioned below from the Stretch -13 in the above table:

Section-5: From km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e. Proposed Margherita - Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.

0.3 Existing Characteristics of the Project Road

The salient features of the existing project road are given in **Table 0.2**.

Table 0.2: Salient Features of the Existing Project Road

Sl No.	Items	Section-5
1	Length as per RFP	20.532 KM
2	Districts Enroute	Tinsukia
3	Important Settlements	Margherita, Ledo
4	Terrain	Plain, Rolling
5	Landuse	Agricultural/ Open-83%, Residential/Commercial-11%, Tea Garden-6%
6	National Park	Nil
7	Existing ROW	25m at existing NH-38 (near Golaigaon) for 0.950 km and in bypass section 45m ROW transferred by CALA, Tinsukia vide letter no .TRQ.5/2018/276 dated 09.09.2022 where acquisition was done earlier by LA Act 1894.
8	Forest Stretches	Nil
9	Present Road Condition	Good -Fair (2-Lane c/w)
10	Bypass/Realignment to be Involved	Proposed Margherita-Ledo Bypass (from km 28+100 to km 47+682)
11	Built Up Stretches	Golai Gaon, Margherita, Ledo

Sl No.	Items	Section-5
12	Carriageway Width	7m Carriageway and 1.5m earthen shoulder both side
13	Average Journey Speed	60 kmph
14	Requirement of Bypasses	At Margherita, Ledo- (Sec-5 comprises of proposed Margherita-Ledo bypass)
15	Horizontal Geometry	Good-Fair
16	Vertical Geometry	A few curves with inadequate sight distance, otherwise good
17	No. of Existing Structures	Nil
18	No. of Level Crossings	Nil
19	No. of Intersections	Major-2 nos, Minor-16 nos
20	Roadside Trees	52 nos as per JV done with forest department.
21	Major Rivers	Dehing River
22	Water Logging Area	-
23	Roadside Utility	Electric Poles – 152 nos., Transformers – 6 nos., Water Pipeline – 465m (at 10 nos crossing Locations) (As per JV with APDCL and PHED)
24	Road Safety	Sub-standard and Negligible

0.4 Traffic

The summary of Annual Average Daily Traffic (AADT) is shown in **Table 0.3.**

Table 0.3: Average Daily Traffic on Project Road at km 37+500 of NH-38 (in Numbers)

Vehicle Type	At km 37+500 of NH-38 (Traffic in 2021) (HS-3)
Car	2264
Taxi	5
2 Wheeler	2881
3 Wheeler	285
Mini Bus	27
Standard Bus	80
LCV	355
2 Axle	253
3 Axle	182
MAV	52
Tractor	3
Tractor with Trailer	7
Cycle	1169
Cycle Rickshaw	211
Animal Drawn	19
Others	0
Total (numbers)	7838
Total (PCU)	**7500**

Source: Consultant's analysis

The projected combined traffic on the project road sections from start of Golai Gaon to Ledo are presented in **Table 0.4**.

Table 0.4: Projected Total Traffic AADT

Year	2021	2023	2028	2033	2038	2043	2048
Total Traffic (PCU) at km 37+500 of NH-38	7500	8269	10553	13469	17190	21939	28001

0.5 Survey and Investigations

The following engineering survey and investigations were conducted at this stage of project preparation:

a) Reconnaissance Survey: to assess the quality and quantity of features along the alignment, the data was used to finalize the most preferred alignment.
b) Road Inventory: to assess the characteristics of existing road, this was used to finalize plan and profile drawings as well as extent of widening required.
c) Road Condition Survey: to assess condition of existing pavement, the data has helped to assess the usability of existing pavement along with extent of repair work needed.
d) Inventory and Condition Survey of Existing Bridges, Culverts and Other Structures: to check the dimensions and conditions of existing structures, the information obtained has guided to finalize the improvement proposals of existing structures.
e) Topographic Survey: to exactly identify locations of all existing features along the alignment, this survey will dictate the final plan & profile drawings, BOQ etc. This survey will be conducted at the next stage of project preparation.
f) Traffic Survey: To assess possible traffic intensity along the proposed road along with its future projection, this survey is the basic of the entire study. The data has been used to finalize lane configuration, tolling strategy and the viability of the project.
g) Axle Load Survey: to assess possible loading over proposed pavement. The data was used to determine the VDF which ultimately guided the pavement design.
h) FWD Survey: to assess the existing pavement composition from deflection point of view, the data was used to finalize overlay thickness. As the road sections are under construction, the survey could not be conducted for these stretches.
i) Pavement Investigation: to assess characteristics of existing pavement, the data was used for pavement design.
j) Material Investigation: to assess possible sources of construction materials and their suitability, distance of sources from project road was used to calculate the lead distance which is ultimately used for rate analysis.

0.6 Development Proposals

The salient proposals for up-gradation and improvement of the project road are classified into the following engineering aspects:

Where Proposed Alignment Overlaps with Existing Roads

- In general, in this section of proposed stretch follows existing Sections.
- Widening of the project road based on traffic capacity/requirement.
- Improving the horizontal geometry of the existing road based on the design standards as per IRC: SP: 73-2018
- Design of new pavement for widening and realignment of the existing road.
- Provision of overlay at strengthening stretches.
- Improvement of all major and minor intersections.
- Rehabilitation and widening of the existing structures including bridges, culverts etc. and design of new ones as per requirement.
- Provision of comprehensive road furniture for complete road safety measures.

The general design standards for improvement are enumerated in **Table 0.5**.

Table 0.5 : Geometric Design Standards for Road Works (Plain/Rolling Terrain)

Sl No.	Attributes	Geometric Design Standards
1	Design Speed	
	Plain and Rolling Terrain (Cross slope of the ground up to 25 per cent)	Ruling: 100 kmph Minimum: 80 kmph
2	Carriageway Width	2-lane Carriageway -7.0 m wide with 1.5m Paved shoulder both side
3	Width of Shoulder	
	a) Paved Shoulder	2x1.5m
	b) Earthen Shoulder	2x 1.0 m
4	Footpath width at built-up areas	2 x 1.5 m drain cum footpath
5	Camber	
	a) Carriageway	2.5%
	b) Shoulder	3.0%
6	Maximum and Minimum Super-elevation	Maximum limited to 7.0% (for Radius less than Desirable minimum) Minimum limited to 5% (for Radius more than Desirable minimum)
7	Minimum Radius of Horizontal Curves	
	a) Plain and rolling Terrain	Desirable Minimum: 400m Absolute Minimum: 250m
8	Sight Distances for Various Speeds	180m – 360m
9	Longitudinal Gradient	
	a) Plain and Rolling Terrain	Ruling: 2.5%, Limiting: 3.3%
10	Extra Width of Pavement	

Sl No.	Attributes	Geometric Design Standards
	Radius of Curve	Extra Width
	75-100m	0.9m
	101-300m	0.6m

The cross-sectional elements (lane/shoulder width etc.) are as per standards specified in geometric design manual. 9 nos. typical cross sections have been envisaged for the subject project at this stage as mentioned below. These have been prepared on the basis of site reconnaissance and design guidelines.

TCS No.	Description
Type –01	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (WIDENING)
Type –03A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)
Type –03B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
Type –04A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
Type –04B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
Type-08	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
Type-09	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN BUILT-UP AREA (WIDENING)

Details of Cross Sections are presented in Chapter 6 of this Report.

The improvement proposals for the sections are presented below:

Structures proposed for cross drainage purpose and safe movement of road users as summarized in **Table 0.6**.

Table 0.6: Summary of Structures

Structure Type	Total	Remarks
Section-5		
Major Bridge	02	• 2 Nos New Construction
Minor Bridge	10	• 10 Nos New Construction
ROB cum EUP	01	• 1 No New construction
VUP/ LVUP/ CUP/SVUP	12	• 1 no New construction (LVUP) • 11 Nos New Construction (SVUP)
Culvert	26	• 26 Nos New construction (Box)
Total	**51**	

(i) *Intersections:*
   a. Provision of 16 nos. minor intersections and 2 nos. major intersections in Section-5

(ii) Provision of 2 nos.(total) bus bays with bus shelter and 2 nos. bus shelter in Section-5.

(iii) Flexible pavement has been proposed. Proposed pavement compositions (in mm) are stated below:
   - For New construction - Flexible Pavement (for 24msa) - 40 BC, 100 DBM, 250 WMM, 200 GSB, 500 SG

(iv) For Overlay – 30mm BC, 50mm DBM

(v) Drains:
   a. Details of different types of drain is given below:

Design Chainage (km)		Length (m)	TCS	Remarks
From	To			
Section- 5				
27+230	27+431	201	TCS-4A	Footpath cum Covered Drain
27+431	28+192	761	TCS-4B	Footpath cum Covered Drain
28+286	28+680	394	TCS-4B	Footpath cum Covered Drain
28+680	29+040	360	TCS-4A	Footpath cum Covered Drain
Total Length (including Both sides)		**3432**		

(vi) Provision of traffic guidance, regulation, control and safety measures like traffic signs, road markings, road studs, pedestrian guard rails, guard posts etc.

(vii) Provision of pedestrian facilities like footpaths, pedestrian crossings etc.

(viii) Provision of speed breakers

(ix) Provision of illumination

(x) Provision of landscaping and arboriculture including tree plantation

(xi) Toe wall has been proposed in high embankment zone such to restrict the embankment toe within the PROW. Minimum length of 2000m toe wall is required for section-5.

0.7 Proposed ROW and Land Acquisition

Proposed ROW of 40m to 45m is considered for the road section in rural area.
As per assessment at this stage tentative land acquisition is assessed as below:

- ***For Section 5: 17.601 Ha***

0.8 Summary Environmental Screening and Issues

Environmental Protection Act, Forest Conservation Act, Wild Life Protection Act, Water (prevention and control of pollution) Act, The Air (prevention and control of pollution) Act, Noise Pollution Rules, EIA Notification, Fly Ash Notification, National Highway Act, Right to Fair Compensation in Transparency in Land Acquisition and Rehabilitation and Resettlement Act, E waste management Rule, Construction & Demolition Rule, Hazardous & Other Wastes Rules, Solid Waste Management Rules, Plastic Waste Management Rules are considered for Environmental Assessment of the Project.

Climate

Assam has a Tropical Monsoon Rainforest Climate. The average annual rainfall is 2818mm. The monsoon starts late in June and generally lasts up-to September. 90% of the rainfall received from July to September.

Water Resources and Drainage System

The State of Assam comprised of two valleys namely the Brahmaputra and Barak Valley and it is situated in between 90° to 96° North Latitude and 24° to 28° East Longitude. The geographical area of Assam is 78,438.00 Sq. Km out of which 56,194.00 Sq. Km and 22,244.00 Sq. Km fall under the Brahmaputra and Barak Valley including 2 (Two) hill districts respectively. The flood prone area of the state is 31,500.00 Sq. Km as assessed by the Rastriya BarhAyog which is about 39.58 % of the total land area of Assam. This is about 9.40% of total flood prone area of the whole country. The flood prone area of the country as a whole stand at about 10.2 % of the total area of the country, but flood prone area of Assam is 39.58 % of the area of the state. It signifies that the flood prone area of Assam is four times the national mark of the flood prone area of the country. Records show that average annual area affected by flood is 9.31 Lakh Hectares. The flood protected area of the state is 16500.00 Sq. Km till date.

The severity of flood problem of the state has been further aggravated by the acuteness of erosion on both banks of river Brahmaputra and its tributaries. Study reveals that an area of 4.27 Lakh Hectare of the state has been eroded by the rivers since 1950, which is 7.40 % of area of the state. The average annual rate of erosion is 8000.00 Ha. The world's largest river island Majuli is also under the grip of erosion by river Brahmaputra and about 60 % of its original area has already been engulfed by the river.

0.9 Summary of Social Screening and Issues

One of the most crucial and difficult works in implementing a road project is land/property acquisition and resettlement of households thereof, particularly in towns and semi-urban areas. Anticipating this problem, the Consultant has started identifying various social issues all along the project road. During the field visit no ROW (Right-of-Way) pillars were observed for the section. However, the Consultant has collected the same details from the concerned offices.
At this junction, social issues gathered from the site are rather approximate but will help in taking tentative decisions on various aspects related to improvement. During field visits social issues (types of land, affected buildings etc.) are collected with an idea of proposed widening schemes which are also generally guided by the presence of roadside utilities and residential/commercial structures in semi-urban/urban areas.

0.10 Cost Estimates

Abstract of cost is provided in **Table 0.8**.

Table 0.8: Abstract of Cost

Item	Bill Description	Rate (Rs.)	Amount(Rs)	Amount(Crs)
BILL# 01	**Site Clearance & Dismantling**	Rs.	31,34,675	0.31
BILL# 02	**Earthwork**	Rs.	83,23,30,003	83.23
BILL# 03	**Base & Sub Base**	Rs.	39,55,87,100	39.56
BILL# 04	**Pavement (Flexible)**	Rs.	20,93,78,968	20.94
BILL# 05	**Drainage & Protection**	Rs.	14,42,77,405	14.43
BILL# 06	**RE Wall**	Rs.	4,44,54,531	4.45
BILL# 07	**Landscaping**	Rs.	1,80,35,792	1.80
BILL# 08	**Junction**	Rs.	5,61,30,442	5.61
BILL# 09	**Bus Bay**	Rs.	34,91,063	0.35
BILL# 10	**Illumination**	Rs.	51,74,361	0.52
BILL# 11	**Road Furniture**	Rs.	11,14,43,271	11.14
BILL# 12	**Ground Improvement**	Rs.	6,07,10,750	6.07
1	**Civil Cost for Highways**	**Rs.**	**1,88,41,48,360**	188.41
	Culvert	Rs.	10,53,21,455	10.53
	MNB	Rs.	21,66,99,471	21.67
	LVUP and SVUP	Rs.	4,75,60,722	4.76
	MJB	Rs.	75,71,39,869	75.71
	ROB	Rs.	89,57,18,970	89.57
	Civil Cost for Structures	**Rs.**	**2,02,24,40,488**	202.24
2	**Total Civil Cost (1+2)**	**Rs.**	**3,90,65,88,848**	390.65
	Civil cost per Km (in Cr.)		**19.03**	
1	**Civil Cost**	Rs.	**3,90,65,88,848**	390.65
2a	**Utility Shifting APDCL (Exclusive of GST)-**	Rs.	**1,75,79,634.10**	1.76

Item	Bill Description	Rate (Rs.)	Amount(Rs)	Amount(Crs)
2b	Utility Shifting PHE (Exclusive of GST)	Rs.	**14,43,280**	0.14
3	Cost of Civil work i/c utility shifting	Rs.	**3,92,56,11,762**	**392.55**
4	GST @18% on 3	Rs.	70,66,10,117	70.66
5	Cost of LA(LA+ Assests + Tree afforestation Cost)	Rs.	1,14,63,02,883	114.63
6	Supervision Charge 2.5% of 2+GST @ 18%	Rs.	5,61,176	0.06
7	Contingency @ 1% of 1	Rs.	3,90,65,888	3.91
8	Agency Charges @ (3% of 1) + GST @ 18%	Rs.	13,82,93,245	13.83
9	Supervision Charge @ 3% of 1	Rs.	11,71,97,665	11.72
10	Price Adjustment @ 5% of 1	Rs.	19,53,29,442	19.53
11	Maintenance @ 2.5% of 1 + GST @ 18%	Rs.	11,52,44,371	11.524
12	Shifting of Gas pipeline (AGCL)	Rs.	5,00,13,807	5.00
13	Total Project Cost	Rs.	**6,43,42,30,358**	**643.41**
14	Total Civil Cost per km		**19.03**	
15	Total Project Cost per km		**31.34**	

0.11 Economic Analysis

The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Dibrugarh to Ledo via Lahowal, Chabua, Tinsukia and Margherita on the Southern part of the Brahmaputra will be improved if the project road is developed.

0.12 Conclusions and Recommendations

a. Conclusions

(i) Concession period of the road project is 30 years including 24 months' construction period.
(ii) All the traffic moving on the project road is through traffic.
(iii) The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Dibrugarh to Ledo via Lahowal, Chabua, Tinsukia and Margherita on the Southern part of the Brahmamutra will be improved if the project road is developed.

b. Recommendations

The proposed project road of these sections i.e. from Km 27+150 (Golai Gaon) to km 47+682 (Ledo) of being developed as 2-lane+ Paved shoulder carriageway configuration of NH-38 part recommended under EPC Construction.

Recommendation for Immediate Development

Road Segment	Traffic in Base Year in PCU	Traffic in Year of Opening (2023) in PCU	Recommendation
Total Traffic (PCU) at km 37+500 of NH-38	7500	8269	2-Lane with Paved Shoulder from opening year (2023)

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

1.1 Project Background

The National Highways & Infrastructure Development Corporation Limited has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India. The National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the assignment of preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana.

In view of the above work NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. for Package IV under Lot-1 to carry out the Feasibility Studies including field investigations, road inventory, structure inventory, FWD test, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The letter of invitation (LOI) has been issued vide memo no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/2017, dated October 30, 2017, whereas, the letter of acceptance (LOA) has been issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package IV/2017/28, dated February 02, 2018. Letter of commencement (LOC) for the consultancy services was issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package IV/2017/79, dated April 13, 2018.

1.2 Project Road Description

The project road comprises 14 stretches as mentioned in the RFP as mentioned below in **Table 1.1**.

Table 1.1 : List of Road Segments as per RFP

Stretches	Description
Stretch-1	Dibrugarh Ghat/Bogibil Bridge (South Bank)-Bogibil Bridge (North Bank) (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=8 km)
Stretch-2	Bogibil Bridge (North Bank)-Kandulijan Gaon (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=11 km)
Stretch-3	Kandulijan Gaon-Dimow Charali (Feeder Route-Inland Waterways) Section of NH-515 in Assam (L=21 km)
Stretch-4	Dimow Charali-Sangajan (Feeder Route-Inland Waterways) Section of Majorbai Road in Assam (L=8.2 km)
Stretch-5	Kamar Gaon-Dibrugarh Ghat/Bogibil Bridge (South Bank) (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=15 km)
Stretch-6	Naltoli-Silghat (Feeder Route-Inland Waterways) Section of Silghat-Naltoli Road in Assam (L=4 km)

Stretches	Description
Stretch-7	Jorhat-Neamati (Feeder Route-Inland Waterways) Section of Neamati Ghat-Jorhat Road in Assam (L=10.4 km)
Stretch-8	Dimow Charali-Oriyamghat Road (Feeder Route-Inland Waterways) Section of NH-515 in Assam (L=62 km)
Stretch-9	Oriyamghat Road-Oriyamghat (Feeder Route-Inland Waterways) Section of Oriyamghat Road in Assam (L=6.7 km)
Stretch-10	Kamar Gaon-Lahowal (EC-Economic Corridor NER) Section of Dibrugarh Bypass in Assam (L=16 km)
Stretch-11	Lahowal-Tinsukia (EC-Economic Corridor NER) Section of NH-15 in Assam (L=38 km)
Stretch-12	Tinsukia-Makum (EC-Economic Corridor NER) Section of NH-15 in Assam (L=10 km)
Stretch-13	Makum-Digboi (EC-Economic Corridor NER) Section of NH-315 in Assam (L=25 km)
Stretch-14	Digboi-Margherita (EC-Economic Corridor NER) Section of NH-315 in Assam (L=13 km)

Project location on state and district maps are presented on **Figure 1.1** and **1.2** respectively.

Different road segments are schematically presented in **Figure 1.3**.

This report includes the road sections as mentioned below from the Stretch -14 in the above table:

Section-5: From km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e. Proposed Margherita - Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.

1.3 Other Information Relevant to the Project Road

1. Ownership of roads
    - Existing Dibrugarh bypass (L=15.447km) (i.e. from km 581+700 to km 597+147) is under NHIDCL.
    - Km 20 to km 53 of NH-38 (corresponding to proposed Digboi-Margherita-Ledo bypass) was handed over to NHIDCL by PWD NH Division, Dibrugarh.
    - Balance stretch (existing NH-37 as well as bypasses) towards southern side of river Brahmaputra is under PWD NH Division, Dibrugarh except 8.659km southern approach of Bogibil bridge which is under PWD NH Division, Jorhat.
    - Ownership details of the project road is presented in **Figure 1.4**.
2. Two SDOs are involved under PWD NH Division, Dibrugarh – Dibrugarh & Dumduma sub-division.
3. ROB (new and/or widening) approval process shall be initiated from railway office, Tinsukia and ultimate approval to be obtained from Railway Division, Guwahati.

4. NH-52B is a part of Trans Arunachal Highway. Its starts from Kanubari at Arunachal Pradesh and passes through Moram, Rajgarh with a length of 63.4 km upto meeting point with NH-37. Last 41.4 km of this highway is under PWD NH Division, Dibrugarh.
5. NH-38 ends at km 56+350 which is km 0+000 of NH-153 as well. NH-153 (a historical road) ends at km 23+700 at Jairampur which is at AP border.
6. Nearest NHIDCL office is at Dibrugarh. Other offices are at Tejpur and Jorhat.
7. There were U/G oil pipe lines along existing Lahowal and Tinsukia bypass. OIL / IOCL had shifted the lines and laid the pipe lines by the side of these bypasses. Hence proper joint verification held with OIL / IOCL authority (Digboi) about the location of these pipe lines before finalizing widening scheme.
8. Bogibil bridge is a rail cum 3-Lane road bridge.
9. Objective of bypass proposal parallel to NH-37 is nothing but presence of railway track on one side and settlements on other side very close to NH-37 which did not have any option for widening.

1.4 Improvement Objective

The objective of the scheme presented in this report is to create a 4-lane partially access controlled facility with provision of at grade intersections, grade separators with/without ramps etc. as appropriate/necessary, within the stipulated Right-of-Way by improving the existing single/two lane road and/or developing a new 4-lane road in case of locations with poor geometry and dense settlements to a standard 4-lane road with paved shoulder. To this end, land to the extent necessary will be acquired. Further, the development cost may be recouped, to the extent practicable, from collection of tolls from users of the improved facility. As such, the improvement schemes for the project road should be as economical as possible consistent with the functional requirements and amenable for quick implementation without much gestation delays.

1.5 Objectives of Consultancy Services

The main objective of the consultancy services is to establish the technical, economical and financial viability of the project and prepare detailed project reports for development of economic corridors, inter-corridors and feeder routes, as the case may be. These corridors are proposed for development to at least 4-lane access controlled (fully access control for Economic Corridors). The Consultant has already consulted State/Central Governments, authorities, Corporations and bodies dealing with works related to freight movement to assess the project requirement.

The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features,

quantities of various items of works, cost estimates and economic analysis within the given time frame.

The Detailed Project Report (DPR) would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, solutions for congestions/bottlenecks in highway/routes including bypass alignment & design, if needed, safety aspects, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.

Other major objectives of consultancy services are preparation of DPR incorporating aspects of value engineering, quality audit and safety audit requirement, carry out Road Safety Audit at various stages as per TOR. Besides, viability analysis (both economic and financial), assessment of preferred mode of implementation on which the civil works for the stretches are to be taken up and cost estimates are also in the list.

1.6 Scope of Work

General scope of services shall cover but shall not be limited to the following major tasks:

General

i) review of all available reports and published information about the project road and project influence area;
ii) Environmental and social impact assessment, including such as related to cultural properties, natural habitats, involuntary resettlement etc.;
iia) Public consultation including consultation with communities located along the road, NGOs working in the area, other stake holders and relevant Govt. departments at all the different stages of assignment (such as inception stage, feasibility stage, preliminary design stage and once final designs are concretized);
iii) Detailed reconnaissance;
iv) Identification of possible improvements in the existing alignment and bypassing congested locations with alternatives, evaluation of different alternatives with comparison on techno-economic and other considerations and recommendations regarding the most appropriate option;
v) Traffic studies including traffic surveys, axle load surveys and demand forecasting for next thirty years;
vi) Inventory and condition surveys for road;
vii) Inventory and condition surveys for bridges, cross drainage structures, other structures, river bank training/protection works and drainage provisions;
viii) Detailed topographic surveys using LiDAR equipped with minimum engineering grade

system or any other better technology having output accuracy not less than (a) specified in IRC SP 19 (b) Total Station (c) GPS/ DGPS. The use of conventional high precision instruments i.e Total Station or equivalent can be used at locations such as major bypasses, water bodies etc. where it may not be possible to survey using LiDAR. Use of mobile / Aerial LiDAR survey is preferable;

ix) Pavement investigations;

x) Sub-grade characteristics and strength : investigation for required sub-grade and sub-soil characteristics and strength for road and embankment design and sub-soil investigation;

xi) Identification for source of construction material;

xii) Detailed design for road, its x-sections, horizontal and vertical alignment and design of embankment for height more than 6.0m and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design for structures, preparation of GAD and construction drawing and cross-drainage structures and underpasses etc.;

xiii) Identification of type and the design of intersections;

xiv) Design of complete drainage system and disposal point for storm water;

xv) Value analysis/value engineering and project costing;

xvi) Economic and financial analysis;

xvii) Contract packaging and implementation schedule;

xviii) Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over and underground) and the scheme for their relocation, trees to be felled, transplanted and planted and land acquisition requirements including schedule for LA: reports, documents and drawings arrangement of estimates for cutting/ transplanting of trees and shifting of utilities from the concerned department;

xix) Develop 3D engineered models of terrain and elevation, as-is project highway, proposed and project highway along with all features, current and proposed structures, current and proposed utilities and land acquisition plans;

xx) To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up;

xxi) Preparation of Detailed Project Report, cost estimate, approved for construction drawings, rate analysis, detailed bill of quantities, bid documents for execution for civil work through budgeting resources;

xxii) Design for toll plaza, identification for their numbers and location and office cum residential complex including working drawings;

xxiii) Design of weighing stations, parking areas and rest areas;

xxiv) Any other user oriented facility en-route toll facility;

xxv) Tie-in of ongoing/sanctioned works of MoRTH/NHIDCL/other agencies;

xxvi) Preparation of social plans for the project affected people as per policy of the lending agencies/Govt. of India R&R policy;

1.7 Stages of Project Submission

Project preparation activities will be split into three stages as mentioned below.

Stage-1	:	Inception Report (IR) and Quality Assurance Plan (QAP)
Stage-2	:	Alignment Option Report and Feasibility Report (FR)
Stage-3	:	LA and Clearance Report-I including Strip Plans and Utility Shifting Proposal
Stage-4	:	Draft Detailed Project Report (DPR)
Stage-5	:	Bid Documents and Technical Schedules
Stage-6	:	LA & Clearances II Report
Stage-7	:	Award Determination Report (LA-III)
Stage-8	:	Land Possession Report (LA-IV)

The stages will generally follow a sequence though stages are inter-related and inter-dependent on one another. This report is under Stage-4 activity. Feasibility report has been finalized on the basis of final alignment which was approved vide NHIDCL letter no. 'NHIDCL/Bharatmala/DPR/ Phase-I/Lot-1/Package-II/2017/2762 dated 10.10.18. The Feasibility Report was approved vide Letter No. NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/Package-IV/2017/24/4983 dt. 18.02.2019. The DPR is being submitted w.r.t. the Letter No. NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/ Package IV/2017/28 dt. 21.11.2019.

1.8 Structure of Detailed Project Report

The Detailed Project Report has been prepared in following four volumes:

Volume-I	-	Main Report
Volume-IA	-	Appendices to Main Report
Volume-II	-	Design Report
Volume-III	-	Material Report
Volume-IV	-	Environmental Assessment Report
Volume-V	-	Technical Specification
Volume-VI	-	Rate Analysis
Volume-VII	-	Cost Estimates
Volume-VIII	-	Bill of Quantities
Volume-IX	-	Drawings (Road Works and Structure Works)

This Main Report has been presented in the following structural format:

Executive Summary

Chapter-1	:	Introduction
Chapter-2	:	Existing Characteristics of the Project Road
Chapter-3	:	Socio-Economic Profile
Chapter-4	:	Engineering Surveys and Investigations

Chapter-5	:	Traffic Surveys and Analysis
Chapter-6	:	Development Proposals
Chapter-7	:	Environmental Impact Assessment (EIA) Report and Environmental Management Plan (EMP)
Chapter-8	:	Social Impact Assessment
Chapter-9	:	Cost Estimates
Chapter-10	:	Economic Analysis
Chapter-11	:	Financial Analysis
Chapter-12	:	Road Safety Audit
Chapter-13	:	Conclusions and Recommendations

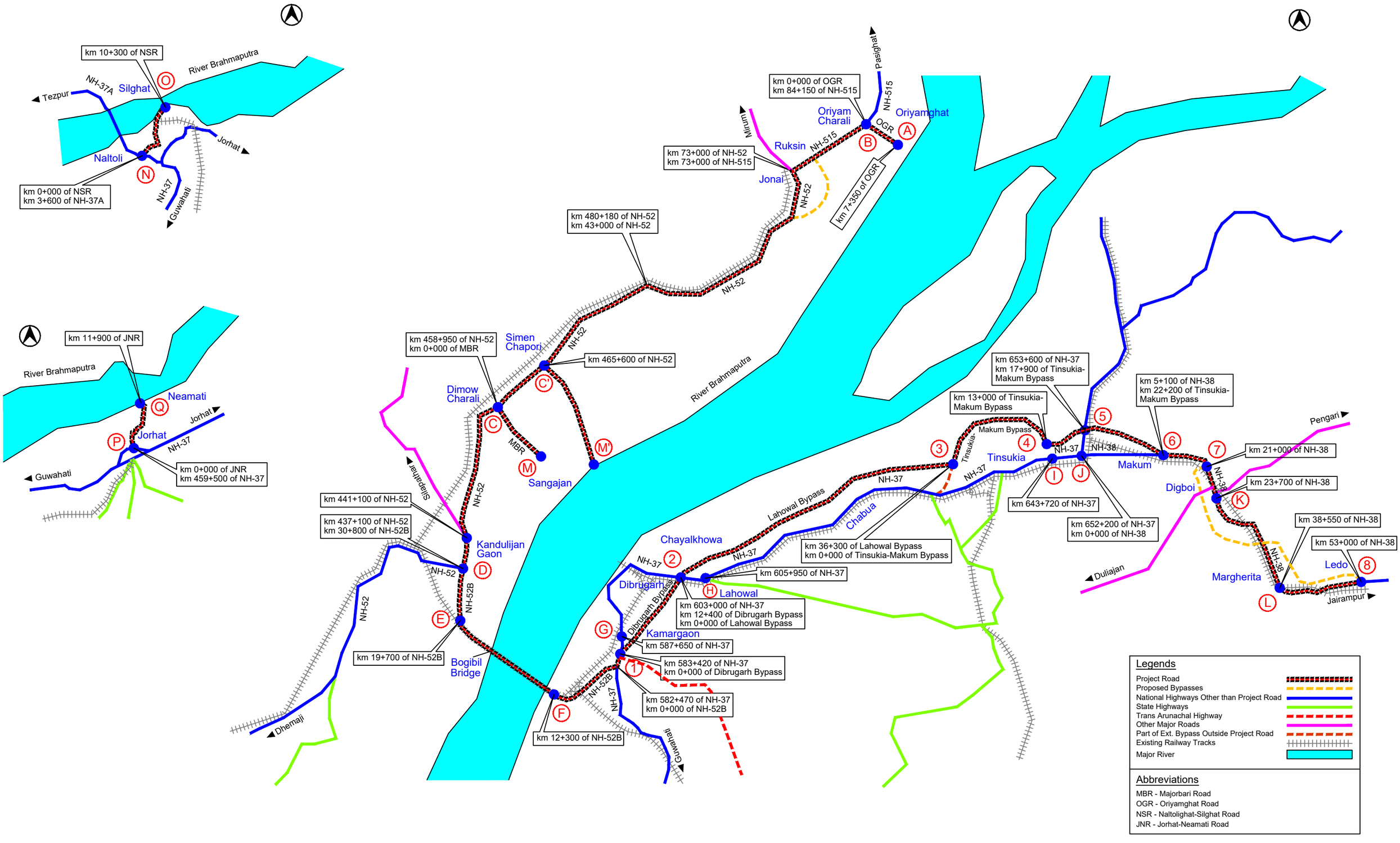


Figure 1.3
Schematic Diagram of Different Road Segments
Scale - NTS

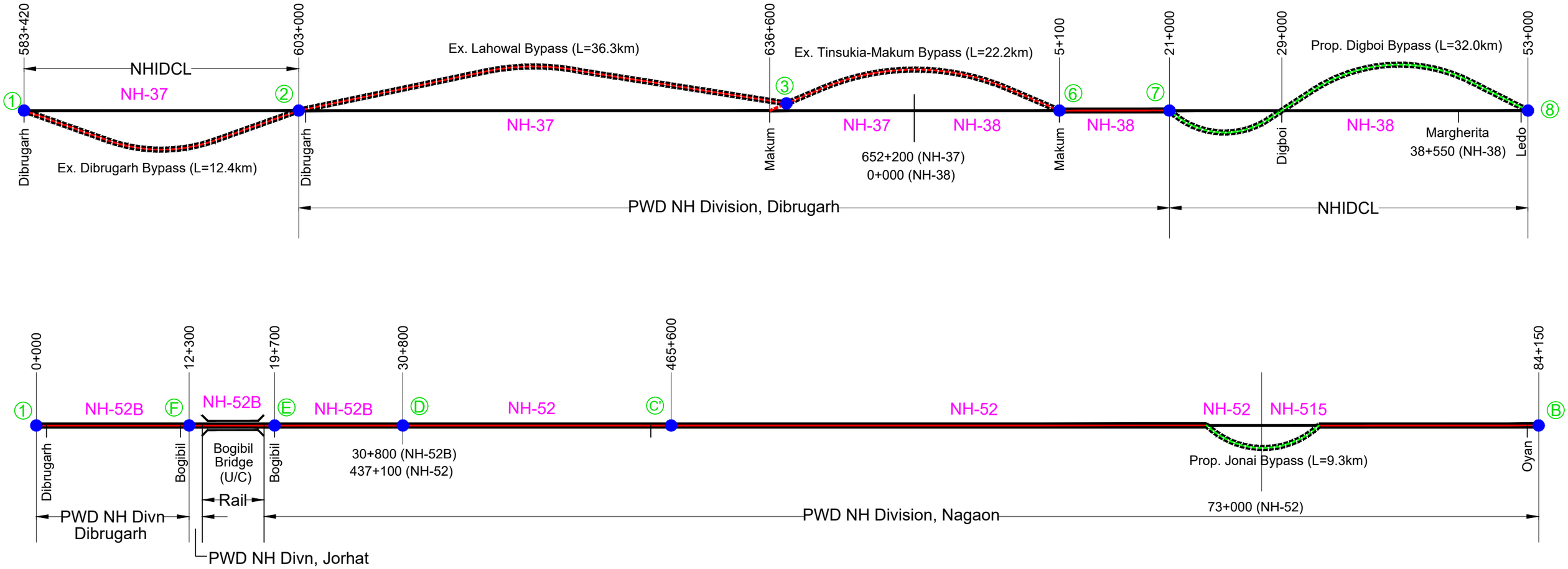


Figure 1.4 : Linear Plan Showing Bypasses and Ownership Details of the Project Road

CHAPTER 2

EXISTING CHARACTERISTICS OF THE PROJECT ROAD

2.0 Existing Characteristics of the Project Road

2.1 General

As mentioned in Chapter-1, the project road in this report comprises Section 4 as mentioned in **Table 2.1**.

Table 2.1: List of Road Sections

Section	Description	Type	Length (km)	Remarks
5	Km 27.150 to km 47.682	Economic Corridor	20.532	NH 38

The section 5 of Dibrugarh-Ledo section starts Design Km 27+150 km near Golai Gaon and terminates at Km 47+682 (End of Ledo Bypass) of NH-38 .The road runs through Tinsukia District. The total length is 20.532 km.

Key plan of the project road is provided in **Figure 2.1** whereas the index map is provided in **Figure 2.2**.

2.2 Terminal Points including Important Cardinal Points

The project road has following cardinal points including terminal points.

1. Start point of section-5 at Km 27+150 of NH-38–Node A
2. End point of section-5 at Km 47+682 of NH-38– Node-B

2.3 GPS Co-ordinates

Consultants have captured co-ordinates (latitude and longitude) of various features like major structures, major junctions etc. during reconnaissance survey through hand held GPS for various cross referencing. A list of such co-ordinates is presented in **Annexure 2.1**.

2.4 Status of Existing km Stones

- ❖ Most of the Km Stones are not present along the project road

2.5 Important Settlements along the Project Road

- ➢ There are some important settlements in section-5 (on NH-38) which are Golai goan, Powai, Margheria and Ledo.

In addition, few lower order settlements were found at some locations along the project road in scattered manner.

2.6 Connectivity

The project connects the settlements directly as mentioned in the above paragraph. Besides, it connects the following major towns:

- Pasighat through NH-515
- Miram (through junction from Jonai)
- Silapathar (through junction from Kandulijan Gaon)
- Dhemaji through NH-52
- Guwahati through NH-37
- Dibrugarh, Tinsukia, Makum, Digboi and Margherita through NH-37

2.7 Terrain and Land use

The project road is passing mainly through plain terrain with a nominal stretch in rolling. Major part of the project road is passing through settlement areas with residential and commercial activities. Open area and tea garden stretch are found at few locations which covers few length. Land use pattern for the balance stretch is either agricultural or a mixture of agricultural, open and residential/commercial.

2.8 Existing Right of way (ROW)

As per relevant information from respective PWD, NH Division and revenue maps, the existing ROW as mentioned in **Table 2.3**.

Table 2.3: Existing Right of Way (ROW) along Ex. Road Details

Stretch	Road Segment	Chainage		Existing Average ROW (m)
		From	To	
Section 3				
1	NH-38	Km 27+150	Km 47+682	25

Note : In bypass section of proposed Margherita-Ledo bypass 45m ROW transferred by CALA, Tinsukia vide letter no .TRQ.5/2018/276 dated 09.09.2022 where acquisition was done earlier by LA Act 1894.

2.9 Existing Cross-Sectional Elements

Variable cross-sectional parameters were found for the project road as mentioned in **Table 2.4**.

Table 2.4: Existing Cross-Sectional Parameters

Chainage (km)		Length (km)	Existing Carriageway		Existing Shoulder	
From	To		Type	Width (m)	Type	Width (m)
Section 4 (Nh-38)						
27+150	47+682	20.532	Bituminous	7-10	Earthen	1.0-1.5

Presence of roadside drain is not that conspicuous. In general, the project road is predominantly on embankment varying between 1.0m-2.0m height.

2.10 Geometry

Horizontal Geometry

Horizontal Alignment is found poor along the project roads. Existing road configuration is 2 lane road with both side earthen shoulder.

Vertical Geometry

The vertical alignment is found mostly fair. However, at few locations inadequate sight distance is observed and vertical alignment improvements are required.

Specific HFL Data as collected through local enquiry indicates that there is no location of overtopping.

2.11 Pavement

Status of existing pavement is provided in **Table 2.5**.

Table 2.5: Status of Existing Pavement

Section	Chainage		Length(m)	Status of Existing Pavement
	From	To		
Section 5	27+150	47+682	20.532	Good to Fair

2.12 Road Intersections/Cross-roads

The project road stretch forms at-grade intersection with cross road(s) at several locations. There is 1 no. existing Major Intersections along this section and 25nos. minor junctions present.

2.13 ROB/Railway Level Crossing

There is no ROB exists across project stretches.

S. No.	Chainage (km)	Type of Structure		No. of Spans with span length (m)	Width (m)	ROB/ RUB
		Foundation	Superstructure			
NIL						

2.14 Bridges and Culverts

There are no major bridges, minor bridges and culverts along the existing stretches. Summary of existing structures are presented in **Table 2.8**.

Table 2.8: Summary of Existing Structures

Sections	Road Segment	No. of Existing Structures					Total
		MJB	MNB	UP	ROB Cum VUP	Culvert	
Section-5	Km 27+150 to Km 47+682	-	-	-	-	-	-

2.15 Other Facilities

Except passenger shelter, shops and vehicle repair center, no major roadside facilities have been found along the project corridor.

2.16 Existing Utilities

High tension and low-tension electrical lines exist on one or both sides of the project road. High-tension electric transmission line crosses the project road at few locations. At some location water pipeline present along this section. Necessary letters for the purpose have been obtained from client.

2.17 Project Road Deficiencies

At a glance, existing deficiencies of the project road vis-à-vis their possible preventive measures which needs attention during design stage are listed in **Table 2.6**.

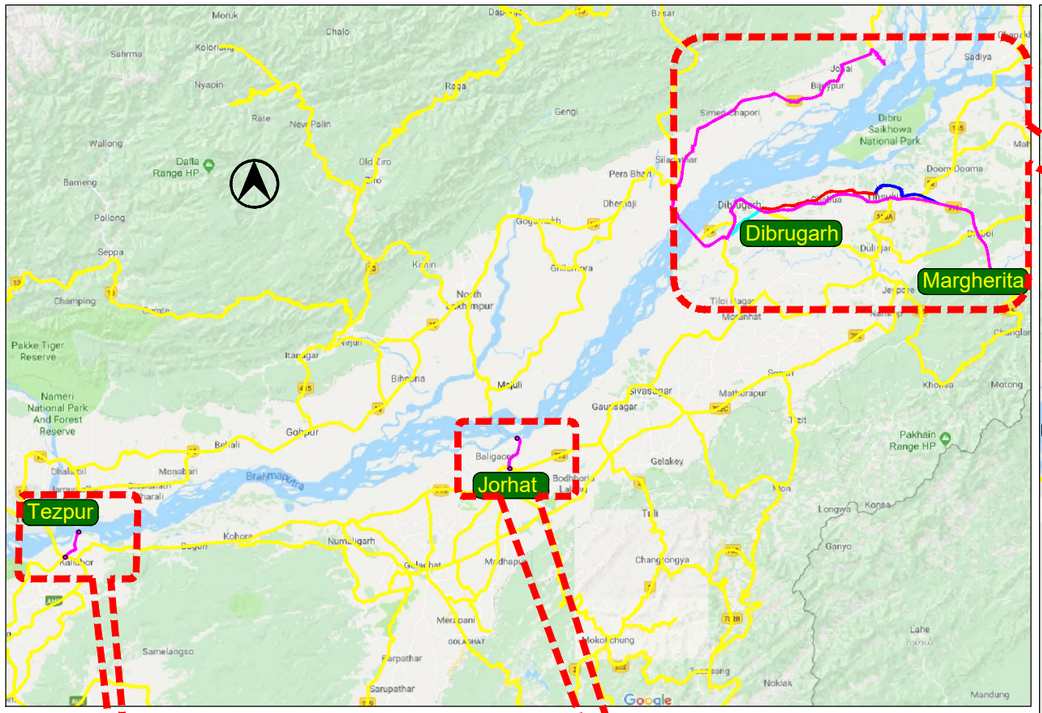
Table 2.6: Existing Deficiencies and their Possible Preventive Measures

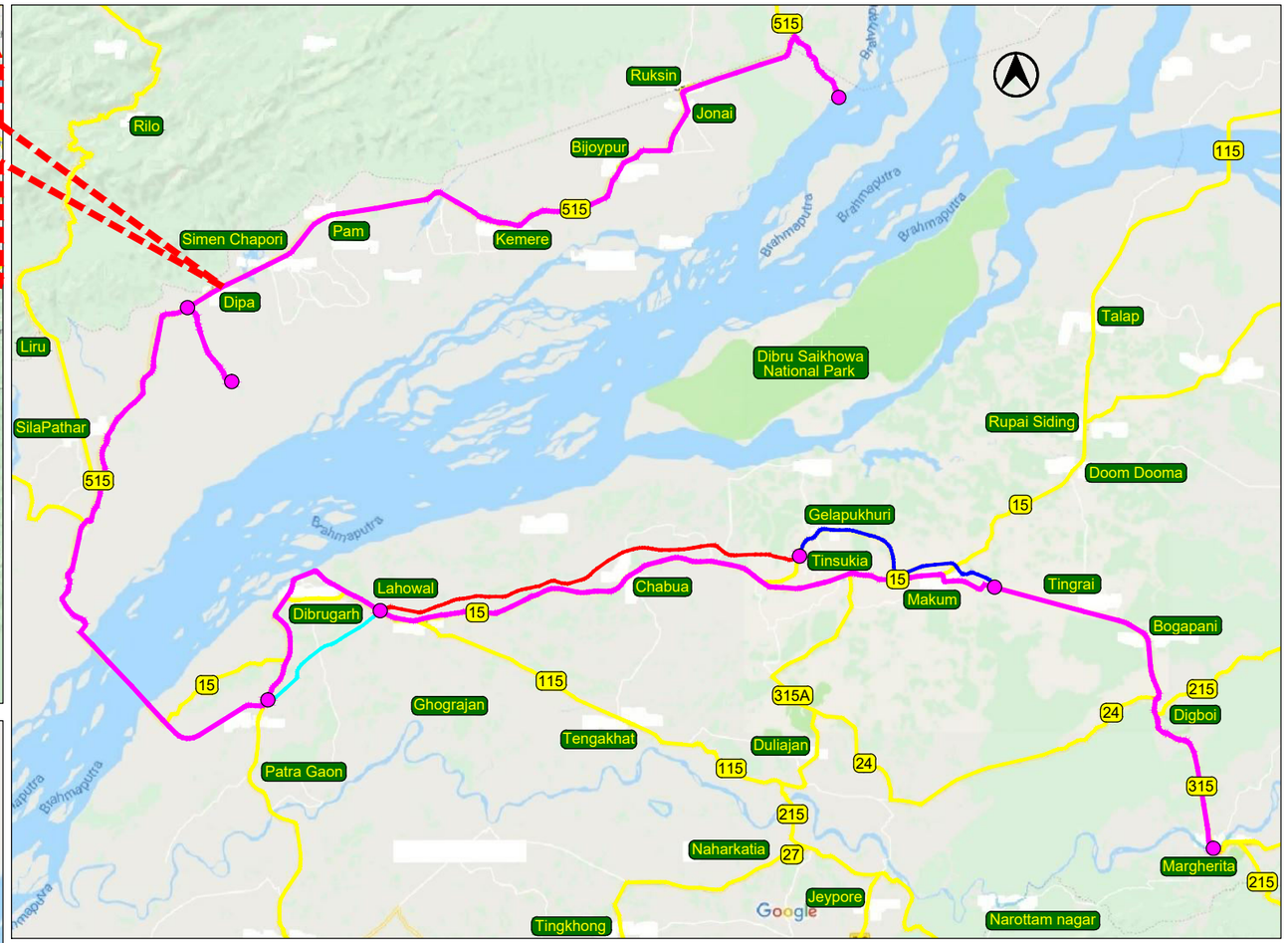
Sl No.	Deficiencies	Proposals
1.	Insufficient ROW	Acquisition of land wherever required
2.	Poor horizontal geometry at few locations	Geometric improvement
3.	Poor vertical geometry at few locations	Improvement of vertical geometry with optimum cut-fill quantity
4.	Poor condition of few structures	Reconstruction of the same
5.	Improper intersection layout, resulting in accidents at major intersections	Proper at-grade intersection improvement
6.	Use of road component (mainly shoulders) by local people for household purposes almost at all built-up areas	Provision of raised footpath

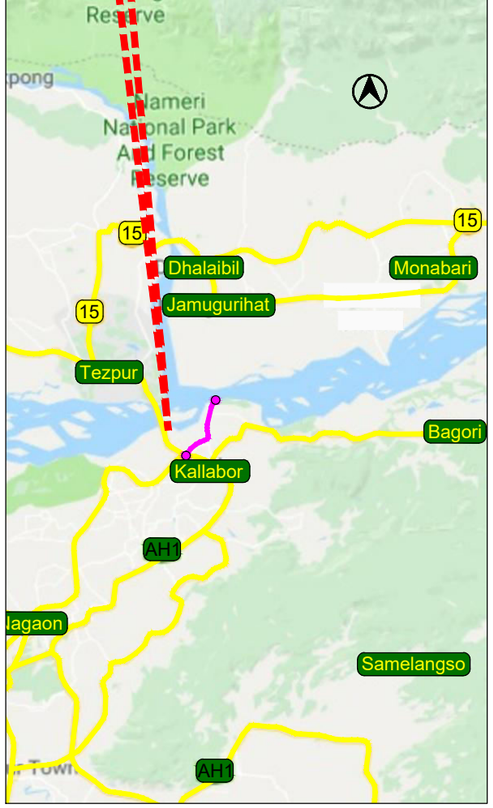
Sl No.	Deficiencies	Proposals
7.	Absence of roadside drains	Provision of unlined drains at rural areas and covered drains at urban areas
8.	Insufficient illumination	Provision of illumination
9.	Presence of congested settlement with poor geometry at Digboi	Provision of bypasses

2.18 Critical Areas Needing Attention

No major critical areas of concern are there for the sections under consideration.







