



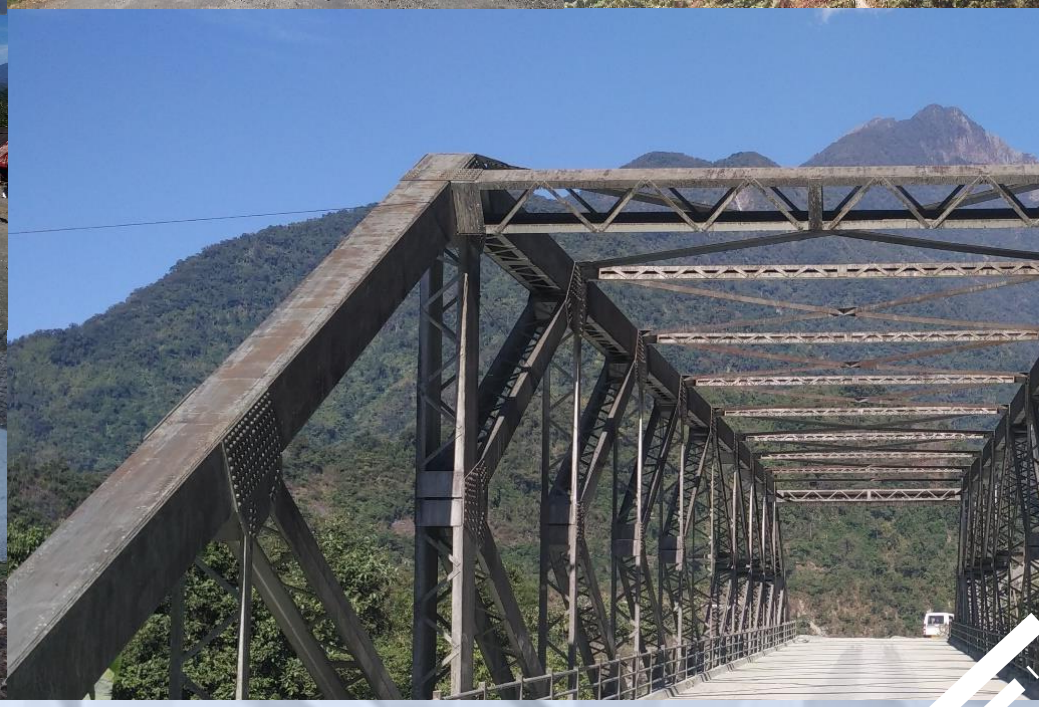


Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report and providing preconstruction services in respect of Two Laning with paved shoulder NH configuration of Demwe–Brahmkund Section from Km. 0.00 to Km. 19.22 of Demwe– Hawai Road under SARDP–NE on Engineering, Procurement and Construction mode in the state of Arunachal Pradesh.

DETAILED PROJECT REPORT

VOLUME I: MAIN REPORT

Client:

NHIDCL
BUILDING INFRASTRUCTURE - BUILDING THE NATION

Consultant:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

0.1 BACKGROUND

North-east India, which comprises of eight states, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, is geographically connected to the rest of the country, by a narrow corridor of land in West Bengal, flanked by Nepal and Bangladesh. For decades, poor infrastructure and limited connectivity have acted as roadblocks hindering the socio-economic development of these states. The Indian government's 'Act East' policy, focuses on strengthening relations with neighbouring countries and Prime Minister Narendra Modi as well as Transport Minister Shri Nitin Gadkari is spearheading initiatives to enhance connectivity through various projects pertaining to road, rail, air, telecom, power and waterways. Despite being one of the largest state in the country, Arunachal Pradesh has the least road density. The Union Ministry of Road and Transport, is planning to expedite the Trans-Arunachal Highway project. The ministry will be driving the Special Accelerated Road Development Program of Roads and Highways covering 2,319 kilometres. Construction plans for the Arunachal Frontier Highway and East West Corridor, has also been proposed. Many roads connecting Trans Arunachal Highway to Indo China border are being developed to provide better connectivity to the borders. The cities or towns in Arunachal Pradesh is not connected directly but through major highways. Hence projects have been declared connecting the cities directly.

Organisations like BRO, NHIDCL, PWD, CPWD are working relentlessly in inhospitable terrain, hazardous working conditions, un-conducive weather in extremely remote areas to construct roads for national security as well as for development of the state.

National Highways and Infrastructure Development Corporation Limited (NHIDCL), a fully owned company of the Ministry of Road Transport & Highways, Government of India, has decided to engaged in an ambitious Special Accelerated Road Development Programme (SARDP-NE) for development of road network in the north-eastern States of the Country. This programme envisages providing road connectivity to backward and remote areas, areas of strategic importance and neighbouring countries.

This project is a part of the above mentioned programme and project awarded to Consultant is Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report and providing pre-construction services in respect of 2 laning with hard shoulders, i.e. NH configuration of Demwe - Brahmakund Road on NH-13 in the state of Arunachal Pradesh.

- Project Stretch: Demwe - Brahmakund Road on NH-13

In order to fulfil the above task, NHIDCL has entrusted the work of preparation of the feasibility study and Detailed Project Report for the above project to M/s S. M. Consultants., vide contract agreement dated 01st June 2017. The Letter of Acceptance was communicated vide letter No NHIDCL/DPR/Ar.Pr./Demwe-Hawai/2017/135.

Figure 1: LOCATION MAP

National Highway 13 (NH 13) is a National Highway in North East India that connects Tawang in Arunachal Pradesh to Wackro in Arunachal Pradesh. NH 113 starts from Tohangam on NH 13 to Kibthu in Arunachal Pradesh.

The road is as shown in the map below.

Figure 2: ROAD NETWORK OF ARUNACHAL PRADESH

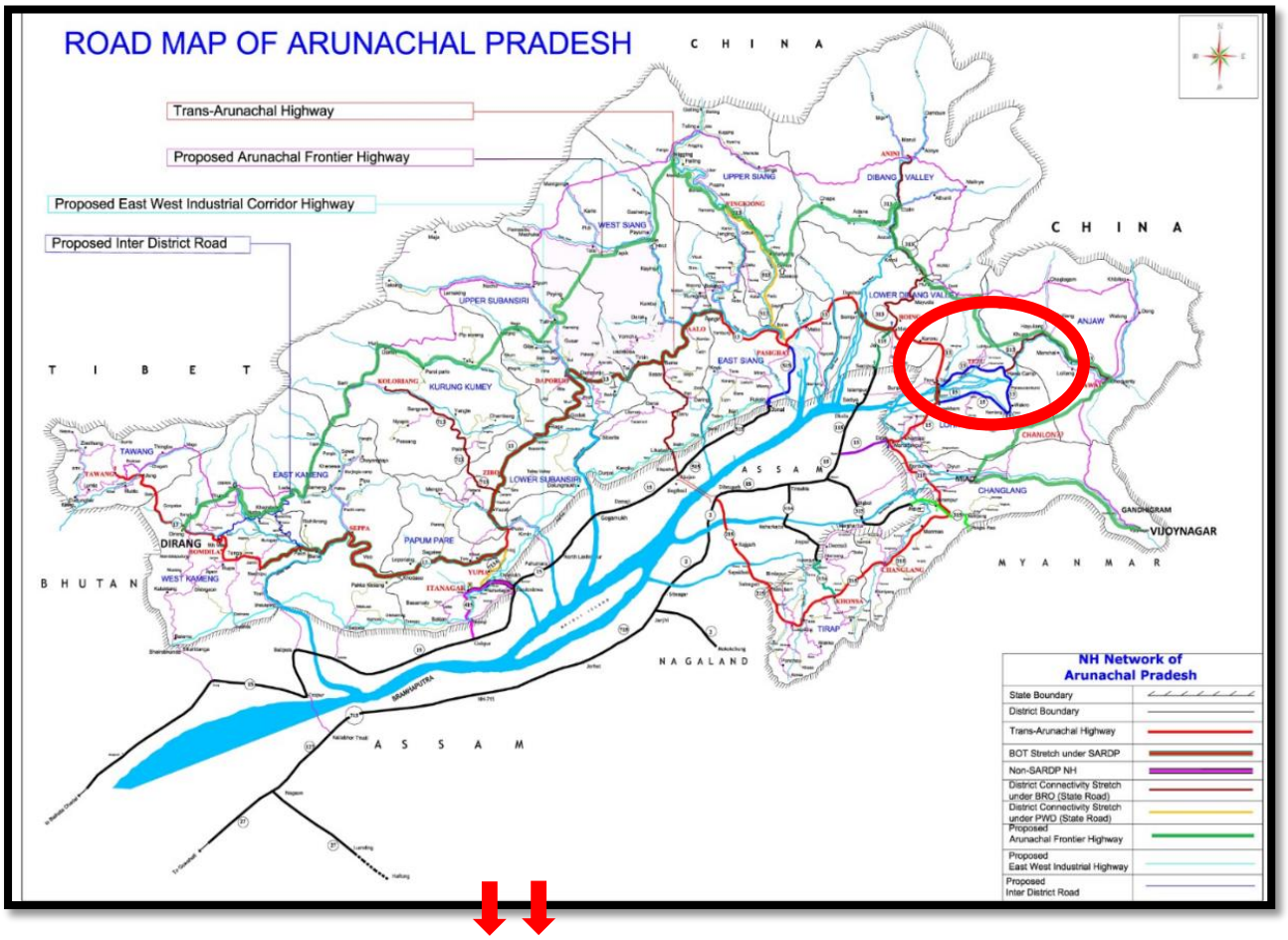
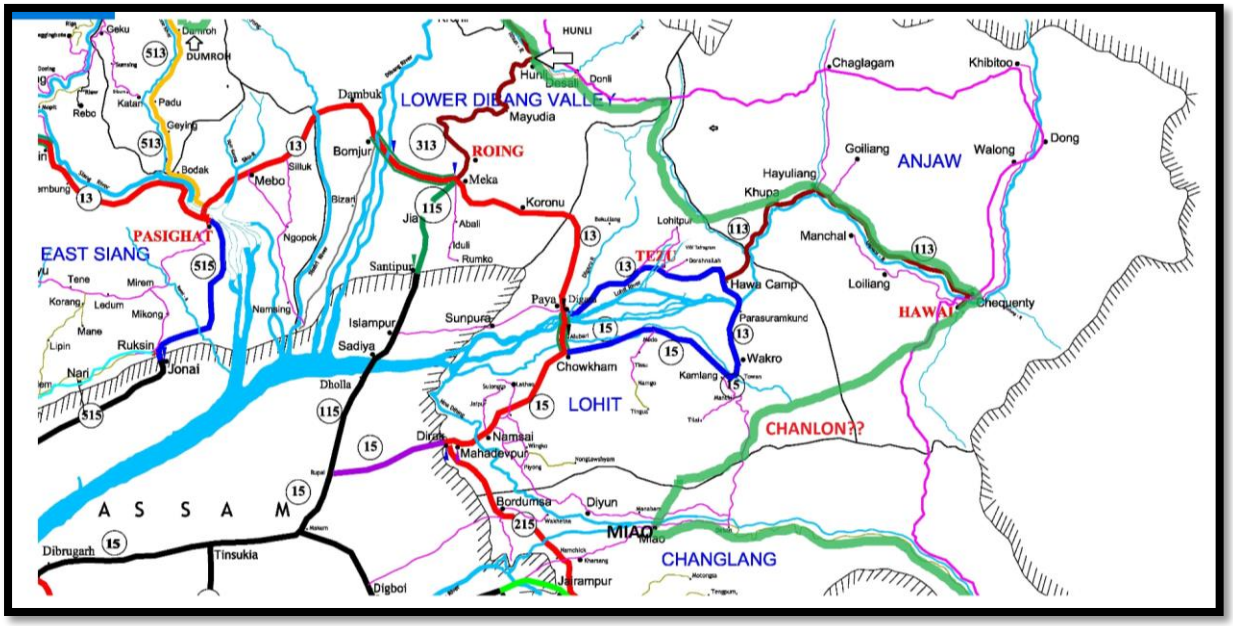
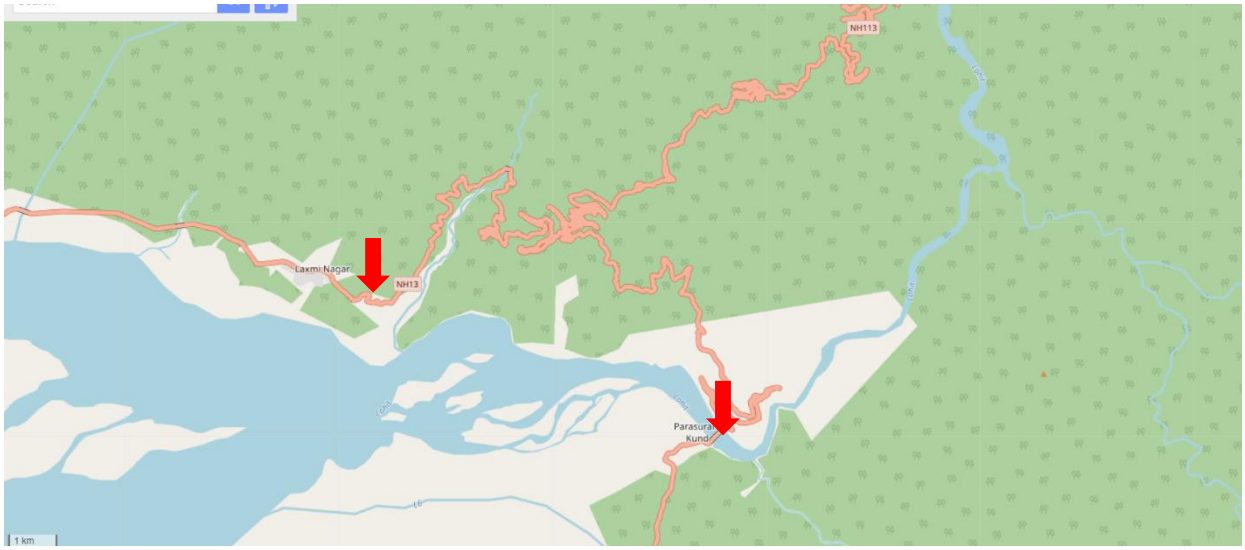


Figure 3: PROJECT AREA



The existing Demwe Brahmakund road starts from Demwe BRO camp and passes through Tohangum junction before moving to Brahmakund and Parsuramkund. The road is a single lane pavement with many hair pin bends and sharp curves with sliding and rockfall stretches.