Legends:
- Project Road as per RFP
- Other Road
- Tinsukia-Makum Bypass
- Lahowal Bypass
- Dibrugarh Bypass

Figure 2.1
Key Plan
Scale - NTS

Note:
The current project road will follow Dibrugarh, Lahowal & Tinsukia-Makum bypass.

CHAPTER 3

SOCIO ECONOMIC PROFILE

3.0 SOCIO ECONOMIC PROFILE

3.1 Introduction

A detailed accounting of the socio-economic profile of the Project Influence Area (PIA) has been prepared which traces the PIA's economic performance of the past and establishes the likely growth prospects of the future. The output of this Chapter is the economic growth prospects of the PIA with respect to certain selected economic variables and serves as the basis for arriving at a realistic traffic growth rate, for different vehicle categories.

3.2 Project Influence Area

The project comprises of 14 stretches under Oriyamghat-Oriyamghat Road- Dimow Charali-Kandulijan Gaon- Bogibil Bridge (North Bank)- Dibrugarh Ghat/Bogibil Bridge (South Bank)-Kamar Gaon- Lahowal-Tinsukia- Makum-Digboy- Margherita, Dimow Charali-Sangajan, Naltoli-Silghat and Jorhat-Neamati. The project stretches are in mainly in Assam through the districts of Dhemaji, Dibrugarh, Tinsukia, Nagaon and Jorhat. East Siang district of Arunachal Pradesh also have some road stretch. The details of the project road stretches are presented in Chapter 1 of this report.

This report is prepared for Section 5 of the project corridor (Dibrugarh-Ledo)

Section-5: From km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e Proposed Margherita Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.

The direct influence of the project is identified as the vicinity on both sides of the project road. The indirect influence area will consist of (1) Dhemaji district, (2) Dibrugarh district, (3) Tinsukia district, (4) Nagaon district, (5) Jorhat district & (6) East Siang district. The project road stretches plying situated through the States of Assam and Arunachal Pradesh, are considered as the tertiary influence area.

The socio-economic profile of the project influence area is prepared based on secondary official sources of information.

3.3 The State of Assam at a Glance

The state of Assam is located in the in northeastern part of India. It is bounded by Bhutan and Arunachal Pradesh state in the north, Nagaland and Manipur states in the east, Mizoram and

Tripura states in the south and Bangladesh, Meghalaya state and West Bengal state in the west. The neighboring states of Arunachal Pradesh, Nagaland, Mizoram and Meghalaya are one part of the Assam. The state capital of Assam, formerly Shillong (now the capital of Meghalaya) was shifted to Dispur in suburb of Guwahati, in 1972.

Now, Assam has an area of 78,438 sq. km. and has 33 districts, including newly created 6 districts. 214 Urban Centres include Guwahati, one of the 100 fastest growing cities in the world. Guwahati is the gateway to the North-East India. Silchar, (in the Barak valley) the 2nd most populous city in Assam and an important centre of business, education and tourism. Other large cities include Dibrugarh, an oil, natural gas, tea and tourism industry centre, Jorhat, and Tinsukia.

Assam is shaped roughly like a "Y" laid on its side, is a land of plains and rivers valleys. The state has three principal physical regions: the Brahmaputra River valley in the north, the Barak River valley in the south, and the hilly region between Meghalaya (to the west) and Nagaland and Manipur (to the east) in the south-central part of the state.

Average temperatures in Assam range from 36 °C in August to about 7 °C in January. Although some rain occurs from March through May, the heaviest precipitation comes with the southwest monsoon, which arrives in June, stays through September, and often causes widespread and destructive flooding. Annual rainfall in Assam is not only the highest in the country but also ranks among the highest in the world; its annual average varies from about 1,800 mm in the west to more than 3,000 mm in the east.

In the early 21st century about one-third of Assam was covered with various types of woodlands, including tropical evergreen and deciduous forests, broad-leaved hill forests, pine forests, and swamp forests, as well as grasslands. Assam is home to some 75 species of trees, many of which have commercial value. Sal (Shorea robusta) and hollong (Dipterocarpus rhetusus) trees are among the most bountiful of the hardwoods. Bamboo, orchids, and ferns also are abundant.

Assam has numerous wildlife sanctuaries, the most prominent of which are two UNESCO World Heritage sites: 1) Kaziranga National Park (designated in 1985), on the bank of the Brahmaputra River, and 2) Manas Wildlife Sanctuary (designated in 1992), near the border with Bhutan. Both are refuges for the fast-disappearing Indian one-horned rhinoceros, and the sanctuary at Manas is known especially for its tigers and leopards. Among the other notable inhabitants of Assam's forests are elephants, gaurs (wild oxen), wild pigs, various species of deer, and primates, such as langurs and hoolock gibbons. Common birds include cormorants, herons, ducks, and other water birds, as well as warblers, thrushes, owls, and peacocks. Hornbills are characteristic of Assam, although they are endangered in some areas. The state also has dozens of species of reptiles, including poisonous snakes, such as kraits, cobras, and vipers; an array of lizards, skinks, and geckos; and many types of turtles.

As per Census 2011, Assam has a population of 3,12,05,576. The decadal growth rate of population is 17.07% during 2001 and 2011. Assam has predominantly rural having the share of

84.6%. The population density is 398 persons per square kilometer. The sex ratio is 958 females per 1000 male population. The SC population is 7.15% and share of ST population is 12.45%, of which the Bodos constitute the majority with 40% among the ST. The overall literacy rate is 72.19%. The share of BPL families is 31.98%.

Assamese and Bodo are the major indigenous and official languages, while Bengali is the second most widely spoken languages after Assamese. Bodo is the third most spoken language.

Hinduism is the majority religion in the state at 61.47%, followed by Islam at 34.22% and Christianity at 3.7%. Other religions are Buddhism, Jainism, Sikhism etc. Many Hindus in Assam are followers of the Ekasarana Dharma sect of Hinduism, which gave rise to Namghar, designed to be simpler places of worship than traditional Hindu temples.

Assam's economy is based on agriculture and oil. Assam produces more than half of India's tea. The Assam-Arakan basin holds about a quarter of the country's oil reserves, and produces about 12% of its total petroleum. The economy of Assam today represents of backwardness amidst plenty. Despite its rich natural resources, and supplying of up to 25% of India's petroleum needs. According to the quick estimates of 2016-17, Assam's Gross State Domestic Product (GSDP) is ₹249,801 crores at current prices and per capita income in Assam has reached ₹73,677.

The Agriculture, Forestry and Fishing sectors holds 19.33% of the GSDP, whereas Industrial Sector accounts for 28.72% and service sector contributes 45.51%.

Assam has four oil refineries in Digboi (Asia's first and world's second refinery), Guwahati, Bongaigaon and Numaligarh and with a total capacity of 7 million metric tonnes per annum. There are several other industries, including a chemical fertiliser plant at Namrup, petrochemical industries at Namrup and Bongaigaon, Paper mills at Jagiroad, Hindustan Paper Corporation Ltd. Township Area Panchgram and Jogighopa, sugar mills at Barua Bamun Gaon, Chargola, Kampur, Cement plant at Bokajan and Badarpur, cosmetics plant of Hindustan Unilever (HUL) at Doom Dooma, etc. Moreover, there are other industries such as jute mill, textile and yarn mills, Assam silk, and silk mills.

Assam has a rich tradition of crafts, Cane and bamboo craft, bell metal and brass craft, silk and cotton weaving, toy and mask making, pottery and terracotta work, wood craft, jewellery making, and musical instruments making have remained as major traditions.

The tourism in Assam in Wildlife, cultural, and historical destinations have attracted visitors. There are five national parks of 1) Kaziranga National Park, 2) Manas National Park, 3) Orang, 4) Dibru-saikhowa and 5) Nameri. The Sivasagar consists of historical statues and structures of the old Ahom Kingdom. The Kamakshya Temple in Nilachal Hills in Guwahati is a special Shaktipitha of Hindu Religion and attracts a huge number of devotees all the year round.

3.4 District Profile: Dibrugarh

The district of Dibrugarh is situated in the eastern part of Assam. The district is surrounded by Dhemaji district and a part of Lakhimpur district in the north, part of Sivasagar district and Arunachal Pradesh in the south, Tinsukia district in the East and Sivasagar district in the West. The district occupies an area of 3,381 Sq. Km.

The river Brahmaputra flows throughout the North Western boundary of the district. The only tributary falling at Brahmaputra in the district is Buridihing tributary which divided the district from East to West. The Dibrugarh district is a plain district of Assam. The entire is flat with gradual slop from the East Arunachal hills to the West. The soil of the district is mostly fertile Alluvial soil and this adjorning with the river Brahmaputra are composed sand and clay in varying proportion.

3.4.1 Climate

Dibrugarh's climate is classified as warm and temperate. The summers are much rainier than the winters in Dibrugarh. The average annual temperature in Dibrugarh is 23.2°C and generally varies from 28°C to 18.4°C. The average annual rainfall is 2781 mm.

3.4.2 Demography

The population of the district is 13,26,335, according to Census 2011. The district is predominantly rural with 81.16% population resides in rural areas. The males constitute of 51% and females of 49% with a sex ratio is 961.

Hindus contribute 90% of the total population and are the largest religious community in the district followed by Muslims which contribute 5% of the total population and Christians are the third largest religious community here with 4% population.

Total about 8.8 lakh people in the district are literate, among them about 4.9 lakh are male and about 3.9 lakh are female. Literacy rate (children under 6 are excluded) of Dibrugarh is 76%. 83% of male and 69% of female population are literate here.

3.4.3 Working Profile

Dibrugarh has 42% (about 5.6 lakh) population engaged in either main or marginal works. 54% male and 30% female population are working population. 42% of total male population are main (full time) workers and 12% are marginal (part time) workers. For women 16% of total female population are main and 13% are marginal workers.

3.4.4 Economy

Dibrugarh is considered as an economic hub of North East region of India. Dibrugarh is at the centre of economic activities dominated by the following industries: (a) Oil and natural gas (b) Tea production (c) Tourism (d) Power generation (e) Fertilizer (f) Cottage industry.

Oil and Tea are the major industries of the district. The headquarter of the Oil India Ltd. is located at Duliajan. The Fertiliser Corporation of India and Assam Petro-Chemicals Ltd. At Namrup and the Assam Gas Co. at Duliajan, NEEPCO near Duliajan are some of the other major industries in the district.

Dibrugarh district boasts of the highest amount of tea production in India. There are several tea gardens dating back to the British era. The first garden was at Chabua, a place 20 miles (32 km) away from Dibrugarh, owned by Maniram Devaan. Today, the headquarters of the Directorate of Development of Small Tea Growers in India is functioning from Dibrugarh, besides a Regional Office of the Tea Board of India headed by a Deputy Director of Tea Development (Plantation) is also located in the city.

Rail, road and air connectivity coupled with the presence of large number of tourist spots in and around Dibrugarh city has seen impressive growth of tourism industry in this part of India in recent part. Dibrugarh has also become an important destination as well as a major transit point for tourists from both India and abroad. Such tourist circuits include - Dibrugarh - Roing - Mayudia - Anini Tourist Circuit, Dibrugarh - Guwahati river cruise besides 'Tea Tourism' for tourists who prefer serenity and novelty to the hustle-bustle of established tourist destinations.

3.5 District Profile: Tinsukia

The Tinsukia district, of Assam, is situated at the easternmost part of the state and is bounded by Dibrugarh and Dhemaji in the west and north-west respectively, Arunachal Pradesh in the north and Nagaland state in the south. Total geographical area is 3790 sq. km.

3.5.1 Climate

The climate here is mild, and generally warm and temperate. When compared with winter, the summers have much more rainfall. The temperature varies from 9.7°C in January to 30.8°C in July. The average annual temperature in Tinsukia is 23.1°C. The rainfall here averages 2679 mm.

3.5.2 Demography

The total population of the district is 13,16,948 according to Census 2011. The population density is 347 per sq. km. Majority of the population (about 80%) resides in Tinsukia rural part. The males constitute of 51.33% and females are 48.67%. The sex ratio is 948 numbers of female for every 1000 population of male. The literacy rate is 70.92%.

Hindus (89%), Christians (6%), Muslims (4%). The major communities of the district are the Tea-tribes (Adivasi), Ahoms, Sonowal Kachari, Chutiya Kachari, Moran Kachari, Muttock Kachari, Singpho, and Indian Gorkha. There are migrant communities like Bihari and Bengali. There are also a few small tribes like Tai Phake, Khamyang, and Nocte.

3.5.3 Economy

Tinsukia is an industrial district of Assam. The Oldest oil refinery in India is situated at Digboi and places like Margherita and Ledo are famous for open cast coal mining. Tinsukia is one of the premier commercial centres in Assam. The district also has a cosmetic plant of Hindustan Unilever (HUL)

It is an industrial district, yet it produces a sizeable amount of tea, oranges, ginger, other citrus fruits and paddy (rice).

Dibru Saikhowa National Park is famous for birds and is a biodiversity hotspot with over 350 species of avifauna providing unique habitat for globally threatened species. A safe haven for extremely rare white winged wood duck and many migratory birds. Its feral horses are precisely sufficient to make the visitor wild. Dehing Patkai Wildlife Sanctuary is one of the last remaining lowland tropical wet evergreen forests of Assam. It spreads over an area of 300 sq.km. in the southern and eastern parts of the district. It is home to various types of wildlife like the hoolock gibbon, pig-tailed macaque, slow loris, tiger, elephant, clouded leopard, and hornbill. An ayurvedic spa has been opened recently which offers traditional ayurvedic KERALA massage by a trained therapist. The Nature Cure Centre at Barooah Lodge, behind Barooah market also provides Jacuzzi baths (hydrotherapy), acupressure treatment and physiotherapy as well. The massage given here has therapeutic values and has the power to rejuvenate the body.

Digboi, National Oil Park, War Cemetery, Margherita and Golfing Resort in Digboi are the famous tourist spots.

3.6 District Profile: Jorhat

Jorhat is an administrative district of Assam, located in the central part of Brahmaputra Valley. The district is bounded by Majuli on north, Nagaland state on the south, Charaideo on the east and Golaghat on the west. On the north of the district, the river Brahmaputra forms the largest riverine island of the world. The area of the district is 2851 sq. km.

3.6.1 Climate

The climate in Jorhat is warm and temperate. The summers here have a good deal of rainfall, while the winters have very little. The temperature here averages 24.0 °C. About 2324 mm of precipitation falls annually

3.6.2 Demography

At Present, the district spreading over 2851 sq. km. with a population of 10,92,256 (2011 census) and a density of 383 persons sq. km. The sex ratio is 962 per 1000 male. The disrict has SC and ST population of 7.61% and 12.09% respectively of the total population. The literacy rate is 83.42%.

Hindus contribute 91% of the total population and are the largest religious community in the district followed by Muslims which contribute 6% of the total population and Christians are the third largest religious community here with 2% population Main communities in the district are Tea tribes (Adivasi), Chutiya, Ahom, Tiwa (Lalung), Sonowal Kacharis, Thengal Kachari. There is also presence of Bengali Hindus in the urban areas

3.6.3 Economy

Jorhat has 45% (about 4.1 lakh) population engaged in either main or marginal works. 58% male and 31% female population are working population. 45% of total male population are main (full time) workers and 13% are marginal (part time) workers. For women 16% of total female population are main and 15% are marginal workers.

There are about 135 tea gardens, including out gardens, and the predominant field crop is rice, with per capita food grain production of 205 kg per annum.

The district has a number of small-scale and cottage industries in the field of cane work and bamboo work, silver jewelry, furniture making, brass smithing, umbrella making, soap manufacturing, packaged food manufacturing etc.

Jorhat is the central location for reaching out to many interesting places of international importance: Majuli, Khaziranga National Park, Dhekiakhowa Bornamghar, Lachit Borphukan's Maidam, Raja Maidam, Jorhat Science Centre & Planetarium, Jorhat Gymkhana Club, Chandrakanta Handique Bhavan, Ayur Sanjeeva, Jorhat District Museum, Thengal Bhawan, Gibbon Wildlife Sanctuary, Kaziranga Golf Resort, Sukapha Samannay Kshetra, Mou Chapori, Mulai Forest, Jagannath Temple, public parks and gardens.

3.7 Direct PIA

The vicinity of the road in both sides has been considered as the direct project influence area and the Social Screening of the likely project affection is discussed in Chapter 8: Social Screening.

Population data for Assam, Dhemaji, Dibrugarh, Tinsukia and Nagaon is provided in **Table 3.1**.

Table 3.1 : Population Data

Sl. No.	Description	Assam		Dhemaji		Dibrugarh		Tinsukia		Nagaon	
		2011	2001	2011	2001	2011	2001	2011	2001	2011	2001
1	**Total Population - Gender wise**	31205576	26655528	686133	571944	1326335	1185072	1327929	1150062	2823768	2314629
	Male	15939443	13777037	351249	294643	676434	613555	680231	601099	1439112	1190950
	Female	15266133	12878491	334884	277301	649901	571517	647698	548963	1384656	1123679
	Sex Ratio (No. of females per 1000 males)	958	935	953	941	961	931	952	913	962	944
2	**Total Population (0-6 years) - Gender wise**	4,638,130	4,498,075	104247	99558	163210	172625	181826	184847	459940	426265
	Male	2,363,485	2,289,116	53457	50531	83168	87984	92777	94433	234203	215800
	Female	2,274,645	2,208,959	50790	49027	80042	84642	89049	90414	225737	210465
	Sex ratio (No. of females per 1000 males)	962	965	950	970	962	962	960	957	964	975
3	**Total Population (Sector Wise)**	31205576	26655528	686133	571944	1326335	1185072	1327929	1150062	2823768	2314629
	Rural	85.90%	87.10%	92.96%	NA	81.62%	NA	80.06%	NA	86.91%	NA
	Urban	14.10%	12.90%	07.06%	NA	18.38%	NA	19.94%	NA	13.09%	NA

CHAPTER 4

ENGINEERING SURVEY AND INVESTIGATIONS

4.0 ENGINEERING SURVEY AND INVESTIGATIONS

4.1 Introduction

The Consultants have conducted different types of field studies, engineering surveys and investigations to gather data and information necessary for project preparation. The aim of the investigations was to develop an adequate supportive database for selecting and preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The engineering investigations and surveys have been carried out in line with the specifications laid out in the TOR. The basic data and results of investigation are compiled and included in Volume-II of this Report.

The following engineering survey and investigations were conducted or yet to be conducted:

a) Reconnaissance Survey
b) Road Inventory
c) Pavement Condition Survey
d) Inventory and Condition Survey of Existing Bridges, Culverts and Other Structures
e) Alternative Alignment Study for Bypasses
f) Topographic Survey
g) Traffic Survey
h) Axle Load Survey
i) FWD Survey
j) Roughness Survey
k) Pavement Investigation
l) Material Investigation
m) Sub Soil Exploration

4.2 Reconnaissance Survey

This is basically a visual survey of the project road and its environs. This activity has already been completed by the concerned key personnel of the Consultant's team after a study of available maps of the area. Accordingly, teams for subsequent survey and investigation were planned for mobilization at site. The assessment of important aspects made during reconnaissance including few problems as perceived is brought out below:

a) Topographical Features of the Area

A preliminary observation of the topographical features in the project road corridor and surrounding area was made during reconnaissance survey. The terrain, roadside physical features, road alignment, drainage characteristics, existence of major bridges and structures, railway crossings, junctions, involvement of forest land, problems at site, etc. were noted. This helped in making an assessment of the nature and complexity of the project, which in turn, determined the extent of the various surveys and investigations required for the project preparation.

b) Widening Scheme

Side of widening has been assessed during this study. Location of roadside settlements, water bodies, utilities, curvature, forest area, existing ROW etc. were considered to assess the most suitable widening scheme. Normally attempt shall be made to match the edge of existing carriageway with respective edge of proposed paved shoulder. Concentric widening shall be followed in built-up locations and cut sections.

c) Realignment Requirements including Provision of Bypasses/Diversion at Congested and Critical Locations

The bypass/diversion option has been considered from the angle of relative economics/ physical feasibility of the alternative: (i) to acquire structures alongside the existing road and carry out parallel widening and (ii) to go in for bypass/diversion.

d) Preliminary Identification of Improvement Requirements including Treatments and Measures Needed for the Cross Roads

There is a good nos. of cross roads along the project road. During reconnaissance survey it was found that these roads seem to carry very low traffic and there is no prime facie warrant for grade-separation. It appears from first impression that there is no requirement of grade separator except at few major ones.

e) Inventory of Major Aspects of Existing Roadway and Bridges/Culverts/Other Structures

Primary inventory data of road, bridge, culverts, intersections, utility lines, trees, landuse, roadside features, etc. have also been collected from site. The inventory data will constitute an important input for the Report.

4.3 Road Inventory

A detailed inventory of the existing road has been prepared through dimensional measurements and visual inspection to assess the existing status. Features like existing kilometerage, terrain, landuse, width of pavement and shoulders, height of embankment, geometric deficiencies, important road intersections, utilities, other features etc. were recorded. Findings of Road Inventory have been presented in **Appendix 4.1-4.9** (included in Volume-IA) as mentioned below. The inventory is essentially included to collect physical information on the road and its environment for enabling preliminary assessment of the project.

Appendix 4.1	Road Inventory
Appendix 4.2	Details of Cross Roads
Appendix 4.3A	Schedule of Existing Utilities (Parallel and Across the Project Road)
Appendix 4.3B	Number of Electric Poles
Appendix 4.3C	Summary of Roadside Utilities along the Project Road
Appendix 4.4	Details of Built up Area
Appendix 4.5	List of Major Features
Appendix 4.6A	Summary of Trees to be Felled (Kilometer wise Details)
Appendix 4.6B	Break up of Approximate Numbers of Trees to be Felled
Appendix 4.7	List of Items to be Dismantled
Appendix 4.8	Details of Arboriculture
Appendix 4.9	Details of Geometric Deficiencies

4.4 Pavement Condition Survey

Pavement condition survey has been carried out for road and pavement surface conditions covering the following:

- pavement condition (surface distress type and extent);
- shoulder condition;
- embankment condition; and
- drainage condition

The survey was conducted through Network Survey Vehicle (NSV). The NSV Digital Laser Profiler (DLP) is an affordable, portable system that measures longitudinal profile, macro texture (MPD and SMTD) and roughness (IRI).

A World Bank Class 1 profiler, the NSV DLP measures road profile in one or two wheel-paths using accelerometers and up to two precision laser sensors to compensate for vehicle body movement. The DLP is completely portable using a detachable sensor beam and comes complete with a tow-bar mounting kit, making it perfect for less frequent survey demands. An accurate Distance Measuring Instrument

(DMI) and the Heartbeat module are used to precisely link the data to distance/chainage. It is used in conjunction with the Hawkeye Processing Toolkit software, operators to produce a wide range of reports to review network condition and performance. This information can then be simply exported to CSV, or applications such as HDM-4 and GIS tools.

The NSV is capable of supporting a profiler with up-to three lasers, two digital imagery cameras, DGPS and a Gipsi-Trac Geometry system

Complete information about condition of existing pavement and shoulder was collected so that design parameters related to pavement can be established.

The information collected consists of the details of cracking (narrow and wide), rut depth, raveling, potholing, patching in the form of percentage area as well as edge break in terms of length and rut depth in mm. affected of the existing pavement and paved shoulder material loss, rut depth, corrugation, edge etc. in the case of unpaved shoulders.

The study shall identify defects and road section with similar characteristics i.e. homogeneous sections.

Pavement condition survey, using NSV, has been carried out for the stretches of Package-4. However, the stretches for Section-1, 2 and 3 are under construction and thus the survey could not be conducted for particularly these stretches.

Besides, pavement condition survey has been carried out as per visual investigation with sample measurements. The existing pavement is of bituminous type with varying composition and characteristics. Detailed field study including pavement condition, shoulder condition, embankment condition, drainage condition etc. were carried out by visual means supplemented by measurements as per the guidelines mentioned in the TOR. The following measurements were involved:

- % area of fine cracks < 3 mm
- % area of wide cracks > 3 mm
- % area of ravelling
- The length of edge failure expressed in meter
- % area of patching
- % area of potholes

Rut depth, measured transversely across the outer wheel paths using 2 meter long straight edge and graduated wedge. Shoulder and embankment conditions by visual means and the existence of distress modes and extent thereof were noted. The field data has been recorded at 500m interval.

4.5 Inventory and Condition Survey of Existing Bridges, Culverts and Other Structures

Inventory and condition survey of the existing bridges, culverts and other structures were carried out to identify their number, type, condition and hydrological aspects. Mainly visual inspection and dimensional measurements have been carried out during this survey. Data has been collected as per proforma mentioned in the QAP.

4.6 Alternative Alignment Study for Bypasses

Alternative alignment study was not required for the sections under consideration.

4.7 Topographical Survey

The specific objective of the topographical survey is to delineate accurately the complete existing natural and man-made features, so as to study and develop the existing road to 4 lane with paved shoulder, creating an accurate Digital Terrain Model, which is also a fundamental requirement to design the highway through latest software. The detailed topographical survey for the new and existing road was carried out in consonance with the procedure outlined in the TOR using LiDAR, Total Station and Auto Level.

The survey was performed over 35m (in general) on either side w.r.t. the proposed centre line or upto the existing Right-of-Way (ROW) line on either side, whichever is more. The survey involved the following sequential steps:

(1) Establishing GPS stations : in order to ensure the global co-ordinate system, the corridor shall be framed through GPS survey. A pair of GPS pillars shall be established at every 5.0km along the corridor.

(2) Establishing Bench Marks : in order to ensure locational and directional as well as vertical control along the project road, bench mark pillars (BM) shall be established at about 250m interval, in general, depending upon visibility between two pillars. This bench mark pillars shall be connected to the GPS pillars.

(3) Traversing and Levelling : shall be done to connect the reference BM pillars.

(3) Cross-section Surveying/Detailing : Detailed cross sections shall be surveyed at 25m interval, in general, using Total Station. The cross sections shall be extended up to the survey limits mentioned earlier. The main features captured in the cross-sections are:

- Ground level along the proposed corridor
- Carriageway crown, carriageway edges and two intermediate carriageway points
- Roadway edges (shoulder break-points)
- Embankment toe-line

- Borrow pit / pond / ditch / toe drain profile, where present
- All break-points of natural ground
- Positions of individual entities such as trees, utility lines and poles, wells and tube wells, other pillars like ROW, forest pillar etc.
- Property lines and structures (with description)
- Salient points on bridges and culverts (e.g. abutment, headwall, invert level, etc.)

The data for each survey point shall be recorded in terms of Northing, Easting, and Elevation. To ensure standardization of works of different survey teams and to facilitate further CAD works, a rational coding system shall be developed and used.

The survey data collected in the field shall be downloaded in text file format and converted to graphic files using suitable software.

4.8 Traffic Survey

Following traffic surveys were conducted at site to assess the present and future traffic on the project highway:

- Classified directional traffic volume count survey (TVC)
- Origin-Destination (O-D) and commodity movement survey
- Intersection Turning Movement Count Survey (TMC)

Details of traffic survey have been provided in Chapter 5 of this report.

4.9 Axle Load Survey

The survey was carried out near km 622 of NH-37 (Before Tinsukia) and km 439 of NH-52 (before Shilapathar junction) to study the traffic load characteristics on the project road.

The survey was conducted for 48 hours at suitable time interval in either direction. Necessary assistance was provided to the Consultants by the District police at the survey locations for stopping of the vehicles on sample basis and guiding them to the axle load pad.

VDF summary is presented in **Table 4.1**.

Table 4.1 : VDF Summary

Type of Vehicle	Dibrugarh – Ledo		
	From Dibrugarh to Tinsukia	From Tinsukia to Dibrugarh	Recommended VDF
2-Axle Trucks	2.55	4.00	3.28

3-Axle Trucks	10.31	11.07	10.69
MAV	14.97	11.27	13.12
LCV	0.77	1.20	0.98
Bus	1.12	1.03	1.08

Axle load survey data for Dibrugarh-Ledo section is provided in **Appendix 4.16**.

4.10 Falling Weight Deflectometer (FWD) Survey

4.10.1 TOR Requirements

This survey was conducted to obtain the structural strength of existing pavement in accordance with IRC 115:2014 requirements.

Based on the data collected from condition survey, the road length has been classified into sections of uniform performance in accordance with the criteria given in the **Table 4.2**.

Table 4.2 : Criteria of Pavement Classification

Classification	Pavement Condition
Good	Isolated cracks of less than 3.0 mm width in less than 5% area of total paved surface and average rut depth less than 10 mm
Fair	Isolated or interconnected cracks of less than 3.0 mm width in 5 to 20% area of total paved surface AND/OR average rut depth between 10 to 20 mm
Poor	Wide interconnected cracking of more than 3.0 mm width in 5 to 20% area (include area of patching and raveling in this) of paved area OR cracking of any type in more than 20% area of paved surface AND/OR average rut depth of more than 20 mm

As it is inexpedient to change the sample size for deflection measurement at frequent intervals, it is always preferable to keep the length of each uniform section at a minimum of 1 km except in the case of localized failures or in other situations requiring closer examination where minimum length of section should be 0.3 km from the consideration of profile correction and constructability.

Deflection measurement scheme to be adopted is provided in **Table 4.3**.

Table 4.3 : Pavement Deflection Measurement Scheme

Type of Carriageway	Type of Measurement Scheme	Maximum Spacing for Test Points along Selected Wheel Path for Pavements of Different Classification		
		Poor	Fair	Good
Two Lane Two Way Single Carriageway	Measure along both outer wheel path	60	130	500

Note - The spacing given in the table are with the assumption that the length of uniform section is 1.0 km. The actual spacing to be adopted can be obtained by multiplying the spacing given in the table by the length of uniform section

4.10.2 Falling Weight Deflectometer (FWD)

FWD is an impulse-loading device in which a transient load is applied to the pavement and the deflected shape of the pavement surface is measured. The working principle of a typical FWD is illustrated below. DO, D1, etc., mentioned in the figure are surface deflections measured at different radial distances. Impulse load is applied by means of a falling mass, which is allowed to drop vertically on a system of springs placed over a circular loading plate. The deflected shape of the pavement surface is measured using displacement sensors which are placed at different radial distances starting with the center of the load plate. Trailer mounted as well as vehicle mounted FWD models are available commercially. The working principle of all these FWD models is essentially the same. A mass of weights is dropped from a pre-determined height onto a series of springs/ buffers placed on top of a loading plate. The corresponding peak load and peak vertical surface deflections at different radial locations are measured and recorded.

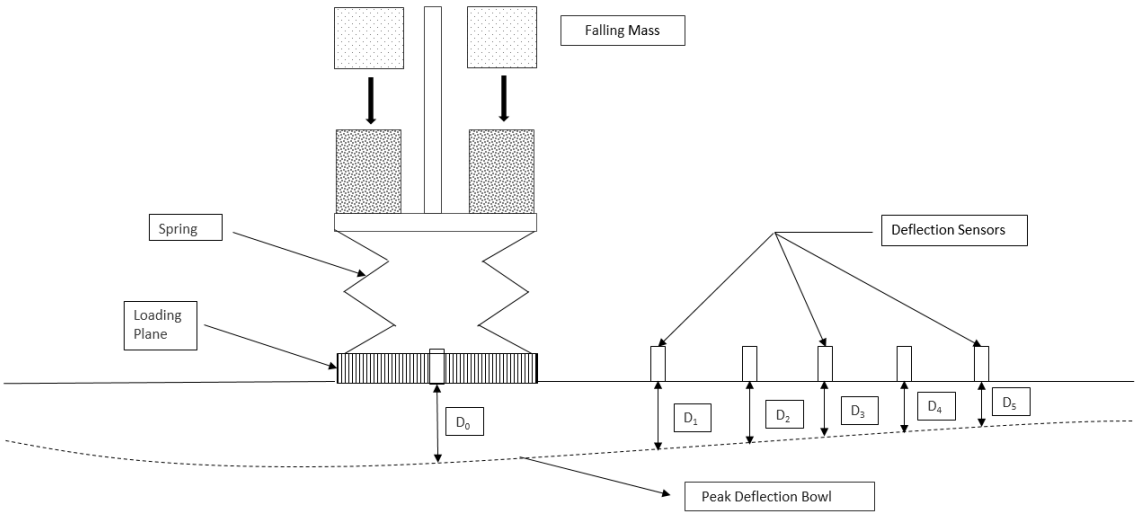
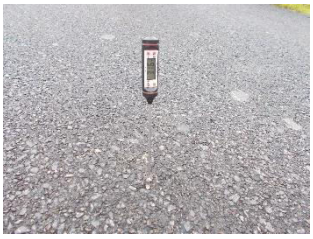


Fig 1: Working Principle of Falling Weight Deflectometer

Different magnitudes of impulse load can be obtained by selection of a suitable mass and an appropriate height of fall. Under the application of the impulse load, the pavement deflects. Velocity transducers are placed on the pavement surface at different radial locations to measure surface deflections. Geophones or seismometers are used as displacement transducers. Load and deflection data are acquired with the help of a data acquisition system.

Typical Falling Weight Deflectometers (FWD) include a circular loading plate of 300 or 450 mm diameter. In these guidelines 300 mm diameter load plate is recommended. A rubber pad of 5 mm minimum thickness should be glued to the bottom of the loading plate for uniform distribution of load. Alternatively, segmented loading plates (with two to four segments) can be used for better load distribution.

A falling mass in the range of 50 to 350 kg is dropped from a height of fall in the range of 100 to 600 mm to produce load pulses of desired peak load and duration. Heavier models use falling mass in the range of 200 to 700 kg. The target peak load to be applied on bituminous pavements is 40 kN (+/- 4 kN), which corresponds to the load on one dual wheel set of a 80 kN standard axle load. The target peak load can be decreased suitably if the peak maximum (central) deflection measured with 40 kN load exceeds the measuring capacity of the deflection transducer. Similarly, the load can be increased to produce deflection of at least 10µm at a radial distance of 1.2 m. If it is known from construction records or from coring or from test pits that subgrade is stiff and hence smaller than 10 pm deflections are expected, testing with increased loads will not be required. If the applied peak load differs from 40 kN, the measured deflections have to be normalized to correspond to the standard target load of 40 kN. The normalization of deflections can be done linearly. For example, if the measured deflection is 0.80 mm for an applied peak load of 45 kN, the normalized deflection for a standard load of 40 kN is 0.711 mm (0.80 * (40/45)). The load cells used to measure load pulses produced by FWD should have a reading resolution of 0.1 kN or better and should give readings accurate to 2 percent of measured value.



The stiffness of bituminous layers and hence the response of a pavement depends on the pulse shape of the applied load (COST 336, 2005). Most FWDs have a load rise time (from start of pulse to peak) of between 5 ms and 30 ms and have a load pulse base width in the interval of 20 ms to 60 ms (COST 336, 2005). The duration of impulse load is maintained approximately equal to the time needed to traverse the length of a tyre imprint at a speed of about 60 km/h which is in the range of 20 to 30 ms. The FWDs used for evaluation should be capable of producing load pulses with loading time in the range of 15 to 50 ms.

Sufficient number of deflection transducers should be used to adequately capture the shape of deflection bowl. Six to nine velocity transducers (geophones) are generally adequate for measuring surface deflections of flexible pavements. Deflection sensors are placed on the surface of pavement at different radial direction aligned in the longitudinal direction. The deflection transducers used should have a reading resolution of at least 1 µm and 5 should be accurate to +/- 2 percent of the reading. Typical geophone position configurations (number and radial distances measured from center of load plate) commonly used for flexible pavement evaluation are ;- (i) 7 sensors at 0, 300, 600, 900, 1200, 1500 and 1800 mm radial distances (ii) 7 sensors at 0, 200, 300, 450, 600, 900, 1500 mm radial distances (iii) 6 sensors at 0, 300, 600, 900, 1200 and 1500 mm radial distances and (iv) 6 sensors at 0, 200, 300, 600, 900, 1200 mm radial distances.

4.10.3 Data Verification

The FWD test data collected from different load drops at each test point primarily consist of peak load, peak deflections at different radial locations. Unrealistic deflection values and obviously erroneous data must be removed. Some of the checks that should be applied to the deflection data are:-

(i) deflections should decrease with increasing distance from the loading plate and
(ii) deflection values should not be more than the capacity of the sensors.

Average values of load and deflections are calculated from the three drop test data collected at a given location.

The deflections are normalized to correspond to a standard target load of 40 kN as explained in Clause 4.4.

4.10.4 Identification of Homogeneous Sub-sections

The identification of sections of uniform performance done in Section 4 of these guidelines was done primarily to select an appropriate sample size for conducting deflection testing. Since the assessment of the remaining life of existing pavement and the strengthening requirement in terms of bituminous overlay will be done on the basis of the back calculated moduli of in-service pavement layers, it is prudent to identify homogeneous sections for the purpose of structural design primarily based on deflection bowl parameters and other relevant information.

Identification of homogeneous sections is generally done on the basis of the following parameters :- peak deflections or peak deflection bowl parameters, subgrade strength, design traffic, layer thicknesses and extent and severity of distress, back calculated surface modulus of the total bituminous layers, remaining life of pavement and overlay thickness requirement. It is proposed in these guidelines that one of the deflection bowl parameters, which typically represent the stiffness of the upper layers along with design traffic and subgrade strength, should

be used for identification of homogeneous sections.

Other parameters as may be deemed suitable can also be considered for this purpose. Surface Curvature Index (SCI) calculated as the difference between D_0 and D_{3QQ} where, $D_{0\ and}$ D_{3QQ} are the peak deflections (mm) measured at the center of loading plate and at a radial distance of 300 mm is a bowl shape parameter, which reflects the contribution of upper layers, is the bowl shape parameter to be used, alongwith other parameters, for identification of homogeneous sections. SCI is expressed in mm here whereas the parameter is used in inches or mils in many empirical expressions available in literature for empirically estimating moduli of layers.

A statistical technique popularly used for identification of homogeneous sections is the "Cumulative Difference" approach. This approach is already being used extensively in India in many highway projects. In this approach, the sequence of actual cumulative sums in a measurement series is compared with the sums that would have resulted from adding averages. The difference between these values is termed as cumulative difference. The series of cumulative differences (zj for the measured sequence of a given variable 'x' (SCI, subgrade strength, etc.) can be obtained using the following expression.

$$Z_k = \sum_{i=1}^{i=k} (xi - kx)$$

For all k = 1,....., n

Where,

$$X = (1/n) \sum_{i=1}^{i=n} (xi)$$

Wherever the trend changes from positive to negative and vice-versa in the plot of cumulative difference VS distance (or number of test location), that should be considered as a possible delineator for identifying homogeneous sections. However, judgment has to be applied for considering a particular change in trend to be significant enough to suggest the presence of a delineator there.

Homogeneous sections can be identified with reference to different parameters such as SCI, traffic, subgrade strength, etc. Delineation carried out based on different parameters will yield a number of sub-sections. No sub-section should be shorter than 1.0 km in length and each subsection should have at least twelve deflection test locations. If a subsection has only one or two test points, it is a case of the pavement in need of localized rehabilitation measures. The spacing considered for deflection measurement in each subsection can be rounded off to convenient practical values.

4.10.5 Work Procedure

The following steps have been followed for measuring deflections at each test point. The exact sequence of operations may be different for different models of FWD.

(i) Mark the test point on the pavement.

(ii) Centre the load plate of the duly calibrated FWD over the test point.

(iii) Lower the loading plate onto the pavement. There should be no standing water (surface texture completely filled with water) on the pavement surface. The loading plate should be in proper contact with pavement surface. If a non-segmental plate is used the presence of rutting at test location should be noted if it affects the contact between plate and pavement surface. The longitudinal and transverse slope of the pavement should not exceed 10 percent at the test location for accurate measurement of deflection.

(iv) Lower the frame holding the displacement transducers (geophones) so that the transducers are in contact with pavement surface

(v) Raise the mass to a pre-determined height required for producing a target load of 40 kN

(vi) Drop one seating load. Load and deflection data for seating load drop need not be recorded

(vii) Raise the mass and drop. Record load and deflection data into the computer through data acquisition system. While peak load and peak deflections at different selected radial positions must be recorded, complete time history of load and deflections can be stored for each load drop if feasible

(viii) Repeat step at least two more times.

(ix) If, during steps vii and viii, the deflections measured are too large or too small as discussed in Clause 4.4, the test may be repeated by changing the peak load

(x) Raise the geophone frame and load plate and move to the next test location

(xi) Record air temperature at half hourly interval

(xii) Record pavement surface temperature (optional) if non-contact temperature sensors are available

(xiii) Measure pavement surface layer temperature at half-hourly intervals by drilling holes of 40 mm depth into the pavement surface layer. Fill the hole with a drop of glycerol. Insert the thermometer into the hole and record the temperature after three minutes

(xiv) Deflection measurements should not be made when the pavement temperature is more than 45°C. Guidelines given in Clause 6.4.3 may be followed for deflection measurement in colder areas and areas of altitude greater than 1000m.

FWD survey was carried out for the stretches under Package-IV. As the stretches under Section-1, 2 and 3 (i.e. from Start of Dibrugarh Bypass to Start of Tinsukia-Makum Bypass) were under construction, the survey could not be conducted for these stretches.

4.11 Roughness Survey

The survey has been carried out to assess the roughness index survey of existing pavement. The results of the survey will be expressed in terms of BI and IRI, and shall be presented in both tabular and graphical forms. Based on the data, homogenous segments with respect to surface roughness has been determined based on cumulative difference method.

The roughness values which represent pavement functional performance are essentially intended for use in economic/financial analysis, and for checking against the pavement designs proposed for different sections.

The equipment used for the survey is Network Survey Vehicle (NSV) mounted laser profilometer. Detailed description of equipment, data capture methodology and type of output data are already provided in para 4.4 of this chapter.

In addition, the following criteria have been met by the process of defect detection:

- Roughness measurement with outputs of both raw longitudinal profiles and IRI calculation shall be reported at 100m referenced to the preceding LRP. The roughness must meet ASTM-E950 (equivalent to Class I road profiler).

- The IRI shall be determined for both wheel-paths over a minimum length of 250m for a minimum of 6 calibration sites with a roughness range between 2m/km and 8m/km. Calibration shall be made for speeds of 20, 30, 40, 50, 60 km/hour.

The survey was conducted along the outer wheel paths covering two runs along the wheel paths for each direction. The data derived from survey have been compared with the data obtained from the pavement condition survey and assessment of riding over the road.

Roughness survey, using NSV, has been carried out for the stretches of NH-37, NH-38, NH-52B, NH-52 and NH-515 except the stretches under construction and bridges. Result obtained from the survey is summarized below:

- BI < 2000 mm/km - 19.5% Stretches
- BI between 200 & 3000 mm/km - 79.8% Stretches
- BI > 3000 mm/km - 0.7% Stretches

Roughness survey using NSV was carried out for the stretches under Package-IV. As the stretches under Section-1, 2 and 3 (i.e. from Start of Dibrugarh Bypass to Start of Tinsukia-Makum Bypass) were under construction, the survey could not be conducted for these stretches.

4.12 Sub grade Investigation

4.12.1 Sub-grade Investigation Methodology (Test Pits)

The basic objective of the investigation was to form a database for characterization of existing pavement. The investigation was carried out by digging trial pits staggered left/right.

4.12.2 Large Pits (1.0m x 1.0m x 1.0m)

Large Trial pits of size 1m x 1m x 1m and small trial pit size 0.5m x 0.5m x 0.5m were dug at the

pavement shoulder interface, extending through the pavement layers down to the subgrade level. Pits were at least 300 mm within the carriageway. Pits were made in such a way that half of the pit remains within the carriageway and the other half (in the shoulder), ensuring minimum damage to the original pavement and disruption to the traffic. Large test pits are done on both sides of the project road were dug at the pavement shoulder interface extending through the pavement layers down to the sub-grade level.

The following sequence of operation was followed for each large test pit:

- Manual excavation of 1.0 m x 1.0 x1.0 m and pit down to subgrade level. The thickness of the different pavement layers were measured and type of material examined and logged from three sides.
- Field (in-situ) dry density using sand replacement method as per IS 2720: Part 28 was carried out at the subgrade level.
- Adequate sample in sealed polythene bag were collected for classification tests as per IS: 2720 (relevant parts)

    - Field moisture content
    - Grain size analysis
    - Atterberg limits

One sample of 40 kg was collected from the top 300 mm of subgrade for the following laboratory tests (as per IS:2720)

- Free swell index
- Moisture-Density test (heavy compaction)
- CBR (4 days soaked at three energy levels of 10, 35 and 65 blows)

After the completion of field tests and collection of samples, the pits were backfilled with the excavated materials and compacted suitably so as not to jeopardize the smooth movement of traffic of the existing road.

The existing pavement structure mostly comprises of three layers, namely bituminous layer, base course and sub-base course. During the present investigation the surfacing course is reported, on the whole, as bituminous course (BC). The base course comprises of stone ,gravel, cobble mix with clay mix with sand only and few stretch present in WBM mix . The sub-base course consists mainly occasional presence of sand layer along the stretches.

4.12.3 Existing Pavement Composition

The existing pavement composition for the newly constructed Dibrugarh Bypass (from Km 0+000 to Km 12+500) is as below:-
BC: 40mm
DBM: 100mm

WMM: 250
GSB: 200mm

The existing pavement of Tinsukia Bypass and NH-38 are as follows the pavement thickness is as below:

Sl.No.	LOCATION &CHAINAGE	Stretch	GSB+WMM (mm)	DBM+BC (mm)	TOTAL(mm)
1	Ch.626+070 edge of				
	paved shoulderRHS	at NH-37	310	100	410
2	Ch.631+100 edge of				
	paved shoulder LHS	at NH-37	260	100	360
3	Ch.635+000 edge of				
	paved shoulder LHS	at NH-37	270	100	370
4	Ch.638+160 edge of				
	carriage way RHS at NH-37	at NH-37	280	100	380
5	Ch.641+640 edge of				
	carriage way RHS at NH-37	at NH-37	300	100	400
6	Ch.644+140 edge of				
	paved shoulder LHS at NH-37	at NH-37	380	100	480
7	Ch.645+800 edge of		230	100	330
	carriage way LHS at NH-37	at NH-37			
8	Ch. 649+100 edge of		300	100	400
	carriage way LHS at NH-37	at NH-37			
9	Ch.0+350 edge of		220	100	320
	paved shoulder LHS at NH-38	at NH-38			
10	Ch.4+100 edge of		280	100	380
	paved shoulder LHS at NH-38	at NH-38			
11	Ch.7+610 edge of		350	100	450
	paved shoulder LHS at NH-38	at NH-38			
12	Ch.12+880 edge of		370	100	470
	paved shoulder RHS at NH-38	at NH-38			

4.12.4 Laboratory Properties of Sub-grade Soil

The laboratory test results consist of gradation, Atterberg limits, field moisture content, Field dry density (FDD), compaction characteristics (maximum dry density and optimum moisture content relationship as per heavy compaction), CBR (soaked) etc. for the subgrade soils underneath the existing pavement.