Figure 4: EXISTING ROAD CONNECTING DEMWE BRAHMAKUND



The project road is a part of the National Highway 13, connecting Demwe (Existing Chainage 717.675) to Brahmakund (Existing Chainage 745.20 km) in the state of Arunachal Pradesh has a great potential to promote the socio-economic development due to the road's connectivity to Parasuram Kund. The existing road length is 27.075 kms.

The sequence of finalization of alignments are as follows:

1. Approval of greenfield alignment along river Lohit with a 2 km length tunnel and total length 8.86 kms was finalized. DPR and clearances were completed for the project.
2. Existing single lane alignment was proposed to be developed to two lane configuration
3. Existing single lane alignment was proposed to be rehabilitated. DPR was prepared and submitted.
4. Finally, the alignment partly greenfield and partly brownfield was finalized. It uses part of finalized alignment 1 and alignment 2.

The finalized alignment of length 18.464 kms is being proposed for development which has greenfield alignment of 13.350 kms and brownfield stretch of 5.114 kms. It lies in the district of Lohit.

The present submission is for final detailed project report in line with the terms of reference.

0.2 Project Development Description

0.2.1 General

The project road starts from Demwe (717.675 km) on NH 13 and ends at the start of the new alignment of Brahmakund to Arrowa (745.20 km) on NH 13. The road lies completely in the district of Lohit, Arunachal Pradesh. The length of the road is 27.075 km. The road passes through the settlements of 48 BRTF Camp, Tohangam and BRO Camp. The road lies completely in hilly terrain.

The proposed alignment finalized starts from Demwe near BRO Camp, traverses on existing alignment for 2 kms, crosses the Dus river with a major bridge, traverses greenfield along River Lohit, meets existing road at chainage 15.350 km and moves along the existing road till it meets the BRO road to Arrowa.

The road is in hilly terrain with good condition at most of the stretches. The existing project stretch has configuration of single lane with earthen shoulders throughout the stretch. Most of the stretches are in poor condition due to soil type and occurrence of landslides at those stretches.

The roadside environment is mostly covered with dense forest, with intermediate semi-urban settlements and semi-rural open areas with most built-up sections have small businesses of agricultural products scattered throughout the route.

0.2.2 Need for the Road

Road has a special importance as vital infrastructure for economic development of the state. High priority is given in the plans and programme for construction of roads to develop the economy. Highways and roads are regarded as arteries and veins of a state which are essential for its growth. This road is of vital importance as every year numerous pilgrims come to visit this holy ground of Brahmakund as taking bath in the water in the Kund directs to emancipation. According to the Hindu Legend (Kalki Purana), the place is dedicated to Lord Parashuram where the people from Nepal often visit. In addition, many people from all over India came to this place to offer prayers. Here, more than 70,000 devotes as well as Sadhus take bath every year during Makara Sankranti in the month of January. In the winter season, the people take holy dip to wash off the sins according to Hindu traditions and believe. As per the Kalika Purana, Mahabharata and Bagavat Gita, Lord Parasurama came to this place and took bath to wash away his sins. The place is also wonderful for trekking, angling, hiking, river rafting, fishing etc. near River Lohit. In addition to religious importance this place has mesmerizing beauty.

To improve inflow of tourists, to provide smooth connectivity to the places nearby widening & strengthening of the road is necessary. Pathetic road condition in the hill districts of the state has always been detrimental for their development. It also determines the interaction among the people. In most of the villages inter village roads are not surfaced.

0.2.3 Traffic Volume

The summary of the average daily traffic for the project stretch is given in Table 1. The count was made at 3 location for the one homogeneous stretches in the month of July 2017.

Table 1: TRAFFIC DATA SUMMARY

Location	-
Car, jeep, Van, Light Motor Vehicle	74
Light Commercial vehicle	39
Bus/2 Axle truck	4
3 Axle	0
Multi axle truck	0
Tollable ADT	117
Non Tollable ADT	27
Total ADT	144

0.2.4 Traffic Projected

The traffic projected for the project stretch with 5% traffic growth rate has been tabulated below.

Table 2: PROJECTED TRAFFIC FOR 15 YEARS

Duration	Total Vehicles	Total PCU	No of Years
2017	144	158	Base Year
2018	153	169	Construction Year 1
2019	163	182	Construction Year 2
2020	174	195	Operation Year 1
2021	185	209	Operation Year 2
2022	196	222	Operation Year 3
2023	207	236	Operation Year 4
2024	219	250	Operation Year 5
2025	232	265	Operation Year 6
2026	246	282	Operation Year 7
2027	260	298	Operation Year 8
2028	275	316	Operation Year 9
2029	290	333	Operation Year 10
2030	305	351	Operation Year 11
2031	322	371	Operation Year 12
2032	340	391	Operation Year 13
2033	359	413	Operation Year 14
2034	378	434	Operation Year 15

0.2.5 Proposed Development plan

- The project road follows the existing alignment upto 2.000 km and then proceeds with a green field alignment till 15.350 km then again it tracks on the existing alignment with necessary geometric corrections.
- The road is proposed for development to two lane with hard shoulder on hill side and earthen shoulder on valley side for the full road.

Figure 5: TYPICAL CROSS-SECTION 1 (Widening Section)

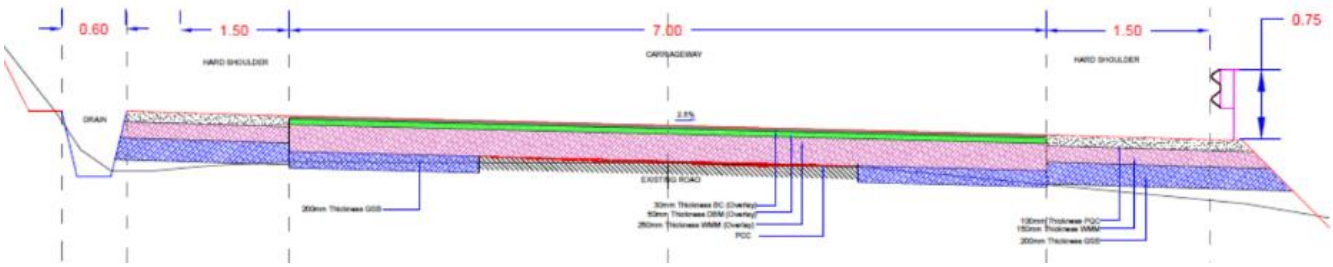
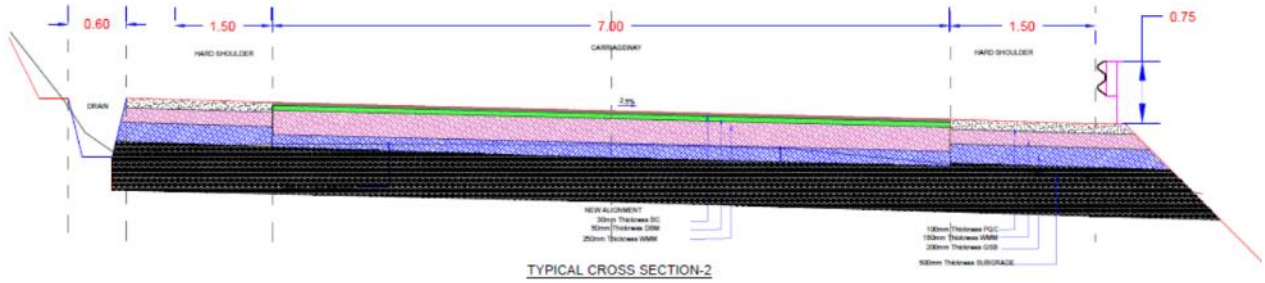


Figure *6:* TYPICAL CROSS-SECTION 2 (Realignment Section)



- Notwithstanding anything to the contrary contained in this agreement, the contractor shall design the pavement of main carriageway for design traffic of 20 MSA for non-bituminous courses & 5 MSA for bituminous courses with a minimum design period of 20 years. Maximum value of CBR to be taken for design shall not exceed 8%, even if CBR obtained at site is more than 8%.

Table 3: DETAIL OF PAVEMENT DEVELOPMENT

Chainage	Design traffic (MSA)	CBR of subgrade (%)	Viscosity grade of bitumen	Proposed pavement thickness
0/00-18/464 km	20 MSA	8 %	VG 30-40	530 mm

- The average characteristic deflection values to be used for design purposes have been worked from BBD survey. The thickness is deduced from Fig 9 of IRC 81-1997 in terms of bituminous macadam construction. However to match with the new pavement thickness, and

keeping in view the deteriorated condition of the existing pavement overlay thickness proposed are presented in table below.

Table 4: DETAIL OF PAVEMENT OVERLAY

Chainage from and to	Design traffic (MSA)	Characteristic deflection	Overlay	Proposed Bitumen overlay
0/00-2/00	20 MSA	1.19 mm	0 mm	330 mm
15/350 – 18/464	20MSA	1.19 mm	0 mm	330 mm

- However as the road has been maintained in the near past and the road is in good condition overlay of 50 mm DBM and 30 mm BC with 250 mm WMM is provided.
- The road has 3 junctions where all are minor junctions which has been upgraded to at grade priority controlled intersection with project highway.
- The road has existing 1 major bridge and 1 minor bridges. The development proposal for the bridge are as follows

Table 5: DEVELOPMENT PROPOSAL FOR BRIDGES

Sl. No.	Existing Type	Proposed Type	Recommendation	Nos.
1	RCC Slab	RCC Slab	Reconstruction	1
		RCC Slab	New Construction	8
2		RCC T Girder	New Construction	3
3		PSC Girder	New Construction	2
4		Steel Girder	New Construction	2
5		Composite Girder	New Construction	1

- There are 24 nos. of culverts existing on the project road, where 20 are proposed for reconstruction, 4 for new construction and 54 new culverts on the alignment. The summary of the culverts are as follows

Table 6: PROPOSAL FOR CULVERTS

Sl.No.	Existing Type	Proposed Type	Recommendation	Nos.
1	RCC Slab	RCC Box	New construction	4
			Reconstruction	20
			New	54

0.3 Public Utilities

All most all kinds of utility services that can be located along roads are present in the entire project road stretch including crossings these services need not be reallocated as the road has been designed not affecting the utilities. Some services are just located at the edge of the shoulder and some at the toe.

INTRODUCTION

CHAPTER I INTRODUCTION

1.1 BACKGROUND

Ministry of Road Transport and Highways (MORT&H) through National Highway Infrastructure & Development Infrastructure (NHIDCL) intends to develop the National Highways of the state. As a part of this endeavour, the Authority has decided to undertake development of the project road through EPC mode.

The road under consideration for the present submission is Demwe to Brahmakund Section on NH 13 in the state of Arunachal Pradesh. The length of the road is 18.464 kms.

In the above backdrop, National Highway and Infrastructure Development Corporation has appointed M/s SM Consultants as consultant for carrying out the feasibility study and preparation of detailed project report of the project highway.

- Demwe – Brahmakund Section on NH 13

1.2 PROJECT DESCRIPTION

The project road is a part of the National Highway 13, connecting Demwe to Brahmakund (18.464 kms) in the state of Arunachal Pradesh has a great potential to promote the socio-economic development. Tezu is the district head quarter of Lohit District. Demwe is 14 km away from Tezu. Thus development of the road will provide scope to entrepreneurs to explore the growth opportunities. National Highway 13 (NH 13) is a National Highway in India that links Tawang to Wakro in the state of Arunachal Pradesh via Bomdila, Nechipu, Seppa, Sagalie, Ziro, Daporijo, Along, Pasighat and Tezu terminating at its junction with NH 15 near Wakro. It runs for a distance of 1150 km in the state of Arunachal Pradesh.

1.3 COMMENCEMENT

The work for Consultancy services for preparation of feasibility study and detailed project report for improvement of road connecting Dewme to Brahmakund has been awarded to consultants vide letter no.: NHIDCL/DPR/Ar.Pr./Demwe-Hawai/2017/135 on dated 13.04.2017.

The consultancy service has various systematic steps to prepare the detailed project report of Project Highway. In the first step, the Inception Report with Quality Assurance Plan is submitted to provide an overview of the project site, the mobilisation process to take up the work and the assurance of the work to be carried out for the consultancy service. The second phase includes the feasibility report which is in two phases- draft feasibility report submission with presentation and submission of final feasibility report after incorporating the comments on draft feasibility report. The last phase requires submitting the detailed project report with the strip maps, schedules, clearances and execution plans with bid documents.

1.4 Project Objective

Arunachal Pradesh, lying in the north eastern tip of India and bounded by long international borders of 1628 km with Bhutan on the west, China to the north and north east and Myanmar on the east is not only the sentinel to the nation but also a potential corridor for trade and commerce across the borders with these neighbouring countries. In absence of other means of communication like inland water transport, railways or air services, road is only the means of transportation of men and materials in the state. The absence of road of proper standard in the state is the major stumbling blocks for development in many other sectors like power, horticulture, industries, tourism etc.

The main objectives of the consultancy service will focus on establishing technical, economic and financial viability of the project and prepare detailed project reports for rehabilitation/ up gradation/ construction of the existing/missing road to four lane/ two lanes NH with paved shoulder configuration with the following points to be ensured.

- Ensure Enhanced safety of the traffic, the road users and people living close to the Highway
- Ensure enhanced operational efficiency of the highway
- Ensure fulfilment of the access needs of the local population
- Ensure minimal adverse impact on the road users and the local population due to construction
- Minimal additional acquisition of land
- Formulation of up-gradation to two lane/four lane
- Provide technical assistance including designing and cost estimation
- Superior operation and maintenance enabling enhanced operational efficiency of the Project Highway.

1.5 Scope of Work

The study includes all field works and detailed engineering studies for the widening and improvement of the existing road to intermediate lane within existing ROW. The scope of services as detailed in TOR is as follows:

- As far as possible, the widening/improvement work to intermediate lane within existing ROW avoiding land acquisition, except for locations having inadequate width and where provisions of short bypasses, service roads, alignment corrections, improvement of intersections are considered necessary and practicable and cost effective. The Consultant shall furnish land acquisition details as per revenue records/maps for further processing of land acquisition. Consultant shall also submit 3a, 3A and 3D draft notification for acquisition of land. Scope of services includes all activities up to completion of the Land Acquisition

process till 3G Notification as per LA Act of acquisition of land either under NH Act or State Act, as applicable.