4.12.5 Grain Size

The fraction of the materials of the sub-grade soils passing 75μ sieve is 14.0% to 16.0 % on an average. The soil is inorganic clay with low to medium plasticity (CL), Clayey sand (SC) and silty sand (SM) type soil.

4.12.6 Atterberg Limit

The liquid limits for existing pavement of the soil are NP to plastic.

4.12.7 Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)

Soil samples obtained by test pits have been compacted in the laboratory at various moisture contents to derive moisture content vs. dry unit weight relationship. The method of heavy compaction in accordance with IS 2720 (Part 8) has been used. The results of heavy compaction test carried out on sub-grade samples of existing pavement to determine the maximum dry density (MDD) and optimum moisture content (OMC) relationship.

For existing sub-grade soil the maximum dry density (MDD) of ranges between 18.31 kN/ m3 and 18.69 kN/m3. The optimum moisture content varies between 10.6 % and 12.2 %. The result indicates that the maximum dry density of existing sub-grade soil is greater than 17.5 kN/ m3 at all chainages which satisfies the unit weight requirement of sub-grade soil as specified by MORT&H.

4.12.8 CBR of Existing Sub Grade Soil

California Bearing Ratio (CBR) tests were carried out on the pit samples in the laboratory as per standard procedures. At optimum moisture content (OMC) soil samples were compacted at three different energy levels corresponding to 10 blows, 35 blows, 65 blows as per IS:2720 (Part 8). These compacted soils at different compaction levels were tested after immersion in water for four days. Soaked CBR at 97% maximum dry density (MDD) has been interpolated from CBR-dry density curve. The soil, soaked CBR value at 97% MDU ranges from 6.9 % to 7.8 %.

4.12.9 Field Dry Density

Field dry density, as obtained from laboratory test results, is provided in **Table 4.4**.

Table 4.4 : Field Dry Density

Sl No.	Name of Road	Existing Chainage (km)	Side	Moisture Content (%)	Dry Density (gm/cc)	MDD (gm/cc)
Section-1						
1	DIBRUGARH BYPASS	4+000	RHS	8	1.717	1.847
2		10+800	LHS	6	1.727	1.869
Section-2						
3		6+500	LHS	5.5	1.731	1.857
4		16+000	LHS	5	1.709	1.842
Section-3						
5	TINSUKIA TO MAKUM BYPASS	3+000	RHS	5	1.687	1.826
6		7+500	RHS	4.5	1.731	1.851
7		12+600	LHS	5	1.675	1.839
8		17+200	LHS	5	1.758	1.875
9		22+000	LHS	6	1.735	1.849
10	NH-38	5+500	LHS	4	1.727	1.838
11		9+700	LHS	6	1.746	1.871
12		13+000	LHS	4.5	1.693	1.813
13		20+000	LHS	6	1.75	1.852

4.12.10 Laboratory Properties of Sub-Grade Soil

Laboratory test results of sub-grade soils are presented in **Table 4.5**. Field photographs of trial pit sampling are provided in **Volume-III: Materials Report**.

Table 4.5 : Test Results of Existing Subgrade Soil

Sl No.	Name of Road	Existing Chainage (km)	Side	Grain Size Analysis			Heavy Compaction		Atterberg Limits			FSI	At 97% CBR Soaked
				Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)		
1	DIBRUGARH BYPASS	4+000	RHS	2.90	35.30	61.80	1.847	11.20	33.80	23.60	10.20	20.00	9.9
2		10+800	LHS	4.70	43.00	52.30	1.869	10.60	23.60	23.10	10.00	15.00	10.5
3	LAHOWAL TO CHABUA BYPASS	6+500	LHS	4.10	39.20	56.70	1.857	10.80	31.80	22.20	9.60	17.50	10.2
4		16+000	LHS	3.60	32.10	64.30	1.842	11.40	33.70	22.90	10.80	20.00	9.5
5		30+000	LHS	2.70	26.50	70.80	1.831	12.20	34.20	23.60	10.60	25.00	8.6
6	TINSUKIA TO MAKUM BYPASS (SEC-3) NH-37	3+000	RHS	0.00	24.40	75.60	1.826	12.30	34.60	24.10	10.50	30.00	8.7
7		7+500	RHS	4.10	36.60	59.30	1.851	10.90	32.40	22.80	9.60	15.00	10.1
8		12+600	LHS	2.20	28.10	69.70	1.839	11.60	33.80	23.80	10.00	25.00	9.3
9		17+200	LHS	5.40	45.00	49.60	1.875	10.20	30.40	21.90	8.50	12.50	10.8
10		22+000	LHS	3.50	31.70	64.80	1.849	11.20	33.10	23.40	9.70	22.50	9.6
11	NH-38 (Sec-4)	5+500	LHS	0.00	26.80	73.20	1.838	11.80	34.30	24.10	10.20	27.50	9.4
12		9+700	LHS	4.50	41.50	54.00	1.871	10.40	30.80	22.10	8.70	15.00	10.7
13		13+000	LHS	0.00	22.70	77.30	1.813	12.60	35.60	24.40	11.10	30.00	8.2
14		20+000	LHS	3.30	36.20	60.50	1.852	11.00	32.00	22.90	9.10	17.50	10.1

4.13 Material Investigation

4.13.1 Borrow Area Material Survey

The Consultants has conducted necessary survey to find out the general characteristics of earth materials available in the area. The objective of this investigation is mainly to assess the general availability of soil required for construction of sub-grade and embankment as per design CBR recommended for design of new pavement.

Grain Size

The fraction of the materials of the Borrow area soils passing 75μ sieve is 64.33% on an average, indicating higher sand content in the borrow area soil and that the soils are predominantly sandy silty clay with gravel.

Atterberg Limit

The PI value for borrow soil ranges between 9.55% to 10.00%.

Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)

For borrow area soil the maximum dry density (MDD) of ranges between 17.94 kN/m^3 and 18.62 kN/m^3. The optimum moisture content varies between 10.20% and 12.30%. The result indicates that the maximum dry density of borrow area soil is greater than 17.5 kN/m^3 at all chainages which satisfies the unit weight requirement of sub-grade soil as specified by MORT&H.

CBR of Borrow Area Soil

The soaked CBR values at 97% MDD for borrow area soil is the soaked CBR value at 97% MDD ranges from 7.40 % to 10.2%.

Testing of borrow area samples collected from test pits were carried out in the laboratory and the test results are given in **Table 4.6**.

Table 4.6 : Summary of Laboratory Test Results of Borrow Area Soil Samples

SL. No	Location	Grain Size Analysis			Heavy Compaction		Atterberg's Limit			AT 97% Soaked
		Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)	CBR
1	BA-15 @ 12+600 RHS Lead 6.0 km on Tinsukia-Makum Bypass	3.40	26.30	70.30	1.847	11.30	33.90	23.50	10.40	9.1
2	BA-16 @ Digboi Bypass LHS Lead 0.500 km on NH-38	0.00	24.10	75.90	1.829	12.30	34.40	23.10	10.60	7.8
3	BA-17 @ Digboi Bypass RHS Lead 4.00 km on NH-38	3.60	29.50	66.90	1.851	11.10	33.30	22.60	10.20	9.3
4	BA-18 @ Ledo Bypass LHS Lead 5.00 km on NH-38 (Utpal Baruah-1,2 no Golai Goan 8133957752	6.10	42.10	51.80	1.871	9.60	32.10	24.10	9.50	10.2
5	BA-19 @ Ledo Bypass LHS Lead 8.00 km on NH-38- Baharu Tati (Dehing Village- 7002756652	1.20	25.20	73.60	1.838	12.00	34.80	22.90	10.70	7.7
6	BA-20 @ Ledo Bypass RHS Lead 5.00 km on NH-38 (Ramu Tamang-Rajkhowa Gaon - 7002871007	4.20	41.00	54.80	1.862	10.20	32.60	24.00	9.70	9.6
7	BA-21 @ Ledo Bypass LHS Lead 3.00 km on NH-38	0.00	21.30	78.70	1.827	12.40	34.90	23.80	10.90	7.4

4.13.2 Quarry Material Survey

The material investigation for road construction has been carried out to identify the potential sources of construction materials and to assess their general availability, engineering properties and quantities. This is one of the most important factors for stable, economic and successful implementation of the road program within the stipulated time. The material investigation is quite representative, but more exhaustive search may surely be explored by the contractors at the time of construction. For improvement work as well as for new construction the list of materials includes the following:

- *Granular materials for sub-base works*
- *Crushed stone aggregates for base , bituminous surfacing and cement concrete works*
- *Sand for bituminous and cement concrete works, sub-base, filter materials and filling materials etc.*
- *Borrow earth materials for embankment, sub-grade and filling*

Objective

The following are the basic objective to make material investigation:

- Source locations indicating places, kilometerage, availability and the status whether in operation or new source.
- Access to source, indicating the direction and nature of the access road i.e. left/right of project road, approximate lead distance from the gravity center and type of access road.
- Ownership of land/ quarries, either government or private.
- Test results, indicating the quality of materials with respect to their suitability in construction.
- Probable use indicating the likely use of materials at various stages of construction work i.e. fill material, sub-grade, sub-base, base, bituminous surfacing and cross drainage structures.

The potential sources of construction materials were selected from consideration of the availability and suitability of the materials, easy access to the source and minimum hauling distance from the source in order to make the construction economical and feasible as far as possible. The samples from various identified sources have been collected for laboratory testing as per IRC/MoRT&H/BIS standards.

(A) Coarse Aggregate

Coarse aggregates such as trap rocks consisting of mainly basalt, black and grey in colour, are available in the vicinity of the project road.stone quarries have been primarily identified as stone aggregate source for construction of various components of road, namely, Bituminous Concrete, Semi dense Bituminous concrete (SDBC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM),Granular sub-Base (GSB) as well as for the cement concrete works. The sources identified including their location details, lead distance and availability of the stones are tabulated in **Table 4.7**.

Table 4.7 : Details of Coarse Aggregate Quarry Sources

Sl. No	Sample No	Crusher Plant Location/ Village Name	Side	Lead (km)
1	Coarse Aggregate-1	Mr. Manoj, Dilighat, Namrup Stone Quarry	RHS	Lead 35 from centre of Project Road

Laboratory Test Results of Coarse Aggregate Samples

Laboratory tests carried out for the above mentioned samples are presented in **Table 4.8** to **Table 4.10**.

Table 4.8 : Test Results of Aggregate Samples of Size 20mm

Description	% of Passing of Quarry Sample
Passing through 40mm	100
Passing through 20mm	92.80
Passing through 10mm	5.10
Passing through 4.75mm	1.30

Table 4.9 : Test Results of Aggregate Samples of Size 10mm

Description	% of Passing of Quarry Sample
Passing through 12.5mm	100
Passing through 10mm	91.60
Passing through 4.75mm	10.20
Passing through 2.36mm	2.60

Table 4.10 : Summary of Laboratory Test Results of Aggregates

Sample No	Crusher plant location/Village Name	AIV (%)	LAV (%)	Specification	FI+EI (%)	Specifi c-ation	Specific Gravity	Water Absorption (%)	Specifi c-ation
CA-2(20 MM)	**LIKABALI STONE QUARRY**	16.3	24.5	Not more than 30% for non-bituminous work, 27% & 24% for DBM and BC work respectively	25.4	Not more than 35%	2.674	0.62	Not more than 2%
CA-2(10 MM)	**LIKABALI STONE QUARRY**	18.8	26.1	Not more than 30% for non-bituminous work, 27% & 24% for DBM and BC work respectively	27.7	Not more than 35%	2.668	0.69	Not more than 2%

The results from **Table 4.10** indicate that all the quarry samples are of approved standard and can be used for road construction.

(B) Fine Aggregate

Many sources are available in the vicinity of the project road. The quarry location and approximate lead distance from project is given in **Table 4.11**.

Table 4.11 : Details of Fine Aggregate Quarry Sources

S. No.	Sample No	Crusher plant location/Village Name Village Name	Side	Lead (km)
1	FA-1	Namrup	LHS	LEAD 35 KM from proposed Ledo Bypass

Laboratory Test Results of Fine Aggregate Samples

Laboratory tests carried out on the sand samples collected from the river. These are summarized in **Table 4.12.**

Table 4.12 : Gradation of Fine Aggregate Samples

Sl. No.	Sieve Size (mm)	% of Passing	FA Zone I	FA Zone II	FA Zone III	FA Zone IV
1	10	99.20	100	100	100	100
2	4.75	95.60	90 - 100	90 - 100	90 - 100	95-100
3	2.36	86.20	60 - 95	75 - 100	85 - 100	95-100
4	1.18	68.40	30 - 70	55 - 90	75 - 100	90-100
5	600 mic	42.20	15 - 34	35 - 59	60 - 79	80-100
6	300 mic	16.40	5-20	8-30	12-40	15-50
7	150 mic	3.40	0 - 10	0 - 10	0 - 10	0-15
8	Fineness Modulus (F.M) of FA	2.886				
9	Specific Gravity	2.628				
10	Water Absorption	1.24				

Table 4.12 shows that fine medium coarse sand is available from the above river. The grading zone and fineness modulus of above stone crusher Zone II & Zone II (IS 383 2016) is 2.886 which indicates that it is suitable for road pavement and structural concreting works.

4.13.3 Manufactured Materials

Cement, bitumen, steel are the manufactured materials. Cement and steel with I.S. certification are indigenously available in abundance from the manufacturers. Bitumen of VG-10,VG-20,VG-30&VG-40 viscosity grade and emulsion are available from IOCL Haldia, within the vicinity of project road .The regular supply of bitumen and cement can be satisfactorily met by advance agreements with the manufacturers. The grades of bitumen should be selected as per the guidelines of the MORT&H Specifications for Road and Bridge Works.

A) Cement

Cement to be used in the construction work shall be any of the following types with the prior approval of the Engineer:

- Ordinary Portland cement, 33 Grade, conforming to IS: 269
- Rapid Hardening Portland Cement, conforming to IS: 8041
- Ordinary Portland cement, 43 Grade, conforming to IS: 8112
- Ordinary Portland cement, 53 Grade, conforming to IS: 12269
- Sulphate Resistance Cement, Conforming to IS: 12330

The chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO_3) shall in no case exceed 2.5 percent and 3.0 percent when tri-calcium aluminates present by mass is upto 5 or greater than 5 respectively. Good quality cement is locally available.

B) Steel

For plain and reinforced concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement/un-tensioned steel, as the case may be, shall consists of the following grades of reinforcing bars as shown in **Table 4.13** are available with local stockists. Before incorporation into the work, steel shall be got approved by the engineer.

Table 4.13 : Characteristics Strength of Reinforcement Steel

Grade Designation	Bar Type conforming to governing IS Specification	Characteristic Strength f_y(MP_a)	Elastic Modulus GP_a
Fe500	IS:1786 High Yield Strength Deformed Bars (HYSD)	500	200

C) Bitumen

Bitumen of viscosity grade VG-10 and VG-30 is available from IOCL Haldia within the vicinity of project road, either in bulk tanker or in drums. It is advised that Polymer Modified Bitumen / Crumb Rubber Bitumen to be used for construction of bituminous layer.

Sl No.	Name of Company	Location
1	IOCL	Haldia

D) Water

Detailed survey for locating water sources for the use in concrete works and for construction of road works were carried out in the vicinity of the project road. The most suitable sources of water are those which are in close proximity to some points of the alignment of the rivers along with numerous nallas cross the alignment at suitable intervals. However to facilitate construction works it is always advisable to install wells with due permission from the authority at suitable places for obtaining water for construction purposes.

4.14 Lead Charts

Lead chart for borrow area materials quarry materials are provided in **Figure 4.1-4.2**.

4.15 Hydrological and Hydraulic Study

Preliminary hydraulic and hydrological investigations have been carried out for economical design of drainage structures. The hydrological and hydraulic study for the project includes:

- Study of available open series maps (OSMs).
- checking the adequacy of existing cross-drainage structures and to determine the additional number and size of cross-drainage structures, if any, to allow the estimated design flow of the streams to cross the road safely.
- design of roadside drainage system along the alignment.

During the reconnaissance survey and further data collection/investigations, the Consultants approached local residents and different Government Organisations concerned to the project road to identify the high flood conditions on the project road and on structures. So far as local enquiry is concerned, there is no history of overtopping along the road. Gradual deposition of transported bed material in the wake of every monsoon at most of the bridge sites and on their upstream and downstream sides have resulted in partial blockage in the flow area leading to afflux and reduced clearance under some of the bridges.

Necessary Hydrological and Hydraulic features such as HFL, river bed condition, bank condition, land use, scouring have been noted for all the cross drainage structures.

Based upon data availability, detailed hydrological and hydraulic study of the cross-drainage structures is being carried out. On initial assessment it has been found that number of cross-drainage structures is inadequate at some stretches. Adequate numbers of new culverts have been proposed at those stretches. Details of these new culverts have been presented in Chapter 6 of this report. Additional cross drainage structures would be required in bypass reaches also.

4.16 Secondary Data Collection

Besides the primary surveys conducted / arranged so far, the Consultants also endeavored to collect data and information from secondary sources, as necessary for conducting the study. Some of the secondary data, especially those related to land records are indeed very important, as besides the various formalities related to land transfer/acquisition, these aspects sometimes even dictate the alignments of new/widening proposals.

Consultants prepared a list of secondary data to be collected. Most of the data were collected and few are in process as these are not under direct control of consultant. List of secondary data collected is mentioned below:

1. Districts Involved
2. Existing road nomenclature
3. Ownership details of road
4. Survey of India open series maps
5. Forest maps and forest shape files
6. Accident data from concerned police stations
7. Fuel sale data from nearby fuel stations
8. Vehicle registration data from RTO office
9. Statistical handbooks
10. SOR,13-14 with Escalation
11. Existing ROW information through discussion with concerned officers/site measurements
12. IOCL underground pipelines
13. Land and building rates
14. High flood level (through local enquiry)

Figure 4.1 : Lead Chart for Borrow Area Materials

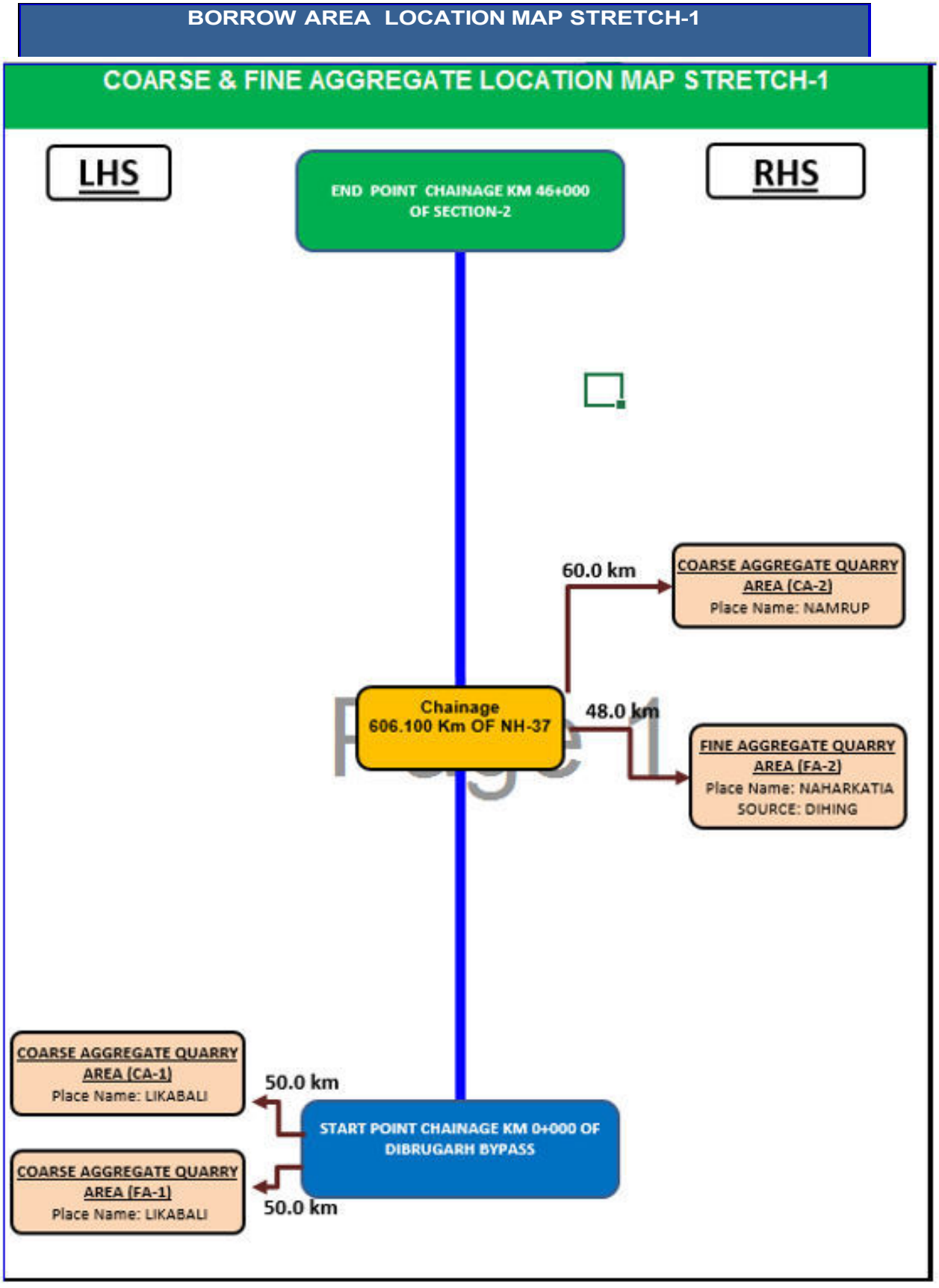
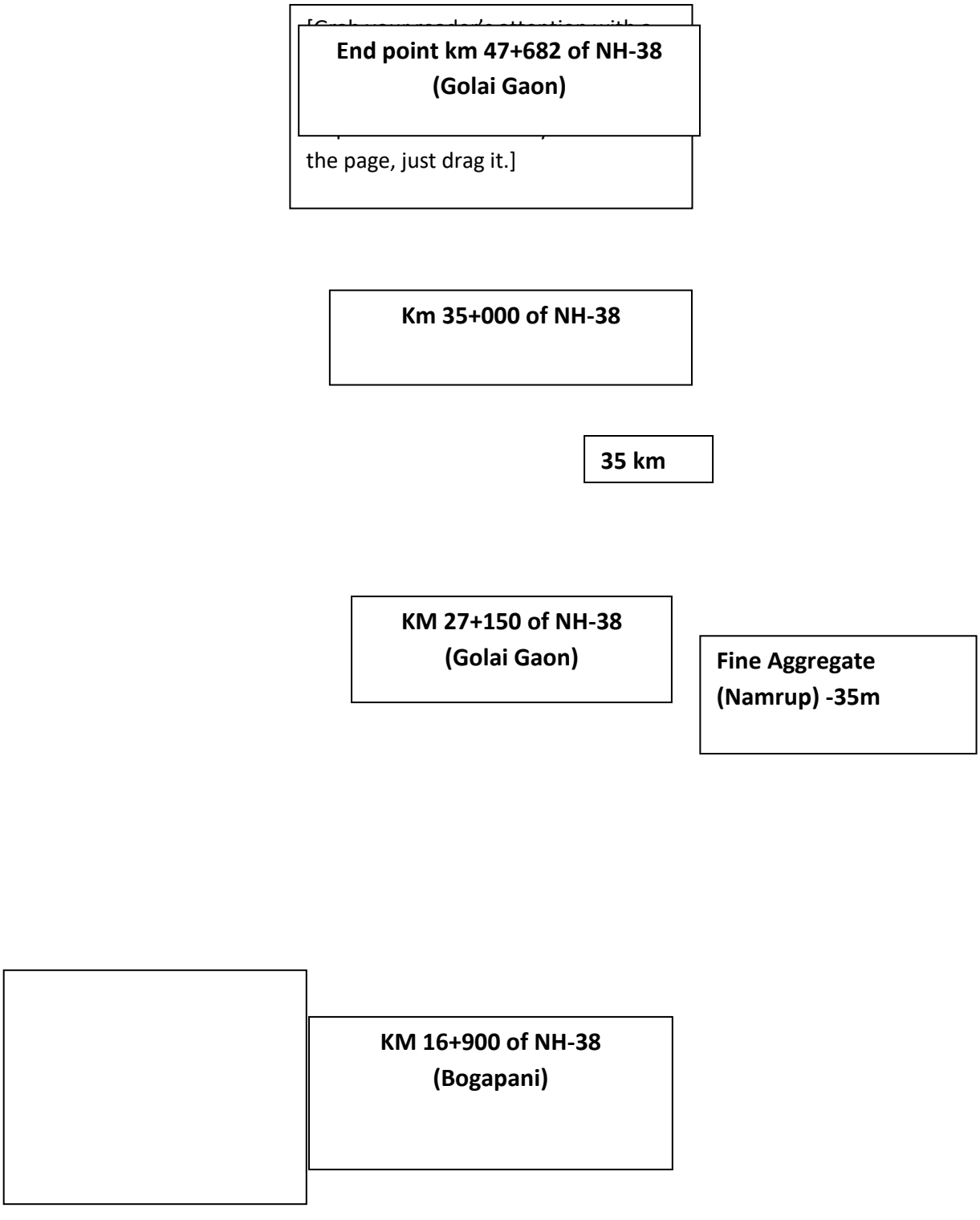


Figure 4.2 : Lead Chart for Quarry Materials



CHAPTER 5

TRAFFIC SURVEY AND ANALYSIS

5.0 TRAFFIC SURVEY AND ANALYSIS

5.1 Introduction

Traffic studies and analyses carried out for consultancy services for preparation of detailed project report for Package IV Lot 1 under Bharatmala Pariyojana are presented in this chapter. The results of analysis will form the inputs for developing capacity augmentation proposals for the project road, design of intersections, design of the pavement, wayside amenities and enhancement of other facilities.

5.2 Road Connectivity

- Existing NH-37 connects Dibrugarh with major towns of Lahowal, Tinsukhia, Makum, and then to Digboi, margareta and Ledo via NH-38. It also connects Doom Dooma, Dhola Sadia and Namsai and other parts of Arunachal Pradesh via NH-52.
- Before opening of the Dibrugarh ROB, majority of the traffic used the existing NH-37 through the towns of Lahowal, Tinsukhia and Makum. However after opening of Dibrugarh ROB majority of traffic got diverted to the existing two lane Bypass of Lahowal, Tinsukhia and Makum.
- The project road follows the existing two lane Bypass from Dibrugarh to Makum and stretches for a length of 62 kms. From Makum the road follows the existing NH-38 till Digboi town stretching to a length of 23 kms.
- A bypass of 31 km is proposed for bypassing the towns of Digboi, Margareta and Ledo

Road network plan is provided in **Figure 5.1**.

5.3 Traffic Homogeneous Sections

Based on traffic volume and nature of traffic flow, the project stretch from Bogibeel Bridge to Ledo has been divided into three traffic homogeneous sections as described in **Table 5.1**.

Table 5.1 : Traffic Homogeneous Sections

Sl No	Homogeneous Section	Description	Existing Chainage
1	HS1	Bogibeel to Makum	km 19+700 of NH-52B to km 652+200 of NH-37
2	HS2	Makum to Digboi	km 652+200 of NH-37 (km 0 of NH-38) to km 23+500 of NH-38
3	HS3	Digboi to Ledo	km 23+500 of NH-38 to km 53 of NH-38

Source: Consultant's study

5.4 Traffic Survey Schedule

In order to capture the traffic flow characteristics and travel pattern along the project road, the Consultant has conducted the following primary surveys:

- Classified Traffic Volume Count
- Origin-Destination Survey
- Speed and Delay Survey
- Turning Movement Survey
- Axle Load Survey

Traffic survey stations were selected by the consultants based on an understanding of the road network and a consideration of the following aspects:

- to represent homogeneous traffic section
- to be outside urban and local influence area
- to be located at a level with good visibility
- O-D stations to be preferably at some police/forest/sales tax barriers for the convenience and safety of stopping vehicles for roadside interview

Traffic survey locations are depicted in **Figure 5.2**. The schedule of survey is given in **Table 5.2**.

Table 5.2 : Schedule of Traffic Survey

Sl No.	Type of Survey	Date of Survey	Period of Survey	Location
1	Mid Block Volume Count	26.07.18 to 01.08.18 (8:00 AM) (8:00 AM)	7 days x 24 hrs	Km 622 of NH37
		26.07.18 to 01.08.18 (8:00 AM) (8:00 AM)	7 days x 24 hrs.	Km 8 of NH38
		26.07.21 to 01.08.21 (8:00 AM) (8:00 AM)	7 days x 24 hrs	Km 37+500 of NH38
		28.12.20 to 29.12.20 (8:00 AM) (8:00 AM)	3 days x 24 hrs	km 48+200 of Lahowal-Chabua Bypass
2	O-D Survey	27.07.18 to 28.07.18 (8:00 AM) (8:00 AM)	1 day x 24 hrs	Km 622 of NH37
		27.07.18 to 28.07.18 (8:00 AM) (8:00 AM)	1 day x 24 hrs	Km 653 of NH37
3	Turning Movement Count Survey at Intersections	28.07.18 to 29.07.18 (10:00 AM) (10:00 AM)	1 day x 24 hrs	Km636+600 of NH37
		28.07.18 to 29.07.18 (8:00 AM) (8:00 AM)	1 day x 24 hrs	Km 0+000 of NH38 & Km 652+200 of NH37

Sl No.	Type of Survey	Date of Survey	Period of Survey	Location
		28.07.18 to 29.07.18 (10:00 AM) (10:00 AM)	1 day x 24 hrs	Km 23+500 of NH38
		28.07.18 to 29.07.18 (10:00 AM) (10:00 AM)	1 day x 24 hrs	Km 24+000 of NH38
4	Speed Delay Survey	30.07.18-31.07.18	-	project road stretch
5	Axle load Survey	27.07.18 to 28.07.18 (8:00 AM) (8:00 AM)	2 days x 24 hrs	Km 622 of NH37

Source: Consultant's schedule

5.5 Methodology of Traffic Survey

5.5.1 Classified Traffic Volume Counts

Classified traffic volume count survey was conducted at four mid-block locations. The count was conducted for a full week spread over 7 consecutive days and 24 hours a day. For carrying out the traffic survey, vehicle classification, as given in **Table 5.3** was adopted.

The survey was conducted using the Video Image Detection ATCC system. Manual counting by trained enumerators was conducted on a sampling basis for auditing the raw ATCC data. Trained supervisors were deployed to supervise the traffic surveys. Trained enumerators supervised by traffic engineers analyzed the video images to record the count data at 15-minute intervals for each vehicle group in each direction of travel.

Table 5.3 : Vehicle Classification System

Motorized Traffic		Non-Motorized Traffic
2 wheelers: : Scooters, bikes, motor cycles, mopeds etc		Bicycle
Auto Rickshaw/ Tempos/ other three wheelers		Cycle Rickshaw/ Rickshaw van
Passenger Car: car, taxi		Hand Cart
Bus	Mini Bus, Standard Bus	Animal Drawn
Truck	Light Commercial Vehicle	
	2 axle Truck	
	3 – Axle Rigid Truck (HCV)	
	Multi axle Truck	
	Agriculture Tractor, Tractor & Trailer	
Other Vehicles	Heavy Construction Machinery	

5.5.2 Origin-Destination Survey

The primary objective of conducting origin-destination survey was analysing the travel pattern of freight and passenger traffic along the study corridor. To assess the influence of states/ regions,

located nearby and those at large distances on the project road traffic, 69 traffic zones were delineated. The road network surrounding the project stretch was studied in detail in order to arrive at a practical zoning system. Origin- Destination zones and commoditiy types, with respective code numbers, are presented in Appendix. OD survey was carried out for 24 hours duration. Roadside interview method was adopted for the survey. The vehicles were stopped on random sample basis with the help of police, and trained enumerators interviewed the drivers/ occupants collecting the required information/ data. The survey was conducted under the guidance of traffic engineers and supervisors. Information pertaining to trip length, trip purpose, occupancy as applicable for various vehicle types were recorded during the survey.

The results are useful for identifying the influence area of the project road, estimating the growth rates of traffic, planning tolling strategies and locating toll plazas on the most viable sections of the project road.

5.5.3 Speed and Delay Survey

The survey was conducted by adopting the Floating car or riding check method. The test vehicle was driven along the project corridor at the perceptible average speed of traffic stream. Observers traveling in the test vehicle noted the number of vehicles overtaking the test vehicle, number of vehicles overtaken by the test vehicle, number of vehicles travelling in direction opposite to the test vehicle, delay time at different locations, journey time. The test vehicle run in both directions of the traffic stream.

5.5.4 Turning Movement Survey

Turning movement survey was conducted at five intersections to obtain information on directional movement of traffic on the project road. The survey was conducted for 24 hours at a stretch to capture the traffic conditions during day and night. Trained enumerators were engaged for conducting the survey. Each turning movement at the intersection was recorded by deploying enumerators at suitable locations.

5.5.5 Axle Load Survey

The survey was carried out at two locations to study the axle load characteristics on the project road. The survey was conducted in both directions for 48 hours at a stretch. Axle load pads were installed at the side of the road in both travel directions. Vehicles were stopped on a sample basis by trained enumerators with the assistance of the District police and guided to the axle load pad. The vehicle type and wheel loads were recorded in prescribed format. The survey was monitored by trained supervisors and Engineers.

5.6 Data Analysis

5.6.1 Traffic Volume Count

Data collected from the site were collated, edited and entered into the computer and analyzed using spread sheet. The various vehicle types having different sizes and characteristics were converted into a single unit called passenger car unit. Passenger Car Unit (PCU) values are adopted from Indian Road Congress publication on "Capacity of Roads in Rural areas", IRC-64-1990. The PCU values used are presented in **Table 5.4**.

Table 5.4 : PCU Factors Adopted for the Study

Vehicle Type	PCU	Vehicle Type	PCU
Passenger Car/ Utility Vehicle	1.0	Tractor	1.5
Mini Bus	1.5	Tractor with Trailer	4.5
Standard Bus	3.0	Two Wheeler	0.5
Light Commercial Vehicle (LCV)	1.5	Auto Rickshaw (Three Wheeler)	1.0
2 Axle Truck (MCV)	3.0	Bullock Cart (small)	6.0
3 Axle Truck (HCV)	3.0	Cycle	0.5
MAV (semi-articulated & articulated)	4.5	Cycle Rickshaw/Rickshaw Van	2.0

Source: IRC 64-1990

The summary of seven day volume counts, in number and PCU, leading to estimation of Average Daily Traffic (ADT) is provided in Appendices.

For the TVC locations at km 37+500 of NH-38 the directional distribution is given in **Table 5.5**.

Table 5.5 : Directional Distribution of Km 8+300 and Km 37+500 of NH-38

Directional Distribution		
TVC Location	Directional distribution in Vehicle Nos	Directional distribution in PCU
	Bogibeel to Ledo : Ledo to Bogibeel	
Km 37+500 of NH-38	53:47	52:48

Source: Consultant's analysis

Average Daily Traffic (ADT)

ADT by vehicle type for km 37+500 of NH-38 are presented in **Table 5.6**.

Table 5.6 : Average Daily Traffic on Project Road at km 37+500 of NH-38 (in Numbers)

Vehicle Type	At km 37+500 of Nh-38 (Traffic in 2021) (HS-3)
Car	2307
Taxi	5
2 Wheeler	2834
3 Wheeler	280
Mini Bus	29
Standard Bus	85
LCV	375
2 Axle	267
3 Axle	192
MAV	55
Tractor	3
Tractor with Trailer	7
Cycle	1169
Cycle Rickshaw	211
Animal Drawn	19
Others	0
Total (numbers)	7838
Total (PCU)	7651

Source: Consultant's analysis

IHMCL data was also collected at a few locations along the project road.

Average Annual Daily Traffic (AADT)

Seasonality factor was determined using the sale of diesel and petrol at petrol pumps along/near the project road. Seasonality correction factor (SCF) used to calculate the AADT is presented in

Table 5.7.

Table 5.7: Seasonality Correction Factor (SCF)

Vehicle Type	Car	Taxi	Shared Auto	Two Wheeler	Three Wheeler	Mini Bus	Standard Bus	LCV	2-Axle
SCF	0.98	0.95	1.02	1.02	1.02	0.95	0.95	0.95	0.95
Vehicle Type	**3-Axle**	**MAV**	**Tractor**	**Tractor with Trailer**	**Cycle**	**Cycle Rickshaw**	**Animal cart**	**Others**	
SCF	0.95	0.95	0.95	0.95	1.00	1.00	1.00	1.00	

Source: Consultant's analysis

The AADT obtained for the existing ADT for different vehicle types at Km 622 of NH37, and at km 48+200 of Lahowal-Chabua bypass are presented in **Table 5.8**.

Table 5.8 : Average Annual Daily Traffic on Project Road at km 37+500 of NH-38 (in Numbers)

Vehicle Type	At km 37+500 of NH-38 (Traffic in 2021) (HS-3)
Car	2264
Taxi	5
2 Wheeler	2881
3 Wheeler	285
Mini Bus	27
Standard Bus	80
LCV	355
2 Axle	253
3 Axle	182
MAV	52
Tractor	3
Tractor with Trailer	7
Cycle	1169
Cycle Rickshaw	211
Animal Drawn	19
Others	0
Total (numbers)	7792
Total (PCU)	7500

Source: Consultant's analysis

Traffic Survey conducted by IHMCL on NH-38 i.e. the project road of Sec-4 dated Jan 2022. The details are provided below:

TVC-3 KM 4+100 (NH-38)															
Survey Period	**Bicycle**	**2 Wheeler**	**3 Wheeler**	**Tractor**	**Tractor with Trailer**	**SCV 2 Axle Small Commercial Vehicle**	**LMV 2 Axle Light Motor Vehicle**	**LCV 2 Axle Light Commercial Vehicle**	**2 Axle Truck or Bus**	**3 Axle Truck or Bus**	**Multi Axle Vehicles (MAV)**	**Oversized Vehicle (OSV)**	**Cycle Rickshaw**	**Construction Equipment**	**Total**
1/7/2022	862	2846	350	0	4	798	3102	284	688	110	100	0	0	3	**9147**
1/8/2022	813	2644	338	2	8	717	3088	269	673	152	124	0	9	4	**8841**
1/9/2022	721	2588	479	1	1	534	3551	142	345	132	131	0	3	0	**8628**
Grand Total	**2396**	**8078**	**1167**	**3**	**13**	**2049**	**9741**	**695**	**1706**	**394**	**355**	**0**	**12**	**7**	**26616**

5.6.2 Analysis of OD Survey Data

Travel Pattern

The travel pattern of vehicles along the project corridor was studied. The data collected from the field was subsequently grouped according to origin and destination of vehicles, which led to development of the zoning system.

Zoning System

Origin-Destination (OD) analysis is required for designation of the PIA in terms of codified origin and destination zones. It is thus important to code the trips recorded at site for origin and destination zones. The zoning, emanating from the understanding of the surrounding road network and the travel pattern of the vehicles by the consultants, was done in four levels.

In the first level, all-important towns located along the project stretch were assigned zone code. Secondly, immediate influence areas of project road were considered and nearby areas/ towns were defined as separate zones. In next level, all nearby district were grouped in different zones. Finally, states beyond the influence area were aggregated broadly in terms of direction and entry point to the project road.

Zone list is provided in Appendices in Volume-II.

Commodity Groups

Due consideration was given to include all possible commodities moving along the project road and to categorize them into homogeneous groups.

Data Coding and Checking

The collected data were coded and computerized. Checking of data for incorrect entries and coding was carried out by cross checking with original field data sheets. The data were also checked for inconsistencies. The checking included:

- Code number exceeding highest code
- Matching vehicle type with commodity carried
- Vehicle type with their corresponding lead/load/occupancy for any inconsistencies

Development of Origin-Destination Matrices

After coding of Origin and Destination data, expansion factors were calculated by comparing the sample size collected for each vehicle type with traffic count data. After calculating expansion factors, vehicle-wise O-D matrices were developed. On the basis of O-D matrices, travel pattern of the vehicles moving on the project road was determined.

Commodity Analysis

Commodity movement pattern shows that there is considerable movement of petroleum products, finished and manufactured products. Significant movement of food grains, other agricultural products, fruits and vegetables is also observed. A large proportion of empty vehicles was recorded at the location.

Mode-wise distribution of various commodities observed at km 622 of NH-37, km 653 of NH-37 are presented in **Table 5.12A and5.12B** respectively.

Table 5.12A : Vehicle wise Commodity Distribution (in Percentage) at km 622 of NH-37

Sl No	Commodities	LCV	MCV	HCV	MAV
1	Food grains and other agricultural products	2	1	0	0
2	Fruits, vegetables - perishables	4	0	0	0
3	Wood and Forest Products	1	0	0	0
4	Petroleum, oil, gas, lubricants	2	4	2	6
5	Minerals, chemicals, fertilizer	3	1	0	0
6	Iron , Metal, Steel	0	0	0	0
7	Finished and manufactured products	5	2	1	1
8	Parcel Service & Containers	1	1	0	0
9	Building materials	0	0	0	0
10	Mining (Sand, Bajri, Coarse Aggregate)	0	1	0	1
11	Cement	1	0	0	0
12	Miscellaneous goods (Livestock, Waste, paper etc)	4	2	0	2
13	Empty vehicles	32	10	3	4

Source: Consultant's analysis

Table 5.12B: Vehicle wise Commodity Distribution (in Percentage) at km 653 of NH-37

Sl No	Commodities	LCV	MCV	HCV	MAV
1	Food grains and other agricultural products	14	10	3	1
2	Fruits, vegetables - perishables	1	1	0	0
3	Wood and Forest Products	1	1	0	0
4	Petroleum, oil, gas, lubricants	2	1	1	1
5	Minerals, chemicals, fertilizer	1	1	0	0
6	Iron , Metal, Steel	2	1	0	1
7	Finished and manufactured products	3	2	1	1
8	Parcel Service & Containers	2	0	0	0
9	Medicines	0	0	0	0
10	Building materials	1	0	0	0
11	Mining (Sand, Bajri, Coarse Aggregate)	1	1	1	1

Sl No	Commodities	LCV	MCV	HCV	MAV
12	Cement	0	0	0	0
13	Miscellaneous goods (Livestock, Waste, paper etc)	2	2	1	1
14	Empty vehicles	16	9	5	5

Source: Consultant's analysis

Passenger Vehicle

The analysis of passenger vehicles recorded at Km 622 of NH-37 shows that 30% traffic circulates within Dibrugarh district (Assam). Traffic between Dibrugarh and Tinsukia districts is 56%, between Tinsukia and Rest of Assam 6%. Spatial distribution of passenger trips at km 622 of NH-37 is presented in **Table 5.13A**.

Table 5.13A : Major Distribution of Passenger Vehicle at km 622 of NH-37

Between	% Share
Within Dibrugarh	30
Within Tinsukia	4
Dibrugarh - Tinsukia	45
Dibrugarh - Rest of Tinsukia	11
Dibrugarh - Rest of Assam (Except Tinsukia)	3
Tinsukia - Guwahati	1
Tinsukia - Rest of Assam (Except Dibrugarh, Guwahati)	6
Assam - Arunachal Pradesh	1

Source: Consultant's analysis

The analysis of passenger vehicles recorded at Km 653 of NH-37 shows that 44% traffic circulates within Tinsukia district (Assam). Traffic from Dibrugarh to Tinsukia districts is 13% and from Tinsukia to Doom Dooma is 20%. Spatial distribution of passenger trips at km 653 of NH-37 is presented in **Table 5.13B**.

Table 5.13B : Major Distribution of Passenger Vehicle at km 653 of NH-37

Between	% Share
Tinsukia village to Doom Dooma	20
Within Tinsukia (Except Doom Dooma & Tinsukia)	44
Tisukia to Assam (Except Dibrugarh)	4
Tinsukia to Arunachal Pradesh	8
Within Dibrugarh	0
Dibrugarh to Tinsukia	13
Dibrugarh to Arunachal Pradesh	2
Assam to Arunachal Pradesh (Except Dibrugarh & Tinsukia)	2

Source: Consultant's analysis

Desire line diagram for Passenger vehicles are presented in **Figure 5.9A to 5.9B** for the above three locations respectively.

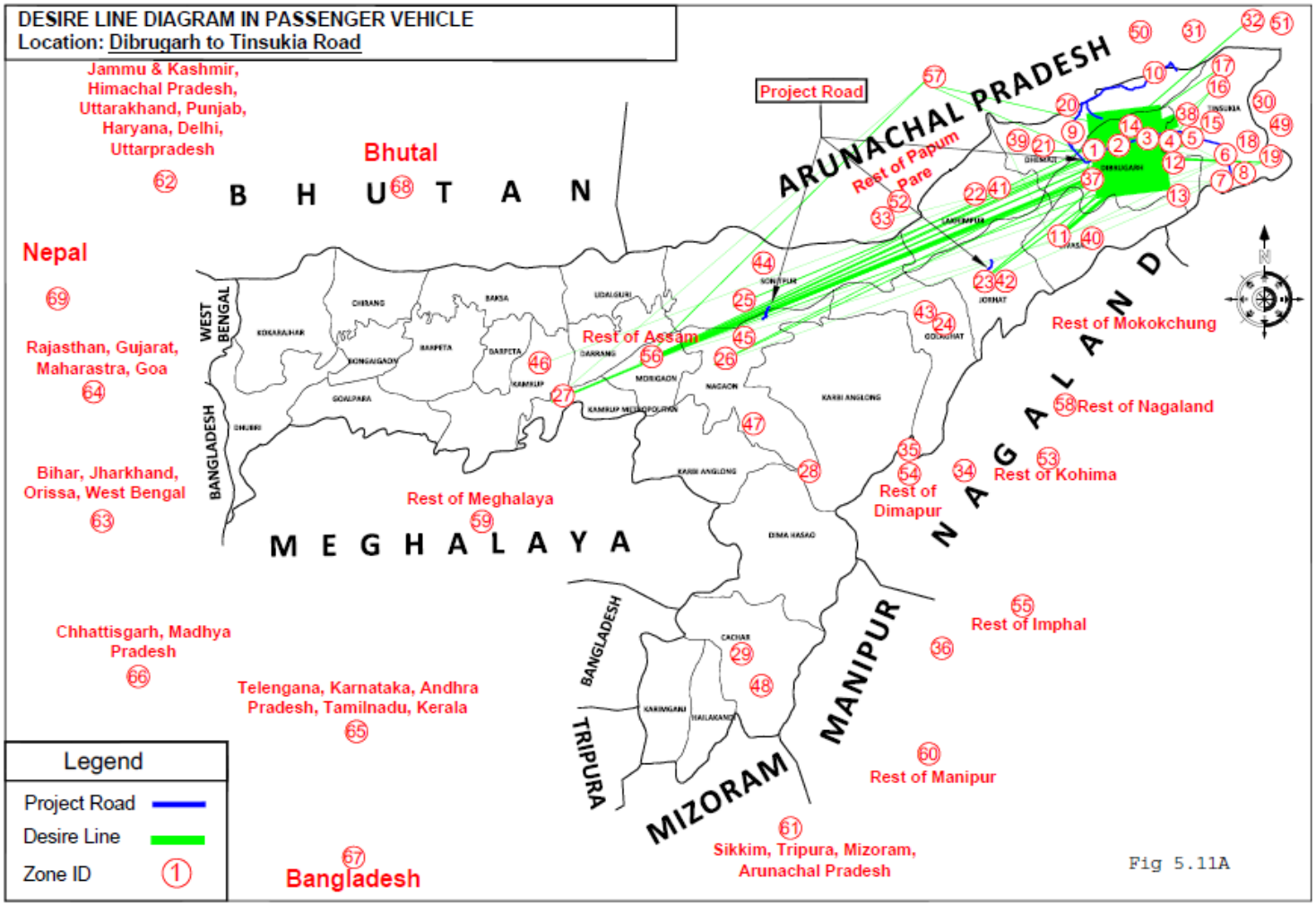


Figure 5.9A : Desire Line Diagram for Passenger Vehicles for km 622 of NH-37

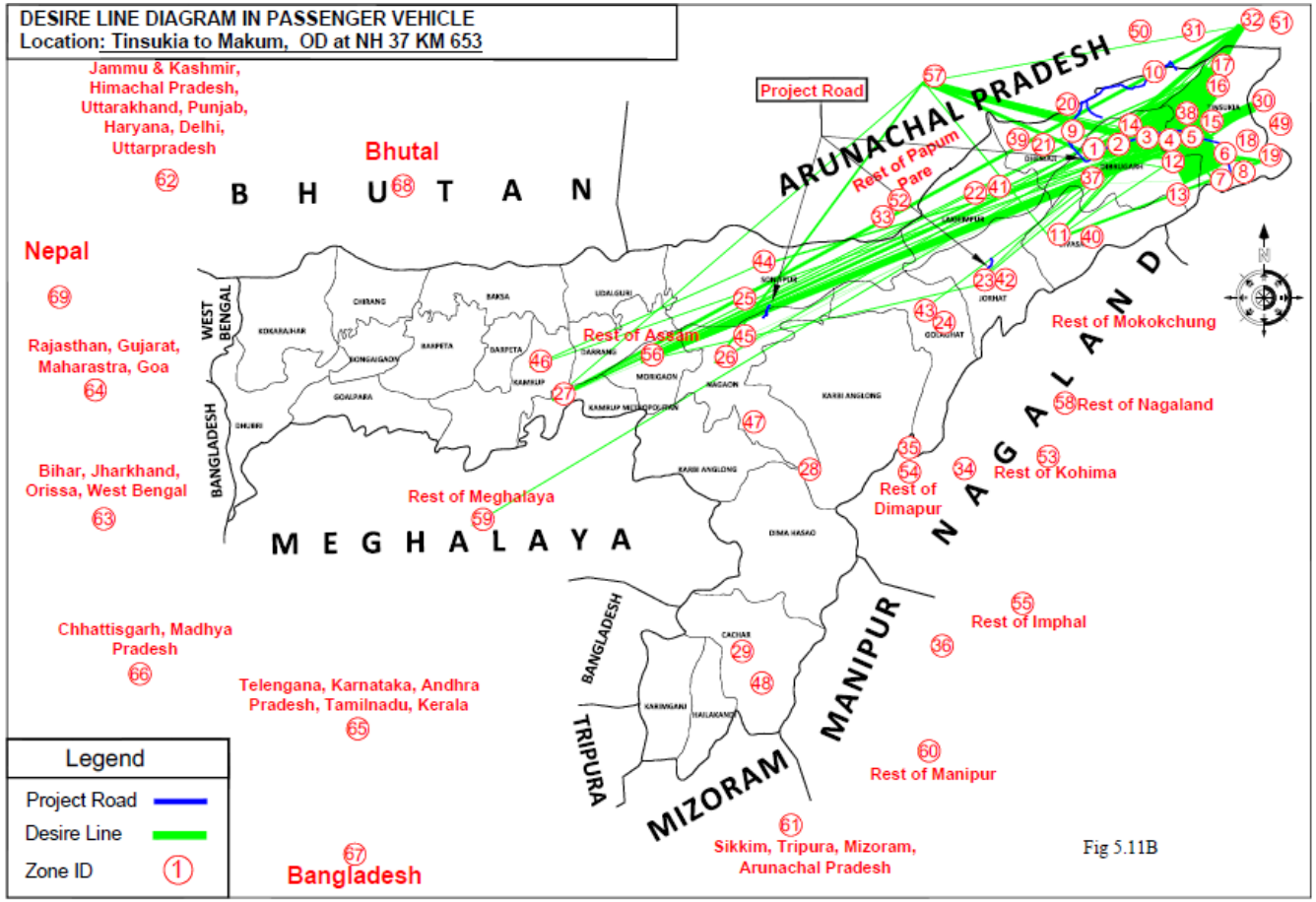


Fig 5.11B

Figure 5.9B : Desire Line Diagram for Passenger Vehicles for km 653 of NH-37

Freight Vehicles

Analysis of goods vehicles at km 622 of NH-37 reveals that 20% trips circulate within Dibrugarh. Trips plying between Dibrugarh and Tinsukia districts account for 52% of freight trips. **Table 5.14A** shows the distribution of freight trips at the location.

Table 5.14A : Major Distribution of Goods Vehicle at km 622 of NH-37

Between	% Share
Within Dibrugarh	20
Within Tinsukia	6
Dibrugarh - Tinsukia	34
Dibrugarh - Rest of Tinsukia	18
Dibrugarh - Rest of Assam (Except Tinsukia)	3
Tinsukia - Guwahati	5
Tinsukia - Rest of Assam (Except Dibrugarh, Guwahati)	9
Assam - Arunachal Pradesh	3

Source: Consultant's analysis

Analysis of goods vehicles at km 653 of NH-37 reveals that 62% trips circulate within Tinsukia. Trips plying from Tinsukia to Doom Dooma account for 20% of freight trips. **Table 5.14B** shows the distribution of freight trips at the location.

Table 5.14B : Major Distribution of Goods Vehicle at km 653 of NH-37

Between	% Share
Tinsukia village to Doom Dooma	20
Within Tinsukia (Except Doom Dooma & Tinsukia)	62
Tisukia to Assam (Except Dibrugarh)	10
Tinsukia to Arunachal Pradesh	3
Within Dibrugarh	0
Dibrugarh to Tinsukia	5

Source: Consultant's analysis

Desire line diagram for Goods vehicles are presented in **Figure 5.10A to 5.10B** for the above three locations respectively.

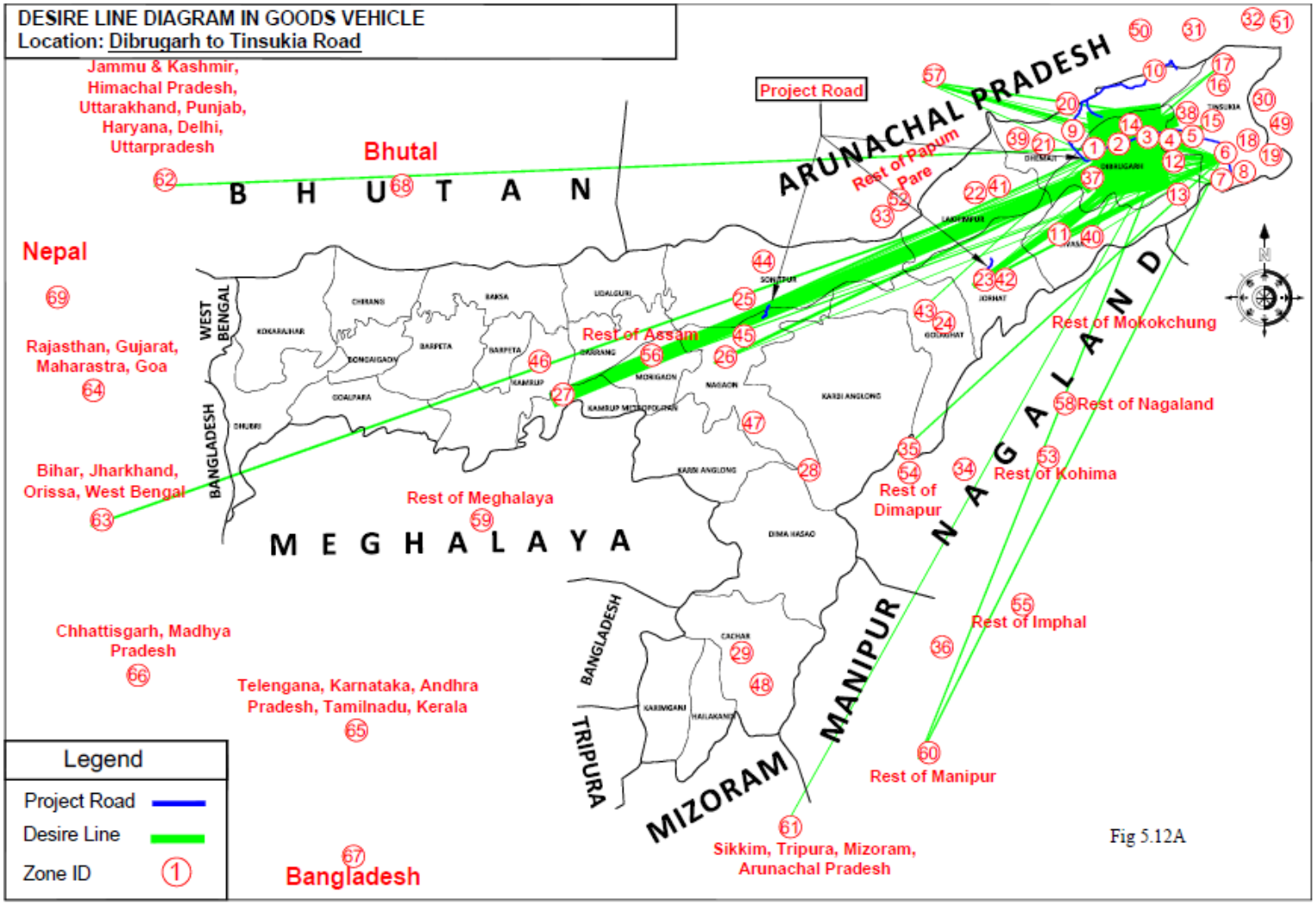


Figure 5.10A : Desire Line Diagram for Goods Vehicles for km 622 of NH-37

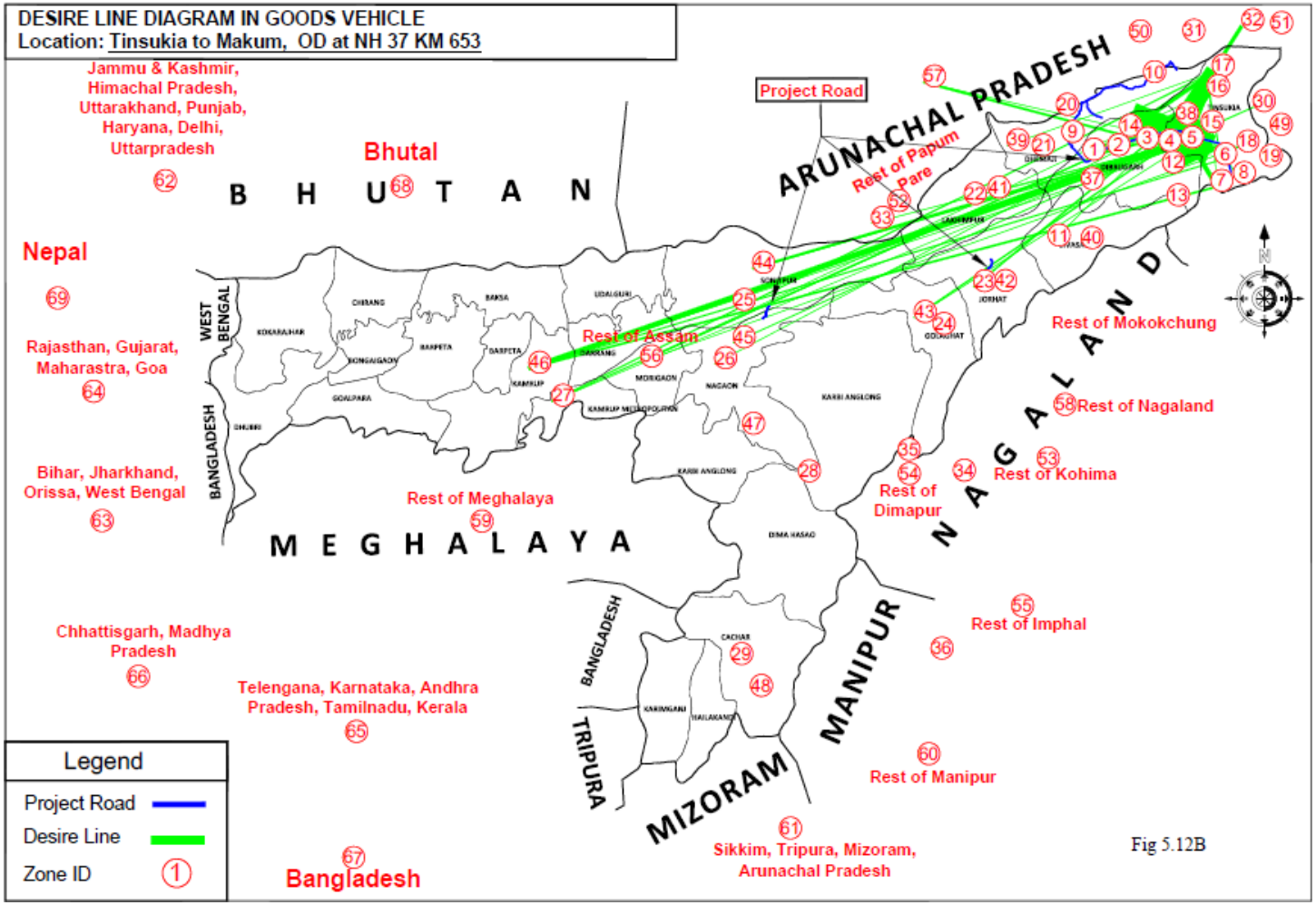


Figure 5.10B : Desire Line Diagram for Goods Vehicles for km 653 of NH-37

Occupancy and Trip Purpose

Average occupancy for passenger cars and buses at km 622 of NH-37 is observed as 4 and 35 respectively. The distribution of car passengers by trip purpose at the OD location is shown in **Table 5.15A**. Trips related to work or business is 79% at the location.

Table 5.15A : Distribution of Car Passengers by Trip Purpose at km 622 of NH-37

Trip Purpose	Percentage of Car Trips at km 622 of NH-37
Work	43
Education	1
Business	36
Social	0
Others	19

Source: Consultant's analysis

Average occupancy for passenger cars and buses at km 653 of NH-37 is observed as 5 and 27 respectively. The distribution of car passengers by trip purpose at the OD location is shown in **Table 5.15B**. Trips related to work or business is 72% at the location.

Table 5.15B : Distribution of Car Passengers by Trip Purpose at km 653 of NH-37

Trip Purpose	Percentage of Car Trips at km 653 of NH-37
Work	28
Education	0
Business	44
Social	11
Others	17

Source: Consultant's analysis

Lead Distribution

The lead distribution of vehicles at the OD survey locations is given in **Table 5.16A-5.16B**.

Table 5.16A : Trip Lead Distribution at km 622 of NH-37

Vehicle Type	Lead in km							
	0-20	20-50	50-100	100-200	200-500	500-1000	>1000	Total
Car	20.9	36.9	37.4	3.8	1.0	0.1	0.0	100.0
Bus	11.1	24.9	59.0	3.6	1.4	0.0	0.0	100.0
LCV	59.4		32.1	5.9	2.6	0.0	0.0	100.0
MCV	61.9		28.8	7.3	0.0	2.1	0.0	100.0
HCV	44.9		42.1	8.1	0.0	4.9	0.0	100.0
MAV	32.8		46.4	4.9	1.3	14.6	0.0	100.0

Source: Consultant's analysis

Table 5.16B : Trip Lead Distribution at km 653 of NH-37

Vehicle Type	Lead in km							
	0-20	20-50	50-100	100-200	200-500	500-1000	>1000	Total
Car	34.7	26.3	31.6	6.1	1.1	0.2	0.0	100.0
Mini Bus	56.4	2.4	26.6	14.6	0.0	0.0	0.0	100.0
Bus	12.6	17.6	44.0	14.5	4.4	6.9	0.0	100.0
LCV	73.2		22.4	2.4	2.0	0.0	0.0	100.0
MCV	83.0		15.0	1.4	0.7	0.0	0.0	100.0
HCV	80.2		16.9	0.0	3.0	0.0	0.0	100.0
MAV	84.5		10.1	5.5	0.0	0.0	0.0	100.0

Source: Consultant's analysis

It is evident that passenger and goods vehicles have different trip characteristics.

5.6.3 Analysis of Turning Movement Count Survey

Turning movement count survey was conducted at five major intersections along the project road. The 24 Hour Classified Traffic Volume Count, Peak Hour Traffic and flow diagrams are presented in Appendices. Peak hour, peak hour PCUs and vehicles are separately provided in given in **Table 5.17**.

Table 5.17 : Peak Hour Traffic

Junction	Type	Peak Hour	Peak Hour Traffic in 2017 (Vehicles)	Peak Hour Traffic in 2017 (PCU)	Total Traffic (PCU)
km 23+500 of NH-38	3 Leg	11am – 12pm	953	976	11152
km 24+000 of NH-38	3 Leg	10am – 11am	1238	1143	11755

5.6.4 Analysis of Speed and Delay Survey

Speed-delay survey data was analyzed to derive the mean journey and running speed of the corridor. It is seen that mean journey and running speed for Dibrugarh to Ledo is 35.7 and 41.8 kmph respectively.

5.6.5 Analysis of Axle Load Survey

Summary of VDF as obtained from axle load survey is presented in Chapter 4 of this report.

5.7 Traffic Forecast

Investment priorities are governed by the traffic demand, assessed benefits and cost of the project. Demand plays the important role, governing which type of facility / infrastructure needs to be created. A highway project of this nature calls for significant investment. Thus prediction of traffic demand becomes an important task which necessitates realistic estimation of traffic growth rates. Accurate estimation of traffic has direct bearing on the viability of the project. Recognizing this, efforts need to be made to carefully assess all the parameters that help in predicting the traffic demand. Transport demand changes due to shifts in the pattern of economic activities in the surrounding regions. Hence, traffic estimation necessitates a preview of the probable pattern of future growth of the economy. In this project, traffic growth rates have been estimated using elasticity method as per IRC: 108.

5.7.1 Past Vehicle Registration Details

It is revealed from OD survey that traffic in the project stretch is mainly influenced by Assam and also by Nagaland to some extent. For establishing traffic growth rates, economic data of Assam and Nagaland state have been considered. The vehicle registration data of Assam and Nagaland are presented in **Table 5.18**.

Table 5.18 : Past Vehicle Registration Data of Assam and Nagaland

Year	Car / Jeeps	Two Wheelers	Bus	Commercial Vehicles
Assam				
2012-13	49,611	145,010	1,091	222,942
2013-14	48,513	167,602	1,102	243,780
2014-15	57,085	189,102	1,109	282,709
2015-16	28,118	206,135	1,556	188,144
2016-17	63,891	203,413	1,419	252,350
CAGR	6.5	8.8	6.8	3.1
Nagaland				
2013-14	128,597	70,873	6,876	108,689

Year	Car / Jeeps	Two Wheelers	Bus	Commercial Vehicles
2014-15	134,210	75,158	6,919	114,120
2015-16	146,398	81,482	7,268	139,202
CAGR	6.7	7.2	2.8	13.2

Source: India Stat Organization, Central Statistical Organization and various websites of state governments

5.7.2 Past Growth of the Economy

Growth of traffic on the project road is influenced by the existing development and future growth prospects of the project influence area (PIA). The time series data of state income NSDP at constant prices, state population, per-capita income of PIA states have been collected and analyzed to assess the past performance of the influencing state economies. **Table 5.19** and **Table 5.25** depicts these economic indicators.

Table 5.19 : Economic Indices of Assam at Constant Prices (2011-2012)

Year	Indices of Assam		
	NSDP	PCI	Population
2012-13	13,251,760	46,247	30,945,000
2013-14	13,872,476	49,339	31,319,000
2014-15	14,931,269	52,601	31,693,000
2015-16	16,072,406	56,003	32,069,000
2016-17	17,892,900	60,126	32,132,440
CAGR	7.8	6.8	0.95

Source: of www.indiastat.com, Office of the Registrar General & Census Commissioner, ministry of statistics and programme implementation and various websites of state governments

Table 5.20 : Economic Indices of Nagaland at Constant Prices (2004-2005)

Year	Indices of Nagaland		
	NSDP	PCI	Population
2013-14	988,690	49,962	2,700,000
2014-15	1,052,220	51,887	2,860,000
2015-16	1,120,253	61,363	2,920,000
CAGR	6.4	10.8	4.0

Source: of www.indiastat.com, Office of the Registrar General & Census Commissioner, ministry of statistics and programme implementation and various websites of state governments

5.7.3 Transport Demand Elasticity

As discussed earlier, the elasticity approach has been used for determining growth rates of future traffic. Since time series traffic data on project road is not available, traffic growth rates and elasticity values are established by using registered vehicles by type as the dependent variables and economic parameters as independent variables.

5.7.4 Description of Regression Analysis

The Regression Analysis tool performs linear regression analysis by using the "least squares" method to fit a line through a set of observations. It analyzes how a single dependent variable is affected by the values of one or more independent variables. In the present case, registered vehicles by type are the dependent variables whereas the economic parameters are independent variables. Regression analysis is carried out by creating econometric models suggested in IRC: 108. The explanatory variable used for different vehicle categories and the elasticity coefficient for each vehicle class obtained from Regression Analysis are presented in **Table 5.21**.

5.7.5 Traffic Forecasting Methodology

Growth rates of a vehicle class 'a' in a particular state 'i' is calculated from Eqn (a).

$G_{ai} = R_i x E_{ai}$ ..... Eqn (a)

where
G_{ai} = growth rates of vehicle class 'a' in state 'i'
R_i = growth rate of economic indicator in state 'i'
E_{ai} = elasticity coefficient for vehicle class 'a' in state 'i'
Traffic growth rates for Assam and Nagaland calculated from Regression Analysis is presented in **Table 5.21**.

Table 5.21 : Traffic Growth Rate for Assam and Nagaland calculated from Regression Analysis

Mode	Explanatory Variable (EV)	Average Growth Rate of EV	Elasticity	Growth Rate of Vehicle (%)	Correlation Coefficient
Assam					
Two-Wheeler	PCI	6.8	1.35	9.14	0.94
Car	PCI	6.8	0.004	0.03	0.001
Bus	Population	0.9	8.83	8.36	0.84
Trucks	NSDP	7.8	0.002	0.016	0.002
Nagaland					
Two-Wheeler	PCI	11.06	0.62	6.84	0.97

Mode	Explanatory Variable (EV)	Average Growth Rate of EV	Elasticity	Growth Rate of Vehicle (%)	Correlation Coefficient
Assam					
Car	PCI	11.06	0.60	6.60	0.99
Bus	Population	4.01	0.58	2.32	0.77
Trucks	NSDP	6.45	1.98	12.77	0.94

Source: Consultant's analysis

Growth rate of a vehicle class for the project is given by

$$G_{ap} = \sum G_{ai} x I_{ai}$$

where G_{ap}= growth rate of vehicle class 'a' for the project
G_{ai}= growth rates of vehicle class 'a' in state 'i'
I_{ai} = influence factor for vehicle class 'a' in state 'i'.
The Influence Factor for different states is estimated from OD survey analysis.

5.7.6 Traffic Growth Rates

Based on past trend of economic performance, development potential and development thrust in the region three traffic growth scenarios are envisaged. Traffic growth rates for the most likely scenario, optimistic scenario and pessimistic scenario are presented in **Table 5.22-5.24**.

Table 5.22: Traffic Growth Rates in Most Likely Scenario

S.No.	Year	2/3 Wheeler	Car	Bus	LCV/2 Axle Truck	3 Axle Truck	MAV
1	2018-2020	8.6	7.5	7.6	7.1	7.0	7.0
2	2021-2025	8.3	7.4	7.4	6.9	6.8	6.8
3	2026-2030	7.7	6.1	5.7	6.1	5.8	5.8
4	Beyond 2030	6.7	5.3	5.1	5.5	4.8	4.8

Source: Consultant's analysis

Table 5.23: Traffic Growth Rates in Optimistic Scenario

S.No.	Year	Two Wheeler/Three Wheeler	Car	Bus	LCV/2 Axle Truck	3 Axle Truck	MAV
1	2018-2020	10.6	9.5	9.6	9.1	9.0	9.0
2	2021-2025	10.3	9.4	9.4	8.9	8.8	8.8
3	2026-2030	9.7	8.1	7.7	8.1	7.8	7.8
4	Beyond 2030	8.7	7.3	7.1	7.5	6.8	6.8

Source: Consultant's analysis

Table 5.24 : Traffic Growth Rates in Pessimistic Scenario

S.No.	Year	Two Wheeler/Three Wheeler	Car	Bus	LCV/2 Axle Truck	3 Axle Truck	MAV
1	2018-2020	6.6	5.5	5.6	5.1	5.0	5.0
2	2021-2025	6.3	5.4	5.4	4.9	4.8	4.8
3	2026-2030	5.7	4.1	3.7	4.1	3.8	3.8
4	Beyond 2030	4.7	3.3	3.1	3.5	2.8	2.8

Source: Consultant's analysis

The slow moving vehicles essentially cater to short haul traffic, meeting localised demand for transportation. Non–motorised traffic will be gradually replaced by motorised vehicles with economic improvement. Therefore nonmotorized vehicles are expected to decline by a negative growth rate of -2% per annum. Growth rates of tractors have been considered at 2% per annum.

However, the Traffic Projections are done considering the CAGR of 5% for all types of traffic.

5.7.7 Diverted Traffic

A study of the road network reveals that diversion of traffic from or to the project road is not expected.

5.7.8 Generated Traffic

No proposed industrial development is reported in the project area. Hence generated traffic is not considered.

5.7.9 Total Traffic

Total traffic was estimated for the homogeneous sections as the sum of normal, diverted and generated traffic.

5.7.10 Traffic Projection

Based on the traffic growth rates of 5% CAGR, estimated, the existing traffic volume (expressed in AADT) including the generated traffic and diverted traffic was projected for thirty years of operation. The final projected traffic for the project road sections for a particular year is the sum of projected normal traffic using the estimated rate of growth, diverted traffic and generated traffic.

Table 5.25 presents the total traffic on homogeneous sections for the cardinal years considering traffic growth rates of 5% CAGR.

5.8 Traffic Projection:

Projection of Traffic for 30 years with growth rate as obtained in **Most Likely scenario** is presented in **Table 5.25.**

Table 5.25: Traffic Growth Rates in Most Likely Scenario

Year	2021	2023	2028	2033	2038	2043	2048
Total Traffic (PCU) at km 37+500 of Nh-38	7500	8334	11036	14887	20336	28014	38810

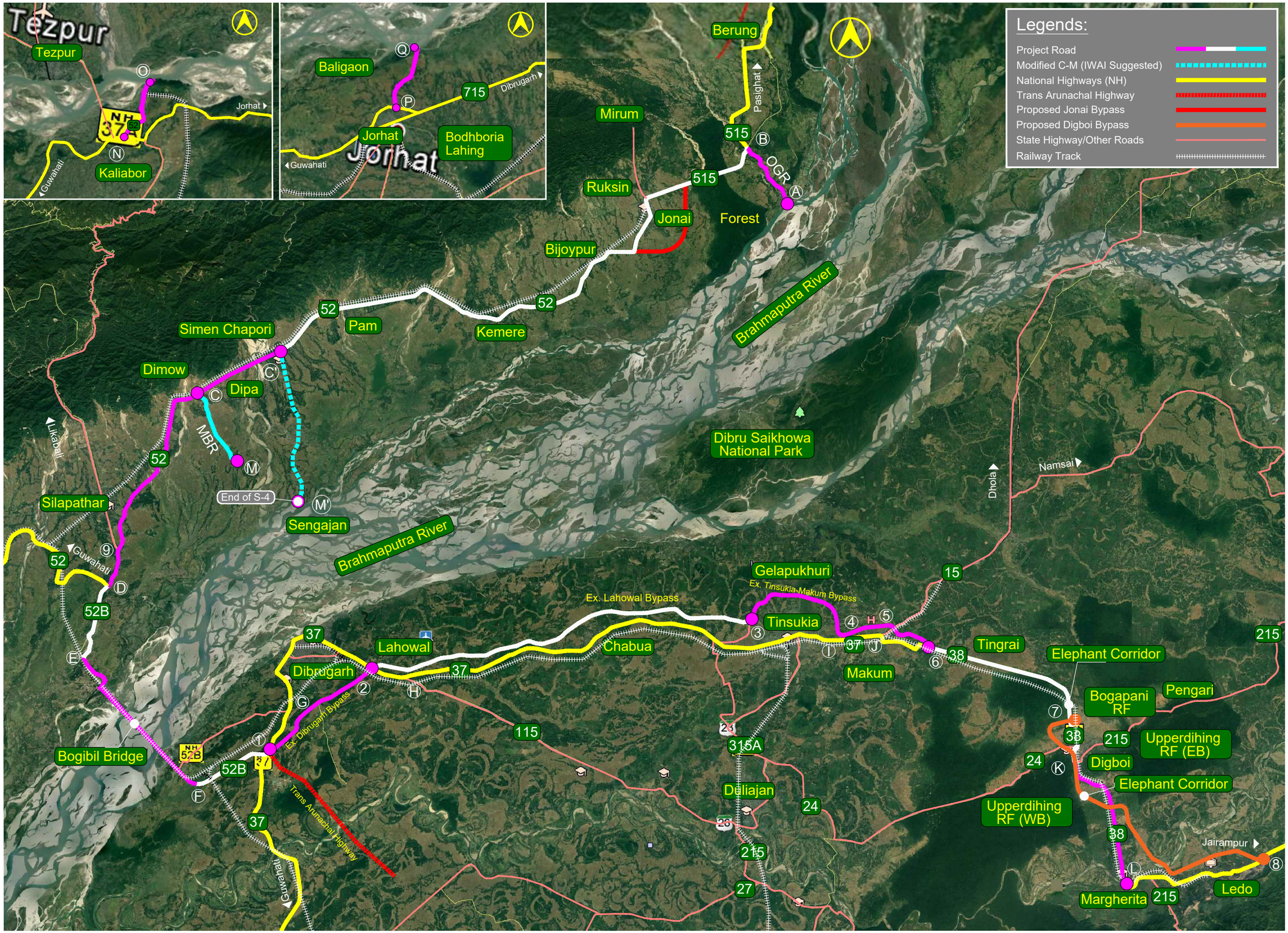
Based on the traffic **growth rates of 5% CAGR**, estimated, the existing traffic volume including the generated traffic and diverted traffic was projected for thirty years of operation. The final projected traffic for the project road sections for a particular year is the sum of projected normal traffic using the estimated rate of growth, diverted traffic and generated traffic mentioned in **Table 5.26.**

Table 5.26: Traffic Growth Rates as Per 5% CAGR

Year	2021	2023	2028	2033	2038	2043	2048
Total Traffic (PCU) at km 37+500 of Nh-38	7500	8269	10553	13469	17190	21939	28001

Table 5.27: Traffic projection in the year of opening

Road Segment	Traffic in Base Year in PCU	Traffic in Year of Opening (2023) in PCU	Recommendation
At km 37+500 of Nh-38	7500	8269	2-Lane with Paved Shoulder from opening year (2023)



Note:
The current project road will follow Dibrugarh, Lahowal & Tinsukia-Makum bypass.

Figure 5.1 : Road Network Plan

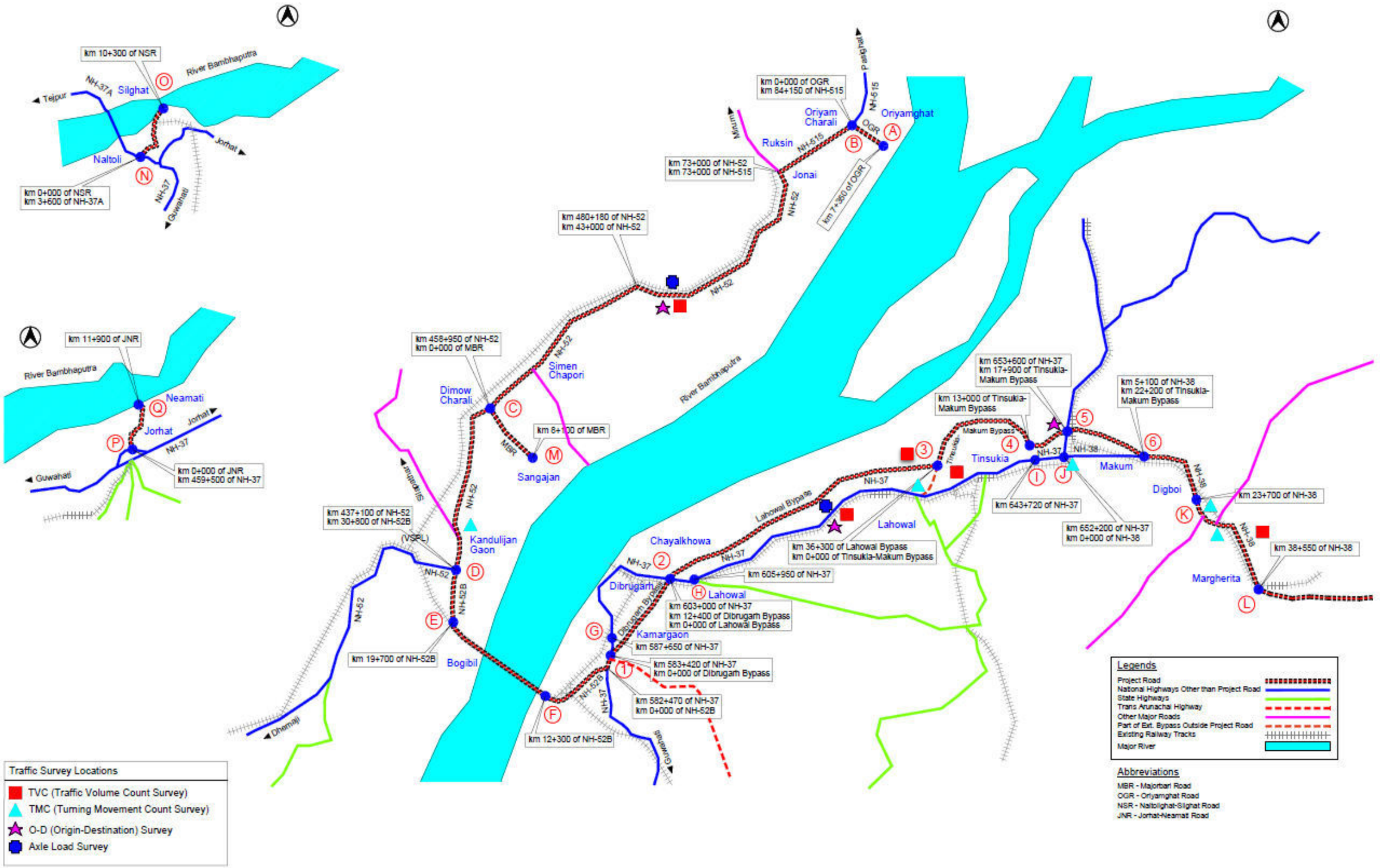


Figure 5.2
Traffic Survey Location Map
Scale - NTS

CHAPTER 6

DEVELOPMENT PROPOSALS

6.0 Development Proposals

6.1 General

The salient proposals for up-gradation and improvement of the project road are classified into the following engineering aspects:

Where Proposed Alignment Overlaps with Existing Roads

- In general, in this section of proposed stretch follows existing Sections.
- Widening of the project road based on traffic capacity/requirement.
- Improving the horizontal geometry of the existing road based on the design standards as per IRC: SP: 84-2019
- Design of new pavement for widening and realignment of the existing road.
- Provision of overlay at strengthening stretches.
- Improvement of all major and minor intersections.
- Rehabilitation and widening of the existing structures including bridges, culverts etc. and design of new ones as per requirement.
- Provision of comprehensive road furniture for complete road safety measures.

6.2 Geometric Improvement

6.2.1 Codes and Guidelines

The design criteria / method applied for important components of the project are as follows:

Geometric Design : IRC: 73-1980 Geometric design standard for rural highways
IRC and other relevant IRC Codes and guidelines on geometric design.
IRC:SP- 73-2018- Manual for 2-laning with paved shoulder

Pavement Design : Overlay
- IRC 115-2014 for designing and strengthening requirements of existing pavement

New Pavement
- IRC 37-2018 for design of flexible pavements
- IRC 58-2015 for design of rigid pavements

Road Furniture & Roadside Facilities	:	Related standards of IRC Manual of Specification & MoRT&H publications

The Codes and references as per the following table are followed for the Design of the structures for the project stretch.

IRC:5-2015	Standard Specification & Code of Practice for Road Bridges, Section I - General Features of Design (7th Revision)
IRC:6-2017	Standard Specifications & Code of Practice for Road Bridges, Section II - Loads & Stresses (Fourth Revision)
IRC:78-2014	Standard Specifications & Code of Practice for Road Bridges, Section VII – (Foundations & Substructure Second Revision)
IRC:83-2015	Standard Specifications & Code of Practice for Road Bridges, (Part II Section IX – Elastomeric Bearings, Part-III: POT POT-CUM-PTFE, PIN AND METALLIC GUIDE BEARING)
IRC: 112 -2011	Code of Practice for Concrete Road Bridges
IRC: SP:69-2005	Guidelines & Specifications for Expansion Joints
MORTH	Specification for Road and Bridge Works – 2013 (Ministry of Road Transport & Highways)
IS:1786-1985	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
IS: 800:2007	General Construction in Steel - Code of Practice
IS:432-1982	Mild Steel & Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement: Part I – Mild Steel and Medium Tensile Steel Bars
IS:2062-2011	Hot Rolled Medium and High Structural Steel-Specifications.
IS:2911 (Part-I/ Sec 2)	Design and Construction of Pile Foundation – Concrete Piles Bored Cast-in-situ
IS:2911 (Part-IV)	Load Test of Piles
IS:14268-1995	Uncoated Stress Relieved Low Relaxation Seven-Ply Strands for Pre-stressed Concrete
IS:2502-1963	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS:13920-1993	Ductile Detailing

6.2.2 Design Concept

Following points have been considered during preparation of layout at this stage:

- Minimum curvature as compatible to 100 to 80 kmph design speed, in general at normal section;
- Safe distance from village limits to avoid acquisition of structures as far as possible;
- Safe distance from religious structures and other sensitive features like schools, Govt./Pvt.

properties etc. as far as possible;

- Safe distance from designated water bodies as far as possible;
- Safe distance from flood prone zones;
- Crossing of rivers, streams with minimum skew angle;
- Safe distance from water logged areas as far as possible;
- Sufficient embankment heights as well as proper protection works like pitching / chutes have been considered, where it was unavoidable to pass through low lands / submerged areas. HFL / HWL were enquired from site and accordingly proposals have been framed.
- Efficiency and Comfort in Vehicle Operation
- Access Control

The design philosophy basically involves providing suitable horizontal alignment, longitudinal section, cross section layout, and safety and access control to cater to the fast and uninterrupted movement of through traffic.

6.2.3 Geometric Design Standards

This project is essentially widening the existing standard 2-lane road to 4-lane with paved shoulder as the alignment follows predominantly existing roads. The geometric designs are as per recommendations of IRC: SP: 84-2019. The general design standards for improvement are enumerated in **Table 6.1**.

Table 6.1: Geometric Design Standards for Road Works (Plain/Rolling Terrain)

Sl No.	Attributes	Geometric Design Standards
1	Design Speed	
	Plain and Rolling Terrain (Cross slope of the ground up to 25 per cent)	Ruling: 100 kmph Minimum: 80 kmph
2	Carriageway Width	7.0m carriageway
3	Width of Shoulder	
	a) Paved Shoulder	1x 1.5 m
	b) Earthen Shoulder	1.0 m
4	Footpath width at built-up areas	2 x 1.5 m drain cum footpath
5	Camber	
	a) Carriageway	2.5%
	b) Shoulder	3.0%
6	Maximum and Minimum Super-elevation	Maximum limited to 7.0% (for Radius less than Desirable minimum) Minimum limited to 5% (for Radius more than Desirable minimum)

Sl No.	Attributes	Geometric Design Standards
7	Minimum Radius of Horizontal Curves	
	a) Plain and rolling Terrain	Desirable Minimum: 400m Absolute Minimum: 250m
8	Sight Distances for Various Speeds	180m – 360m
9	Longitudinal Gradient	
	a) Plain and Rolling Terrain	Ruling: 2.5%, Limiting: 3.3%
10	Extra Width of Pavement	
	Radius of Curve	Extra Width
	75-100m	0.9m
	101-300m	0.6m

6.2.4 Widening Proposal

The stretch is proposed with concentric widening as the 2-lane with paved shoulder configuration. At built-up Area Margherita & Ledo , 2-Lane Paved shoulder Margherita Ledo bypass is proposed.

6.2.5 Cross-section for Improved Facility

Cross-section for the improved facility should be adequate to cater to the traffic expected over the design period and offer safe and convenient traffic operation at speeds consistent with the terrain conditions and functional classification of this road.

The cross-sectional elements (lane/shoulder width etc.) are as per standards specified in geometric design manual. 7 nos. typical cross sections have been envisaged for the subject project at this stage as mentioned below. These have been prepared on the basis of site reconnaissance and design guidelines.

TCS No.	Description
Type –01	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (WIDENING)
Type –03A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)
Type –03B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
Type –04A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
Type –04B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
Type-08	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)

TCS No.	Description
Type-09	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN BUILT-UP AREA (WIDENING)

Typical cross sections for the project road are presented in **Annexure 6.1 & 6.6**. Summary of cross sections is shown in **Table 6.2**.

Table 6.2: Summary of Cross Sections for Section-5 (Km 27+150 TO Km 47+682 of NH-38):

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
1	27+150	27+230	80	TCS-9	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN BUILT-UP AREA (WIDENING)
2	27+230	27+424	194	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
3	27+424	28+194	770	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
4	28+194	28+275	81	STR	ROB RDSO Steel Composite Girder
5	28+275	28+674	399	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
6	28+674	29+040	366	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
7	29+040	29+300	260	TCS-3A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)
8	29+300	29+452	152	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
9	29+452	29+462	10	STR	MNB RCC Box (1x10.0)m
10	29+462	30+110	648	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
11	30+110	30+130	20	STR	MNB RCC Box (2 x 10)m
12	30+130	31+263	1133	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
13	31+263	31+270	7	STR	SVUP (1x7.0m)

Sl No	Chainage		Length	TCS Type	Description
14	31+270	31+715	445	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
15	31+715	31+766	51	STR	MNB RCC I girder (3x17.0)m
16	31+766	32+997	1231	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
17	32+997	33+004	7	STR	SVUP (1x7.0m)
18	33+004	33+907	903	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
19	33+907	33+914	7	STR	SVUP (1x7.0m)
20	33+914	33+973	59	TCS-3B	2-LANE CARRIAGEWAY WITHPAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)[ECCENTRIC CONSTRUCTION]
21	33+973	33+988	15	STR	MNB RCC Box (2x7.5)m
22	33+988	35+699	1712	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
23	35+699	35+711	12	STR	LVUP (1x12.0m) -RCC Box
24	35+711	35+800	89	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
25	35+800	35+841	41	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
26	35+841	35+909	68	STR	MJB RCC I Girder (Span 4x17.0m)
27	35+909	37+115	1206	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
28	37+115	37+155	40	STR	MNB RCC I girder (2x 20.0)m
29	37+155	37+290	135	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
30	37+290	37+297	7	STR	SVUP (1x7.0m)
31	37+297	37+460	163	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
32	37+460	37+470	10	STR	MNB RCC Box (1x10.0)m
33	37+470	38+068	598	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
34	38+068	38+733	665	STR	MJB- PSC I girder (span -19x35.0m)

Sl No	Chainage		Length	TCS Type	Description
35	38+733	39+797	1064	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
36	39+797	39+804	7	STR	SVUP (1x7.0m)
37	39+804	39+880	76	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
38	39+880	39+895	15	STR	MNB RCC Box (2x7.5m)
39	39+895	40+462	567	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
40	40+462	40+469	7	STR	SVUP (1x7.0m)
41	40+469	42+047	1578	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
42	42+047	42+054	7	STR	SVUP (1x7.0m)
43	42+054	42+747	693	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
44	42+747	42+754	7	STR	SVUP (1x7.0m)
45	42+754	43+199	445	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
46	43+199	43+214	15	STR	MNB RCC Box (2x7.5)m
47	43+214	44+700	1487	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
48	44+700	44+877	177	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
49	44+877	44+884	7	STR	SVUP (1x7.0m)
50	44+884	45+731	848	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
51	45+731	45+741	10	STR	MNB RCC Box (1x10.0)m
52	45+741	45+817	76	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
53	45+817	45+824	7	STR	SVUP (1x7.0m)
54	45+824	46+952	1129	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
55	46+952	46+962	10	STR	MNB RCC Box (1x10.0)m

Sl No	Chainage		Length	TCS Type	Description
56	46+962	47+264	302	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
57	47+264	47+271	7	STR	SVUP (1x7.0m)
58	47+271	47+500	229	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
59	47+500	47+682	182	TCS-1	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (WIDENING)
Total Length (m)			**20532**		

6.2.6 Cross-section for Bridges, Culverts and Other Structures

Cross section for bridges, culverts and other structures shall be as per relevant guidelines of IRC: SP-73-2018. In general, full roadway width will be proposed between the outer to outer face of crash barrier/ parapet for culverts. Generally, 2- lane configurations for bridges/culverts/other structures are provided in **Table 6.3**.

Table 6.3: General Structural Configuration

Type of Structure	Width of Structural Components (m)					Remarks
	C/W	FP (both side)	CB (both side)	Railing (both side)	Overall	
2-Lane Bridge	13	1.5	0.5	0.5	18.0	IRC SP-73-2018 fig no 7.6
2-Lane Gr. Separator	11.0	-	0.5	-	12.0	Fig. 7.10 of IRC: SP:73-2018

The overall width of culverts for 2 lane configurations shall be equal to the total roadway width of the approaches. The outer most face of railing or parapet shall be in line with the outer most edge of shoulder. However, in general typical cross section for culverts shall be (as per Fig. 7.1, Fig. 7.2 and 7.3 of IRC: SP:73-2018).

Thickness of wearing course shall be 65 mm (40 m BC + 25 mm mastic asphalt).

6.2.7 Horizontal Alignment

The geometric design has been done within the broad framework of design specifications. The

design speed adopted is 80-100kmph as far as possible, with an allowable maximum super elevation of 5%, in general. While designing, utmost attempt has been made to avoid acquisition of residential as well as commercial / religious / historic structures. Details of horizontal curves proposed along project road is given in **Annexure 6.2**. Design of horizontal alignment has been done separately for three sections.

Extra widening for horizontal curves with radius <=300m has been considered as clause 2.7.2 of IRC: SP: 73-2018.