- The Consultant shall study the possible locations and design of toll plaza. Wayside amenities required on tolled highway shall also be planned. The local and slow traffic may need segregation from the main traffic and provision of service roads and fencing may be considered, wherever necessary to improve efficiency and safety.
- The general scope of services is given in the sections that follow. However, the entire scope of services would, inter-alia, include the items mentioned in the Letter of Invitation and the TOR. The Consultant will also make suitable proposals for widening/improvement of the existing road to intermediate lane within existing ROW and strengthening of the carriageways, as required at the appropriate time to maintain the level of service over the design period. The Consultants shall prepare documents for EPC contracts for each DPR assignment.
- All ready to implement 'good for tender drawings and designs' shall be prepared.
- Environmental Impact Assessment, Environmental Management Plan and Rehabilitation and Resettlement Studies shall be carried out by the Consultant meeting the requirements of the lending agencies like ADB/ World Bank/JICA, etc.
- a. As regards Railway ROB/RUB, the Consultant will liaise with concerned authorities, wherever required and arrange all clarifications. Approval of all drawings including GAD and detailed engineering drawings will be obtained from the Railways by the Consultant. However, if Railways require proof checking of the drawings prepared by the Consultants, the same will be got done by NHIDCL and payment to the proof Consultant shall be made by NHIDCL directly.

  b. Consultant will also obtain 'NO Objection Certificate' from Ministry of Environment and Forest and also facilitate to obtain the estimates for shifting of utilities of all types involved from concerned local authorities in the DPR. Consultant will also be required to prepare all Land Acquisition papers (i.e. all necessary schedule and draft 3a, 3A, and 3D, 3G notification as per L.A. act) for acquisition of land either under NH Act or State Act(as applicable).
- Preparation of the Bid Documents, based on the feasibility report, due to exigency of the project for execution if desired by NHIDCL.
- Consultant shall obtain all types of necessary clearances required for implementation of the project on the ground from the concerned agencies. The client shall provide the necessary supporting letters and any official fees as per the demand note issued by such concerned agencies from whom the clearances are being sought to enable implementation.
- The Consultant shall prepare documents for the chosen mode of implementation on EPC after studying various options like BOT, Annuity and EPC.

- The Consultant shall prepare the bid documents including required schedules as per EPC mode. For that, it is suggested that Consultant should also go through the EPC documents of ministry before bidding the project. The Consultant shall assist the NHIDCL and its Financial Consultant and the Legal Adviser by furnishing clarifications as required for the financial appraisal and legal scrutiny of the project highway and bid documents.

The scope of consultancy service as set out in the TOR includes the following major tasks:

- ✓ Traffic surveys and demand assessment
- ✓ Engineering surveys and investigations of the project
- ✓ Location and layout of toll plaza
- ✓ Location and layout of truck lay byes.
- ✓ Location and layout of bus bays and bus shelters
- ✓ Identification of possible improvements in the existing alignment (horizontal & vertical) 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
- ✓ inventory and condition surveys for the road
- ✓ Social impact assessment
- ✓ Environmental impact assessment
- ✓ Inventory and condition surveys for bridges, cross drainage structures and drainage provisions.
- ✓ Detailed topographic surveys using total stations
- ✓ Pavement investigations
- ✓ subgrade, subsoil characteristics and strength;
- ✓ Identification of sources of construction materials;
- ✓ Preliminary design of road, cross drainage and other structures, bypasses if necessary, preparation of GAD.
- ✓ Identification of the type and the design of intersections
- ✓ Design of complete drainage system and disposal point for storm water
- ✓ Value analysis / value engineering and project costing;
- ✓ Economic and financial analysis;
- ✓ Contract packaging and implementation schedule;
- ✓ Preparation of strip plans 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 and planted and land acquisition requirements including schedule for LA;
- ✓ Reports documents and drawings;

- ✓ Financial viability of project and financing options like BOT, Annuity, SPV;
- ✓ Preparation of Feasibility cum preliminary project report, cost estimate, approved for construction drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources on BOT basis.
- ✓ Design of toll plaza and identification of their numbers and location and office cum residential complex including working drawings;
- ✓ Design of weighing stations, parking areas and rest areas as required;
- ✓ Any other user oriented facility enroute toll facility;
- ✓ Tie-in of on-going / sanctioned works of MOSRT&H /NHAI/ other agencies;
- ✓ Preparation of social plans for the project affected people as per policy of the lending agencies/ Govt. of India R & R Policy.
- ✓ The Consultant shall be guided in its assignment by the Model Agreement for Engineering, Procurement and Constructions (EPC) and the Manual of Specifications and Standards for four lane of highways through Engineering, Procurement and Constructions (EPC) published by IRC:SP: 73 (the "Manuals") along with relevant IRC codes for design of long bridges and other features.

The Consultant shall be guided in its assignment by the Model Agreement for Engineering, Procurement and Constructions (EPC) and the Manual of Specifications and Standards for two lane of highways through Engineering, Procurement and Constructions (EPC) published by IRC (IRC: SP: 73-2015) along with relevant IRC codes for design of long bridges.

1.6 Project Appreciation

The Project Road under consideration is a part of the newly renamed National Highway 13 (previous NH 223) of length 1150 km starting from National Highway in India that links Tawang to Wakro in the state of Arunachal Pradesh via Bomdila, Nechipu, Seppa, Sagalie, Ziro, Daporijo, Along, Pasighat and Tezu terminating at its junction with NH 15 near Wakro. The project highway starts from Demwe 0/000 km of design chaiange (existing Chainage 717.675 km) NH 13 and ends at the 18.464 km of design chaiange (745.2 km of existing chainage) NH 13 in the state of Arunachal Pradesh.

The road is a prime link connecting many small villages, and tourist destination like Tezu (Hill Station), Parsuramkund, Brahmakund and Hawa Camp (Lohit View) which after up gradation will provide commercial enhancement of the Project Influence Area.

The existing Road under consideration is completely single lane configuration with earthen shoulder passing through entirely through hilly terrain. The condition of the road is fair but there were many stretches found with heavy land slide where carriageway is completely washed out. Deficiencies seen were bad geometry (Sharp curves, reverse curves, blind curves and hairpin

bends), deficiency in sight distance in curve sections, over topping, encroachment etc. The development of the road shall be widening and upgrading the road to NH standards with paved shoulders and strengthening of the existing road including making well the defects of the geometries, pavement and structures.

1.7 Structure of the Report

Volume I : Main Report

- Chapter 1 : Introduction
- Chapter 2 : Overview of NHIDCL Organisation & Project Financing
- Chapter 3 : Project Corridor
- Chapter 4 : Preliminary Design & Design Standards
- Chapter 5 : Surveys and Investigations
- Chapter 6 : Traffic Survey, Analysis & Forecast
- Chapter 7 : Improvement & Engineering Proposals
- Chapter 8 : Structures
- Chapter 9 : Cost Analysis
- Chapter 10 : Financial Analysis
- Chapter 11 : Environmental & Social Impact Appraisal
- Chapter 12 : Traffic Operation & Safety Plans
- APPENDICES

Volume II : Technical Specifications

Volume III : Rate Analysis

Volume IV : Cost Estimates

Volume V : Bill of Quantities

Volume VI : Drawings

OVERVIEW OF NHIDCL & PROJECT FINANCING

CHAPTER 2
OVERVIEW OF NHIDCL & PROJECT FINANCING

2.1 General

The National Highway 13 is a highway network of 1150 km starting from Tawang in Arunachal Pradesh in to Wakro in Arunachal Pradesh. NH 13 is a newly declared National Highway.