6.2.8 Vertical Alignment

The existing vertical geometry is generally good except at few stretches where inadequate sight distance has been observed. The longitudinal grade of the project road is generally within the limits, in general it has been kept as it is with necessary corrections/ strengthening/profile corrective courses. However, at the existing submersible bridge locations, the vertical profile shall be raised as per codal provisions. Longitudinal gradient of the proposed profile shall be followed as per prevailing standards. The details of the proposed curves are presented in **Annexure-6.3.**

6.2.9 Service Road

Service Road with Footpath have been considered at VUP and ROB approaches as mentioned below.

Design Chainage (km)		Length (m)	TCS	Remarks
From	To			
27+230	27+424	194	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
27+424	28+194	770	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
28+275	28+674	399	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
28+674	29+040	366	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM

Design Chainage (km)		Length (m)	TCS	Remarks
				ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
Total Length (including Both sides)		**3458**		

6.2.10 Proposal for Built-up Areas

Proposed alignment basically is bypass alignment i.e Margherita - Ledo bypass. However, for this section no major built up is found. The details of which are provided in in **Table 6.4**.

Table 6.4: Stretches with Footpaths and Drains

Design Chainage (km)		Length (m)	TCS	Remarks
From	To			
27+230	27+424	194	TCS-4A	Footpath cum Covered Drain
27+424	28+194	770	TCS-4B	Footpath cum Covered Drain
28+275	28+674	399	TCS-4B	Footpath cum Covered Drain
28+674	29+040	366	TCS-4A	Footpath cum Covered Drain
Total Length (including Both sides)		**3458**		

6.2.11 Proposal for Forest Areas

There is no forest stretch present in the section-5. A list showing the forest stretches is presented in **Table 6.5**

Table 6.5: List of Forest Stretches

Sl No.	Design Chainage (km)		Length (m)	Forest Name
	From	To		
Section 5				
NIL				

6.2.12 Realignments and bypass

Table 6.7 provides the list realignment stretches where the proposed alignment does not overlap with the existing roads.

Table 6.6: List of Stretches with Bypass

Sl No	Chainage	Length (m)	TCS Type	Description

	From	To			
3	28100	28+194	94	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
4	28+194	28+275	81	STR	ROB RDSO Steel Composite Girder
5	28+275	28+674	399	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
6	28+674	29+040	366	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
7	29+040	29+300	260	TCS-3A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)
8	29+300	29+452	152	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
9	29+452	29+462	10	STR	MNB RCC Box (1x10.0)m
10	29+462	30+110	648	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
11	30+110	30+130	20	STR	MNB RCC Box (2 x 10)m
12	30+130	31+263	1133	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
13	31+263	31+270	7	STR	SVUP (1x7.0m)
14	31+270	31+715	445	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
15	31+715	31+766	51	STR	MNB RCC I girder (3x17.0)m
16	31+766	32+997	1231	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
17	32+997	33+004	7	STR	SVUP (1x7.0m)

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
18	33+004	33+907	903	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
19	33+907	33+914	7	STR	SVUP (1x7.0m)
20	33+914	33+973	59	TCS-3B	2-LANE CARRIAGEWAY WITHPAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)[ECCENTRIC CONSTRUCTION]
21	33+973	33+988	15	STR	MNB RCC Box (2x7.5)m
22	33+988	35+699	1712	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
23	35+699	35+711	12	STR	LVUP (1x12.0m) -RCC Box
24	35+711	35+800	89	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
25	35+800	35+841	41	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
26	35+841	35+909	68	STR	MJB RCC I Girder (Span 4x17.0m)
27	35+909	37+115	1206	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
28	37+115	37+155	40	STR	MNB RCC I girder (2x 20.0)m
29	37+155	37+290	135	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
30	37+290	37+297	7	STR	SVUP (1x7.0m)
31	37+297	37+460	163	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
32	37+460	37+470	10	STR	MNB RCC Box (1x10.0)m
33	37+470	38+068	598	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
34	38+068	38+733	665	STR	MJB- PSC I girder (span -19x35.0m)

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
35	38+733	39+797	1064	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
36	39+797	39+804	7	STR	SVUP (1x7.0m)
37	39+804	39+880	76	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
38	39+880	39+895	15	STR	MNB RCC Box (2x7.5m)
39	39+895	40+462	567	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
40	40+462	40+469	7	STR	SVUP (1x7.0m)
41	40+469	42+047	1578	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
42	42+047	42+054	7	STR	SVUP (1x7.0m)
43	42+054	42+747	693	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
44	42+747	42+754	7	STR	SVUP (1x7.0m)
45	42+754	43+199	445	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
46	43+199	43+214	15	STR	MNB RCC Box (2x7.5)m
47	43+214	44+700	1487	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
48	44+700	44+877	177	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
49	44+877	44+884	7	STR	SVUP (1x7.0m)
50	44+884	45+731	848	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
51	45+731	45+741	10	STR	MNB RCC Box (1x10.0)m

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
52	45+741	45+817	76	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
53	45+817	45+824	7	STR	SVUP (1x7.0m)
54	45+824	46+952	1129	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
55	46+952	46+962	10	STR	MNB RCC Box (1x10.0)m
56	46+962	47+264	302	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
57	47+264	47+271	7	STR	SVUP (1x7.0m)
58	47+271	47+500	229	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
59	47+500	47+682	182	TCS-1	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (WIDENING)

6.3 Drainage

Due consideration has been given to drainage while preparing the design. The cross-sections incorporating roadside drains have been proposed at various stretches of the highway taking into account the existing and natural conditions as well as anticipated situation. At super elevated sections with raised median, rectangular cross median drains have been considered @10m interval to facilitate drainage from outer carriageway to the inner carriageway. Earthen toe drain is considered on both sides of the road for all along the stretch. The details are provided below:

Type of Drain	Side	Total Length including both side (m)	Applicable TCSs
Section-5			
Unlined Trapezoidal Drains	Both	35276	TCS –1, 3A, 3B, 8
RCC Covered Drain	Both	3596	TCS –4A,4B,9 and Major junctions
Trapezoidal V-shaped Drain	Both	-	-

6.4 Bridges, Culverts and Other Structures

Bridge and CD Structures

Bridges and other Cross Drainage (CD) structures are the vital infrastructure elements of a highway network. Maintaining serviceability of bridges and other CD structures, consequently retaining their level of reliability during their lifetime therefore deserves high priority from techno-economic considerations. While bridges and structures are integral to the envisaged development of the Project Road, a comprehensive inventory and condition surveys is pivotal for an assessment of functional and operational adequacies of the existing structures. In turn such an assessment forms the basis for zeroing on to rehabilitation/ widening, reconstruction and new-construction requirements.

A detailed condition survey along with visual inspection of the existing structures has been carried out by the concerned key professionals to assess and ascertain the existing condition/ characteristics of the bridges and other CD structures. Inventory of bridges has been prepared based on the condition survey, which consists of recording relevant technical data for each bridge, such as name, location, length, type of material, carriageway width, type of structure etc.

The existing road consists of ***no culverts.***

The summary of existing structures is presented in the **Table 6.7**.

Table 6.7: Summary of Existing Structures

Sections	Road Segment	No. of Existing Structures					Total
		MJB	MNB	VUP	ROB cum VUP	Culvert	
Section-5	Km 27+150 to Km 47+682	-	-	-	-	-	-

Condition Assessment Surveys

Inventory and condition survey report have been prepared with the objective to verify the form of construction, the dimensions of the structure, the nature and condition of the structural components, etc. to assess necessary information on which decision would be made for carrying repairs, strengthening, widening, replacement of the structural part or rebuilding of the bridge and culverts. Inspection covered not only the condition of individual components but also the condition of the structure as an entity, especially noting signs of distress, if any, and its cause to ascertain long-term remedial measures to provide assurance that the bridge is structurally safe and fit for its designed use.

Inspection was not only confined to searching of defects that are existing, but also the range of

anticipating problems and recognizing these areas. During and following the inspection, it was aimed to determine the cause to prevent the repetition and spread of the deterioration.

Checklist for Visual Inspection

The reasons for deterioration are either physical or chemical process, which cause visible signs of damage. Therefore, during inspection, the following signs of deterioration were particularly noted at locations indicated in **Table 6.5**.

Table 6.8: Signs of Deterioration

Locations	Deterioration
All over	• General condition of the structure and pre-stressed components in particular • Condition of concrete/masonry • Cracks • Honeycombing • Corrosion signs • Scaling of concrete • Spalling of concrete • Efflorescence • Condition of construction joints
Top and bottom of deck slab	• Cracks • De-lamination • Blocking of drainage • Worn out wearing coat • Seepage • Corrosion signs • Leaching • Scaling • Damage due to accident or any other causes
Steel girders	• Pitting • Painting condition • Loose rivet • Loss of Camber • Deformation • Cracks and bends in flanges/webs
Support point of bearings	• Whether the seating of girder over bearing is uniform • Condition of anchor bolts, if any • Spalling/crushing/cracking around bearing support
Webs of girders	• Cracks • Corrosion signs
Junction of slab and girder	• Separation
Drainage spouts	• Whether provided • Clogging • Physical condition • Adequacy of projection of spout on the underside
Joints in precast construction	• Separation • Physical appearance
Expansion joints	• Check whether the expansion joint is free to expand and contract • Hardening/cracking of bitumen filler • Condition of sliding plates – check for corrosion, damage of welds, etc. • Debris in joints • Alignment checking • Distortion
Elastomeric Bearing:	• Whether the bearing is free to move/rotate in different directions as envisaged in design • Whether the bearings are fully and evenly seated • Whether all the bearings are at same level • Physical condition • Cleanliness • Flattening of bearings • Splitting/tearing • Bulging • Oxidation

Locations	Deterioration
	• Non uniform thickness other than that which may be the result of normal rotation • Displacement (longitudinal or lateral) from original position • Whether correct operation of the bearings is prevented or impaired by structural members built into abutment or pier.
Piers, Abutments, Retaining Walls and Wing Walls	• Tilting and rotation, in any direction • Rocking • Cracking, splitting and spalling • Erosion beneath water level • Weathering and material deterioration, including lack of pointing for masonry • Growth of vegetation • Lack of effective drainage • Internal scour, and leaching of fill • Settlement of fill
Waterway	• Width of Waterway • Observed Scour Depth • Crossing Angle • Evidence of Submergence, if any • Flow Direction • Any obstruction to the free flow • Vertical clearance
Parapet/ Railing, Wearing coat, Drainage spout, Utility lines, Floor protection, Approach slab and Embankment slope protection • Whether provided • Physical condition • Material type	

General Recommendations

Recommendation on structure includes widening, repair and reconstruction/ new construction of bridges and other cross drainage structures depend on its present structural condition, available width of carriageway, history/ past record of submergence of the existing structures & highway geometry.

Existing bridges having deck width less than 13.5m but in good condition, are proposed for widening to 13.5m deck width and those having the width more than 13.5m and in good condition are proposed to be retained with repair & rehabilitation measures to the existing bridge.

Since the structures are proposed for 4 lanes with shoulder, minimum total width of 2x11m is proposed for slab culverts & pipe culverts depending upon road cross-section. However, the existing railing which are damaged or broken, will be replaced with RCC crash barrier by chipping the edge of deck and exposing the reinforcement and then casting the RCC crash barrier in case of slab culverts.

Culverts: -

- The culverts proposed to be reconstructed are mainly for very poor structural condition in case of slab or arch culverts by Box culverts
- For slab culverts widening is to be done up to the overall width of the road with Box culvert of same span.
- All existing Hume Pipe culverts having vent opening less than 0.9 m shall be replaced with 1.2m diameter pipes.

- All new construction/reconstruction of Hume Pipe culverts is to be done by 1.2m diameter pipe.

Rehabilitation Scheme of Existing Structures

Rehabilitation measures for existing bridges have been recommended aiming at improving its structural adequacy and life span of the bridge. The basic measures taken into repair and rehabilitation are listed below:

- Repair of existing scour protection/ bed protection or slope protection (wherever necessary);
- Replacement of wearing coat if needed;
- Providing/repairing of drip course in all existing major and minor bridges;
- Providing/replacing expansion joints in all culverts, minor and major bridges;
- Providing new bearings in structures wherever require;
- Replacement of highly corroded reinforcement;
- Repair of cracks (width $\geq$ 0.5mm) by epoxy injection; Repair of cracks (width $\leq$ 0.5mm) by PMC mortar.
- General Repair / Rehabilitation recommended are given below:

a) Crack Repairs

For cracks smaller than 0.5 mm, high thermo set monomers such as Monopol of Krishna Conchem or equivalent are recommended. For crack between 0.5 mm to 1.0 mm, low viscosity epoxy injects such as 'KP 250/HP 259 of Krishna Conchem or equivalent is recommended. For the cracks more than 1 mm, polymer modified cement grout Rendroc –RG of Fosroc Chemical or equivalent is recommended.

b) Spalling

For minor distress, repair of concrete is carried out with anticorrosive polymer modified mortar such as 'Monoband 2000 of Krishna Conchem or equivalent.

c) Guniting

At places where large area of soffit of deck slab (RCC) is distressed and shows spalling of concrete, corroded and exposed reinforcement, guniting is recommended with the help of Sicken – Gunit

6.4.1 Major Bridges (MJB)

2 nos. Major Bridges are falling within the section considered for this report.

Table 6.9a: Details of Major Bridges Proposed

SL. No.	Design Chainage (Km)	Category	Span	Total Width	Superstructure Type
1	35+875	MJB	4 x 17m	18.0	RCC I girder
2	38+400	MJB	19 x 35m	18.0	PSC I girder

6.4.2 Minor Bridges

10 nos. Minor Bridges are falling within the section considered for this report.

Table 6.9b: Details of Minor Bridges Proposed

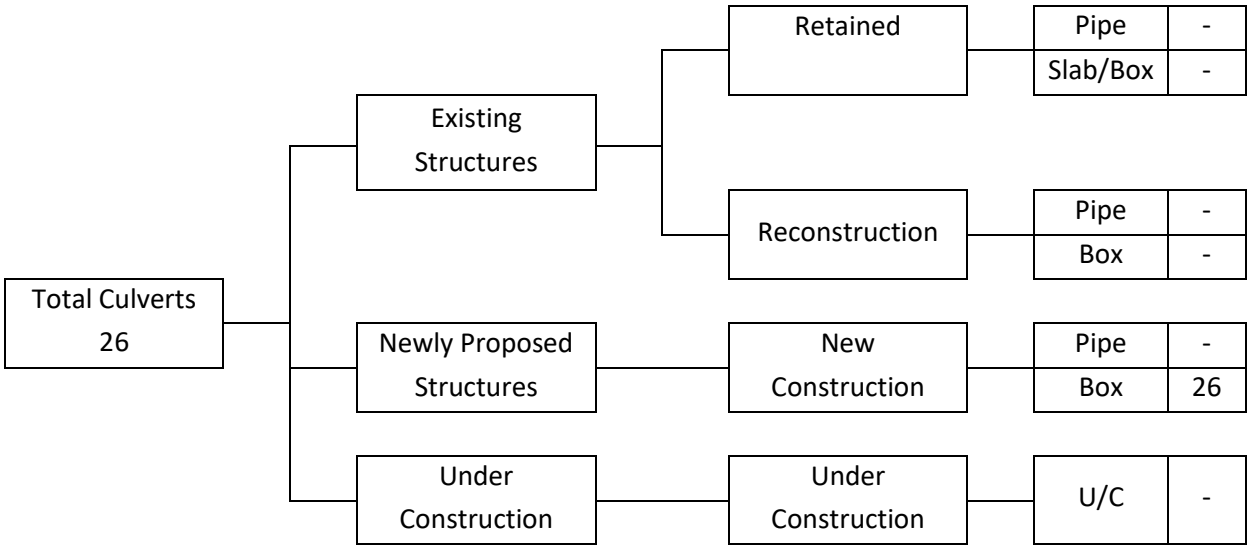
SL. No.	Design Chainage (Km)	Category	Span	Total Width	Superstructure Type
1	29+457	MNB	1 x 10m	18.0	RCC Box
2	30+120	MNB	2 x 10m	18.0	RCC Box
3	31+740	MNB	3 x 17m	18.0	RCC I girder
4	33+980	MNB	2 x 7.5m	18.0	RCC Box
5	37+135	MNB	2 x 20m	18.0	RCC I girder
6	37+465	MNB	1 x 10m	18.0	RCC Box
7	39+887	MNB	2 x 7.5m	18.0	RCC Box
8	43+206	MNB	2 x 7.5m	18.0	RCC Box
9	45+736	MNB	1 x 10m	18.0	RCC Box
10	46+957	MNB	1 x 10m	18.0	RCC Box

Improvement proposals for proposed minor bridges are given in **Annexure-6.5**.

6.4.3 Culverts

Total 26 nos. culverts have been considered for the project road as mentioned below:
Section – 5: 26 Nos. of Culverts

Section-5: From Km 27+150 (near Golai Gaon) to Km 47+682 (Ledo)



Improvement schemes for these culverts have been decided on the basis of inventory, condition survey and proposed geometry. Details of culverts proposed for retain and widening are provided in **Table 6.10.**

Table 6.10: Details of retained culverts

Sl No	Design Ch. (KM)	Type of Ex. Culvert	Ex. Span Arrangement /Dia. (m)	Type of Prop. Culvert	Prop. Span Arrangement (m)	Improvement Proposal
From km 27+150 to km 47+682 km (Sec-5)						
Nil						

Table 6.11: Details of Reconstruction of culverts

Sl. No.	Design Chainage (km)	Type of Existing Culvert	Existing Span Arrangement /Dia. (m)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
From km 27+150 to km 47+682 km (Sec-5)							
Nil							

Table 6.11a: Details of New Construction of Culverts

Sl. No.	Design Chainage (km)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal
From km 27+150 to km 47+682 km (Sec-5)				
1	28+880	Box	1 X 3 X 2	New construction
2	32+307	Box	1 X 6 X 3	New construction
3	32+480	Box	1 X 6 X 3	New construction
4	32+635	Box	1 X 3 X 2	New construction
5	34+428	Box	1 X 6 X 1.6	New construction
6	36+025	Box	1 X 2 X 3	New construction
7	36+135	Box	1 X 2 X 3	New construction
8	36+440	Box	1 X 6 X 6	New construction
9	36+680	Box	1 X 3 X 4	New construction
10	37+720	Box	1 X 2 X 3	New construction
11	40+300	Box	1 X 2 X 2	New construction
12	41+000	Box	1 X 2 X 2	New construction
13	41+470	Box	1 X 6 X 4	New construction
14	42+080	Box	1 X 2 X 2	New construction
15	42+380	Box	1 X 2 X 2	New construction
16	42+425	Box	1 X 2 X 2	New construction
17	43+000	Box	1 X 2 X 2	New construction
18	43+625	Box	1 X 6 X 4	New construction
19	44+065	Box	1 X 6 X 3	New construction
20	44+515	Box	1 X 6 X 4	New construction
21	45+400	Box	1 X 2 X 1.5	New construction
22	45+975	Box	1 X 3 X 4	New construction
23	46+112	Box	1 X 3 X 3	New construction
24	47+315	Box	1 X 6 X 3	New construction
25	47+300	Box	1 X 2 X 2	New construction
26	47+630	Box	1 X 2 X 2	New construction

***Box on service road only**

6.4.4 Underpasses

Twelve underpasses have been proposed in this section. Details of underpasses are provided in **Table**

6.12A.

Table 6.12.A: Details of Underpasses

SL. No.	Design Chainage (Km)	Category	Span	Total Width	Superstructure Type
1	31+266	SVUP	1 x 7 x 4	12.0	RCC Box
2	33+000	SVUP	1 x 7 x 4	12.0	RCC Box
3	33+910	SVUP	1 x 7 x 4	12.0	RCC Box
4	35+705	LVUP	1 x 12 x 4	12.0	RCC Box
5	37+293	SVUP	1 x 7 x 4	12.0	RCC Box
6	39+803	SVUP	1 x 7 x 4	12.0	RCC Box
7	40+465	SVUP	1 x 7 x 4	12.0	RCC Box
8	42+050	SVUP	1 x 7 x 4	12.0	RCC Box
9	42+750	SVUP	1 x 7 x 4	12.0	RCC Box
10	44+880	SVUP	1 x 7 x 4	12.0	RCC Box
11	45+820	SVUP	1 x 7 x 4	12.0	RCC Box
12	47+267	SVUP	1 x 7 x 4	12.0	RCC Box

6.4.5 Rail Over Bridge (ROB)

One ROB cum Elephant Corridor Flyover has been proposed for the road sections. Details of the proposed Structure is as in the table 6.12.B below.

Table 6.12.B: Details of ROB

SL. No.	Design Chainage (Km)	Category	Span	Total Width	Superstructure Type
1	28+239	ROB & EUP	2x35+14x50+25.0+ 31.28+25+50+10x35	19.0	PSC I & Box-Girder + RDSO Steel Composite Girder + PSC Box & I-Girder

6.4.6 Flyover

One ROB cum Elephant Corridor Flyover has been proposed for the road sections. Details of the proposed Structure is as in the table 6.12.B above.

6.4.7 Interchanges

No Interchanges are considered for the road sections.

6.5 Intersection Improvement Proposals

The proposed project road will form a no. of intersections with existing roads. Improvement of this intersection has been thought off with minimum of land acquisition. There are 2 nos Major Junctions which are proposed for development. Proper acceleration and deceleration lanes have been considered with proper traffic signage. In general, standard codal provisions have been followed for design of these intersections. Detail layouts are provided in Drawing Volume. There are 16nos. of minor intersections along the project road which shall be operated as normal left-in and left-out principle. Improvement proposals of major and minor intersections are provided in **Table 6.13**.

Table 6.13a: Improvement Proposals of Major Intersections

Sl No.	Existing Chainage (km)	Type	Side	Destination	Surfacing Type	Carriageway Width (m)
NH-38						
1	47+350	At Grade	RHS	End point of Bypass	Bituminous	7.0

Table 6.13b: Improvement Proposals of Minor Intersections

Sl. No.	Design Chainage (km)	Type of Intersection	Type	Side
1	27+600	At Grade	3 legged	Left
2	27+960	At Grade	3 legged	Left
3	32+070	At Grade	4 legged	Both
4	37+120	At Grade	4 legged	Both
5	43+680	At Grade	4 legged	Both

6.6 Pavement Design

6.6.1 General

The pavement existing on the project stretch is flexible in nature. The project envisages new Four Lanes with Paved Shoulder configuration. The general design Procedure for the flexible pavement for the proposed road as new construction of whole stretch as per the guidelines of IRC: 37-2018 – "Guidelines for the design of Flexible Pavements".

New pavement design is based on the design traffic (MSA) and the subgrade strength (soaked CBR).

6.6.2 *Methodology of Pavement Design*

Introduction

The flexible pavements are usually referred as a layered structure comprising generally bituminous surface like Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM) base and Granular Sub-Base (GSB) course of finite thickness, resting on subgrade of minimum thickness of 500 mm. The thickness design of these layers principally depends on the subgrade CBR and the traffic loads that the pavement has to carry during its design life. Ideally, the flexible pavement is built to such a depth that stresses on any given layer should not cause unwarranted rutting, fatigue, shoving, or other differential movements which may result in an uneven wearing surface. The chief function of the surfacing course is to provide a smooth wearing surface, resistant to traffic. However, the wearing course can provide some shearing resistance to the base structure and some added resistance to deformation.

Base courses are usually layers of aggregates that must possess high resistance to deformation in order to withstand the higher pressures imposed by wheel loads. High –quality processed aggregates are usually required, which also provide good internal drainage sub bases and generally made up of locally available aggregates, satisfying codal specification/requirements.

The design methodologies widely used for the flexible pavement design are Indian Road Congress (IRC) method, AASHTO methods and Asphalt Institute Method. For this project latest IRC (IRC:37-2018) method is used for designing the flexible pavement. The brief about the method is given below.

IRC: 37-2018 Method of New Flexible Pavement Design

It gives pavement design catalogue for subgrade CBR values ranging from 5% to 15 % and eight levels of design traffic ranging from 5 to 50 MSA. The pavement compositions given in the design catalogues are relevant to Indian conditions, materials and specifications. For higher traffic values, the pavement layer thicknesses are worked out using IITPAVE software.

IRC: 58-2015 Design of Rigid Pavement

IRC: 58-2015 “Guidelines for the design of plain jointed rigid pavements for highways” gives the design of rigid pavements and adopted for designing the rigid pavement for carriageway.

6.6.3 *Design of New Flexible Pavement*

IRC: 37-2018 method is adopted for the design which is based on the empirical – analytical approach, and provides catalogues for design of flexible pavements. The design inputs required for pavement design are explained as follows.

Design Theory

The pavement design method is based on elastic response of the pavement to traffic stresses (i.e. each of the materials in the pavement structure behaves in an elastic manner). The materials in the pavement are characterized by parameters whose values are determined from field and laboratory testing. The method assumes that failure will not occur as a result of permanent deformation of granular or bound materials (and this assumption will be valid as long as good construction procedures are followed, and the pavement is not subjected to very high wheel loads such as can be caused by a very heavily overloaded vehicle). The method also assumes that loss of pavement serviceability can occur due to:

- fatigue of bitumen bound or cemented layers due to repetitions of tensile strains at the bottom of such layers; and/or
- Permanent deformation of the sub-grade due to repeated vertical compressive strains induced in the sub-grade

The critical locations for pavement failure are therefore the bottom of bitumen bound layers (where tensile strains occur) and the top of the sub-grade (where compressive strains occur).

The base course and sub-grade are structural elements of the pavement. In conjunction with the overlying bituminous surface, their purpose is to distribute traffic wheel loads over the whole foundation. To perform this function, we build the base course and sub-grade with the necessary internal strength properties.

Bituminous pavement layers have both tensile and compressive strength to resist internal stresses. For example, **Figure 6.1** shows how wheel load (W) slightly deflects the pavement structure, causing both tensile and compressive stresses within the pavement.

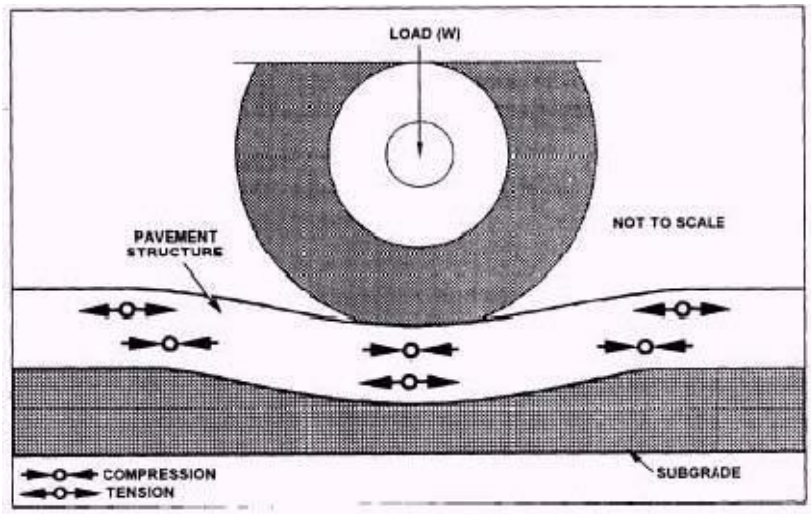


Figure 6.1: Pavement Deflection Results in Tensile and Compressive Stresses in Pavement Structure

Required total thickness of the pavement layers is determined by engineering design procedure. Factors considered in the procedure are as follows:

- Traffic to be served initially and over the design service life of the pavement
- Strength and other pertinent properties of the prepared sub-grade
- Strength and other influencing characteristics of the materials available or chosen for the layers (or courses) in the total pavement structure
- Special factors such free swelling property of existing soil

Design of New Flexible Pavement

Design of new pavement has been carried out based on IRC 37-2018 "Guidelines for the Design of Flexible Pavements" for design life of 20 years. Procedure for the same is given below:

Step 1: To find out initial traffic in the year of completion of construction in terms of the number of the number of commercial vehicles per day (CVPD)

Step 2: To determine traffic growth rate factor by studying the past trends of traffic growth

Step 3: Design life of Pavement

Step 4: To find out Vehicle Damage Factor to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetition. It may be obtained by conducting axle load survey at site.

Step 5: To find out lane distribution factor of traffic over the carriageway

Step6: To determine design traffic in cumulative number of standard axles (msa) by the following formula mentioned below:

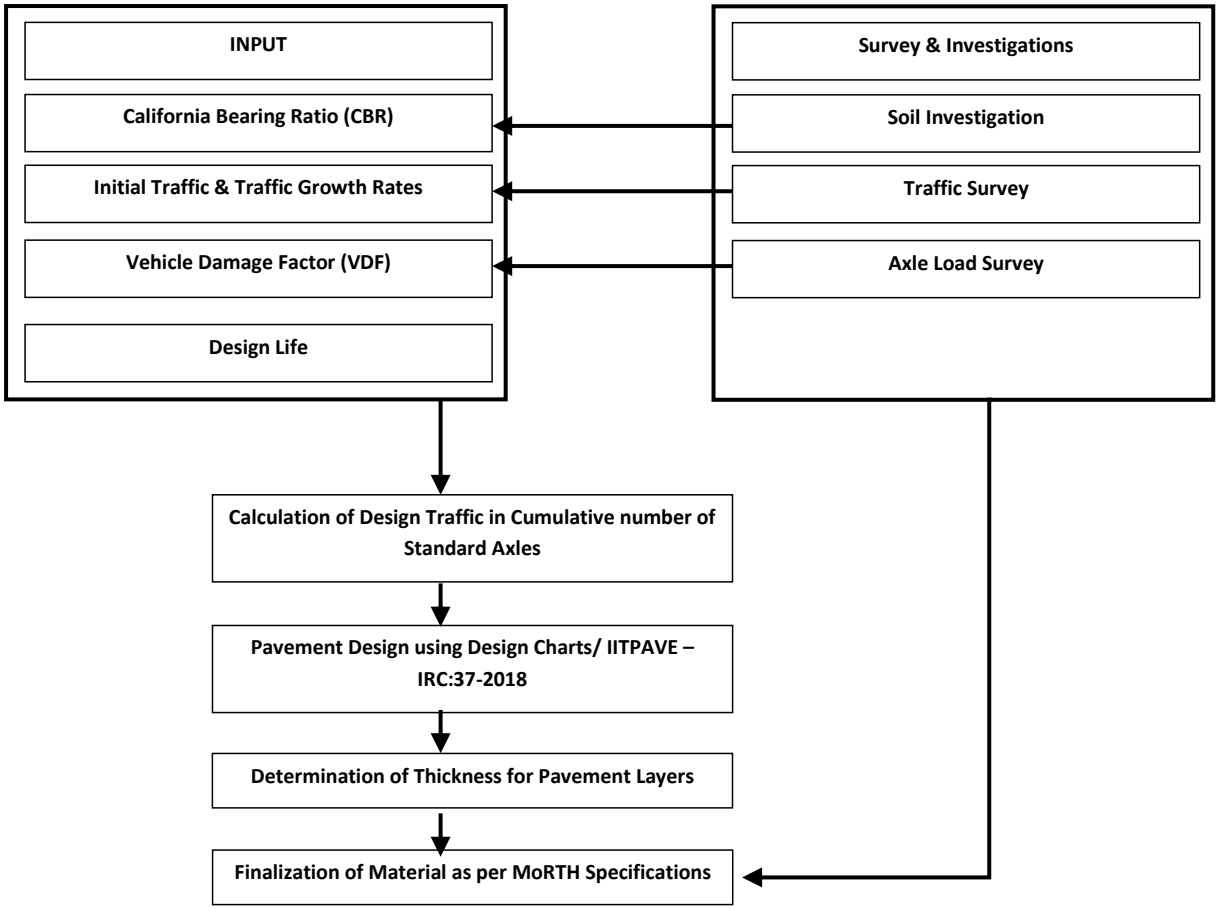


Figure 6.2 : Methodology Flow Chart for Design of New Flexible Pavement

$N= [365 \times \{(1+r)^n-1]/r\}] \times A \times D \times F$

Where,

N = Cumulative number of standard axles to be catered for in the design in terms of msa

A = Initial traffic in the year of completion of construction in terms of number of commercial vehicles per day

D = Lane Distribution Factor

n = Design life in years

r = Annual growth rate of commercial vehicles

F = Vehicle damage factor

Step 7: To determine total pavement thickness and crust composition by charts/graphs with respect to CBR and cumulative number of standard axles.

Methodology flow chart for the design of new Flexible pavement has been shown in **Figure 6.2** above.

MSA Calculation

MSA calculation has been presented in **Annexure 6.4** for Dibrugarh-Tinsukia section.

Adopted design life for pavement design has been considered for 20 years period.

Lane Distribution Factor

The lane distribution factor adopted for the project road is as given under:

- Dual Two-Lane carriageway roads: 75 percent of number of Commercial vehicles in each direction as per IRC-37-2018.

Vehicle Damage Factor (VDF)

VDF summary is provided below.

Type of Vehicle	Dibrugarh – Tinsukia		
	From Dibrugarh to Tinsukia	From Tinsukia to Dibrugarh	Recommended VDF
2-Axle Trucks	2.55	4.00	3.28
3-Axle Trucks	10.31	11.07	10.69
MAV	14.97	11.27	13.12
LCV	0.77	1.20	0.98
Bus	1.12	1.03	1.08

Design CBR

The subgrade CBR for design has been considered as 8.0%. Subgrade of 500 mm thickness is required as an integral part of the pavement structure. Details of msa calculated for flexible pavement design are provided in **Table 6.14** for Dibrugarh-Ledo Section.

Traffic Surveys were conducted at Km. 8 of NH-38 and *the total stretch is to be developed as 2-lane carriageway with paved shoulder road*. The details of the msa calculated are presented below:

Table 6.14A: MSA for 2-Lane Dual Carriageway

Location	msa
Km. 8 of NH-38	**24**

Pavement layer thicknesses based on inputs mentioned above is given in **Table 6.15**. The GSB-II layer will be extended till earthen shoulder to facilitate of proper drainage in the pavement structure. The design has been carried out as per Plate-4 of IRC:37-2018.

Table 6.15: Proposed Pavement Thickness (For New Construction Bypass)

Pavement Layer Thickness (for new pavement-Digboi Bypass) in mm					
msa	**BC**	**DBM**	**WMM**	**GSB**	**Total Pavement Thickness**
24	40	100	250	200	590

Stretch - Dibrugarh - Ledo

For 2-Lane Dual Carriageway (Bogapani to Golai Goan)		
Location	**msa**	**Adopted msa**
Km 8 of NH38	**23.95**	**Say, 24 msa**

At NH-38 Part Overlay with BC and DBM is proposed. (30mm BC and 50mm DBM)-Portion following the existing NH-38

6.6.4 *Overlay Design*

Condition of existing pavement is mostly good to fair condition and in some stretches there are some cracks and rutting.

Overlay design has been carried out based on the results of the FWD Tests.

From the above results it is evident that the existing pavement crust is not sufficient to carry the corresponding design traffic. Hence considering the bituminous overlay the results obtained are presented in **Table 6.18**.

Table 6.18 : Results of Overlay Thickness

Road Sections	Considered Bituminous Overlay (mm)	Design Traffic (msa)
Section 5	*30mm BC + 50mm DBM*	24

Hence, the bituminous overlay as presented in Table 6.18 above is recommended.

6.7 Protection Works

Various protection works have been considered as per design requirement as well as from safety point of view as mentioned below:

- Metal Beam Crash Barriers
- Breast wall and Toe wall
- Kerb and Kerb with Channel: Kerb has been considered all through except at inner edges of outer carriageway at super elevated stretches where kerb with channel are considered.

6.8 Other Highway Facilities

6.8.1 *Bus Bays*

Several towns, villages and settlements are abutting the project corridor and buses shall be one of the major modes of passenger traffic movement along the corridor. It is imperative to provide bus bays in order to eliminate the conflict between buses and other moving vehicles as well as to ensure safety of passengers boarding and alighting. Proposed bus bays have been kept sufficiently away from the intersections to avoid traffic congestion. Total 2 nos. of bus bays with bus shelters & 2 nos. Bus Shelters have been considered for the section.

6.8.2 *Truck Lay Bye*

There is no truck lay-byes proposed in section 5.

6.8.3 *Toll Plazas*

No Toll plaza has been proposed.

6.8.4 *Wayside Amenities*

Way side amenities are not considered for this section.

6.8.5 *Illumination*

Highway illumination shall be considered at various location as per clause 12.3 of IRC: SP: 73-2018. Details are considered as follows:

A. Double Arm Poles –major intersections, bus bays and truck lay byes
B. High Mast Poles – Considered at major intersections and truck lay byes.

6.8.6 *Miscellaneous Provisions for Traffic Guidance and Safety*

The objective of a high-speed facility includes providing safe, efficient and economic movement of motorized through traffic with comfort and pleasing environment during the journey. This requires certain miscellaneous provisions for traffic guidance and safety. However, it is evident that after implementation of the project, high speed environment will make the areas more accident-prone unless proper safety controls are exercised. The Consultants propose to rectify any geometric and engineering deficiency existing along the critical stretches. The safety measures and devices as proposed are described below:

- Traffic Guidance, Regulation, Control and Safety Measures
- Pedestrian Facilities
- Speed Breakers

Traffic Guidance, Regulation, Control and Safety Measures

For notification of road features and also for safety and guidance of the road users, the project road will be provided with all the necessary traffic control and safety devices. These include:

- Traffic Signs – mandatory, cautionary and informatory Road Markings
- Provision of road studs or similar tools, for carriageway centerline and edge delineation
- Metal Beam Crash Barrier
- Concrete Beam Crash Barrier
- Pedestrian Guard Rail
- Guard Posts

To ensure safety of vehicles, W-Beam type metal beam crash barriers shall be provided on both edges of the road where embankment height (road height) is equal to or greater than 3m. Suitable reflectors have been proposed to be fixed on the beam @ 3 m centre-to-centre for proper delineation of the barrier line. The metal beam crash barrier sections shall start and finish with a parabolic flare away from the carriageway. Concrete guard posts shall be provided on both side of the carriageway for the balance reaches. Besides, trapezoidal reflectors have been considered on guard posts at forest stretches.

Pedestrian Facilities

The facilities to be provided for pedestrian safety include:

- Pedestrian crossings at important intersections and urban areas
- Footpaths of adequate width
- Road signs cautioning drivers of Pedestrian Crossings ahead
- Pedestrian signals at intersections

The above will be provided at important intersections.

Speed Breakers

Speed breakers shall be provided on minor cross-roads to alert the drivers and control the speed of vehicles approaching the project road, forming priority junctions, and these shall be constructed as per IRC: 99-1988. The speed breaker will be provided at about 10m into the cross-road from the project road. Another speed breaker will precede this at 100-120m. Appropriate warning signs "hump ahead" will be provided in advance to caution the drivers.

6.9 Landscaping and Arboriculture

(i) The aim of landscaping will be conservation of existing natural or manmade features e.g. ponds, historical buildings and scenic vistas along the highway.

(ii) Landscaping will address the issue of drainage to ensure minimum disturbance to the natural drainage and at the same time ensure protection of natural surfaces from erosion.

(iii) Proper landscaping will be provided for highway Alignment, to fit-in with surroundings for pleasing appearance, reducing adverse environmental effects such as air pollution, noise pollution and visual intrusion.

(iv) Landscaping will include stabilization of embankment by pitching and/or turfing/ plantation. The treatment of embankment slopes along the highway will be as per recommendations of IRC:56–1974, depending upon soil type involved.

(v) Trees, their spacing and arrangement in different situations will be as per IRC:21–1979 and IRC: SP:66–1976.

(vi) Compensatory afforestation as per applicable rules.

6.10 Proposed ROW and Land Acquisition

Proposed ROW of 40m to 45m is considered for the road section in rural area.

As per assessment at this stage tentative land acquisition is assessed as below:

- ***For Section 5: 17.601 Ha***

6.11 Protection Work for High Embankment Zone

Toe / Retaining Wall

Toe wall has been proposed in high embankment zone such to restrict the embankment toe within the PROW. Minimum length of 2000m toe wall/retaining wall is required for section-5.

CHAPTER 7

ENVIRONMENTAL SCREENING

7.1 INTRODUCTION

7.1.1 Project Background

The National Highways & Infrastructure Development Corporation Limited has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India. The National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the assignment of preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana.

In view of the above work NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. for Package IV under Lot-1 to carry out the Feasibility Studies including field investigations, road inventory, structure inventory, FWD test, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The letter of invitation (LOI) has been issued vide memo no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/2017, dated October 30, 2017, whereas, the letter of acceptance (LOA) has been issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package IV/2017/28, dated February 02, 2018. Letter of commencement (LOC) for the consultancy services was issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package IV/2017/79, dated April 13, 2018.

7.1.2 Project Road Description

The project road comprises 14 stretches as mentioned in the RFP as mentioned below in Table 7.1

Table 7. 1: List of Road Segments as per RFP

Stretches	Description
Stretch-1	Dibrugarh Ghat/Bogibil Bridge (South Bank)-Bogibil Bridge (North Bank) (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=8 km)
Stretch-2	Bogibil Bridge (North Bank)-Kandulijan Gaon (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=11 km)
Stretch-3	Kandulijan Gaon-Dimow Charali (Feeder Route-Inland Waterways) Section of NH-515 in Assam (L=21 km)
Stretch-4	Dimow Charali-Sangajan (Feeder Route-Inland Waterways) Section of Majorbai Road in Assam (L=8.2 km)
Stretch-5	Kamar Gaon-Dibrugarh Ghat/Bogibil Bridge (South Bank) (Feeder Route-Inland Waterways) Section of NH-15 in Assam (L=15 km)
Stretch-6	Naltoli-Silghat (Feeder Route-Inland Waterways) Section of Silghat-Naltoli Road in Assam (L=4 km)
Stretch-7	Jorhat-Neamati (Feeder Route-Inland Waterways) Section of Neamati Ghat-Jorhat Road in Assam (L=10.4 km)

Stretches	Description
Stretch-8	Dimow Charali-Oriyamghat Road (Feeder Route-Inland Waterways) Section of NH-515 in Assam (L=62 km)
Stretch-9	Oriyamghat Road-Oriyamghat (Feeder Route-Inland Waterways) Section of Oriyamghat Road in Assam (L=6.7 km)
Stretch-10	Kamar Gaon-Lahowal (EC-Economic Corridor NER) Section of Dibrugarh Bypass in Assam (L=16 km)
Stretch-11	Lahowal-Tinsukia (EC-Economic Corridor NER) Section of NH-15 in Assam (L=38 km)
Stretch-12	Tinsukia-Makum (EC-Economic Corridor NER) Section of NH-15 in Assam (L=10 km)
Stretch-13	Makum-Digboi (EC-Economic Corridor NER) Section of NH-315 in Assam (L=25 km)
Stretch-14	Digboi-Margherita (EC-Economic Corridor NER) Section of NH-315 in Assam (L=13 km)

This report includes the road sections as mentioned below from the Stretch -10 and 11 in the above table:

Section-5: From km 27+150 (Golai Gaon) to km 47+682 (Ledo)* i.*e Proposed Margherita – Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.

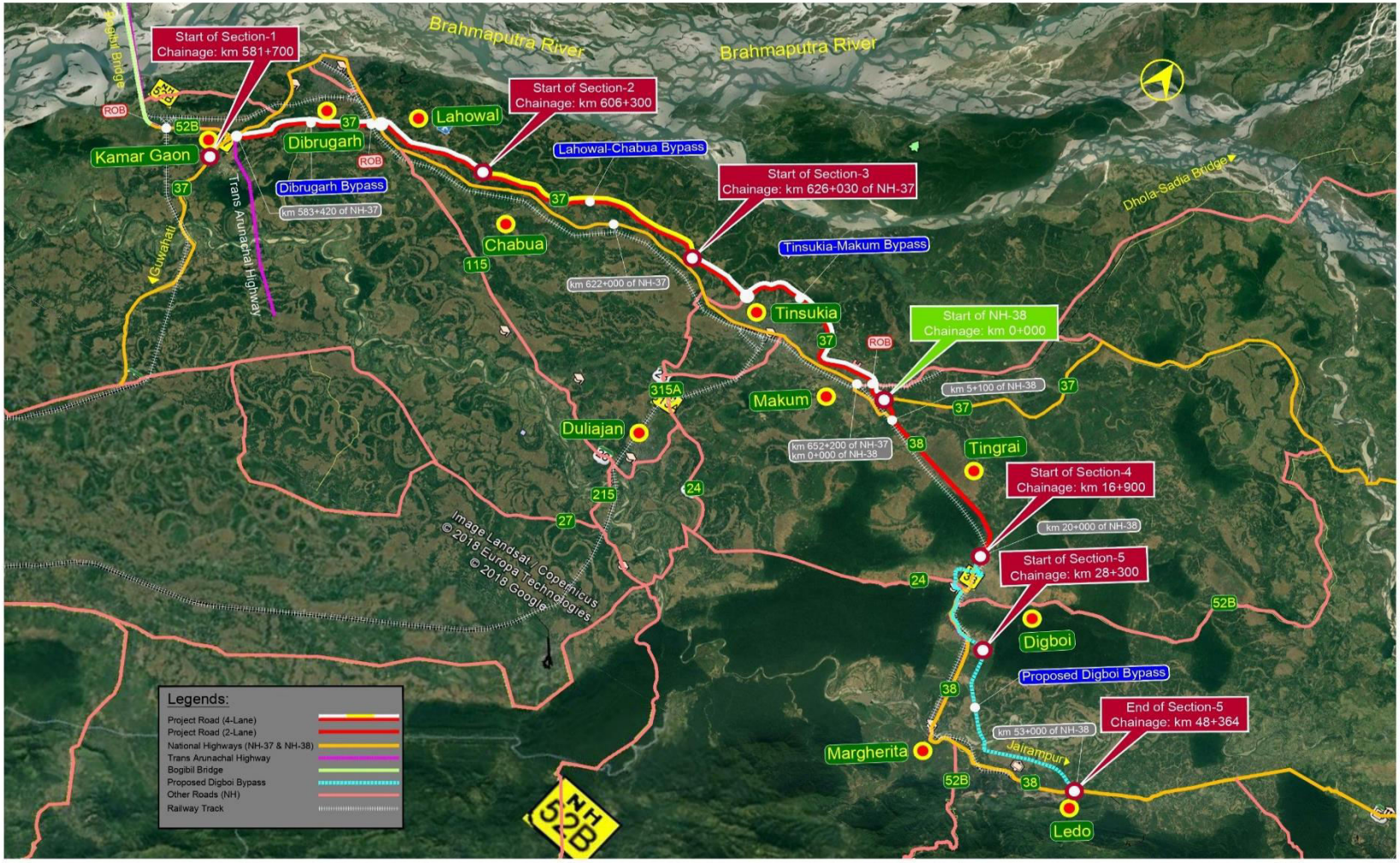


Figure 7.1: Project Road Index Map

7.2 ENVIRONMENTAL SCREENING

Project screening in EIA is the first step in the initial assessment of the possible environmental impacts of the proposed project. The purpose of the environmental screening is to identify if the proposed project requires an EIA through the elimination of irrelevant environmental issues and the forcing on the attention at the planning stages on potentially significant issues. The scope of the screening studies includes:

- Consideration of biophysical and socio-economic issues and the relevant legislative framework
- Consultation with key decision-makers and experts to identify key issues.

The screening process can have one of four outcomes:

i. No further level of EIA is required;
ii. A full and comprehensive EIA is required;
iii. A less detailed/ limited EIA is required; or
iv. Further study is necessary to determine the level of EIA required (often called an [1]Initial Environmental Examination (IEE).

The screening exercise establishes the basis for scoping, which identifies the key impacts to be studied and establishes terms of reference for an EIA. Typical environmental screening procedure is illustrated in the **Figure 7.2** below:

[1] Initial Environmental Examination (IEE) as defined by several multilateral-funding agencies such as The World Bank (WB), The Asian Development Bank (ADB) and the United States Agency for International Development (USAID) is "a preliminary attempt to evaluate environmental impacts in order to determine whether a full-scale environmental impact assessment is needed. Also called Initial Environmental Investigation (IEI), partial EIA or "Preliminary EIA".
In Accordance to USAID "Initial Environmental Examination (IEE) is the first review of the reasonably foreseeable effects of a proposed action on the environment. Its function is to provide a brief statement of the factual basis for a Threshold Decision as to whether an Environmental Assessment or an Environmental Impact Statement will be required." (Reference: USAID Automated Directives System - ADS - Chapters 200-204)
Source:https://www.usaid.gov/sites/default/files/documents/1865/204.pdf)

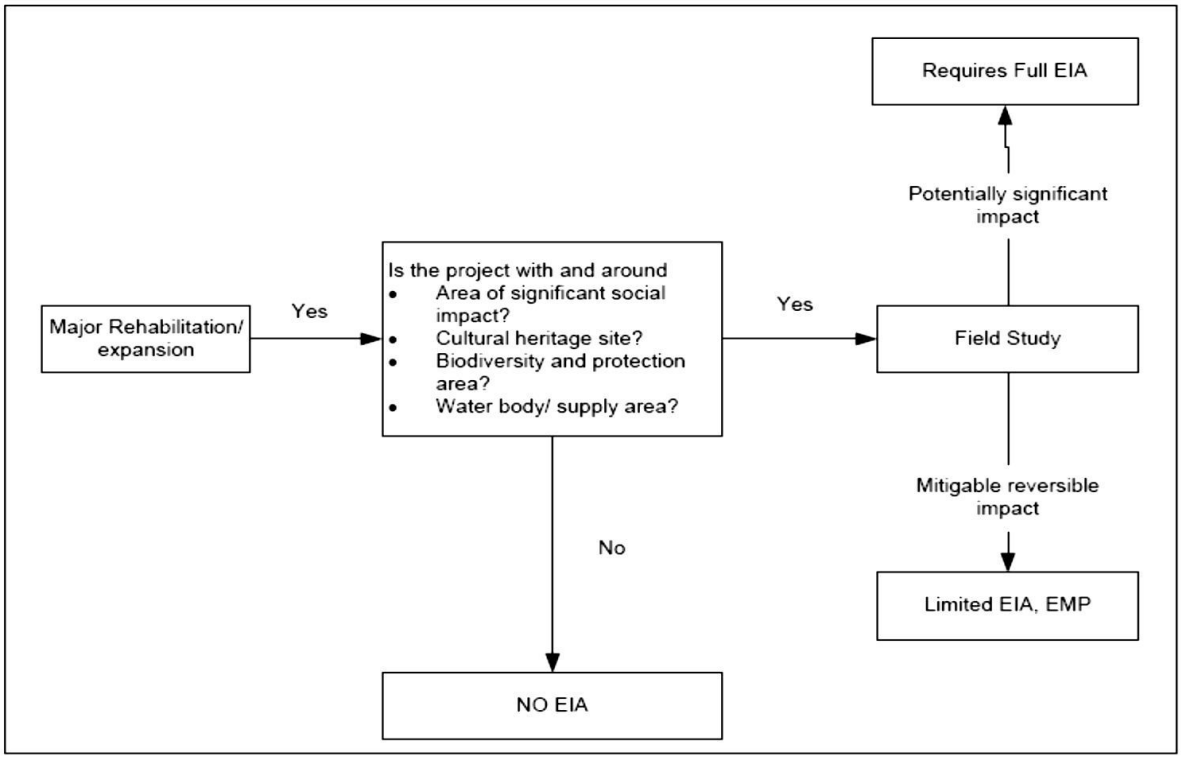


Figure 7.2: Typical Environmental Screening Procedure

7.2.1 Scope of Environment Screening

The purpose of the Environmental Screening (ES) is to:

- Categorize the project in terms of potential environmental impact based on Ministry of Environment, Forests and Climate Change (MoEF&CC) definitions and guidelines detailed in Environmental Impact Assessment (EIA) Notification, 2006 and its subsequent amendments
- Provide environmental direction early in the project; Alert the proponent and design team of any potential environmental concerns that must be addressed in detail in the EIA; and

The ES shall identify:

- Required environmental baseline data and analyses to be scoped in or out of the EIA, with sound justification;
- Potential positive and/or negative environmental impacts during the life cycle of the project, including construction and operation, that shall be analyzed in detail in the EIA;
- Potential catastrophic pollution releases (e.g., Solid & Hazardous waste, etc.) to be analyzed in detail in the EIA; and
- The survey methodology and techniques to be used in the EIA process.
- The project's category according to its likely level of environmental impact

The planned road development for the aforesaid sections of the road stretche-1 and 2 under Lot-I of Package-II in the state of Assam may have adverse environmental impacts on the immediate surrounding and ambient environment, an Environmental Screening (ES) Report is prepared with a view to properly categorizing the project and identifying and prioritizing environmental issues to be scoped in and scoped out during the detailed EIA Stage.

The important environmental component studied during the Environmental Screening Stage are given in **Table 7.2** as follows:

Table 7. 2: Important Environment Components

S. No.	Environmental Attributes	Environmental Components
1	Topography	Plain/Rolling
2	Land use	Agriculture, settlements, forest, industrial areas, tourism etc.
3	Water resources	Rivers, canals and ponds in study area
4	Forests & Wild Life	• Designated Protected Areas like Biosphere Reserves, National Parks and Sanctuaries etc.) within 10 Km from the proposed project location boundary • Presence of Wildlife Corridor along the project stretch • Presence of Reserve Forests (RF), Protected Forest (PF) and other forests within study area
5	Road side Plantations	Green Tunnels, Strip Plantation
6	Settlements	Towns and villages abutting the road corridor
7	Sensitive Receptors	Sensitive receptors such as educational and health facilities
8	Drinking water sources	Wells, hand pumps, community water points / taps etc.
10	Religious Structures	Temples, shrines, mosque, Church, Gurudwara etc.
11	Cultural Properties	Protected / unprotected archaeological monuments
12	Common Property Resources	Community recreational areas; cremation / burial grounds etc.

7.3 METHODOLOGY AND WORK PLAN

7.3.1 Approach to Screening and Scoping

Several guideline documents have described screening in different ways. The overall approach for the environmental screening has taken into account:

- Preparation of baseline;
- Identification & assessment of impacts;
- Policy & Legal Implications;
- Scoping of Work under EIA.

The scoping process is designed to ensure that the environmental studies provide all the relevant information on:

- The impacts of the project, in particular focusing on the most important impacts;
- The alternatives to the project;

- Time frame for the EIA based on potential impact; and
- Any other matters to be included.

7.3.2 Project Work Plan

The following activities have been carried out:

- **Task 1:** Mobilization/Orientation of Staff
- **Task 2:** Literature and Related Policies/Legal Review
- **Task 3:** Field investigation and data collection for environmental screening and scoping;
- **Task 4:** Analysis of Environmental Screening data;
- **Task 5**: Recommendations; and
- **Task 6:** Reporting

Task 1: Mobilization and Orientation of Staff

VSPL has mobilized thematic experts experienced in environmental and social impact assessments to carry out screening surveys for the planned road stretches under Package-II (Lot-I).

The Project's EIA have been discussed reviewed and discussed by the VSPL's thematic experts. Thereafter methodology and approach for project execution has thoroughly been discussed.

Task 2: Literature and Policy/Legal Reviews

The project documents (RFP document, project alignment and other relevant documents) collected from the client have been reviewed to have better understanding of the project objectives. These documents guided in the impact screening. All the Environmental Rules and Regulations enacted by MoEF&CC have been reviewed alongside other national and multilateral funding agency policies formulated by Asian Development Bank and World Bank safeguard policies relevant to Environmental Impact Assessment. In addition, relevant baseline data on the physical, biological and social environment have also been reviewed and findings incorporated into the report.

Task 3: Field Investigation and Data Collection

Field data gathering checklist: Field data gathering checklist (for Air, Noise, Water Soil & Socio-economic etc.) have been developed by the project team (thematic experts). The data gathering checklist have been used to capture all relevant information on environmental features, Environmental Sensitive Locations Wildlife flora and fauna (if any) etc.

Data Entry Team: Date entries into the computers have been done by experienced data entry personnel and data entered have been re-validated by the thematic experts to ensure correctness of the data as per the information and data collected during site visit such as GPS Coordinates, Noise Measurements, nearby commercial and industrial facilities, nearest

settlements, flora and fauna, water sources etc. In the context of the planned project, important parameters identified in the field are grouped into three categories:

- Physical Environment (Air Quality, Noise Quality, Waste generation and disposal, Water Resources, Soil Erosion)
- Biological Environment (No. of trees, reserved or protected areas, wetlands, rare or endangered wildlife and vegetation)-if any
- Social Environment (displaced persons, sacred groves, commercial structures on Right of Way (ROW), infrastructure etc.)-if any.

The data have been gathered to provide a reliable basis on which to predict effects likely to arise from the proposed project.

Task 4: Environmental Screening (ES) for Environmental and Social Impact Assessment

The ES identified the types of environmental impacts to be investigated and reported in the environmental impact assessment. The environmental topics that will be considered within the ES report are: air quality, noise and vibration, climate & meteorology, hydrology & draining, waste (solid, liquid & hazardous) management, ecology, soil/land contamination, socioeconomic, cultural heritage; For each topic, the likelihood of significant effects arising has been considered in terms of direct and indirect effects during construction and direct and indirect effects during operation and maintenance. The important Environmental Components considered in the Environmental Screening

7.4 PROJECT DESCRIPTION

7.4.1 Widening Proposal

At about 23% stretches the alignment passes through green field areas. For the balance reaches, where the alignment overlaps with the existing roads, eccentric widening has been followed with the objective to use the existing ROW to the maximum extent possible. At few locations, concentric widening also proposed to allow use of existing crust. However, minor realignments have been incorporated at few locations for geometric correction. Attempts have been made to avoid realignments at built up locations.

This project is essentially widening the existing standard/sub-standard 2-lane road to 4-lane with paved shoulder as the alignment follows predominantly existing roads. The geometric designs are as per recommendations of IRC: SP: 84-2019. The general design standards for improvement are enumerated in Table 7.3.

Table 7. 3: Geometric Design Standards for Road Works (Plain/Rolling Terrain

Sl No.	Attributes	Geometric Design Standards
1	Design Speed	
	Plain and Rolling Terrain (Cross slope of the ground up to 25 per cent)	Ruling: 100 kmph Minimum: 80 kmph

Sl No.	Attributes	Geometric Design Standards
2	Carriageway Width	7.0m carriageway
3	Width of Shoulder	
	a) Paved Shoulder	1x 1.5 m
	b) Earthen Shoulder	1.0 m
4	Footpath width at built-up areas	2 x 1.5 m drain cum footpath
5	Camber	
	a) Carriageway	2.5%
	b) Shoulder	3.0%
6	Maximum and Minimum Super-elevation	Maximum limited to 7.0% (for Radius less than Desirable minimum) Minimum limited to 5% (for Radius more than Desirable minimum)
7	Minimum Radius of Horizontal Curves	
	a) Plain and rolling Terrain	Desirable Minimum: 400m Absolute Minimum: 250m
8	Sight Distances for Various Speeds	180m – 360m
9	Longitudinal Gradient	
	a) Plain and Rolling Terrain	Ruling: 2.5%, Limiting: 3.3%
10	Extra Width of Pavement	
	Radius of Curve	Extra Width
	75-100m	0.9m
	101-300m	0.6m

7.4.2 Project Proponent

The proposed development will be managed by National Highway Infrastructure Development Corporation Ltd. (NHIDCL), Assam, (MoRTH), Govt. of India.

7.4.3 Need of the Project and benefits associated

- Will provide easy access to commuters
- Will cater the traffic growth on the road
- Will provide easy accessibility for school, medical facilities, etc. for the nearby villages even in the rainy season

- Project Road would bring about all-round development activities in the region, such as movement of people and goods, agriculture, commerce, education, health and social welfare, or even maintenance of law and order and security

The need of the project is to create a 4-lane partially access controlled facility with provision of at grade intersections, grade separators with/without ramps etc. as appropriate/necessary, within the stipulated Right-of-Way by improving the existing single/two lane road and/or developing a new 4-lane road in case of locations with poor geometry and dense settlements to a standard 4-lane road with paved shoulder. To this end, land to the extent necessary will be acquired. Further, the development cost may be recouped, to the extent practicable, from collection of tolls from users of the improved facility. As such, the improvement schemes for the project road should be as economical as possible consistent with the functional requirements and amenable for quick implementation without much gestation delays.

7.4.4 Proposed Features of Road

A. Development Proposal

The salient proposals for up-gradation and improvement of the project road are classified into the following engineering aspects:

Where Proposed Alignment Overlaps with Existing Roads

- In general, in this section of proposed stretch follows existing Sections except the bypass proposed.
- Widening of the project road based on traffic capacity/requirement.
- Improving the horizontal geometry of the existing road based on the design standards as per IRC: SP: 73-2018
- Design of new pavement for widening and realignment of the existing road.
- Provision of overlay at strengthening stretches.
- Improvement of all major and minor intersections.
- Rehabilitation and widening of the existing structures including bridges, culverts etc. and design of new ones as per requirement.
- Provision of comprehensive road furniture for complete road safety measures.

B. Bypass and Realignment

The proposed alignment is overlapping with the existing geometric improvement. **Table 7.4** provides the list realignment stretches where the proposed alignment does not overlap with the existing roads.

Table 7. 4: List of Stretches with Realignments

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
1	27+950	28+192	761	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
					CONSRUCTION)
2	28+192	28+286	94	STR	ROB
3	28+286	28+680	394	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
4	28+680	29+040	360	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
5	29+040	29+300	260	TCS-3A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)
6	29+300	29+452	152	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
7	29+452	29+462	10	STR	MNB
8	29+462	30+110	648	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
9	30+110	30+130	20	STR	MNB
10	30+130	31+263	1133	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
11	31+263	31+270	7	STR	SVUP
12	31+270	31+715	445	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
13	31+715	31+766	51	STR	MNB
14	31+766	32+997	1231	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
15	32+997	33+004	7	STR	SVUP
16	33+004	33+907	903	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
17	33+907	33+914	7	STR	SVUP
18	33+914	33+973	59	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
19	33+973	33+988	15	STR	MNB
20	33+988	35+699	1712	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
21	35+699	35+711	12	STR	LVUP
22	35+711	35+800	89	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
23	35+800	35+841	41	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
24	35+841	35+909	68	STR	MJB
25	35+909	37+115	1206	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
26	37+115	37+155	40	STR	MNB
27	37+155	37+460	305	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
28	37+460	37+470	10	STR	MNB
29	37+470	38+068	598	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
30	38+068	38+733	665	STR	MJB
31	38+733	39+797	1064	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
32	39+797	39+804	7	STR	SVUP
33	39+804	39+880	76	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
34	39+880	39+895	15	STR	MNB
35	39+895	40+462	567	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
36	40+462	40+469	7	STR	SVUP

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
37	40+469	42+047	1578	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
38	42+047	42+054	7	STR	SVUP
39	42+054	42+747	693	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
40	42+747	42+754	7	STR	SVUP
41	42+754	43+199	445	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
42	43+199	43+214	15	STR	MNB
43	43+214	44+700	1487	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
44	44+700	44+877	177	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
45	44+877	44+884	7	STR	SVUP
46	44+884	45+731	848	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
47	45+731	45+741	10	STR	MNB
48	45+741	45+817	76	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
49	45+817	45+824	7	STR	SVUP
50	45+824	46+952	1129	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
51	46+952	46+962	10	STR	MNB
52	46+962	47+500	538	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]

C. Service Road

Service Road with Footpath have been considered at ROB approaches as mentioned below.

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
1	27+230	27+431	201	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
2	27+431	28+192	761	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
3	28+286	28+680	394	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
4	28+680	29+040	360	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)

D. Cross Drainage Structure

Cross section for bridges, culverts and other structures shall be as per relevant guidelines of IRC: SP-73-2018. In general, full roadway width will be proposed between the outer to outer face of crash barrier/ parapet for culverts. Generally, 2- lane configurations for bridges/culverts/other structures are provided in Table 7.5.

Table 7. 5: General Structural Configuration

Type of Structure	Width of Structural Components (m)					Remarks
	C/W	FP (both side)	CB (both side)	Railing (both side)	Overall	
2-Lane Bridge	13	1.5	0.5	0.5	18.0	IRC SP-73-2018 fig no 7.6
2-Lane Gr. Separator	11.0	-	0.5	-	12.0	Fig. 7.10 of IRC: SP:73-2018

The overall width of culverts for 2 lane configurations shall be equal to the total roadway width of the approaches. The outer most face of railing or parapet shall be in line with the outer most edge of shoulder. However, in general typical cross section for culverts shall be (as per Fig. 7.1, Fig. 7.2 and 7.3 of IRC: SP:73-2018).

Thickness of wearing course shall be 65 mm (40 mm BC + 25 mm mastic asphalt).

Due consideration has been given to drainage while preparing the design. The cross-sections incorporating roadside drains have been proposed at various stretches of the highway taking into account the existing and natural conditions as well as anticipated situation. In general, unlined trapezoidal drains have been considered on either side of road. Lined rectangular uncovered RCC drains have been considered for cut section as well as approaches of major bridges. Covered rectangular drain sections have been proposed in urban stretches as well as approaches of underpasses. At super elevated sections with raised median, rectangular cross median drains have been considered. All the drains shall discharge into the nearest outfall. At high embankment stretches (where embankment height more than 3.0m) chute drains with energy dissipation basins have been proposed @ 5m interval.

The details are provided below:

Type of Drain	Side	Total Length including both side (m)	Applicable TCSs
Section-5			
Unlined Trapezoidal Drains	Both	35276	TCS –1, 3A, 3B, 8
RCC Covered Drain	Both	3596	TCS –4A,4B,9
Trapezoidal V-shaped Drain	Both	-	-

E. Land Acquisition

Proposed ROW of 40m to 45m is considered for the road section in rural area.

As per assessment at this stage tentative land acquisition is assessed as below:

- ***For Section 5: 17.601 Ha***

F. Intersection Design

All junctions have been studied thoroughly with respect to traffic volume and geometric design. The important junctions leading to settlements have been identified and proper junction layouts (including road marking, and traffic signs) shall be applied as per IRC-SP: 41-1994.

G. Traffic Control and Road Safety Features

Traffic control devices and road safety features, including Traffic Signs, Road Markings, Road lighting & Crash Barriers are proposed and designed as per relevant IRC codes and standards.

7.5 LEGISLATIVE FRAMEWORK

7.5.1 Introduction

Project road under study is mostly lies in hilly region and has been upgraded for development. Any developmental activity has both adverse as well as beneficial impact on surrounding environment. The present report is an effort for scrutinised the applicable environmental laws and legislative framework under Ministry of Environment Forests & Climate Change, Govt. of India. This section elaborates on the various clearance requirements for the project from the State Government and MoEF&CC, GoI.

7.5.2 Environment Legislation- India

The Government of India has formulated various policy guidelines; acts and regulations aimed at protection and enhancement of environmental resources. The following **Table 7.6** surmises the existing legislations pertaining to the project, the various clearances required for the project.

Table 7. 6: Environment Laws and their Applicability

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
1	The Environmental (Protection) Act. 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Umbrella Act. Protection and improvement of the environment	Yes	All environmental notifications, rules and schedules are issued under the act	MoEF&CC, State Department of Environment & Forest, CPCB and SPCB
2	The EIA Notification, 14th September 2006 & subsequent amendments	Identifies expansion of National highways projects greater than 100 Km involving additional ROW and land acquisition greater than 40m on existing alignments and 60m on re-alignments or by-passes and All new state highway projects & SH expansion projects in hilly terrain (above 1000 MSL) and or ecological sensitive areas	No	EIA Notification 2006 and its subsequent amendments shall not be applied as the road length is less than 100 km and the PROW is less than 40 meters in existing road and 60 meters in bypass.	MoEF&CC/ SEIAA
3	Notification for use of Fly ash, 3rd November 2009 and subsequent amendment in 25th January 2016	Reuse fly ash discharged from Thermal Power Station to minimize land use for dispersal and minimized borrow area material	No	The project road is traversing through the mountainous region of Assam & Arunanchal Pradesh where No coal based thermal power project in 300 km form the project road.	MoEF&CC, SPCB
4	The Water (Prevention and	Central and State Pollution Control	Yes	Consent required for not	State Pollution Control

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
	Control of Pollution) Act, 1974	Board to establish / enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction / operation of certain facilities.		polluting ground and surface water during construction	Board
5	The Air (Prevention and Control of Pollution) Act. 1981	Empowers SPCB to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission.	Yes	Consent required for establishing and operation of batching, hot mix plants and crushers	State Pollution Control Board
6	Noise Pollution (Regulation And Control) Act, 1990	Standards for noise emission for various land uses	Yes	Construction machineries and vehicles to conform to the standards for construction	State Pollution Control Board
7	Forest (Conservation) Act, 1980	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the Forest conservation Act.	Yes	Part of road packages passes through the Digboi West Block RF, Archia Dimow RF, Zamzing RF, Gali RF and Poba RF	Forest Department, MoEF&CC
8	Coastal Regulatory Zone Notification, 1991	Protect and manage coastal areas	No	The project area is located in landlocked region and there is no designated coastal zone.	MoEF&CC, State Department of Environment
9	Wild Life Protection Act, 1972	Protection of wild life in sanctuaries and National Park	No	No Eco-Sensitive Areas such as Wildlife Sanctuary, National Park and Biosphere Reserves are	NBWL, SBWL & Chief Wild Life Warden

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
				located within 10 km distance from the project road. However, There are two nos. elephant corridors along proposed Digboi bypass	
10	Ancient Monuments and Archaeological sites & Remains Act 1958	To protect and conserve cultural and historical remains found.	No	No notified archaeological monument is located in the proximity of the planned project road	Archaeological Survey of India, State Dept. of Archaeology
11	The Motor Vehicle Act, 1988	Empowers State Transport Authority to enforce standards for vehicular pollution.	Yes	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
12	The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting & quarrying	Yes	New quarrying operation may require blasting	Chief Controller of Explosives
13	Public Liability and Insurance Act,1991	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials like Bitumen shall be used for road construction	State Pollution Control Board
14	Hazardous Wastes (Management, Handling and Trans-boundary Movement)	Protection to the general public against improper handling and disposal of hazardous wastes	Yes	Hazardous wastes shall be generated due to activities like of maintenance and repair work	State Pollution Control Board

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
	Rules, 2008			of vehicles	
15	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemicals resulting	Yes	Handling of hazardous (flammable, toxic and explosive) chemicals during road construction	District & Local Crisis Group headed by the DM and SDM
16	Mines &Minerals (Regulation & Development) Act, 1957 as amended in 1972	Permission of Mining of aggregates and sand from river bed & aggregates	Yes	Mining of sand or aggregates	State Department of Mining
17	The Building & Other Construction Workers (Regulation of Employment & Conditions of Service) BOCW Act, 1996	Employing Lab our / workers	Yes	Employment of labors	District labor Commissioner

7.5.3 International Agreements

Key international agreements that India is signatory to and relevant for the project are provided below:

- Convention Relative to the conservation of Flora and Fauna in their Natural State (1933)
- International Plan Protection Convention (1951)
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar, 1971)
- Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
- Convention in International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973)
- Convention on Migratory Species of Wild Animals (Bonn, 1979)
- Convention on the Prior Informed Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC or Rotterdam, 1990)
- United Nations Framework Convention on Climate Change (Rio De Janeiro, 1992)
- Convention on Biological Diversity (Rio De Janeiro, 1992)
- Protocol to the United Nations Convention on Climate Change (Kyoto, 1997)
- United Nations Convention on the law of sea (Jamaica, 1982)
- Convention concerning the Protection of the World's Cultural and Natural Heritage (1975)

The above list of international conventions served as requirements for the project to comply.

7.5.4 Environment and Social Safeguard Policies

A. ASIAN DEVELOPMENT BANK (ADB) SAFEGUARD POLICIES

Environmental and social safeguards are a cornerstone of ADBs support for environmentally sustainable economic growth. The Safeguard Policy Statement builds upon the three safeguard policies on the environment, involuntary resettlement, and indigenous people, and brings them into a consolidated policy framework to enhance effectiveness and relevance. The Safeguard Policy Statements, lays out Policy Principles and outlines a set of specific safeguard requirements that ADB supported projects are expected to meet. The ADB Safeguard Policies cover the following aspects.

- Environmental assessment;
- Environmental planning, and management;
- Information disclosure;
- Consultation and participation;
- Grievance Redress mechanisms;
- Monitoring and Reporting;
- Unanticipated Environment Impacts;
- Biodiversity and sustainable natural resources management;
- Pollution prevention and abatement;
- Health and safety;

- Physical cultural resources; and
- Involuntary resettlement;
- Indigenous peoples

Applicability analysis of the ADBs in reference to proposed project is tabulated below

Table 7. 7: Application of ADB Safeguard Policies to the Project

ADB Safeguard Policy statement	Requirements	Project Information/ Application
1. Environmental assessment	Environmental assessment term is used to identify potential direct, indirect, cumulative, and induced impacts and risks at an early stage of the project	The assessment is made in reference to the ADB standard checklist
2. Environmental planning and management	As per this requirement, borrower should prepare an environmental management plan (EMP) that addresses the potential impacts and risks identified by the environmental assessment. The EMP should include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.	Management and monitoring plan for the project is based on the Impact Intensity in a particular aspect of environment. Performance Indicators are established for post project monitoring.
3. Information Disclosure	Under this requirement borrower should establish regular interaction with the affected populations and stakeholders	Regular interaction with affected population and stakeholders are being made.
4. Consultation and Participation	The borrower / client should carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.	Consultation is a regular practice at the project site. NHIDCL should keep regular interaction with all the stakeholders.
5. Grievance Redress Mechanism	The borrower / client should establish a mechanism to receive and facilitate resolution of affected peoples' concerns, complaints and grievances about the project's environmental performance.	Grievance Redressal Mechanism of NHIDCL, MoRTH, Govt. of India shall be followed.
6. Monitoring and Reporting	The borrower / client should monitor and measure the progress of implementation of the EMP. The extent of monitoring activities should be commensurate with the project's risks and impacts. The borrower / client should prepare periodic monitoring reports that describe progress with implementation of the EMP and compliance issues and corrective	Monitoring plan is defined in this report and same shall be followed during operation of the project.

ADB Safeguard Policy statement	Requirements	Project Information/ Application
	actions, if any.	
7. Unanticipated Environmental Impacts	Where unanticipated environmental impacts become apparent during project implementation, the borrower / client should update the environmental assessment and EMP or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.	At this stage no such unanticipated impact is expected. However, If any unforeseen circumstance takes place, corrective action shall be taken by NHIDCL.
8. Biodiversity and sustainable natural resources management;	NHIDCL should follow and need to identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.	The project road packages are traversing through Eco- sensitive locations such as Daboka, Sildharampur Reserve Forests. Hence the project requires Forest Clearance from the MoEF&CC under the Forest (Conservation) Act, 1980 and Wildlife Clearance from NBWL under Wildlife (Protection) Act, 1972.
9. Pollution prevention and abatement;	During the design, construction, and operation of the project the borrower/ client should apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety (EHS) Guidelines.	NHIDCL shall ensure that any pollution during design, construction, and operation of the project shall be minimal and at any cost should not exceed the permissible limit of CPCB/SPCB.
10. Health and safety;	NHIDCL should provide workers with a safe and healthy working environment, taking into account risks inherent to the particular sector and specific classes of hazards in the work areas, including physical, chemical, biological, and radiological hazards. Borrower / client should take steps to prevent accidents, injury, and disease arising from, associated with, or occurring during the course of work by (i) identifying and minimizing, so far as reasonably practicable, the causes of potential hazards to workers; (ii) providing preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances; (iii)	NHIDCL shall abide with National and International Safety Standards. Labour laws shall be followed in specific reference to Highways and Infrastructure Development Projects.

ADB Safeguard Policy statement	Requirements	Project Information/ Application
	providing appropriate equipment to minimize risks and requiring and enforcing its use; (iv) training workers and providing them with appropriate incentives to use and comply with health and safety procedures and protective equipment; (v) documenting and reporting occupational accidents, diseases, and incidents; and (vi) having emergency prevention, preparedness, and response arrangements in place.	
11. Physical cultural resources	The borrower / client is responsible for siting and designing the project to avoid significant damage to physical cultural resources (Defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance.	NHIDCL shall ensure that the project will not have any impact on any structure(s) of archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance.
12. Involuntary resettlement;	Borrower / client should provide adequate and appropriate replacement land and structures or cash compensation at full replacement cost for lost land and structures, adequate compensation for partially damaged structures, and relocation assistance. The rate of compensation for acquired housing, land and other assets should be calculated at full replacement costs. The calculation of full replacement cost should be based on the following elements: (i) fair market value; (ii) transaction costs; (iii) interest accrued, (iv) transitional and restoration costs; and (v) other applicable payments.	Land for the project shall be acquired from the public/Govt. and local inhabitants following the Govt. of India/State of Assam and NHIDCL/MoRTH Guidelines.
13. Indigenous peoples;	Borrower / client should explore to the maximum extent possible alternative project designs to avoid physical relocation of Indigenous People that shall result in adverse impacts on their identity, culture, and customary livelihoods. If avoidance is impossible, in consultation with ADB, a combined Indigenous Peoples plan and resettlement plan could be formulated to	Land for the project shall be acquired from the public/Govt. and local inhabitants following the Govt. of India/State of Assam and NHIDCL/MoRTH Guidelines.

ADB Safeguard Policy statement	Requirements	Project Information/ Application
	address both involuntary resettlement and Indigenous Peoples issues.	

B. WORLD BANK (WB) SAFEGUARD POLICIES

The World Bank has 10 operational safeguard policies for the development projects that are funded by the Bank. The purpose of these policies is to ensure that social and environmental risks are prevented or at least minimized while increasing socio-economic benefits of approved projects in addition to preserving the environment.

These policies have been a means to increase the effectiveness and positive impacts of development projects and programs supported by the Bank.

The Bank's 10 safeguard policies are:

- OP/BP 4.01 Environmental Assessment
- OP/BP 4.04 Natural Habitats
- OP/BP 4.09 Pest Management
- OP/BP 4.10 Indigenous Peoples
- OP/BP 4.11 Physical Cultural Resources
- OP/BP 4.12 Involuntary Resettlement
- OP/BP 4.36 Forests
- OP/BP 4.37 Safety of Dams
- OP/BP 7.50 Projects on International Waterways
- OP/BP 7.60 Projects in Disputed Areas

With respect to this project, three key policies are being triggered. These are Environmental Assessment (OP/BP 4.01), Involuntary Resettlement (OP/BP 4.12) and Physical Cultural Resources (OP/BP 4.11)

i) OP/BP 4.01 Environmental Assessment

This policy is triggered if a project is likely to have significant adverse environmental impacts in its area of influence. For Category A projects, such as this project, a comprehensive Environmental and Social Impact Assessment and the resultant Environmental and Social Management Plan are required, with emphasis on integrating environmental measures in project planning, design, implementation and operation, in addition to ensuring the environmental soundness and sustainability of investment projects.

The project's ESIA and ESMP take into account the natural environment (air, water, and land); human health and safety; and social aspects (involuntary resettlement, physical cultural resources, etc.) in addition to trans-boundary and global environmental aspects. The policy requires consultations with potentially affected persons and analysis of alternatives as key parts

of the process and documentation. The OP 4.01 is applicable to all components of Bank financed projects.

ii) OP/BP 4.12 Involuntary Resettlement

This policy requires that adverse social impacts of projects it supports be mitigated, including when land or property is acquired or its use modified under a project so that Project-affected Persons (PAPs) suffer loss of income, residence, livelihoods or access to resources, either permanent or temporary, whether the land occupation/use is legal or illegal. Resettlement or relocation of PAPs adversely affected by project activities must be undertaken in accordance with laws, regulations and guidelines for Resettlement/Land Acquisition in Govt. of India/State of Assam Resettlement & Rehabilitation Policy and OP 4.12. If there is a gap between Govt. of India/State of Assam Resettlement & Rehabilitation Policy and the Bank's OP 4.12 then the Bank's provisions must apply.

According to OP 4.12, the main objectives of this policy are:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.
- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.
- This policy covers direct economic and social impacts that both result from Banks assisted investment projects, and are caused by:
- The Involuntary taking of land resulting in:
  - Relocation or loss of shelter
  - Loss of assets or access to assets; or
  - Loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or
- The involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

Furthermore, the Bank requires that appropriate and accessible grievance mechanisms are established for project affected persons. A Resettlement Action Plan (RAP) for the project shall be prepared as a separate document.

iii) OP/BP 4.11 – Physical Cultural Resources

The Policy triggered if there are physical cultural resources will be affected due to proposed development. Procedures to deal with such instances in line with the Govt. of India/State of Assam law and OP 4.11 will need to be integrated into the civil works contract documents, through the ESMP.

iv) Mandatory Policies – BP 17.50 Bank Disclosure Policies

This Bank Policy supports decision making process by the Borrower and Bank through allowing public access to information on environmental and social aspects of projects. Disclosure of key project documents, including Executive summaries in English and in the local language, is mandated:

- In Country – prior to project appraisal in the local language and in English
- In the World Bank Info Shop before project appraisal, in English with the Executive Summary in English and in the local language (documents can be in draft but must meet World Bank standards).

C. OTHER WB GUIDELINES

Other useful guidelines and manuals that have been considered during the ESIA phase of the project include:

- The World Bank Participation Source book
- IFC Involuntary Resettlement Guide book
- Safeguards Policy Basics – Red book
- Environmental, Health and Safety (EHS) General Guidelines of the World Bank Group
- Roads and the Environment. A Handbook. World Bank Technical Paper 376.
- Doing Better Business through Effective Public Consultation and Disclosure – A good Practice Manual, issued by IFC.
- Handbook for Preparing a Resettlement Action Plan, issued by IFC.

7.6 ENVIRONMENT SCREENING

7.6.1 Introduction

The collection of baseline information on biophysical, social and economic aspects of the project area is the most important reference for conducting environment study. Social and Environment team have visited the site to collect environment and socio-economic data pertaining to the planned road project. The outcome of the findings is discussed in this section of the report.

7.6.2 Study Area

Details of affected structures were collected for 22.5 m on either side from the center line of the road. Details of sensitive receptors, those are located beyond 22.5 m were also collected as the

noise and air pollution may take place beyond direct area (approximately 500 meters) of impact.

7.6.3 Data Collection

Efforts have been made to collect the latest information both at regional as well as local level especially along the project roads alignment.

A. Secondary Data

Data collection from the secondary sources has been done from various authentic and published sources. Following are some important information available from secondary sources.

- Project objectives, technical information on existing road features from Contract Document
- Climatic condition & long-term meteorological data from Indian Meteorological Department and government websites
- Geology, seismicity, soil and topography from government websites & district groundwater brochure of CGWB
- Land Use from Google Earth and observation during surveys
- Survey of India Topo-sheet, Google Earth & field observation

B. Primary Data

Field study / monitoring have been carried out to generate and collect primary data in the study corridor, which involves:

- Inventory of road features like drinking water source, water bodies, community structures, environmentally sensitive locations areas, congested locations etc. from physical surveys
- Enumeration of roadside trees by Contractor
- Biological Diversity Data
- Environment Monitoring
- Forest Data from the concerned forest Department.

7.6.4 Location

A. The State- Assam

Assam is a state in Northeast India, situated south of the eastern Himalayas along the Brahmaputra and Barak River valleys. Assam covers an area of 78,438 km2 (30,285 sq mi). The state is bordered by Bhutan and the state of Arunachal Pradesh to the north; Nagaland and Manipur to the east; Meghalaya, Tripura, Mizoram and Bangladesh to the south; and West Bengal to the west via the Siliguri Corridor, a 22 kilometres (14 mi) strip of land that connects the state to the rest of India.

The indigenous people traditionally include ethnic groups like Assamese Brahmins (including Ganaks), Koch Rajbongshi, Ahom, Bodo, Mishings, Sonowal Kacharis, Rabha, Hajong , Karbi, Rengma Naga, Chutias, Kalitas, Keot (Kaibarta), Tiwa, Mech Kachari, Thengal-Kacharis, Sarania Kacharis, Dimasa, Tea Tribes, Tai Phake and other Tai groups, indigenous ethnic groups of other neighbouring North-East states, Deoris, Doms/Nadiyals, Assamese Muslims (particularly Goria, Moria, Deshi communities), Assamese Sikhs and Assamese Christians speaking Assamese or any other tribal dialect of Assam as their mother tongue.

Assam is known for Assam tea and Assam silk. The state has conserved the one-horned Indian rhinoceros from near extinction, along with the wild water buffalo, pygmy hog, tiger and various species of Asiatic birds, and provides one of the last wild habitats for the Asian elephant. The Assamese economy is aided by wildlife tourism to Kaziranga National Park and Manas National Park, which are World Heritage Sites. Sal tree forests are found in the state which, as a result of abundant rainfall, look green all year round. Assam receives more rainfall than most parts of India; this rain feeds the Brahmaputra River; whose tributaries and oxbow lakes provide the region with a hydro-geomorphic environment.

A. District of project Road Stretches in Assam

In Assam, the project stretch road stretches through Dibrugarh and Tinsukia districts.

a. Dibrugarh District: Dibrugarh is an administrative district in the state of Assam in India. The district headquarters are located at Dibrugarh city. The district occupies an area of 3381 km². According to the 2011 census Dibrugarh district has a population of 1,327,748, roughly equal to the nation of Mauritius or the US state of Maine. This gives it a ranking of 367th in India (out of a total of 640). The district has a population density of 393 inhabitants per square kilometer (1,020/sq mi). Its population growth rate over the decade 2001-2011 was 12.04%. Dibrugarh has a sex ratio of 952 females for every 1000 males and a literacy rate of 76.22%. Hindus 1,075,878 (90%), Muslims 53,306 (4.5%), Christians 45,040. The main indigenous Assamese communities inhabiting the district includes Ahoms, Sutiya, Keot(Kaibarta), Sonowal Kacharis, Muttock, Moran people etc. There are also some indigenous Assamese Tai Buddhist communities like Tai Phake, Khamti and Khamyang.

More than half of the district's population consists of Tea tribe (Adivasi) community. Language commonly used in the district are Assamese, English.

b. Tinsukia District: Tinsukia district is one of the 27 administrative districts in the state of Assam, India. The district headquarters are located at Tinsukia. Tinsukia district occupies an area of 3,790 square kilometres (1,460 sq mi).

According to the 2011 census Tinsukia district has a population of 1,316,948 roughly equal to the nation of Mauritius or the US state of New Hampshire or 4.22 percent of the total population of Assam. This gives it a ranking of 371st in India (out of a total of 640). The district has a population density of 347 inhabitants per square kilometer (900/sq mi). Its population

growth rate over the decade 2001-2011 was 14.51%. Tinsukia has a sex ratio of 948 females for every 1000 males and a literacy rate of 70.92%.

Hindus 1,029,142, Christians 62,403, Muslims 40,000 (3.47%). The major communities of the district are the Tea-tribes (Adivasi), Ahoms, Sonowal Kachari, Chutiya Kachari, Moran Kachari, Muttock Kachari, Singpho, and Indian Gorkha. There are migrant communities like Bihari and Bengali. There are also a few small tribes like Tai Phake, Khamyang, and Nocte etc.

7.6.5 Topography, Geology, Seismicity and Soil

The topography, geology, seismicity and Soil of the project districts is detailed in **Table 7.8** as follows:

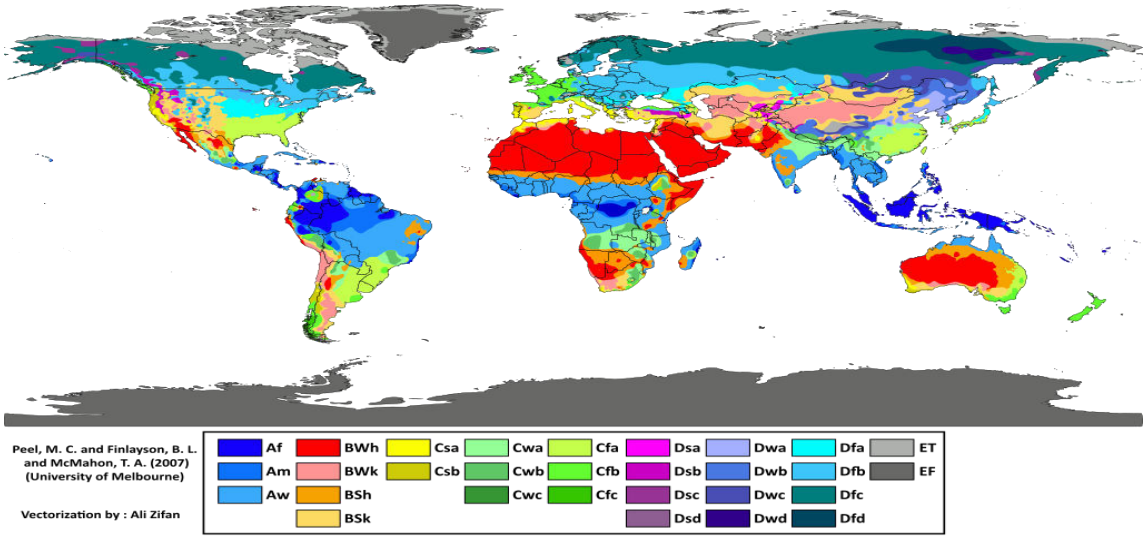
Table 7. 8: Topography, Geology, Seismicity and Soil of the project districts

Factors	Assam	
	Dibrugarh District	Tinsukia District
Topography	Buridihing, a tributary of Brahmaputra, divides Dibrugarh district from east-to-west. Buridihing flows through Naharkatia and Khowang, and at a later stage in its course, Buridihing acts as a divider between Dibrugarh and Sivasagar districts. The region is flat with a gradual slope from the East Arunachal hills to the west.	Tinsukia District is located in the upper region of Assam with its headquarters at Tinsukia. This administrative district of Assam is bounded by Arunachal Pradesh in east-south, by Dibrugarh District in south-west and by Dhemaji District in the north, which is separated from Tinsukia District by Brahmaputra River.
Geology	Unconsolidated alluvial deposits of Quaternary Age cover major part of The Dibrugarh district. Only about 4 % area of the district is underlain by semi consolidated formation of Tertiary Age belongs to Disang and Barail Groups of rock.	The district can be sub-divided into two broad geological Units (1) Tertiary Group of Semi-consolidated rocks (2) Quaternary alluvium of Unconsolidated sediments. Tertiary group of sedimentary rocks are confined to the southernmost part of the area where ground water occurs in the shallow weathered zone.
Seismicity	As per the seismic zoning map of India, as incorporated in Indian Standard Criteria for earthquake Resistant Design of Structure IS:1893-(Part I) 2002: General Provisions and Buildings; the entire state of Assam has been assigned to seismic zone V, which is the most seismotectonically active zones on the map.	As per the seismic zoning map of India, as incorporated in Indian Standard Criteria for earthquake Resistant Design of Structure IS:1893-(Part I) 2002: General Provisions and Buildings; the entire state of Assam has been assigned to seismic zone V, which is the most seismotectonically active zones on the map.

Factors	Assam	
	Dibrugarh District	Tinsukia District
Soil	Soils of the area are sandy to clayey loam type and grayish is color. They are acidic in reaction with PH ranges from 4.6 to 5.9. They are also characterized by low to medium phosphate and medium to high potash content. Based on pedogenic and pedological characters, soils of this area may be classified into following classes: a) Recent riverine alluvial soils (Antisol) b) Old riverine alluvial soils (Inceptisol) c) Old mountain valley alluvial soils (Alfisol)	The soil in the area may be grouped into three broad categories depending upon the origin and occurrence. These are given below: (a) Newer alluvial Soil: Flood plain areas of River Brahmaputra and the tributaries in the northern part are characterized by light grey clay with sand and silt. (b) Older alluvial Soil: It occurs mainly in the central part with limonite yellow to reddish yellow clay. (c) Soil cover in forest and hilly areas : It is deep reddish in colour and occurs over the older geological formation in the southernmost part of the district

7.6.6 Climatology

In accordance to Köppen–Geiger Climate Classification system, The project districts i.e. Dhemaji, Dibrugarh, Nagaon, Jorhat & Tinsukia in Assam and East Siang in Arunanchal Pradesh falls under two (02) different Climate groups. Dhemaji, Dibrugarh, Jorhat, Tinsukia in Assam and East Siang districts Falls under Humid subtropical climate (Cwa), while Nagaon districts falls under Tropical savanna climate (Aw). World Map of Köppen–Geiger Climate Classification is provided in Figure 7.3.



**Source: Peel, M. C., Finlayson, B. L., and McMahon, T. A. (University of Melbourne) Enhanced, modified, and vectorized by Ali Zifan. - Hydrology and Earth System Sciences: "Updated world map of the Köppen-Geiger climate classification"*

Figure 7.3: World Map of Köppen–Geiger Climate Classification

a) **Dibrugarh District:** Dibrugarh's climate is classified as warm and temperate. The summers are much rainier than the winters in Dibrugarh. The climate here is classified as Cwa by the Köppen-Geiger system. The average annual temperature in Dibrugarh is 23.2 °C. The average annual rainfall is 2781 mm. The least amount of rainfall occurs in December. The average in this month is 21 mm. The greatest amount of precipitation occurs in July, with an average of 531 mm. The temperatures are highest on average in August, at around 27.9 °C. The lowest average temperatures in the year occur in January, when it is around 16.2 °C. The variation in the precipitation between the driest and wettest months is 510 mm. The variation in temperatures throughout the year is 11.7 °C. Climograph and temperature graph of Dibrugarh district are presented in **Figure 7.4 and 7.5** respectively.