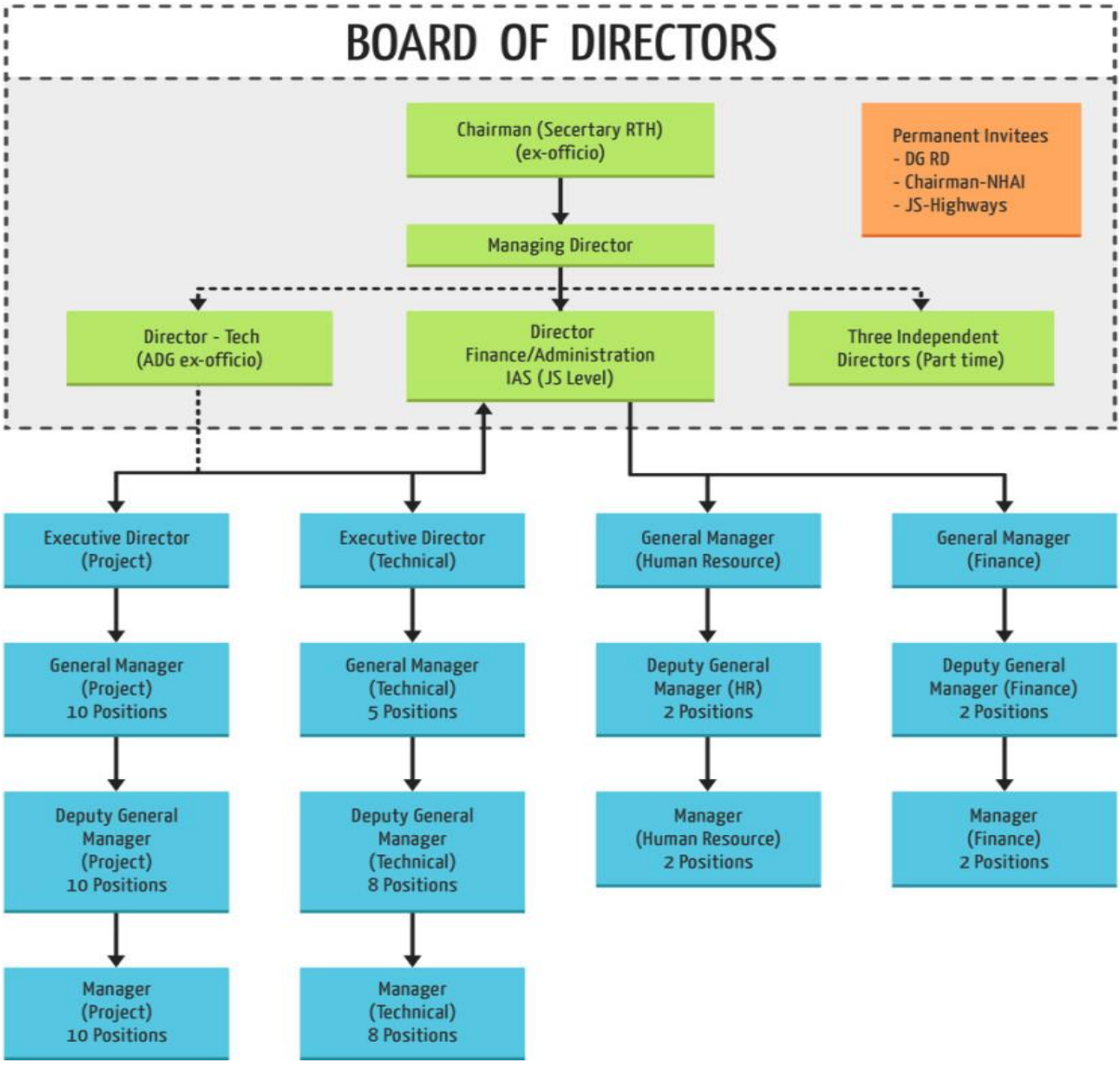
2.2 Objective of NHIDCL

National Highway and Infrastructure Development Corporation is a company which promotes, surveys, establishes, designs, builds, operates, maintains and upgrades National Highways and Strategic Roads including interconnecting roads in parts of the country which share international boundaries with neighbouring countries. The regional connectivity so enhanced would promote cross border trade and commerce and help safeguard India's international borders. An approximate aggregate length of 10,000 kms has been identified to begin with for development through this company.

2.3 Organisation of NHIDCL

NHIDCL is company fully owned by the Ministry of Road Transport & Highways, Government of India. The department's activities are under the supervision of Secretary, Ministry of Road Transport and Highways Shri Mr. Giridhar Aramane and Managing Director, NHIDCL Shri Keshav Kumar Pathak.

Figure 7: ORGANOGRAM OF NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED



2.4 Project Financing Options

Traditionally, financing for development of National Highways in India was from the budgetary resources of the Government of India. In order to augment the available resources, loans have also been raised from multilateral agencies like World Bank, Asian Development Bank (ADB) and Japan Bank of International Cooperation (JBIC).

Presently the development and maintenance of national Highways is financed by following modes:

1. Government's general budgetary sources
2. Dedicated accruals under the Central Road Fund (by levy of cess on fuel)
3. Lending by international institutions:
   a. World bank

b. ADB
c. JBIC

4. Private funding under PPP frameworks:
   a. Build Operate and Transfer/ Design Build Finance Operate and transfer (DBFOT)- Investment by private firm and return through levy and retention of user fee
   b. Build Operate and Transfer (Annuity) – BOT (Annuity) Investment by private firm and return through semi-annual payments from NHAI as per bid.
   c. SPV (with equity participation by NHAI)
   d. Market borrowings

NHAI also has a provision for providing grant up-to 40% of the project cost to make projects commercially viable. However, the quantum of grant is decided on a case to case basis and typically constitutes the bid parameter in BOT projects generally not viable based on toll revenues alone. The disbursement of such grant is subject to provisions of the project concession agreements. NHAI projects, with higher traffic volumes, have also been bid out on Negative Grant. However, under the revised MCA, projects under BOT/ DBFOT framework have also been awarded on a revenue share basis, where the bidder offering the highest revenue share (subject to technical qualification) is awarded the project.

2.5 Mode of Implementation

The present policy of the Government is deciding mode of implementation of projects on BOT (Toll), BOT (Annuity) and Item rate / EPC contract basis following a water-fall sequence. This results into lot of delays in implementation of projects. It is, therefore, desirable that based upon the project report, the Government may decide the mode of implementation of the projects upfront.

2.6 Cost Recovery Mechanism

Evaluation of Proposed alternatives plans is the most critical process. Evaluation is required to evaluate the best out of alternative plans. Having known costs and benefits of a scheme/project, a method is used to arrive at justification in economic terms. Various methods are employed to determine the rate of return from a project cost. The method of Internal Rate of Return Method is a suitable method which produces a long term rate of return and discounts all future benefits to equal the initial investment. This method is used to determine the economic viability.

The mode of recovery of the cost will be through the tolling process. The Road Pricing and rate of user fee should be fixed purely on the basis of the benefits accruing to the users on account of up gradation of the facility as compared the facility existing before. The Government may also consider undertaking a sound cost allocation study of providing and maintaining roads due to cars, buses and trucks.