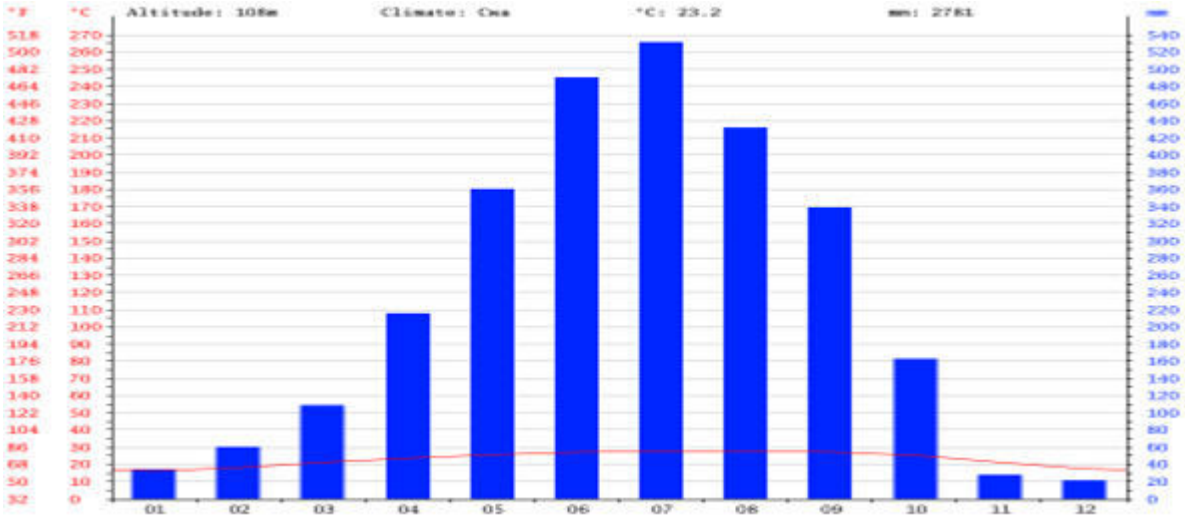


Figure 7.4: Climograph of Dibrugarh District

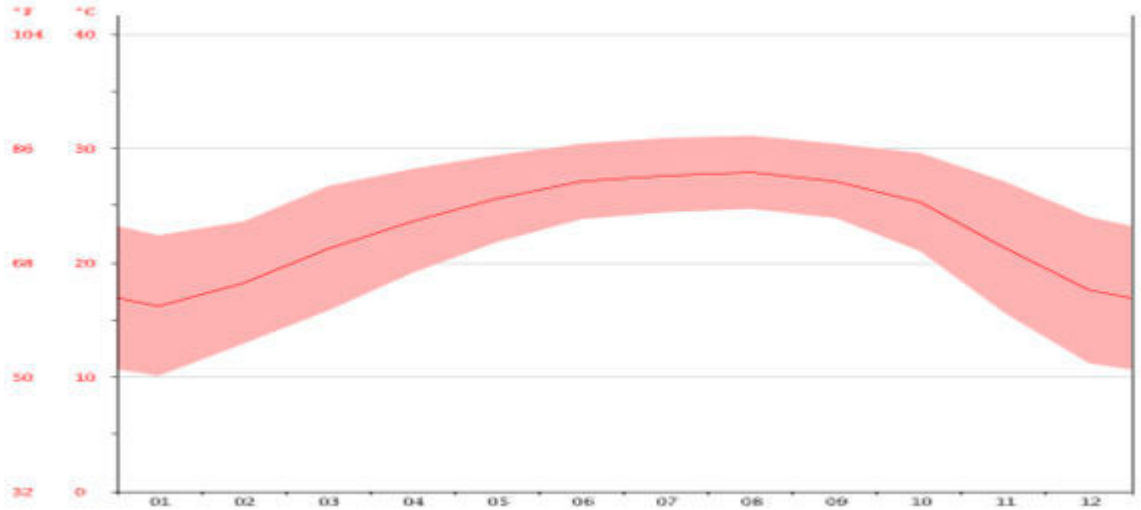


Figure 7.5: Temperature Graph of Dibrugarh District

**Source: https://en.climate-data.org/location/767206/*

a) Tinsukia District: The climate here is mild, and generally warm and temperate. When compared with winter, the summers have much more rainfall. According to Köppen and Geiger, this climate is classified as Cwa. The average annual temperature in Tinsukia is 23.1 °C. The rainfall here averages 2679 mm. Precipitation is the lowest in December, with an average of 22 mm. In July, the precipitation reaches its peak, with an average of 527 mm. At an average temperature of 27.8 °C, August is the hottest month of the year. At 16.0 °C on average, January is the coldest month of the year. Between the driest and wettest months, the difference in precipitation is 505 mm. The variation in annual temperature is around 11.8 °C. Climograph and temperature graph of Tinsukia district are presented in **Figure 7.6** and **7.7** respectively.

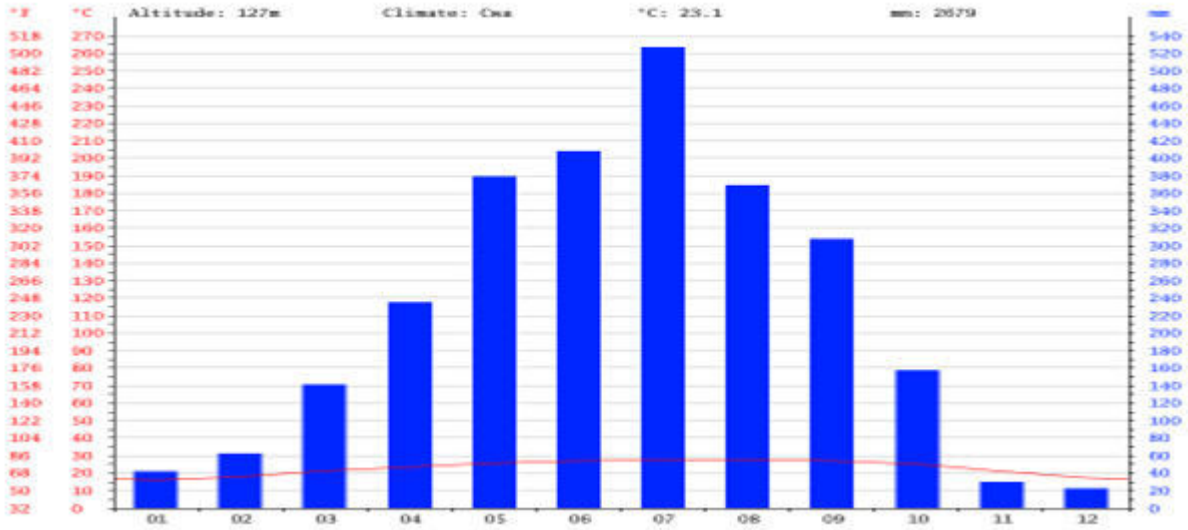


Figure 7.6: Climograph of Tinsukia District

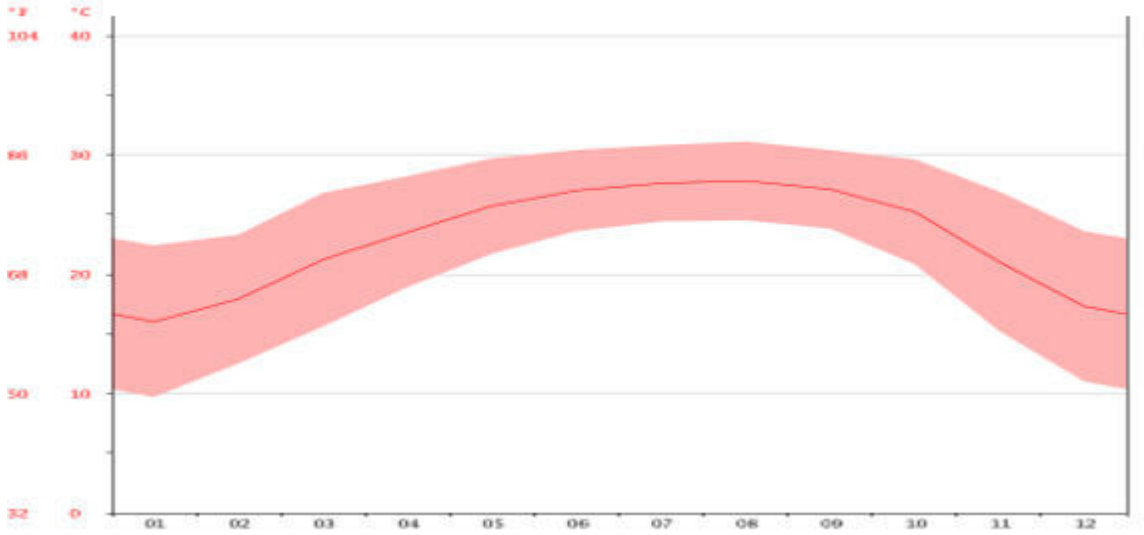


Figure 7.7: Temperature Graph of Tinsukia District

**Source: https://en.climate-data.org/location/24634/*

7.6.7 Drainage Pattern

Dibrugarh district is a part of Brahmaputra river basin. The area is drained by Brahmaputra river and its tributaries. Important tributaries of Brahmaputra river are Burhi Dihing, Disang, Dibru, Sessa and Lekhijan. All these tributaries are pereminal and are highly meandering. The lower order streams present a dendritic pattern but higher older streams show a subparallel pattern. The drainage network of Karbi Anglong District forms the upper catchment of Dhansiri river, Jamuna and Kopili rivers. The drainage pattern is dendritic to sub-parallel and is controlled by structural features and underlying lithology.

Tinsukia District is also drained by mighty River Brahmaputra flowing NE-SW direction and its tributaries Dibru and Burhi-Dihing flowing from Naga-Patkai hill range in the south. All the rivers are ephemeral in nature and carry huge quantities of water and sediment during rainy season and cause submergence of low lying areas. Surface Water Resources in the Project Area.

7.6.8 Surface Water Resources in the Project Area

The project road stretches are traversing through River Brahmaputra and Buridihing River and a Road side pond (LHS) Tinsukia-Makum Bypass as depicted in **Figure 7.8** as follows:

	
River Brahmaputra at Bogibil Bridge in North Bank	**Road side pond (lhs) of Tinsukia Makum Bypass**

7.6.9 Air Quality

Air quality along the project stretch is observed healthy and clean in the study area. No major dust emitting activities was observed along the project road. Ambient air quality monitoring for various parameters like PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO shall be started at project site and surrounding area.

However, during detailed EIA & EMP study, air quality monitoring will be carried out along the road to understand the actual baseline condition.

Central and State Pollution Control Board guidelines shall be followed for sampling and analysis. The data will be compared with the National Ambient Air Quality Standard of CPCB as given in **Table 7.9** below.

Table 7. 9: National Ambient Air Quality Standards

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other areas	Ecological Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1.	Particulate Matter (size less than 10µm) or PM_{10} µg/m^3	Annual* 24 hours**	60 100	60 100	- Gravimetric - TOEM - Beta attenuation
2.	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ µg/m^3	Annual* 24 hours**	40 60	40 60	- Gravimetric - TOEM - Beta attenuation
3.	Sulphur Dioxide (SO_2), µg/m^3	Annual* 24 hours**	50 80	20 80	- Improved West and Gaeke - Ultraviolet Fluorescence
4.	Nitrogen Dioxide (NO_x), µg/m^3	Annual* 24 hours**	40 80	30 80	- Modified Jacob &Hochheiser (Na-Arsenite) - Chemiluminescence
5.	Carbon Monoxide (CO), µg/m^3	8 hours** 1 hour**	02 04	02 04	- Non Dispersive Infra-Red (NDIR)

***Source:** Central Pollution Control Board*

Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval.

***24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be compiled with 98% time in a year. 2 % of the time, they may exceed the limits but not on two consecutive days of monitoring.*

7.6.10 Noise Level

The noise level on road side was found low on the stretch except the market area that has some traffic during day time otherwise the noise level is normal as observed during consultation. Day and night time ambient noise levels will be determined based on monitored data. Monitoring location shall be finalized based on the sensitive receptors and source of noise pollution. The data will be compared with Ambient Noise level standards as given in **Table 7.10** below:

Table 7. 10: Ambient Noise Monitoring Standards

Area/Class	Noise Level (Leq dB (A))*	
	Day Time	Night Time
Industrial	75	70
Commercial/Mixed	65	55
Residential/Rural	55	45
Sensitive	50	40

Note-:

1. *Day time shall mean from 6 a.m. to 10 p.m. and Night time shall mean from 10 p.m. to 6 a.m.*
2. *Silence Zone is an area comprising not less than 100 meters around hospitals, education institutions, courts, religious places or any other area, which is declared as such by Competent Authority.*
3. *Mixed categories of areas may be declared as one of the four above-mentioned categories by the Competent Authority.*
4. ** dB(A) Leq denotes the time weighted average of the level of decibels on scale A which is related to Human Beings*
5. *A "decibel" is the unit in which noise is measured*
6. *"A" in dB (A) Leq, denotes the frequency weighted in the measurement of the noise corresponds to frequency response characteristics of the human ear.*
7. *Leq: It is an energy means of the noise level over a specified period.*

7.6.11 Forest & Biodiversity

a) Assam

In the "Revised Survey of Forest Types in India", Champion and Seth categorized as many as fifty-one different forest types/ sub types for this region. But, the species diversity is so spectacular that it becomes often difficult to clearly identify separate riche to existing plant formations. However, broadly speaking the forest in Assam can be described into following types/ sub types.

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

Important Tree Species along the project road: Hollong (*Dipterocarpus macrocarpus*), *Dipterocarpus terbinatus* (Garjan) *Michelia glabra* (Champ), *Palaquium polyanthum* (Kathalua) etc. Sal (*Shora robusta) Adina cordifolia* (Haldu), *Ficus species* (Bor, Dimoru, Dhupbor, Bot,

Athabor, tengabor, Lotadioru, Khongaldimoru), *Michelia champaca* (Teeta champa*), Terminalia species* (Hilikha, Bhomora, Bohera). *Toona ciliate* (Poma) etc. *Adina cordifolia* (Haldu), *Albizia species* (Siris, *Alstonia scholaris* (Satiana), *Dalbergia species* (Sissoo, Medelua), *Ficus species* (Bot, Bor, Dimoru), *Aegle marmelos* (Bel), *Albizia species* (Siris), *Cassia fistula* (Sonaru), *Bombax ciba* (Simul), *Melia azedarach* (Neem), *Moringa oleifera* (Sajana) and *Terminalia species* (Hilikha,Bhomora) etc.

7.6.12 Reserved Forest and Eco sensitive Locations along the Project Road

Forest stretches are not encountered for the Sections under consideration for this report i.e. from start of Golai Gaon to Ledo (including proposed Margherita-Ledo bypass)

7.6.13 Wild Life Corridor along the Project Road

No Wild life corridor is present along the Sections under consideration for this report i.e. from Golai Gaon to Ledo.

7.6.14 Social and Cultural Feature

There are some important settlements in section-5 (on NH-38) which are Digboi, Golai Goan, Ledo.

7.6.15 Historical/ Archaeological Sites

No archeological site listed under Archeological Survey of India, has been identified in close vicinity of the project road.

7.6.16 Educational Facilities

No education facility is affected by the proposed improvement. The details of the same is in **Table 7.11**.

Table 7. 11: Education Facilities along the Project Road Stretches

S. No.	Features	Existing Chainage (km)	Road Segment	Side	Dist from C/W Edge (m)	Remarks
Section-5						
Nil						

7.6.17 Religious & Cultural Structures

No Religious structure is impacted due to the proposed 2-lane with paved shoulder of the planned road stretches. Details of the Religious structure is given in **Table 7.12**.

Table 7. 12: Religious & Cultural Structures along along the Project Road Stretches

S. No.	Features	Existing Chainage (km)	Road Segment	Side	Dist. from C/W edge (m)

S. No.	Features	Existing Chainage (km)	Road Segment	Side	Dist. from C/W edge (m)
Section-5					
Nil					

7.7 STAKEHOLDER CONSULTATION

7.7.1 Process and Methodology

As a part of the project preparation and to ensure that the community support is obtained and the project supports the felt needs of the people; stakeholder consultations were carried out as an integral component. A continuous involvement of the stakeholders and the affected community was obtained.

Individual interviews, field level observations, transect walk, community consultations & meetings were used to collect stakeholders' input on the project. Meetings with community were conducted in both ways i.e. formal as well as informal.

Detailed Stakeholder consultation and socio-economic surveys shall be carried out during the EIA stage.

7.8 SCREENING OF POTENITAL ENIVRONMNETAL & SOCIAL IMPACTS

7.8.1 Analysis of Data and Environmental & Social Screening

Based on the collected site data and field investigations, the critical sections have been recognized for further detailed Environmental Impact Assessment study. For convenience, the road has been divided into different segments and was screened with respect to sensitive environment features as mentioned in **Table 7.13.**

Table 7. 13: Road Segments with Preliminary Findings

Road Segment	Road Section	Description
Section-5	Golai Goan to Ledo (including Margherita - Ledo Bypass)	▪ Nil

7.8.2 Identification of Critical Sections

All the road sections were subjected to screening considering the major environmental indicators within area of influence, their importance and their presence in the section and their degree of sensitivity.

- Water resources
- Major Settlement/ built-up area
- Religious structures

- Road side tree cutting
- Forest Area
- Environmentally Protected Area

The road sections with more than one environmental feature have been designated as sensitive section. All the sensitive section shall be carefully analyzed during Environmental Impact Assessment study and accordingly safeguard measures will be provided in Environmental Management Plan.

7.8.2.1 Water Resources

River/ pond / lake has major environmental significance in the project area as they are being utilized by the nearby villagers.

7.8.2.2 Settlement / Built-up Areas

The road section with high settlement area has been considered as sensitive zone. The widening process will involve loss of public properties, resettlement and rehabilitation problem. The people residing at roadside are exposed to the emissions and are vulnerable to health problems. During construction phase, they will be directly exposed to additional emissions and noise pollution. The sensitive receptors are located mainly in the settlement area. Thus, the area without any settlement or low built-up area is likely to be affected less. Some section of road is passing through populated area along the road. During detailed study, impacts will be identified on the structures falling within ROW and rehabilitation and resettlement plan will be prepared as per the requirement. Thus, these sections have importance both from environmental and social aspects.

7.8.2.3 Religious/ Cultural Features

A number of religious structures are located both sides along the project corridor. These structures are socially critical issue and hence make the section containing them as highly sensitive impact zones. All these sites are critical and proper attention shall be given during detailed Environmental Impact Assessment study.

7.8.2.4 Roadside Tree Cutting

Tree cutting is a critical environmental issue but the cutting of roadside trees is inevitable during the widening process. Road side trees present throughout length of the project road will be counted during detailed study. Species wise and girth wise details of trees within ROW will be provided in EIA & EMP report.

7.8.3 Potential Environmental Impacts and Mitigation

Attempt has been made to identify and assess the probable impacts on different environmental parameters due to planning, construction and the operation of the proposed development. After studying the existing baseline environmental scenario, initial field surveys, reviewing the process and related statutory norms, the major impacts can be identified and assessed during the design, construction and the operation phases.

Road construction related impacts occur at three stages of the project:

i) Design and Pre-construction
ii) Construction

iii) Operation

The major impacts during Planning and designing phase is related with the land acquisition, since widening needs land area throughout the corridor. The impacts during construction phase, in general, have adverse influence on all the components of environment. Most of these impacts are short lived and reversible in nature. A proper care is must to minimize the negative impacts, which can facilitate the restoration. Operation phase impacts are continuous in nature. To identify these impacts broadly on physical, ecological and social environment Impact Identification Matrix of potential environmental impacts due to the project and preliminary mitigation measures has been developed and is presented in **Table 7.14.**

Table 7. 14: Matrix of Potential Environmental Impacts due to the Project and Preliminary Mitigation Measures

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Preconstruction	Land Acquisition	D	H	L	The alignment selection should be in such manner to minimize the acquisition of land. As far as possible the productive land area should be avoided to acquire.
Construction					
Physical Resources					
Soil	Loss of top soil due to site clearance, excavation, Hill cutting	D	H	L	Top soil should be removed & stored separately during excavation. Re-vegetate the disturbed slope as early as possible
	Soil compaction due to storage of quarry materials and other heavy equipment's, movements of heavy vehicles at the site	D	H	L	Regulation of movement and parking of vehicles and equipment outside ROW. Storage of materials should be allowed only at wasteland or barren area.
Air Quality	Reduced buffering of air pollutants, hotter, drier microclimate due to tree felling and vegetation loss during site clearance	I	L	L	Tree plantation
	Localized increase in pollutants due to increase in number of construction vehicles and equipment's.	D	L	S	Vehicles should be maintained such that exhaust emissions are minimum.
	Dust generation due to earth excavation, transportation & heavy vehicles maintenance or operation, Construction of structures and earth works, asphalt & crusher plants	I	L	S	• Vehicles delivering materials should be covered. • Regular water sprinkling over exposed surfaces.
	Toxic gas emissions during asphalt preparation, bituminous heating	D	M	S	• The asphalt mixing plant should be located in conformity with the statuary requirements. • Consent to Establish and Consent to Operate from SPCB should be obtained prior to operation of plant.

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Noise Quality	Increased noise level due to excavators/ machinery etc., operation and maintenance of heavy vehicles and equipment's, Asphalt preparation and crushing	D	M	S	Noise standards of industrial enterprises shall be strictly enforced. Proper scheduling of the operation of these equipment's. The stationary noise generating equipment's should be installed sufficiently away from habitation area.
Surface Water	Additional pressure on water demand due to the water requirement for construction works	D	M	S	Alternative water supply system for construction should be ensured in such a way to prevent the additional pressure on public water supply system
	Damage to streams, springs, from excavation, cutting of hill, spoil disposal	D	H	L	Prohibit activities which cause blockage or otherwise impede water flow Suitable measures should be taken to avoid any damage to springs.
	Blockage of water flow channels due to unmanaged excavation and earth filling	D	M	S	Proper excavation and disposal of the extra fill material away from stream. Provision of cross drainage during construction along the stream and springs.
	Contamination of water due to spillage, construction wastes	I	M	S	Strict regulation of traffic flow, waste disposals, bunding around fuel storage site, proper disposal system at equipment and vehicle service stations
	Impairment of surface water bodies, new water bodies due to Quarries/ borrow pits	I	H	L	Controlled quarrying and borrowing
Ground water	Ground water exploitation for construction works and workforce camp	I	L	S	Regulation of ground water extraction Surface water should be used for construction

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Drainage Pattern	Interference with natural drainage flow due to earth excavation dumping, disposal of wastes and surplus earth materials, and construction of structures and earthworks	D	M	S	Regulation of dumping of waste materials and proper care should be taken at the site of construction to minimize the wastage. Clean fill material devoid of soil particles to prevent siltation and deposition on the way of natural drainage.
Ecological Resources					
Vegetation	• Impacts on forests from land take and loss of trees. • Fire risks during vegetation clearance and asphalt preparation • Encroachment on to forest for construction camps and loss of forest resources due to demands for fuel woods of workforce and incomers	D/I I D/I	H H M	L L L	Cut only those trees affected by permanent works; specify non-timber construction materials Strengthen forest protection and management. Camp should be established away from forest area Prohibition of clearing of trees for firewood, prohibiting on trapping and killing of wild life Kerosene or gas cylinders should be supplied to campsite to avoid use of firewood.
Wild Animals	Disturbance or hunting of wild animals	I	H	S	Control workforce, awareness programme for the workforce, strict enforcement of Wildlife (Protection) Act,1972. No camp site near forest area. Prohibition of hunting of wild animals
Social Environment					
Resettlement and Rehabilitation	Problem of Resettlement and Rehabilitation	D	H	L	Adjustment in alignment to avoid displacement Early identification and entitlement of the project affected people Early planning of rehabilitation and resettlement
Livelihood	Economic losses as a result of property loss due	D	M	L	The alignment selection should be done in a way to

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
	to land take for widening				minimize the land acquisition
Employment	Employment on road construction, and resultant flow	D	H	S	Encourage local recruitment
Religious / Cultural feature	Impact on religious/ cultural structure	D	H	L	Shifting and restoration of structures through public consultation.
Health	• Health problems to the local people settled near the construction sites because of toxic gaseous emissions due to asphalt preparation and crushing • Asphalt odour and dust due to asphalt and crusher plant and laying of pavement.	D D	M M	S S	Appropriate siting of plant establishment. Strict adherence to the emission standards laid by the Central Pollution Control Board, regular monitoring of emissions. Provision of emergency medical facility.
Sanitation	Insanitation condition at Campsite	D	H	S	Suitable medical facilities for workers First Aid facilities at camp/ construction site
Safety at Work site	Accidents at work and on the road	D/I	M/H	S	Safe working techniques; safety clothing; proper training to workers and drivers
Operational Phase					
Natural Resources	Long term stability problems along some sections of the road	D	M	L	Provide adequate resources for effective maintenance programme
Air Quality	Increase in air quality due to stimulation of traffic flow, intense human activity, congestion	D	L	L	Providing lateral buffer zones in design, regular Regulation of air pollution by legislation and public awareness Regulate development activities along the corridor
Forests	• Increased exposure to anthropogenic activities due to better access • Forest cutting and poaching due to induced development	D I	M M	L L	Enactment and enforcement of laws regulating human intrusions, implementation of traffic control measures such as low speed limits near the forest Better forest management

7.9 ENVIRONMENTAL MANAGEMENT PLAN

A site-specific Environmental Management Plan (EMP) will be prepared for avoiding, mitigating, checking the adverse impacts envisaged during EIA studies on various environmental components during construction and operational phase of the project. This Environmental Management Plan will include brief description about the project, EMP for construction and operation phase, tree plantation strategy and environmental monitoring plans.

7.10 STRUCTURE OF THE EIA & EMP REPORT

The EIA & EMP report will be prepared as per MoEF&CC EIA Notification 2006 and amendments thereafter and chapters will also be structured accordingly. Structure of EIA & EMP report is provided in **Table 7.15**.

Table 7. 15: Structure of EIA & EMP Report

Chapter No.	Report Structure	Content Description
1.	**Introduction**	▪ Purpose of the report ▪ Identification of project & project proponent ▪ Brief description of nature, size, location of the project and its importance to the country, region ▪ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	**Project Description**	▪ Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: ▪ Type of project ▪ Need for the project ▪ Location (maps showing general location, specific location, project boundary & project site layout) ▪ Size or magnitude of operation (incl. Associated activities required by or for the project ▪ Proposed schedule for approval and implementation ▪ Technology and process description ▪ Project description. Including drawings showing project layout, components of project etc. Schematic representations of the feasibility drawings which give information important for EIA purpose
3.	**Description of the Environment**	▪ Study area, period, components & methodology ▪ Establishment of baseline for valued environmental components, as identified in the scope ▪ Base maps of all environmental components
4.	**Anticipated Environmental Impacts & Mitigation Measures**	▪ Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project ▪ Measures for minimizing and / or offsetting adverse impacts

Chapter No.	Report Structure	Content Description
		identified ▪ Irreversible and Irretrievable commitments of environmental components ▪ Assessment of significance of impacts (Criteria for determining significance, Assigning significance) ▪ Mitigation measures
5.	**Environmental Monitoring Program**	▪ Technical aspects of monitoring the effectiveness of mitigation measures (incl. Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
6.	**Additional Studies**	▪ Public Consultation ▪ Risk assessment ▪ Social Impact Assessment. R&R Action Plans
7.	**Project Benefits**	▪ Improvements in the physical infrastructure ▪ Improvements in the social infrastructure ▪ Employment potential –skilled; semi-skilled and unskilled ▪ Other tangible benefits
8.	**EMP**	▪ Description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA
9.	**Summary & Conclusion**	▪ Overall justification for implementation of the project ▪ Explanation of how, adverse effects have been mitigated
10.	**Disclosure of Consultants engaged**	▪ The names of the Consultants engaged with their brief profile

CHAPTER 8

PRELIMINARY SOCIAL IMPACT ASSESSMENT

8.0 PRELIMINARY SOCIAL IMPACT ASSESSMENT

8.1 Introduction

The project roads have been specified in Chapter 1. The project influence area (PIA) of the project has been identified in Chapter 3 Socio-economic profile as: (1) Direct PIA as the vicinity on both sides the project road, (2) Indirect PIA of the districts of East Siang of Arunachal Pradesh and districts of Dhemaji, Dibrugarh, Tinsukia, Nagaon and Jorhat of Assam and (3) Tertiary PIA as the state of Assam and Arunachal Pradesh as a whole. The socio-economic profile of the indirect and tertiary project influence area has been prepared based on secondary official sources of information and discussed in Chapter 3 Socio-economic profile. The present chapter provides with a screening report on possible social impacts of the vicinity of the project based on an initial assessment from the reconnaissance survey and further field investigations.

8.2 Social Screening

The project is expected to bring quite a few benefits, viz.

- Improved connectivity with Arunachal Pradesh with Dibrugarh, Tinsukia and Nagaland;
- Improved connectivity of Dibrugarh, Tinsukia, Makum, Digboi and Margherita through NH-37
- Lower transport costs for freight and passengers of motorised and non-motorised vehicles;
- Improved Road network connectivity to the villages in the vicinity of the road;
- Enhanced traffic facilities and volume in the project road;
- Enhancement in economic opportunities/activities of the local people;
- Enhanced basic amenities to the villages along the proposed road;
- Rural prosperity of the project influence area;

Although such benefits were not quantified, the project is also expected to help alleviate development constraints in agriculture, commerce, education, health, social welfare, and public safety and contribute to general expansion and diversification of development activities.

Preliminary survey activities have been carried out to assess the potential impacts of the proposed project for the direct influence area. Features and properties along the Corridor of Impact (COI) and Right of Way (ROW) and distance from the road to habitations and their distance from the center line were observed, recorded and analyzed and presented.

8.3 Existing Road Width

The average carriageway width is 7-10m for existing road under consideration for Section-5 i.e. from start of Golai Goan to Ledo on NH-38. The width of the earthen shoulder varies from 1.0 m to 2.0 m on both sides.

8.4 Existing Right of Way (ROW)

Some ROW pillars are available on the site. As per the existing ROW pillars and preliminary investigation with sample measurements at site, the existing total ROW at the proposed sections vary between 25m -30m. It appears from the first impression that the improved facility can be accommodated with a minimum quantum of land acquisition.

8.5 Terrain and Land Use

The project road is passing mainly through plain terrain with a nominal stretch in rolling. Few part of the project road is passing through settlement areas with residential and commercial activities. Mainly open area and tea garden stretch are found at few locations which covers most length. Landuse pattern for the balance stretch is either agricultural or a mixture of agricultural, open and residential/commercial.

In general, the entire project road does not pass through any Wild Life Sanctuary or National Park.

8.6 Built up Areas

There are some important settlements in Section-5 (on NH-38) which are Golai Gaon, Powai, Margherita and Ledo. However, few lower order settlements were also found at many locations along the project road in scattered manner.

8.7 Project Impacts

The assessment of potential positive externalities and negative impacts of the project is identified preliminarily. The assessment of impacts is being covered under following variables: number of structures likely to be impacted, number of religious structures likely to be impacted, number of community property and resources likely to be impacted, built up sections along the corridor etc. The project may trigger the following categories of loss:

- Loss of Agricultural/ homestead Land and other Properties
- Loss of Residential Properties
- Loss of Commercial Properties

- Families losing Residential cum Commercial Structures
- Loss of economic/ livelihoods

The project affected families may be categorized in following three broad categories:

- Titleholders: People who are losing land, land & structures, only part of structures, which are under legal ownership of the incumbent
- Non-Titleholders: People who are losing structures/ part of structures, which were erected/ extended on the land not under his legal ownership, and
- Livelihoods Losers: Any person from the previous categories, Kiosks operators, tenants of the affected structures and employees of the affected Business are likely to be affected with existing economic/ physical livelihood losses.

The details of land acquisition and quantum of loss under each category will be given in DPR stage.

8.7.1 Impacts on Land

Initial assessment indicates that the widening of the existing roads is likely to entail minimal land acquisition from the private land holders and also there are likely to more impacts on encroachers operating within the ROW. The Impacts on Land will be estimated in the DPR stage, after the land requirement is finalized followed by proposed road alignment and collection of the official records of Land ownership.

8.7.2 Impacts on Structures

The impacts on structures on the both sides of the existing road have been preliminarily estimated on the basis of visual assessment. All the structures mentioned in the list may not necessarily be affected. The list of affected structures according to utilization is presented in **Table 8.1**.

Table 8.1: Likely Affected Structures According to Utilisation (from Preliminary Survey)

Sl.	Type of Structure	No of Likely Affected Structures
Section 5		
1	RCC Pucca Structure	9
2	Pucca/Semi Pucca/Under construction (Assam type-A)	15
3	Katcha (Assam type-A)	18
4	Other structure (CPR)	Nil
	Total	**42**

Note: The final List of Affected structure will be finalized during Joint measurement survey to be performed during 3G stage.

8.7.3 Impacts on Community Structures

The impacts on community structures on the both sides of the existing road have also been estimated on the basis of visual assessment within 30.0 m on either side of existing centre line. The final design will avoid the community structures as much as possible. The list of likely affected community structures is presented in **Table 8.2.**

Table 8.2: Likely Affected Community Structures According Utilisation

Sl.	Type of Structure	No of Likely Affected Structures
		Section-5
Nil		

8.8 Community Perceptions about the Project

Consultation with Project Affected Persons (PAPs) is the starting point to address involuntary resettlement issues, concerning land acquisition and rehabilitation. People affected by resettlement may be apprehensive that they will lose their livelihoods and communities. Information dissemination of the project is the first principle of consultation. Participation in planning and managing resettlement helps to reduce their fears and gives PAPs an opportunity to participate in key decisions that affect their lives.

8.9 Further Detailed Social & Resettlement Assessment

The detailed Social & Resettlement Assessment will be conducted after the road alignment and development schemes are being finalized. The consultant will undertake census (100%) and socio-economic surveys (25%) of the affected persons, as per the proposed development. In addition to the census and socio-economic surveys, public consultations with the stakeholders including the communities and affected persons had been conducted.

The objective is to establish a base line profile of population which includes data on gender, ethnicity, social structure, employment and labour patterns, sources of income (including production and marketing activities), local tenure and property rights arrangements, access to social services and facilities (including health, education, and agricultural extension and credit); use of community and natural resources relevant to formulation of development strategies in order to assist in determining project impacts on the social, economic, cultural, and livelihood activities of affected communities.

All untitled occupants will be recorded at the initial stages and identify cards will be issued to ensure there is no further influx of people into the project area. All consultations with affected persons should be fully documented

The consultant would prepare Resettlement and Rehabilitation Plan; assess feasibility and effectiveness of income restoration strategies and suitability and availability to relocation sites as per procedures of NH Act 1956 and the compensation and assistance will be guided through Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCTLARR 2013), and/ or guidelines set by Govt. of Assam.

8.10 Conclusions/Recommendations

The people were generally enthusiastic towards the project and believed that it will bring social and economic development in the region. People believed that the development of road will improve connectivity for the local people. Agriculture is the main economic activity in the project area. The farmers believe the road will improve their accessibility with the nearby market places by reducing the travel time. They anticipate better income as the cost of travel will be reduced and access to socio-economic facilities will be enhanced. People wanted that the payment of compensation and other rehabilitation measures be completed before the start of construction work. People were particularly concerned about the road safety issues and expressed the need of proper signage, speed breakers and pedestrian crossings to minimise the risk of accidents. They even demanded facilities like bus stops, public toilets etc. Apprehensions raised by the community include more accidents, houses coming closer to the proposed alignment, more noise pollution, agriculture loss, effect on livelihood, and dug well loss.

The community perceives that the project will help in increasing road safety, promote more business, better service facilities, and better conveyance and promote local employment opportunities. They consider that it would lead to increase in land rates and smooth traffic.

CHAPTER 9

COST ESTIMATES

9.0 COST ESTIMATES

9.1 General

Cost estimate has been prepared for the section considering the various items of works associated with identified improvement proposals using unit rates prevailing currently in order to assess the updated cost structures in general.

9.2 Methodology

9.2.1 Estimation of Quantities

Quantities of different items of work have been calculated on the basis of typical existing cross-sections as developed from the information obtained through inventory/reconnaissance survey and typical proposed cross-sections. Quantities for other work items have also been computed based on proposed improvement, road alignment and widening proposals as recommended. The major items of work considered are:

- Site Clearance and Dismantling
- Earthwork
- Granular Sub Base and Base Courses
- Bituminous Courses (Flexible Pavement)
- Culverts
- Bridges
- Drainage and Protection Works
- Junctions
- Traffic Signs, Marking and Appurtenances
- Bus-bay and Truck Lay byes
- Repair and Rehabilitation
- Road Maintenance

9.2.2 Unit Rates of Civil Works

Unit rates are primarily estimated by using the SOR of P.W.D(Bldg and NH) Department for 2020-21. Carriage of aggregates for road works from Quarry to Plant and Plant to Site exceeding the one considered in the SOR are added to the Base rate to obtain the final rate of the items of

works. Unit rates for other items of work were finalized after considering the current market rates or from information or other major projects of similar standards. Extra lead cost for Aggregates (Road works) are considered as per S.O.R of P.W.D(Bldg and NH) Department for 2020-21.

9.2.3 Civil Cost and TPC

Considering various items of works associated with identified improvements and current unit rates, cost estimate has been prepared.

9.2.4 Other Costs

Costs against various pre-construction activities (asunder listed below) have been assessed on the basis of available information and included in **Table 9.1** above.

- Land Acquisition Cost
- Cost of Assets (Structure, Zeerat, horticulture, fishery etc)
- Utility Shifting Cost
- Tree cutting Cost and Afforestation

The backup of estimate and detail of rate are provided in cost estimate volume.

Abstract of cost is provided in **Table 9.2**.

Table 9.2: Abstract of Cost

Item	Bill Description	Rate (Rs.)	Amount(Rs)	Amount(Crs)
BILL# 01	**Site Clearance & Dismantling**	Rs.	31,34,675	0.31
BILL# 02	**Earthwork**	Rs.	83,23,30,003	83.23
BILL# 03	**Base & Sub Base**	Rs.	39,55,87,100	39.56
BILL# 04	**Pavement (Flexible)**	Rs.	20,93,78,968	20.94
BILL# 05	**Drainage & Protection**	Rs.	14,42,77,405	14.43
BILL# 06	**RE Wall**	Rs.	4,44,54,531	4.45
BILL# 07	**Landscaping**	Rs.	1,80,35,792	1.80
BILL# 08	**Junction**	Rs.	5,61,30,442	5.61
BILL# 09	**Bus Bay**	Rs.	34,91,063	0.35
BILL# 10	**Illumination**	Rs.	51,74,361	0.52
BILL# 11	**Road Furniture**	Rs.	11,14,43,271	11.14
BILL# 12	**Ground Improvement**	Rs.	6,07,10,750	6.07
1	**Civil Cost for Highways**	**Rs.**	**1,88,41,48,360**	188.41
	Culvert	Rs.	10,53,21,455	10.53

Item	Bill Description	Rate (Rs.)	Amount(Rs)	Amount(Crs)
	MNB	Rs.	21,66,99,471	21.67
	LVUP and SVUP	Rs.	4,75,60,722	4.76
	MJB	Rs.	75,71,39,869	75.71
	ROB	Rs.	89,57,18,970	89.57
	Civil Cost for Structures	**Rs.**	**2,02,24,40,488**	202.24
2	**Total Civil Cost (1+2)**	**Rs.**	**3,90,65,88,848**	390.65
	Civil cost per Km (in Cr.)		**19.03**	
1	**Civil Cost**	Rs.	**3,90,65,88,848**	390.65
2a	**Utility Shifting APDCL (Exclusive of GST)-**	Rs.	**1,75,79,634.10**	1.76
2b	**Utility Shifting PHE (Exclusive of GST)**	Rs.	**14,43,280**	0.14
3	**Cost of Civil work i/c utility shifting**	Rs.	**3,92,56,11,762**	**392.55**
4	**GST @18% on 3**	Rs.	70,66,10,117	70.66
5	**Cost of LA(LA+ Assests + Tree afforestation Cost)**	Rs.	1,14,63,02,883	114.63
6	**Supervision Charge 2.5% of 2+GST @ 18%**	Rs.	5,61,176	0.06
7	**Contingency @ 1% of 1**	Rs.	3,90,65,888	3.91
8	**Agency Charges @ (3% of 1) + GST @ 18%**	Rs.	13,82,93,245	13.83
9	**Supervision Charge @ 3% of 1**	Rs.	11,71,97,665	11.72
10	**Price Adjustment @ 5% of 1**	Rs.	19,53,29,442	19.53
11	**Maintenance @ 2.5% of 1 + GST @ 18%**	Rs.	11,52,44,371	11.524
12	**Shifting of Gas pipeline (AGCL)**	Rs.	5,00,13,807	5.00
13	**Total Project Cost**	Rs.	**6,43,42,30,358**	**643.41**
14	**Total Civil Cost per km**		**19.03**	
15	**Total Project Cost per km**		**31.34**	

CHAPTER 10

ECONOMIC ANALYSIS

10.0 ECONOMIC ANALYSIS

10.1 Introduction

The economic analysis covers the following aspects:

(i) Assess the capacity of existing roads and the effects of capacity constraints on vehicle operation costs (VOC).
(ii) Calculate VOCs for the existing road situation and those for the project.
(iii) Quantify all economic benefits, including those from reduced congestion, travel distance, road maintenance cost savings and reduced incidences of road accidents.
(iv) Estimate the economic internal rate of return (EIRR) for the project over 30-year period.
(v) Saving in time value.

The economic evaluation has been carried out within the broad framework of social cost benefit. The economic analysis has been taken into account all on-going and future road and transport infrastructure projects and future development plans in the project area.

The objective is to determine the economic viability of the project as well as sections with respect to proposed improvement schemes that leads to minimizing total transport costs and maximizing benefits to the road users. The indicators for economic viability analysis are Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and NPV/Cost Ratio.

The costs considered comprise agency costs and costs to road users as follows.

Road Agency costs:

- Construction Cost
- Maintenance Cost

Costs of Toll Plazas have been excluded from road agency costs.

Road Users Costs:
- Vehicle Operating Cost
- Travel Time Costs
- Congestion Costs

- Accident Costs.

The benefits accruing to society from the proposed improvement are as follows:

Road User Benefits:

- Vehicle Operating Cost Savings
- Value of Travel Time Savings
- Value of Savings in Accident Costs
- Savings in Maintenance Costs

Social Benefits:

- Improvements in administration, Law and order
- Improvements in health and education
- Improvements in agriculture, Industry, trade and mining
- Improvements in environmental standards
- Appreciation in value of Land adjacent to roads.

At the present state of knowledge in the country, it is possible to monetarily quantify only the direct road user benefits. This report, therefore, restricts itself to only the direct road user benefits.

Road users experience different costs in the "With Project" and "Without Project (Base Option)" conditions. The benefits to road users are constituted by the savings in costs. Increasing traffic volumes as a result of the project implies more vehicle kilometres and hence more vehicles operating costs and, possibly showing more saving in with project conditions viz. benefits as a result of the project.

Based on traffic, Road network and Socio-economic characteristics of the project road, improvement options (with project) have been considered by the consultants with two different combination of proposed up-gradation / improvement Options (4-Lane) of the project road. The Economic analysis is carried out for the following improvement options

- "Without project/ Do minimum" - Routine maintenance of the existing road (Base option)
- "With Project"- Four laning of Project Road as per warrant.

The total transport costs for both the Options have been worked out on yearly basis for the entire analysis period of 30 Years. All costs and benefits considered in the study have been valued in monetary terms and expressed in economic prices for avoiding distortion in the input prices of

labor, materials, equipment and foreign exchange due to market imperfections. The ratio of Economic and Financial costs is taken as 0.85.

Economic analysis is carried out with help of HDM-4 (version 1.1) developed by the World Bank. This is the updated version of HDM-III which incorporates up to date State of Art and the research findings in road user and road deterioration related studies carried out in a number of developed and developing countries including India over the last few decades. The HDM-4 Road User Effects (RUE) sub-model uses mechanistic principles for the modeling of fuel and tyre consumption. The mechanistic forces are comprised of the aerodynamic, gradient, rolling and inverted resistance. It calculates vehicle speeds and operating costs taking into account of road roughness and geometry, together with the characteristics of representative vehicles and also the traffic flow. Although the latest version of HDM III (HDM Manager, 1995) includes congestion analysis, the HDM IV model more accurately represents the prediction of vehicle operating components under congested conditions. The HDM-4 also makes use of the CRRI deterioration models for Indian asphalt mixes such as semi dense carpet and premix carpet and gives accurate predictions of roughness for various road maintenance work components.

This model provides for calibration of crucial input parameters to suit the local condition and analysis of a number of alternatives and sections at relatively greater speed than is possible with HDM III. The Road user cost streams generated by HDM-4 are extracted and Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and sensitivity analysis have been carried out.

10.2 Measures of Project Analysis

In order to quantify the economic viability of a project or projects three measures can be used. All of these use a discounting approach. These are:

- Net Present Value (NPR)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

(1) Net Present Value (NPV)

NPV = Discounted Benefit – Discounted Cost

$$\sum_{i=1}^{n} \frac{B_i}{]1+r]^i} - \sum_{i=1}^{n} \frac{C_i}{]1+r]^i}$$

Where B_I = Benefit in the i^{th} year
C_I = Cost of the i^{th} year

(2) Benefit Cost Ratio (BCR)

$$BCR = \frac{\text{Present Value of benefts}}{\text{Present value of costs}}$$

$$\sum_{i=1}^{n} \frac{B_i}{]1+r]^i} \div \sum_{i=1}^{n} \frac{C_i}{]1+r]^i}$$

(3) Internal Rate of Return (IRR)

$$or, \quad \sum_{i=1}^{n} \frac{B_i - C_i}{]1+r]^i} = 0$$

The IRR is that discount rate r which makes NPV = 0

IRR represents average earning power of the money used in the project over the project life.

10.3 Decision Criteria

The formal decision criterion is to accept all projects with a BCR of one or greater than one, NPV greater than Zero or IRR greater than opportunity cost of capital, since primary tangible returns are greater than primary tangible costs. If funds are limited, the magnitude of IRR or BCR can be used in ranking the order of priority of undertaking projects whose ratios are more than one. This assumes, of course, that the indirect tangible and intangible benefits and costs are of minor importance or are approximately the same for the various projects under consideration. Sometimes, however, the indirect tangible and intangible benefits may dictate over direct tangible benefits and so the projects with even less than one BCR may be selected for the overall intangible benefits of the society. In practice, there is really no single yardstick to measure the economic and financial viability of the project.

10.4 Price Elasticity of Demand and Traffic Forecasting

An important benefit of a capacity expansion project is the reduction in travel times for highway users. Travel time is a major component in overall price or cost to the user, which includes time as well as out-of-pocket costs. As with most goods and services, a lower price can be expected to lead to more quantity demanded - in this case, some additional travel.

Price elasticity of demand is an economic concept used to summarize how much more or less of something people will consume if its price changes. From the standpoint of estimating future

traffic levels, elasticity represents how a change in the cost of driving, due to a reduction in travel time or implementation of a toll, may affect the volume of travel that will take place. These changes in volume result from some drivers' decisions to make more or fewer trips than they otherwise would have made.

Elasticity is stated in percentage change terms, e.g., an "*X*" percent reduction in travel time leads to a "*Y*" percent increase in travel Km or trips. An elasticity of zero implies that travel is unresponsive to a time change, no matter how large, while an infinite elasticity implies that even a one-second decrease in travel time will cause all capacity to be completely absorbed. While price elasticity is a generally accepted tool in economics, there are differing opinions about how to apply it in a transportation context. The transportation economics literature reveals a wide range of measured elasticity values, reflecting different study methods, data, time periods, and locations. No studies, however, suggest that travel demand elasticity is either zero or infinite. When measured on a given facility, observed elasticity includes the effects of both diverted trips, which represent existing traffic that has simply shifted from other routes or time periods, and new travel taken as a consequence of the lower user cost. Additional research is needed to narrow the range of elasticity values that are applicable to a given set of circumstances - whether facility, corridor, or region - and to develop methods for better incorporating demand elasticity into traffic forecasting.

10.5 Road User Costs (RUC) Components

RUC consists of following three components:

- Vehicle operating costs (VOC), that is, the physical costs of operating a vehicle such as fuel, spare parts, depreciation, crew costs, etc;
- Travel time costs (TTC), that is, the value of time spent in travelling that could be used in other activities;
- Accident costs (ACC), that is, the physical costs of an accident and the value of injuries and fatalities.

The financial price is the retail market price to the consumer of the product. The economic price reflects the true value (that is, the real worth) as well as the scarcity premium of the resource to the economy. In the economic jargon, this is termed as a "shadow" or "accounting" price of the resource in the economy. The shadow price of unskilled labor, for instance, may well be lower than the wage to reflect its abundant supply, while that of a skilled professional may be higher than the salary given to him, if his opportunity cost is considered. The economic price of a factor or a product also excludes all tax elements as they reflect mostly a transfer of resources from one sector of the economy to another. On the other hand, subsidy elements, if any, are included with the economic price. Furthermore, market distortion or imperfection and government regulations

or interventions are also taken into consideration while shadow-pricing a factor or a product. In case of imported inputs, economic costs were based on the border prices plus port handling, transportation, assembling and retail cost (profit margin) duly shadow priced. Local inputs of labor and materials were shadow priced using the Standard Conversion Factor of 0.85.

10.6 Inputs to the HDM-4 Model

(A) Project Road Inputs

The description of the stretch Section-2 is provided below in **Table 10.1**.

Table 10.1 : Project Length Details

Section	Description	Type	Length (km)	Remarks
5	***From km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e Proposed Margherita - Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.***	Economic Corridor	20.532	
Total			**20.532**	

(B) General Inputs

Analysis period	-	30 years	
Discount rate	-	12 %	
Construction Period	-	3 Years	
Construction Beginning Year	-	2020	
Opening year to Traffic	-	2023	
Standard Conversion factor	-	0.85	
Salvage value	-	15 %	
Construction Phasing	-	60%	1st Year
		40%	2nd Year

(C) Pavement Characteristics

Road and pavement characteristics obtained from the Road Inventory Survey have been used as Model input. These include road length, carriageway width, width of paved shoulders, existing pavement composition, sub-grade CBR, roughness of the existing road (IRI), structural number, BBD and cracking area.

The details of model inputs for road and pavement characteristics are presented in **Table 10.2**. For the flexible pavement, opening year roughness has been taken as 2.5 IRI.

Table 10.2 : Details of Existing Pavement Conditions

S.no.	DESCRIPTION	SECTION-5
1	Roughness IRI (m/km)	2.57
2	Area of Cracking (%)	0
3	Area of Ravelling (%)	0
4	Number of Potholes (no./km)	0
5	Mean Rut Depth (mm)	0
6	Edge Brake area (m/km)	0

(D) Traffic Composition and Growth Rates

The classified Traffic Volume Count Survey for both the directions have been carried out Km 48+200 of Lahowal-Chabua Bypass.

- Traffic bound to Dhola Sadia, Arunachal Pradesh is following the existing bypass
- Makum, Digboi, margareta, Ledo Bound traffic shall follow the exiting bypass
- Commercial vehicles to and from Tinsukhia town is following the existing Bypass.
- As observed from traffic pattern of traffic from survey in December 2020, 90% of commercial vehicles and 58% of cars have been diverted to the existing bypass after the opening of the ROB at the end of Dibrugarh bypass.
- This was also observed that that 84% of the daily traffic plies the highway during day time and 16% during the night time.

The estimated ADT has been converted in to AADT, by applying the seasonal factor as applicable to the area. The traffic all the three sections following is presented in **Table 10.3**.

Table 10.3 : Traffic Composition in AADT

Vehicle Type	At km 8+000 of NH-38 (Traffic in 2021) (HS-2)	At km 37+500 of NH-38 (Traffic in 2021) (HS-3)
Car	2578	2811
Taxi	113	6
2 Wheeler	1829	3448
3 Wheeler	448	342
Mini Bus	39	36
Standard Bus	172	103
LCV	575	458
2 Axle	436	326
3 Axle	202	234
MAV	68	67
Tractor	4	3
Tractor with Trailer	25	9

Vehicle Type	At km 8+000 of NH-38 (Traffic in 2021) (HS-2)	At km 37+500 of NH-38 (Traffic in 2021) (HS-3)
Cycle	529	1425
Cycle Rickshaw	171	256
Animal Drawn	0	23
Others	0	0
Total (numbers)	7189	7940
Total (PCU)	**8436**	**7642**

(E) Road Side Friction

Roadside friction has to be computed for each project road package considering the following:

- The road width
- Total traffic Volume and its Composition (Slow, Two & Three wheelers Traffic)
- Settlement pattern along the road side
- Percentage of Built-up Area
- Number and location of Dhabas and Fuel Stations

The number of settlements along the roadside and especially the extensive ribbon development that take place is a major factor influencing road performance. The maximum friction factor for the existing condition is taken as 0.9 and the minimum 0.8 amongst different sub projects.

Following the improvements of package the roadside friction factor for the two lanes has to be taken as 1.0.

Roadside friction factors have been incorporated into VOC as well as vehicle speeds for the given volumes and composition of traffic. It is considered that the creation of free flow conditions will be a more important yardstick with which to measure the success of any project improvement rather than increase in vehicle speeds.

(F) Base Vehicle Characteristics and Utilization Data

Base vehicle characteristics and its utilization data has been obtained from manufacturer's literature and various literatures. The same has been used as Vehicle input data for HDM-4.

10.7 Capital Cost of the Project

The capital costs (financial) of the project road have been converted into economic cost by using a standard conversion factor of 0.85, as suggested by the World Bank for highway projects in

India. The conversion factor of 0.85 has been applied to all cost items except land acquisition cost and R&R cost. The economic cost excludes the cost of toll plazas. A salvage value of 15% of capital cost has been considered in the terminal year for flexible pavements. The project costs in financial and economic terms for different schemes are presented in **Table 10.4**.

Table 10.4 : Summary of Capital Cost (Section Wise)

Sections	Financial Cost* (Rs. Crores)	Economic Cost** (Rs. Crores)
From km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e Proposed Margherita - Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.	643.42	537.66

10.8 Routine and Periodic Maintenance Cost

Routine maintenance, Periodic maintenance costs have been considered as per latest MORT&H guidelines. The details of the maintenance costs and administration charges are given in **Table 10.5**.

Table 10.5 : Routine and Periodic Maintenance Cost

Sl No.	Description	Amount (Rs/km)
1	Routine maintenance in every year cost per km for the two lane road with unpaved shoulders	93,800
2	Routine maintenance in every year cost per km for the two lane road with paved shoulders	1,14,300
3	Periodic maintenance in every 5^{th} year cost per km for the two lane road with unpaved shoulders.	23,76,000
4	Periodic maintenance in every 5^{th} year cost per km for the two lane road with paved shoulders.	34,32,000

10.9 Project Benefits

The direct benefits of road improvement considered in the study include vehicle operating cost (VOC) savings for vehicular traffic using the project road and time savings for passengers and goods (carried) in transit. The benefit streams have been computed annually over the 30 year benefit period for all the sections.

VOC Savings

The unit Vehicle Operating Cost (VOC) by vehicle type and VOC savings section-wise has been computed by the HDM model. The VOC computation takes into account capacity augmentation,

pavement characteristics, roughness progression vis-à-vis intervening surface treatment and strengthening policies, traffic characteristics, geometric conditions and vehicle characteristics.

Time Savings

The HDM Model has generated average speeds in km/hr by vehicle type, in the existing (without project) and the improved (with project) road conditions. The time savings for passengers and goods (in transit) vehicles have been derived separately. For computing time saving for passengers of cars and buses, a weighted average occupancy was used viz. Car – 4 persons and Bus – 30 persons. The average payloads considered for goods vehicles are: LCV – 6 tonnes, Truck-16.2 tonnes and MAV – 24 tonnes.

The value of time (VOT) for passengers and goods considered in this analysis has been based on earlier studies carried out in recent years. For the average car passenger, VOT has been taken as Rs. 51 per hour, and for the average bus passenger it was Rs. 35 per hour. The value placed on time is rather on the conservative side. For goods in transit, time value has been worked out using the inventory cost method, with a 15% interest rate considered as the opportunity cost of capital. The VOT for goods (Cargo) vehicle worked out to Rs. 2.56 per hour for LCV, Rs. 7.87 per hour for 2-axle trucks and Rs. 14.72 per hour for multi-axle vehicles. All above said values are based on Road User Cost Study Report by CRRI.

Accident Cost Savings

A distinction made between main cause of accident and the contributory factors of accident. It is usually difficult to identify the main cause of accidents; whereas several factors which could have contributed to accidents can be identified.
Contributory factors of Accidents:

Human Factors: Manner of executions (Deficiency in actions & behavior)
Perceptual errors
Impairment
Lack of Skill

Road Factors: Adverse Road Design
Adverse Environment
Inadequate Furniture or Markings
Obstacles

Vehicle Factors: Tyres
Brakes

Other defects due to poor maintenance
Unsuitable Designs

It is possible to predict the reduction in accidents on account of road improvements. The accidents costs collected from IRC-SP-30 (the values are in the year 1990 and escalated @ 5% per year to get the values in the year 2021 are given in **Table 10.6**.

Table 10.6: Accident Cost Savings

Accident Costs	1990	2021
Cost of fatal accident	2,10,000	9,52,988
Cost of a serious injury accident	32,000	1,45,217
Cost of a minor injury accident	1,100	4,992
Cost of damages to a car	4,700	21,329
Cost of damages to 2-wheeler	1,100	4,992
Cost of damages to a bus	15,800	71,701
Cost of damages to a trucks	18,100	82,139

**Source SP:30 - 1993*

10.10 Economic Viability

The annual cost and benefit streams are used to derive the net cash flow for the project. The EIRR and NPV @ 12% discount rate are determined using the discounted cash flow technique for the Section. The EIRR found is 15.25% (which is > the Discount Rate of 12%). Hence the project is economically viable.

10.11 Sensitivity Analysis

Sensitivity analysis has been carried out for the below mentioned three variations and compared with base case results in costs and benefits. The sensitivity scenarios take into account possible construction delays, construction costs overrun, traffic volume, revenue shortfalls, operating costs, exchange rate variations, convertibility of foreign exchange, interest rate volatility, non-compliance or default by contractors, political risks and force majeure.

Scenario-I	Base Costs and Base Benefits
Scenario-II	Base Costs plus 15% and Base Benefits
Case-III	Base Costs and Base Benefits minus 15%
Case-IV	Base Costs plus 15% and Base Benefits minus 15%

Results of sensitivity analysis also show that the project is economically viable for 30 years

analysis period.

10.12 Conclusions

The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Dibrugarh to Ledo via Lahowal, Chabua, Tinsukia and Margherita on the Southern part of the Brahmamutra as well as from Dibrugarh to Oyan via Kandulijan Gaon, Silapathar on the Northern Part of Brahmaputra will be improved manifold if the project road is developed.

CHAPTER 12

ROAD SAFETY AUDIT

12.0 ROAD SAFETY AUDIT

12.1 Introduction

Road safety is now recognized as a major socioeconomic concern in India. Increasing traffic volumes, the rapid growth in two and three wheeled traffic, higher speeds due to construction improvement / rehabilitation of roads has increased safety problem. A Road Safety Audit (RSA) is the safety performance examination of a road section through experienced road safety expert. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. The road safety audit investigates general safety conditions, focuses on specific concerns or users. This also includes pedestrian safety as well as safety of bus users.

12.2 Stages of Road Safety Audit (RSA)

As per the scope of works RSA needs to be performed in the following stages:

- During Feasibility Study Stage (planning stage)
- On completion of Preliminary Design Stage
- On completion of Detailed Design Stage

This chapter is related to safety audit report at feasibility study stage (planning stage). The audit team reviewed proposed design from road safety perspective and checked the following aspects. RSA related to construction stage and monitoring existing road stage is not discussed here.

12.3 Aspects to be Checked

Broadly following items have been checked or reviewed during the feasibility study stage based on site data, existing road and proposed designs.

- Safety and operational implications of proposed alignment and junction strategy with particular references to expected road users and vehicle types likely to use the road.
- Width options considered for various sections.
- Departures from standards, if any and accordingly actions taken.
- Provisions of pedestrians, cyclists and intermediate transport.
- Safety implications of the schemes beyond its physical limits, i.e., how the scheme fits into its environs and road hierarchy.

Road Safety Audit is a formal procedure that uses extensive safety engineering knowledge to identify safety deficiencies in road sections. A broad experience in road, traffic and safety engineering needs to be acquired to ensure that a Road Safety Auditor has the knowledge and ability to refer back to the basic principles in road safety, and propose appropriate mitigation measures. Following points are generally adequately clarified during a road safety audit.

- Confusion or ambiguity due to design layout for road users that could lead to potential road

traffic accidents
- Insufficient information for road users
- Improper visibility, or an obstruction to road views of road users
- Hazards in layout create or obstacles to road users that could contribute to an increased risk of injuries

In the above cases safety of the scheme may be compromised and remedial measures may be required to remove this potential or actual deficiency. Road users need to perceive and process vast amounts of sensory and visual information to negotiate a road layout. On the other hand role of designer is to provide a safe road environment that should:

- provide adequate information for road users of the layout and conditions ahead;
- provide adequate warning of hazards or unusual layouts ahead;
- provide positive control of road users passage through conflict points or unusual sections;
- provide a road performance that can nullify road user's errors or inappropriate behavior

Desirable minimum Design Standards should be used wherever possible and advance information and warning should be used to inform road users of the layout ahead. However, driver overload must be avoided as it may cause road users to focus too much on the unimportant data and shed vital information. Conflicting information, an overabundance of road signs or a lack of delineation can cause overload. Therefore a "safer" road environment can be defined as a layout that:

- provides clear, concise and phased release of road user information;
- provides a consistent standard of road design and traffic control;
- Provides adequate warning of hazards.

It is important that a road improvement caters for all road users. Often the needs of the motorist are incorporated within a scheme whilst the needs of the vulnerable user are ignored. The vulnerable road users that need to be considered are: pedestrians – the old, young and those with mobility or sight impairment; cyclists – children, commuters and leisure users; and motorcyclists.

Each vulnerable road user has different needs from the road network. In the habitation environment the pedestrian is likely to be the principal user and designs must incorporate safe crossing locations, adequate visibility to and from the crossings and appropriate lighting. In addition to the needs of vulnerable road users, particular attention should be paid to the needs of trucks, buses or other specialist vehicles.

Safe road design varies from the urban to the rural road network; and a number of external factors can create a situation in which a safe road in one location becomes unsafe due to external factors. These factors can include traffic volumes, population density, noise, or road user familiarity. The function of a road should be clear to all road users, and a well-planned and defined road hierarchy can assist in providing a safe road network. The design speed can also be an important factor in influencing the safety of a road and should be appropriate to the location, local road users and level of private access control.

One important aspect to the safety of junctions is that layout as well as control method need to be simple and clear, with defined priorities for all road users. The assumption that 'straight on' traffic has priority is widely accepted and it needs to be remembered that alterations to this,

despite reinforcement with signs and lines can still be confusing if visual clues such as fences, kerbing or lighting remain unchanged. It is important to attempt to make any minor approach perpendicular to the main road. Y-junctions with acute angles should be avoided. These angled junctions pose problem for road users, including restriction of forward and side visibility. Similarly, it is advisable to avoid intersections on the inside of bends as foliage often encroaches into sight lines after several years. Roundabouts used as a form of junction control have their own rules and design requirements. One of the primary requirements in good roundabout design is that the radius is tighter on the entry than the exit. This ensures a slow entry and lower circulating speed. Visibility is a key requirement for all junction types, all road users need to see and be seen by others. Care should be taken with fixing street furniture and vegetation within visibility splays. Vulnerable road users often experience difficulties during crossing at junctions. It is important that their needs are provided for and that safe crossing places are implemented where required.

The relationship between cross-sectional elements (carriageway, shoulders, etc.) and safety is affected by the type and volume of traffic, and also by the surrounding environment. Lane widths can be critical in affecting safety, where they are too narrow vehicles may collide on horizontal curves, and there may also be inadequate space for two wheeled vehicles. Where lane widths are too wide the alignment may encourage excess speed. On high speed links there is a safety benefit to be gained by the provision of a hard shoulder and central reserve gaps should be of adequate width, depending on the size of vehicles turning. Vehicles parked on the carriageway affect the road environment, layout and consequently safety. Safety problems experienced with parked vehicles are:

- parked vehicles causing physical obstructions which are sideswiped or run into
- parked vehicles causing sudden braking or nose-to-tail shunts
- parked vehicles which deflect oncoming vehicles into adjacent vehicle paths
- parked vehicles blocking visibility for any road user
- parked vehicles between which pedestrians emerge

To reduce the risk of parked vehicles contributing to an accident it is important that designs should minimize parking in main traffic lanes. Trees and foliage can greatly enhance the environmental impact of the street scene. However, left un-maintained, they can also restrict visibility considerably. In addition to this, saplings grow into large trees, which can provide an unforgiving road hazard in the event of a road traffic accident.

With the above discussions and study / analysis of the project road sections safety issues that have been conceived are presented below in **Table 12.1**.

Table 12.1: Road Safety Issues

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
A1. General	Departure from Standards	The existing geometry of the road is not adequate with presence of sharp curves and steeper gradient in some location	The proposed alignment has been designed based on IRC: 73-1980 and IRC: SP: 73-2018. Realignment has been proposed at several sharp curve locations to improve horizontal geometry.	The design speed to be reduced based on restricted site conditions and non-availability of adequate land
	Cross sectional Variation	The existing carriageway width is 10.0m in general	The Proposed carriageway width of the project road is 1 x 7.0m (including kerb shyness) with 1.5m paved shoulder on either sides having a total roadway width of 22m as per IRC: SP 73-2018.	Extra widening has been provided on the curves having radius less or equal to 300m
	Drainage	Existing drainage condition is poor with improper camber and longitudinal gradient of carriageway and shoulder and absence of roadside drain.	Efficient drainage system is provided along the project road including structure and outfall facility. For quick disposal of precipitations, carriageway and shoulder have the requisite camber and longitudinal gradient. The water from road and adjacent areas to be intercepted and carried through roadside drains to natural outfall. Mostly in rural areas unlined trapezoidal drain shall be provided, whereas in built up stretches Rectangular Stone Masonry drain is proposed both side of Project road.	

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
	Climatic Conditions	With the "Tropical Monsoon Rainforest Climate", Assam is temperate (summer max. at 35–38 °C and winter min. at 6–8 °C) and experiences heavy rainfall and high humidity. The climate is characterized by heavy monsoon downpours reducing summer temperatures and affecting foggy nights and mornings in winters, frequent during the afternoons. Spring (Mar–Apr) and autumn (Sept–Oct) are usually pleasant with moderate rainfall and temperature. Assam's agriculture usually depends on the south-west monsoon rains The average annual rainfall is 2818mm. The monsoon starts late in June and generally lasts up-to September. 90% of the rainfall received from July to September.		HFL and Pond water level has been considered to fix road top level
	Landscaping	Landscaping on the existing road is not proper due to irregular spacing of trees, absence of proper turfing on embankment slope	Proper Road side Plantation is being provided. Shrubs on median / island are also considered. Turfing is being provided on embankment slope.	Trees and vegetations on the site should be properly trimmed and removed if required so that these should not interfere with the overhead services, clear view of signs and efficiency of roadway lighting. A regular program of pruning of the offending trees shall be under-taken as a part of the maintenance operation. Trees shall be selected based on the soil, temperature, rainfall, water level and should be deep rooted to avoid any damage to the pavement crust.

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
	Service Apparatus	Existing utilities like Electric poles, Transformer, OFC, High Tension Line, Tube well etc. are found along the existing road.	Shifting of existing utilities due to widening of road. Utilities to be relocated at proposed utility corridor within the proposed ROW.	It will be safe during maintenance.
	Lay-byes	No Bus Bays and truck lay-byes have been observed along the existing road	In Section-5, 4 Nos. of Bus Bays are proposed.	
	Footpaths	In very few locations, footpaths are observed along the existing road	In built-up areas and major intersections footpaths are provided of width 2.0m	Footpaths are provided for smooth and safe movement of pedestrian
	Pedestrian Crossings	No pedestrian crossings are observed along the existing road.	Pedestrian crossings are provided at major intersections and other locations like schools, religious structure etc. where substantial conflicts exist between Vehicular and Pedestrian movement	Installation of proper traffic sign/ signal near pedestrian crossings is mandatory. Pedestrian guard rails are also required to guide people
	Access	Existing situation shows maximum access to the private property. As such there is no access control.	Private access should be minimized directly from the proposed carriageway by providing service road in either built up locations.	Private access needs be minimized to maintain the design speed of the corridor as well safe passage to traffic and persons.
	Emergency vehicles	No emergency vehicle have been found along the existing corridor.	It is proposed to provide Emergency vehicles to operate within a certain time frame along the project road.	
	Public Transport	Existing traffic survey shows that 2 wheeler and car/Jeep/Taxi/Van are act major public transport compare to bus and minibus along the existing track	After improvement of road surface to 2-lane with paved shoulder bypass public transport like bus and minibus will be increased	Traffic report shows increase in public transport along the project road

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
	Future Widening	Existing ROW is around 45m to 60m which can accommodate to four lanes	Proposed road is of 2-lane + PS configuration which can be accommodated within existing ROW for the stretches under these Section-5.	The road section needs to be improved to 2-lane with paved shoulder configuration.
	Staging of Contracts	Length of the project Road sections are; Section-2: 19.730 Km	Contract for construction can be made for these sections separately in individual packages.	
	Adjacent Development	Existing shoulders are generally damaged throughout the road Footpaths are not found in the built up stretches Insufficient traffic signs observed along the corridor.	Proposed shoulder on both sides of the carriageway can be used for the movement of slow moving vehicle during emergency as well as parking for stalled vehicle. Footpaths cum RCC drains have been proposed in built up areas for safe movement of pedestrians. Installation of traffic sign (for example- horn prohibited in front of school, health centers, religious structure etc.) is being proposed. Improvement of roads will help in development of new industry along project road	
A2. Local Alignment	Visibility	Visibility is not proper in many places as the existing profile of the road not does not follow required sight distances (horizontal as well as vertical)	For proposed 2-lane roads Intermediate Sight distance is being taken throughout.	At only a very few stretches where intermediate sight distance is not available the profile shall be designed with safe stopping sight distance and overtaking prohibited

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
				traffic shall be installed in the location.
	Safety Aids on hilly terrain	No such stretch present	NA	
	New/ Existing Road Interface	Existing site shows that new/existing road interface are not smooth with improper horizontal and vertical profile	New/ Existing road interface is designed with proper geometry and vertical profile so that riding quality of the vehicle should be smooth	
A3. Junction	Minimize potential conflicts	Existing junctions are not properly developed with insufficient turning radius and absence of road signage as well as markings	2 nos. Major & 16 Minor Junctions for Section-5 are to be developed with proper turning radius, signage and markings to minimize potential conflict between pedestrians and vehicles	Provide pedestrian guard rail on Footpath, median for the safety of pedestrians. Pedestrian crossings shall be provided in proper places in the junctions with signage and markings.
	Layout	Layout of the junctions are not proper	Layout of the proposed junctions are to be made with proper turning radius, acceleration /deceleration lane, island and median etc.	These are designed as per respective IRC guidelines and land acquisition to be kept absolute minimum
	Visibility	Visibility of the existing junctions are not proper	To improve the visibility of the proposed junction's vertical profile of the road is designed with intermediate sight distance. If it is not found it should be taken care that at least intermediate sight distance should be available throughout	Traffic Sign at junctions should informative enough
A4. Non-	Adjacent Land	Existing Scenario shows Pedestrians,	For smooth movement of non-motorized	

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
Motorized road users provisions	Pedestrians Cyclists Non motorized vehicles	Cyclists and non motorized vehicles are plying on the existing road due to damage road shoulder and absence of footpath in built-up areas and causing conflicts with fast moving vehicles which decrease the design speed	road users, pedestrians and cyclist shoulder having 3.5m width has been proposed on both side of the carriageway. Also in built up stretches 1.0m wide footpath has been proposed for less conflict between fast moving vehicle and pedestrians, cyclists etc.	
A5. Signs and Lighting	Lighting	Insufficient Lighting is found in built up areas	Lighting shall be provided on major junctions, bus bays and truck layby locations	
	Signs/ Markings	Insufficient signs found on existing road. Markings are not found in the existing road except some few stretches in the forest area	Traffic Signs and Road Markings are provided on the proposed road for safe guidance of traffic	
A6. Construction and Operation	Build-ability Operational Network Management	Guidelines for safety during construction need to be followed as per IRC: SP-55. Traffic control devices have to be provided as per requirements during construction time. Few of these are: barricading, signs and delineators.		

CHAPTER 13

CONCLUSIONS AND RECOMMENDATIONS

13.0 CONCLUSIONS AND RECOMMENDATIONS

13.1 Conclusions

Section-5: ***From km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e. Proposed Margherita - Ledo Bypass (Green Field and Brownfield of NH-38) of Dibrugarh to Ledo section.***

i) Concession period of the road project is 30 years including 24 months construction period.
ii) All the traffic moving on the project road is through traffic.
iii) It is clear from Financial Analysis read with Profit & Loss Statement, Balance Sheet and Cash Flow Statement that the project is not financially viable under BOT even on 40% grant with 30 years' concession period (including the Construction Period of 24 months).
iv) The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Dibrugarh to Ledo via Lahowal, Chabua, Tinsukia and Margherita on the Southern part of the Brahmaputra will be improved manifold if the project road is developed.

13.2 Recommendations

The proposed project road of these sections i.e. from Km 27+150 (Golai Gaon) to km 47+682 (Ledo) i.e. Proposed Margherita - Ledo Bypass of being developed as 2 lane+ Paved shoulder carriageway configuration of NH-38 part recommended under EPC Construction.

Recommendation for Immediate Development

Road Segment	Traffic in Base Year in PCU	Traffic in Year of Opening (2023) in PCU	Recommendation
Total Traffic (PCU) at km 37+500 of Nh-38	7500	8269	2-Lane with Paved Shoulder from opening year (2023)

Annexure 6.3 : Widening Schedule

Sl No	Chainage		Length (m)	TCS Type	Description
	From	To			
1	27+150	27+230	80	TCS-9	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN BUILT-UP AREA (WIDENING)
2	27+230	27+410	180	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
3	27+410	28+192	782	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
4	28+192	28+286	94	STR	ROB
5	28+286	28+660	374	TCS-4B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER (VIADUCT PORTION) WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
6	28+660	29+040	380	TCS-4A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN APPROACH OF ROB CUM ELEPHANT CORRIDOR FLYOVER WITH SERVICE ROAD ON BOTH SIDE (NEW CONSRUCTION)
7	29+040	29+300	260	TCS-3A	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION)
8	29+300	29+452	152	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
9	29+452	29+462	10	STR	MNB
10	29+462	30+110	648	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
11	30+110	30+130	20	STR	MNB
12	30+130	31+263	1133	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
13	31+263	31+270	7	STR	SVUP
14	31+270	31+715	445	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
15	31+715	31+766	51	STR	MNB
16	31+766	32+997	1231	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
17	32+997	33+004	7	STR	SVUP
18	33+004	33+907	903	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
19	33+907	33+914	7	STR	SVUP
20	33+914	33+973	59	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
21	33+973	33+988	15	STR	MNB
22	33+988	35+699	1712	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
23	35+699	35+711	12	STR	LVUP
24	35+711	35+800	89	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
25	35+800	35+841	41	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
26	35+841	35+909	68	STR	MJB

27	35+909	37+115	1206	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
28	37+115	37+155	40	STR	MNB
29	37+155	37+460	305	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
30	37+460	37+470	10	STR	MNB
31	37+470	38+068	598	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
32	38+068	38+733	665	STR	MJB
33	38+733	39+797	1064	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
34	39+797	39+804	7	STR	SVUP
35	39+804	39+880	76	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
36	39+880	39+895	15	STR	MNB
37	39+895	40+462	567	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
38	40+462	40+469	7	STR	SVUP
39	40+469	42+047	1578	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
40	42+047	42+054	7	STR	SVUP
41	42+054	42+747	693	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
42	42+747	42+754	7	STR	SVUP
43	42+754	43+199	445	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
44	43+199	43+214	15	STR	MNB
45	43+214	44+700	1487	TCS-8	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA IN HIGH EMBANKMENT ZONE (NEW CONSRUCTION)
46	44+700	44+877	177	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
47	44+877	44+884	7	STR	SVUP
48	44+884	45+731	848	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
49	45+731	45+741	10	STR	MNB
50	45+741	45+817	76	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
51	45+817	45+824	7	STR	SVUP
52	45+824	46+952	1129	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
53	46+952	46+962	10	STR	MNB
54	46+962	47+500	538	TCS-3B	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (NEW CONSRUCTION) [ECCENTRIC CONSTRUCTION]
55	47+500	47+682	182	TCS-1	2-LANE CARRIAGEWAY WITH PAVED SHOULDER IN RURAL AREA (WIDENING)
Total			**20532**		

Annexure 6.2: Horizontal Alignment Report

Element ID	ELEMENT DETAILS								Transition Details				Horizontal Intersection Point (HIP)			Deflectin Angle			Speed (Kmph)	Superelevtion	Extra Widening (m)
	Start Chainage	End Chainage	Start Easting	Start Northing	End Easting	End Northing	Radius (m)	Direction	Start Chainage	L1	L2	End Chainage	Chainage	Easting	Northing	Deg	Min	Sec			
1	27+318.055	27+340.871	760438.333	3029650.471	760460.376	3029644.617	230	Left	27+263.055	55	55	27+395.871	27+329.473	760449.209	3029646.997	5	41	1.949	60	7.0%	NR
2	27+609.733	27+616.247	760727.865	3029618.176	760734.351	3029617.576	1800	Right					27+612.990	760731.109	3029617.882	0	12	26.455	60	NC	NR
3	27+913.652	28+000.727	761030.241	3029587.999	761112.33	3029559.88	301	Right	27+858.652	55	55	28+055.727	27+957.495	761073.333	3029579.918	16	34	29.356	60	5.3%	NR
4	28+116.578	28+157.687	761212.839	3029502.585	761252.99	3029494.598	130	Left	28+061.578	55	55	28+212.687	28+137.305	761232.278	3029495.39	18	7	5.103	60	7.0%	0.6
5	28+419.204	28+433.746	761510.94	3029536.248	761525.176	3029539.216	1000	Left	28+369.204	50	50	28+483.746	28+426.475	761518.069	3029537.68	0	49	59.637	100	4.4%	NR
6	28+584.833	28+600.187	761672.731	3029571.464	761687.959	3029573.416	500	Right	28+489.833	95	95	28+695.187	28+592.511	761680.33	3029572.557	1	45	33.895	100	5.0%	NR
7	29+097.275	30+383.988	762184.842	3029584.518	763145.193	3028862.576	1010	Right	29+047.275	50	50	30+433.988	29+844.545	762932.089	3029578.815	72	59	35.809	100	4.4%	NR
8	30+513.837	30+549.984	763178.398	3028737.063	763185.175	3028701.562	700	Right	30+443.837	70	70	30+619.984	30+531.914	763182.245	3028719.4	2	57	31.026	100	5.0%	NR
9	31+045.673	31+162.166	763242.087	3028209.156	763251.806	3028093.086	2000	Right					31+103.936	763248.637	3028151.262	3	20	14.149	100	NC	NR
10	31+234.256	31+376.082	763255.728	3028021.102	763268.455	3027879.878	2000	Left					31+305.199	763259.587	3027950.264	4	3	46.84	100	NC	NR
11	31+661.403	31+749.891	763304.123	3027596.795	763317.122	3027509.275	2000	Left					31+705.654	763309.654	3027552.891	2	32	5.893	100	NC	NR
12	31+891.380	31+924.277	763340.26	3027369.698	763343.921	3027337.007	800	Right	31+831.380	60	60	31+984.277	31+907.831	763342.427	3027353.39	2	21	21.992	100	5.0%	NR
13	32+068.936	32+091.651	763353.563	3027192.683	763356.275	3027170.132	700	Left	31+998.936	70	70	32+161.651	32+080.294	763354.736	3027181.385	1	51	33.051	100	5.0%	NR
14	32+312.011	32+326.559	763396.999	3026953.603	763400.546	3026939.494	700	Left	32+242.011	70	70	32+396.559	32+319.285	763398.699	3026946.53	1	11	26.915	100	5.0%	NR
15	32+718.881	32+767.940	763517.872	3026565.143	763532.108	3026518.196	2000	Right					32+743.412	763525.278	3026541.757	1	24	19.545	100	NC	NR
16	32+968.398	33+090.951	763593.141	3026327.425	763659.949	3026225.255	400	Left	32+853.398	115	115	33+205.951	33+030.158	763618.657	3026271.182	17	33	15.84	100	5.0%	NR
17	33+288.914	33+297.680	763809.432	3026095.832	763816.562	3026090.734	600	Left	33+208.914	80	80	33+377.680	33+293.297	763812.978	3026093.257	0	50	13.247	100	5.0%	NR
18	33+664.331	33+740.260	764125.732	3025894.011	764179.337	3025840.397	400	Right	33+549.331	115	115	33+855.260	33+702.410	764155.086	3025869.756	10	52	34.029	100	5.0%	NR
19	34+208.275	34+358.202	764427.206	3025443.652	764509.869	3025318.614	2000	Left					34+283.274	764466.193	3025379.583	4	17	42.335	100	NC	NR
20	34+492.511	34+548.305	764588.084	3025209.43	764619.94	3025163.625	2000	Right					34+520.410	764604.331	3025186.75	1	35	54.24	100	NC	NR
21	34+706.908	34+772.490	764708.67	3025032.165	764744.463	3024977.215	2000	Right					34+739.702	764727.017	3025004.984	1	52	43.635	100	NC	NR
22	34+847.512	34+963.110	764784.373	3024913.69	764848.662	3024817.638	2000	Left					34+905.327	764815.129	3024864.735	3	18	41.905	100	NC	NR
23	35+050.114	35+246.046	764899.125	3024746.763	765007.476	3024583.558	3000	Right					35+148.115	764955.966	3024666.93	3	44	31.291	100	NC	NR
24	35+416.808	35+422.985	765101.785	3024441.38	765105.787	3024436.674	400	Left	35+301.808	115	115	35+537.985	35+419.897	765103.768	3024439.011	0	53	5.52	100	5.0%	NR
25	35+601.467	35+641.925	765236.565	3024315.422	765265.898	3024287.561	1000	Right	35+551.467	50	50	35+691.925	35+621.699	765251.513	3024301.788	2	19	5.067	100	4.4%	NR
26	35+864.300	36+210.713	765420.344	3024127.575	765674.341	3023892.301	3000	Left					36+037.699	765540.543	3024002.598	6	36	57.596	100	NC	NR
27	36+388.772	36+404.965	765810.979	3023778.15	765822.817	3023767.101	700	Right	36+318.772	70	70	36+474.965	36+396.869	765816.962	3023772.694	1	19	31.596	100	5.0%	NR
28	36+518.656	36+582.198	765901.831	3023685.372	765946.251	3023639.939	2000	Left					36+550.430	765923.68	3023662.303	1	49	13.235	100	NC	NR
29	36+703.357	36+726.973	766032.318	3023554.664	766049.192	3023538.141	2000	Left					36+715.165	766040.706	3023546.353	0	40	35.631	100	NC	NR
30	36+883.600	37+006.213	766161.748	3023429.224	766247.194	3023341.312	2000	Right					36+944.926	766205.819	3023386.578	3	30	45.434	100	NC	NR
31	37+063.609	37+168.732	766285.917	3023298.947	766358.847	3023223.253	2000	Left					37+116.183	766321.387	3023260.142	3	0	41.633	100	NC	NR
32	37+362.568	37+375.047	766496.958	3023087.248	766505.712	3023078.354	2000	Right					37+368.808	766501.405	3023082.869	1	47	15.17	100	NC	NR
33	37+400.004	37+424.361	766522.942	3023060.294	766539.756	3023042.671	400	Left	37+424.365	115	115	37+782.385	37+603.927	766673.754	3022923.587	18	20	14.975	100	5.0%	NR
34	37+869.021	38+068.013	766930.001	3022853.048	767084.775	3022733.794	301	Right	37+794.021	75	75	38+143.013	37+972.306	767027.849	3022819.976	37	52	42.181	80	7.0%	NR
35	38+630.023	38+823.372	767340.754	3022233.865	767513.546	3022173.31	170	Left	38+560.023	70	70	38+893.372	38+738.670	767407.8	3022148.372	65	9	54.488	60	7.0%	0.6
36	39+286.760	39+500.458	767935.117	3022365.028	768134.467	3022441.662	1800	Right	39+246.760	40	40	39+540.458	39+393.735	768032.515	3022409.268	6	48	7.964	100	NC	NR
37	39+606.925	39+679.382	768236.244	3022472.913	768305.139	3022495.336	2000	Left					39+643.158	768270.895	3022483.501	2	4	32.585	100	NC	NR
38	39+776.499	39+855.947	768397.166	3022526.348	768474.199	3022545.657	800	Right	39+716.499	60	60	39+915.947	39+816.256	768435.203	3022537.917	5	41	24.275	100	5.0%	NR
39	40+045.386	40+066.779	768661.138	3022576.287	768682.244	3022579.776	2000	Left					40+056.082	768671.7	3022577.975	0	36	46.275	100	NC	NR
40	40+273.336	40+287.047	768885.815	3022614.767	768899.276	3022617.377	1200	Left	40+233.336	40	40	40+327.047	40+280.192	768892.553	3022616.033	0	39	16.776	100	3.7%	NR
41	40+462.000	40+514.743	769070.333	3022654.08	769122.264	3022663.276	1200	Right	40+422.000	40	40	40+554.743	40+488.376	769096.197	3022659.249	2	31	5.801	100	3.7%	NR
42	40+699.303	40+767.524	769304.991	3022689.187	769371.767	3022703.076	900	Left	40+644.303	55	55	40+822.524	40+733.430	769338.643	3022694.865	4	20	35.164	100	4.9%	NR
43	40+879.827	40+942.358	769480.041	3022732.872	769540.502	3022748.82	2000	Right					40+911.095	769510.147	3022741.319	1	47	28.999	100	NC	NR
44	40+961.324	41+088.714	769558.914	3022753.37	769681.898	3022786.547	3000	Left					41+025.029	769620.758	3022768.653	2	25	58.659	100	NC	NR
45	41+272.210	41+327.068	769858.006	3022838.091	769910.573	3022853.778	5200	Left					41+299.639	769884.331	3022845.796	0	36	16.021	100	NC	NR
46	41+431.016	41+512.906	770010.022	3022884.027	770088.834	3022906.247	2000	Right					41+471.967	770049.2	3022895.944	2	20	45.558	100	NC	NR
47	41+620.600	41+736.211	770193.063	3022933.343	770304.52	3022964.044	4000	Left					41+678.409	770249.013	3022947.888	1	39	21.641	100	NC	NR
48	42+020.996	42+151.680	770577.739	3023044.349	770697.851	3023095.473	800	Left	41+960.996	60	60	42+211.680	42+086.483	770639.888	3023064.995	9	21	34.424	100	5.0%	NR
49	42+263.317	42+386.087	770795.009	3023150.443	770902.676	3023209.42	3000	Right					42+324.711	770848.239	3023181.033	2	20	41.067	100	NC	NR
50	42+863.254	42+924.742	771325.774	3023430.049	771380.722	3023457.636	2000	Right					42+894.000	771353.036	3023444.265	1	45	41.345	100	NC	NR

Element ID	ELEMENT DETAILS								Transition Details				Horizontal Intersection Point (HIP)			Deflectin Angle			Speed (Kmph)	Superelevtion	Extra Widening (m)
	Start Chainage	End Chainage	Start Easting	Start Northing	End Easting	End Northing	Radius (m)	Direction	Start Chainage	L1	L2	End Chainage	Chainage	Easting	Northing	Deg	Min	Sec			
51	43+419.981	43+430.745	771826.676	3023673.015	771836.38	3023677.67	2000	Right					43+425.363	771831.522	3023675.355	0	18	30.022	100	NC	NR
52	43+928.798	43+985.327	772288.178	3023886.786	772343.171	3023899.669	400	Right	43+813.798	115	115	44+100.327	43+957.109	772315.219	3023895.174	8	5	49.728	100	5.0%	NR
53	44+571.735	44+690.139	772929.183	3023914.386	773047.558	3023912.743	2000	Right					44+630.954	772988.395	3023915.317	3	23	31.283	100	NC	NR
54	44+693.362	44+776.658	773050.778	3023912.603	773134.047	3023910.716	2000	Left					44+735.016	773092.393	3023910.792	2	23	10.545	100	NC	NR
55	44+779.012	45+124.291	773136.4	3023910.712	773480.214	3023883.042	2200	Right					44+952.007	773309.395	3023910.394	8	59	32.277	100	NC	NR
56	45+186.348	45+747.098	773541.491	3023873.23	774075.613	3023708.612	2000	Right					45+468.574	773820.166	3023828.607	16	3	51.428	100	NC	NR
57	45+959.467	45+988.646	774267.831	3023618.318	774294.331	3023606.105	2000	Left					45+974.057	774281.036	3023612.115	0	50	9.327	100	NC	NR
58	46+260.307	46+310.443	774541.874	3023494.202	774587.812	3023474.125	2000	Left					46+285.377	774564.717	3023483.875	1	26	10.623	100	NC	NR
59	46+606.714	46+713.210	774860.754	3023358.889	774957.716	3023314.875	2000	Right					46+659.975	774909.821	3023338.173	3	3	3.169	100	NC	NR
60	46+751.634	46+913.332	774992.268	3023298.068	775140.374	3023233.287	2000	Left					46+832.527	775065.011	3023262.682	4	37	56.295	100	NC	NR
61	47+188.781	47+513.658	775398.735	3023138.278	775710.905	3023190.111	410	Left	47+073.781	115	115	47+628.658	47+360.289	775565.661	3023098.903	45	24	0.516	100	5.0%	NR

Annexure 6.3: Vertical Alignment Report

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
1	30+971.873	159.098	60	0.659	1.409	0.750	30+941.873	31+001.873	158.9	159.521	Sag	80.083
2	31+255.485	163.093	460	1.409	-1.997	-3.406	31+025.485	31+485.485	159.853	158.499	Hog	135.053
3	31+560.522	157	100	-1.997	0	1.997	31+510.522	31+610.522	157.999	157	Sag	50.064
4	31+978.185	157	350	0	-2.352	-2.352	31+803.185	32+153.185	157	152.885	Hog	148.839
5	32+449.155	145.925	100	-2.352	-0.305	2.047	32+399.155	32+499.155	147.101	145.772	Sag	48.87
6	32+621.786	145.398	100	-0.305	1.984	2.289	32+571.786	32+671.786	145.551	146.39	Sag	43.689
7	32+991.411	152.73	570	1.984	-2.22	-4.204	32+706.411	33+276.411	147.077	146.404	Hog	135.611
8	33+388.243	143.922	120	-2.22	0.837	3.057	33+328.243	33+448.243	145.254	144.424	Sag	39.26
9	33+914.170	148.324	390	0.837	-2.004	-2.841	33+719.170	34+109.170	146.692	144.415	Hog	137.256
10	34+209.769	142.399	80	-2.004	-0.298	1.706	34+169.769	34+249.769	143.201	142.28	Sag	46.879
11	34+533.715	141.434	100	-0.298	0.312	0.610	34+483.715	34+583.715	141.583	141.59	Sag	163.959
12	34+752.290	142.116	150	0.312	-0.165	-0.477	34+677.290	34+827.290	141.882	141.992	Hog	314.622
13	34+935.000	141.815	100	-0.165	0.313	0.478	34+885.000	34+985.000	141.897	141.971	Sag	209.348
14	35+384.938	143.223	100	0.313	1.863	1.550	35+334.938	35+434.938	143.067	144.155	Sag	64.498
15	35+703.285	149.155	450	1.863	-1.439	-3.302	35+478.285	35+928.285	144.962	145.917	Hog	136.266
16	36+035.670	144.372	100	-1.439	0.146	1.585	35+985.670	36+085.670	145.091	144.445	Sag	63.099
17	36+785.277	145.465	80	0.146	-0.128	-0.274	36+745.277	36+825.277	145.407	145.414	Hog	291.766
18	37+509.002	144.536	60	-0.128	0.297	0.425	37+479.002	37+539.002	144.574	144.625	Sag	141.113
19	37+731.077	145.195	100	0.297	0.926	0.629	37+681.077	37+781.077	145.047	145.658	Sag	159.015
20	37+926.069	147	200	0.926	0	-0.926	37+826.069	38+026.069	146.074	147	Hog	216.058
21	38+698.664	147	200	0	-0.297	-0.297	38+598.664	38+798.664	147	146.703	Hog	673.787
22	39+268.265	145.309	100	-0.297	0.737	1.034	39+218.265	39+318.265	145.458	145.678	Sag	96.739
23	39+817.576	149.357	250	0.737	-0.983	-1.720	39+692.576	39+942.576	148.436	148.129	Hog	145.379
24	40+229.288	145.311	110	-0.983	1.355	2.338	40+174.288	40+284.288	145.851	146.056	Sag	47.059
25	40+463.368	148.482	330	1.355	-1.085	-2.440	40+298.368	40+628.368	146.247	146.691	Hog	135.241
26	40+718.434	145.714	60	-1.085	0.164	1.249	40+688.434	40+748.434	146.039	145.763	Sag	48.014
27	41+179.900	146.472	60	0.164	-0.134	-0.298	41+149.900	41+209.900	146.422	146.432	Hog	201.425
28	41+889.322	145.524	60	-0.134	0.163	0.297	41+859.322	41+919.322	145.564	145.573	Sag	202.257
29	42+050.000	145.786	60	0.163	-0.193	-0.356	42+020.000	42+080.000	145.737	145.728	Hog	168.524
30	42+315.841	145.273	60	-0.193	0.151	0.344	42+285.841	42+345.841	145.331	145.318	Sag	174.569
31	42+749.725	145.927	100	0.151	-0.152	-0.303	42+699.725	42+799.725	145.852	145.851	Hog	330.259
32	43+210.725	145.226	60	-0.152	0.613	0.765	43+180.725	43+240.725	145.272	145.41	Sag	78.467
33	43+711.544	148.294	249.988	0.613	-0.798	-1.411	43+586.550	43+836.538	147.528	147.297	Hog	177.267
34	43+963.915	146.281	150	-0.798	0.252	1.050	43+888.915	44+038.915	146.879	146.47	Sag	142.901
35	44+238.469	146.973	150	0.252	-0.35	-0.602	44+163.469	44+313.469	146.784	146.711	Hog	249.235
36	44+481.468	146.123	125	-0.35	2.486	2.836	44+418.968	44+543.968	146.342	147.677	Sag	44.072
37	44+877.452	155.969	575	2.486	-1.717	-4.203	44+589.952	45+164.952	148.82	151.033	Hog	136.797
38	45+228.735	149.938	80	-1.717	-0.162	1.555	45+188.735	45+268.735	150.625	149.873	Sag	51.462

Annexure 6.3: Vertical Alignment Report

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
39	45+503.337	149.492	80	-0.162	1.472	1.634	45+463.337	45+543.337	149.557	150.081	Sag	48.937
40	45+831.543	154.325	450	1.472	-1.847	-3.319	45+606.543	46+056.543	151.012	150.17	Hog	135.572
41	46+147.819	148.484	105	-1.847	0.597	2.444	46+095.319	46+200.319	149.454	148.797	Sag	42.974
42	46+424.741	150.136	90	0.597	0.955	0.358	46+379.741	46+469.741	149.868	150.566	Sag	251.214
43	46+815.810	153.87	60	0.955	1.946	0.991	46+785.810	46+845.810	153.584	154.454	Sag	60.506
44	47+221.933	161.775	605	1.946	-2.502	-4.448	46+919.433	47+524.433	155.887	154.207	Hog	136.006