PROJECT CORRIDOR

CHAPTER 3
PROJECT CORRIDOR

3.1 GENERAL

Arunachal Pradesh is a state in north eastern India, with the city of Itanagar as its capital. Arunachal Pradesh- the "Land of the dawn-lit mountain", is situated in the north east of India. The State, with a population of only 13.84 Lakhs as per 2011 Census inhabiting over an area of 83,743 sq. km, largest amongst NE States, has a very low density of 17 people per sq. km. Bounded by Bhutan to the West, China to the North and North-East and Myanmar to the East, the State is one of the most splendid and variegated tribal areas of the country. The total length of international border is about 1628 km. It has inter-state borders with Nagaland in East and South-East and Assam in the South.

Arunachal Pradesh is a land that is home to several unique cultures and pristine beauty. The culture of Arunachal Pradesh is truly varied in the sense that the state has 26 major tribes including sub-tribes. Every tribe has their own unique set of traditions and customs. The major tribes of Arunachal are: Adi, Galo, Aka, Apatani, Nyishi, Tagins, Bori, and Bokar etc. Arunachal Pradesh sets it foot in new cultural believes, carrying forward its thriving traditions from thousands of years. The state, on account of its unrivalled aesthetics and diverse cultural heritage possesses a great tourism potential

3.2 ECONOMY OF ARUNACHAL PRADESH

An important characteristic of the Arunachal economy is the rapid growth of the services sector; which along with the manufacturing sector, did not exist prior to 1947. The sectoral composition of the District Domestic Product (DDP) shows that in Arunachal Pradesh, majority of the districts are dependent on agriculture. However, in districts like Papum Pare and West Kameng, share of agriculture is about 14% which is less than half the share of agriculture in the state income as a whole. The tertiary sector contributes 54% of the total income of the district. The Public Administration (PA) has been one of the rapidly growing sectors in the district economy and 30.85% of district income share comes from PA. The per capita net district domestic product as per the estimates of HDR, Arunachal Pradesh is Rs.9334 and the district ranks sixth in terms of its per capita income.

The project roads come under the influence of Lohit districts of Arunachal Pradesh. A brief view of the district and the areas of influence are presented below so that we can overview the effects that the various features of the district are likely to influence the project roads.

3.3 Lohit District-Socio Economic Profile

Demwe is a place in Lohit district in the state of Arunachal Pradesh, India. Tezu is the district head quarter of Lohit district.

Lohit district is the largest district of Arunachal Pradesh with an area of 5212 sq.km. This district is named after popular river, Lohit. It is situated between 27 0 30' to 28 0 21'N & 94 0 18' to 95 0 45' E .It borders Lower Dibang Valley on West, Changlang on the East & China on the North. It has 2 subdivisions, 6 administrative circles with 5 CD Blocks with population of 1,25,086 as per 2001 Census. The district registered a decadal growth rate of 30.8 during the decade 1991-01. The district Hq is located at Tezu. Important places for tourists in the district are Parashuram Kund, Glow Lake & Lohit View etc.

- **Topography**

Lohit District is a mountainous tract. On account of the existence of the hill ridges and the valleys its topography assumes typical character. The hill ridges are situated haphazardly. As soon as one ends the other ridge starts either parallel or in opposite direction. At these intervals the wide or narrow valleys get the foothills constituting 20 per cent to total geographical area of district. The wide and narrow valleys share 35 per cent each to total geographical area. The rest about 10 percent is the snow clad peaks. Due to typical topography the rivers are undulated. There are numerous streams and rivers and are drained by principal river Lohit, Naodihing etc. These principal rivers of the district are drained by the westerly flowing Brahmaputra. These rivers have rendered the human habitations into geographical isolations. At the same time these rivers possess high hydro-power potential. It could be developed as a good industry. The vast natural resources have drawn the attention of the Government during recent years.

- **Soil**

Geomorphologically, Lohit district can be broadly divided into two categories Structural hills and Piedmont plains. Structural hills consist of valleys and ridges of definite trend lines. Piedmont plains are the plains in the foot hill belt of structural hills. All the major settlements like Tezu, Namsai etc. comes under piedmont plains.

The nature and properties of soil vary according to regional variations. In the hilly regions, the soil generally contains high humus and nitrogen due to extensive cover of the forests. The soil along the foothill areas is alluvial, loamy or sandy loam mixed with gravel and pebble brought down by rain from higher attitudes. The soil in the valley is rich in organic content. The soil is mainly acidic in nature. The soils in the district can be divided into a) plain alluvial soils up to 305 m attitude and b) hilly soils above 305m. The plains soils consist of the following types.

1. **Older Alluvium Type**

It represents the formation of higher level terraces in the foothill areas, consisting mainly of coarse sand and organic matter. It covers parts of Man Bum and Namsai forests on the east, Lohitpur and Timai in the middle and Roing to Sonitpur area on the west. The soil is generally loamy and brownish in colour.

2. **Silt Type**

It comprises the area next below the terraced type. The high silt content of this area is confined to the present flood plains on the banks of the big rivers and their tributaries. This type consists or comparatively recent alluvial deposits characterized by shallow surface layer of silt with a sub-soil of coarse sand sometimes mixed with pebbles and boulders. The soil is sandy and comparatively poorer.

3. **Low Level Type**

It includes depressions and swamps which remain submerged under water for sometimes during the rainy season. The surface soil is generally clay.

- **Rivers**

Lohit is the principal river of the district. It rises from the eastern Tibet where it is known as Zayul chu. Flowing southward it enters the district and passes through the heart of the district in east – west direction and finally merges with the Brahmaputra River in Assam. The Lohit is joined by many tributaries, most important of which are Kamlong, Lam, Tezu, Tabang, Metzu and Tenga Pani. Lohit and all its major tributaries are perennial in nature. Drainage pattern of the district is sub-dendritic to sub- angular.

It also has a transitional character developed between the Tirap lineament of the eastern extension of the Himalayas and the Mismi thrust hills aligning in a NWSE direction through which Krawnaan river passes its water to the Brahmaputra river system. The Lohit river basin is well developed by the erosional activities of rivers. It is quite large in its size i.e. more than 10,000 sq.km and has a variety of - 4 - topographic features with well drained eight sub-basins and two interfluves as the Digaru, the Tidding, the Delei, the middle Lohit, the Upper Lohit, the Beiang, the Bara Tenga and the Lohit lowland which include two interfluves as the Lohit and the Tellu interfluves Tellu is main River which forms a well- developed river system in the area. It flows in the Mismi thrust along with the Eastern border of the state. It enters into Arunachal Pradesh through Du pass of about 2,200, elevation and merges in Brahmaputra only at 100m height from M.S.L. It has gentle slope in almost all its sections with a 2,100 m vertical interval at 200 km of total length of the river section.

- **Climate & Rainfall**

The climate is cool and highly humid in lower elevations and in the valleys. The cold season prevails from the later part of November to February and is followed by frequent thunderstorms in the pre-monsoon season from March to May. Very heavy and frequent monsoon showers continue from May to about the middle of October. There is hardly a day during this period when it does not rain.

The climate of the district is largely influenced by the nature of its terrain. Climate is sub-tropical (rather cool), wet and highly humid in the lower elevations and in the valleys. The area falls in heavy rainfall belt and average annual rainfall is 5179 mm.

- **Agriculture**

Lohit is basically an agricultural district and all the resources depend upon the agricultural output. Water is evidently the most vital element in the plant life and is normally supplied to the plants by natural rain. However, the total rainfall in a particular area may be either inadequate or is ill-timed.

Agriculture is the mainstay of the people of the district. Major food crops produced in this district are Paddy, Maize, Millet, Wheat and pulses, and a total of 17905 ha area cultivated under different crops. There is no major irrigation scheme in the district, but a good number of minor irrigation schemes have been constructed. During 2005-06, through 17 canals 159 ha irrigation potential has been created. Net area irrigated is 62 ha while gross area irrigated is 70 ha. Because of limited surface water source, the agricultural practice is basically mono-cropped. With the assured irrigation from ground water sources, more areas can be brought under permanent cultivation with multi cropping pattern.

- **Forestry**

The Lohit District extends over 11,402 km^2 of geographical area of which the forests occupy 9667.44 km^2 reckoning to 84.79%. However, difficult terrain, inaccessibility to sizeable area, and exclusion of projected areas restricted the inventory to 2896.82 km2 of which the Reserved Forests (RF.) occupy 1545.32 km^2 and Unclassed State Forests (U.S.F.) cover 1353.50 km^2. The Forests occurring in the District are typical Tropical Evergreen Forests and Moist Deciduous Forests with dominance of Dipterocarpus macrocarpus (Hollong) and Terminalia myriocarpa (Hollack). In addition to these, Miscellaneous Forests, Bamboo and Riverian Forests also occur in the tract. The inventory results reveal 74.61% of the forest area "supporting tree vegetation, of which Dense Tree forests occupy 4.43%, moderately dense forests 37.61%, open tree forests 19.95%, and balance under young crop, regeneration and Bamboo growth.

From the legal perspective the forests of the state have been classified as:-

i) Reserved Forest (RF), (ii) Protected Forest (PF), iii) Wildlife Sanctuaries (WLS), iv) National Parks (NP), v) Anchal Reserved Forest (ARF) and vi) Village Reserved Forest (VRF).

The ownership right of these forests is vested with the state and has been legally notified. However, in case of Anchal Reserve forests, land is given to the communities with the understanding that 50 per cent of forest produce is to be utilized by the communities and rest should go to the government. The Unclassified State Forests (USF) are yet to be properly surveyed and demarcated. Unclassified State Forests are under the dual control of the Revenue Department and Forest Department. The Revenue Department issues land possession certificate (LPC), while the Forest Department deals the matters related to transit and trade of forest produces.

Table 8: DISTRIBUTION OF LEGAL FORESTS (IN SQ KM.) IN THE DISTRICT OF LOHIT (ARUNACHAL PRADESH)

No.	District	Reserved Forest	PF	ARF / VRF	WLS	NP	USF
1.	Lohit	**4233.53**	------	249.19	**783.0**	-----	1266.481

Source: Statistical Abstract of Arunachal Pradesh-2014

- **Road Infrastructure**

The details of roads in the district is tabulated below.

Table 9: TYPE & LENGTH OF ROADS IN LOHIT DISTRICT

Type of road		BRTF	Forest Dept.	PMGSY	RWD AS PLANNED
National Highway		196.21 km	-	-	-
District Roads	Black Topped	96.61 km	2.25 km	103.24 km	15.85 km
	WBM	-	5.68 km	0	42.28 km
	Gravelled	-	44.06 km	0	-
	Unsurfaced	19.00 km	1.56 km (Colony)	131.18 km	119.52 km
Total Length of Roads		311.82 km	54.16 km	234.42 km	177.65 km

Source: State Profile of Arunachal Pradesh Branch MSME-Development Institute Itanagar, Arunachal Pradesh 2013-14

- **Demographic**

People Speaks Galo, Endangered Sino-Tibetan. Lohit District is divided into 8 Tehsils, 100 Panchayats, and 137 Villages. Sunpura Tehsil is the Smallest Tehsil by population with 4815 population. Tezu Tehsil is the Biggest Tehsil by population with 31304 population.

The details is provided in the table below.

Table 10: DISTRICT/ CIRCLE- WISE POPULATION OF LOHIT DISTRICT AS PER 2011 CENSUS

No.	District	Person	Male	Female
1	Lohit	145726	76221	69505
2	Sunpura Circle	5529	2847	2682
3	Tezu	35320	18852	16468
4	Wakro	8927	4666	4261
5	Chaowkham	21995	11716	10279
6	Namsai	26865	14079	12786
7	Lathao	8390	4353	4037
8	Piyong	10481	5444	5037
9	Lekang	28219	14264	13955

Table 11: DISTRICT/UA/CITY/TOWN-WISE POPULATION, CHILD POPULATION AND LITERATES BY SEX AS PER 2001 CENSUS

Sl No	Civic Status of Town	Status	Population			Child Population (0-6)			Literate		
			Persons	Male	Female	Persons	Male	Female	Persons	Male	Female
1	Lohit	Total	145726	76221	69505	23901	12159	11742	83062	48380	34682
2	-	Rural	113296	58991	54305	19699	10022	9677	60252	35452	24800
3	-	Urban	32430	17230	15200	4202	2137	2065	22810	12928	9882
4	Notified Town	Tezu	18184	9743	8441	2104	1069	1035	13504	7658	5846
5	Notified Town	Namsai	14246	7487	6759	2098	1068	1030	9306	5270	4036

- **Economic Development**

The developmental experience of the district has been full of challenges. Apart from its late start, geographical remoteness and inaccessibility, hilly terrain, lack of infrastructure, population composition, and scarce resource base, the district has indirect effect of continuous insurgency at two districts (Tirap & Changlang), spending much of its resources on administration and related costs at the expense of development. Despite the progress made in a span of 37 years. Lohit economy still confronts many developmental challenges. Foremost among them are the difficult terrain, and inaccessibility to the rest of the world and continued insurgency at Tirap & Changlang where huge chunk of resources are drained. These handicap the District's endeavours towards industrial and entrepreneurial development, private sector partnership in spearheading development initiatives and all round planning. The Gross District Domestic Product for the year 2007-08 is estimated at Rs.46,635 lakhs with a per capita income of Rs.29,952 against state per capita income of Rs 24,264. The Infrastructure Development Index (IDI) of the district is low with the state at 140.22 against the all India average of 138. It continues to confront with many inadequacies in the areas of physical and social infrastructure. The pattern of infrastructure elements for socioeconomic development in the district as on 2006-07 are Educational institutions: 174, No. of Medical (allopathetic): 55, Postal facilities: Headpost NIL, subpost office 5 & EDBPO's29, Market/haat facilities: At Rural/Urban areas, Cooperative 3 nos & others 102 nos, no. of Commercial banks: 27 nos which

includes SBI & Co-operative Apex Bank branches etc. For the development of such essential and critical areas, the district is constantly faced with acute financial and resource problems. One of the reasons for this state of affairs is the almost non-existent Tax base of the state. The tribal traditions and customs of the inhabitants have also been protected by special provisions in the constitution of India as a result of which, the state does not own any land unless purchased from the people or on compensation for specific purposes by the government.

3.4 Demwe

Demwe Village, with population of 826 is Tezu sub district's the 7th most populous village, located in Tezu sub district of Lohit district in the state Arunachal Pradesh in India. Nearest town of the village is Tezu and distance from Demwe village to Tezu is 14 km. The village is fast emerging as a hotspot of commercial activities. The village has BRO Camp near it.

3.5 Brahmakund

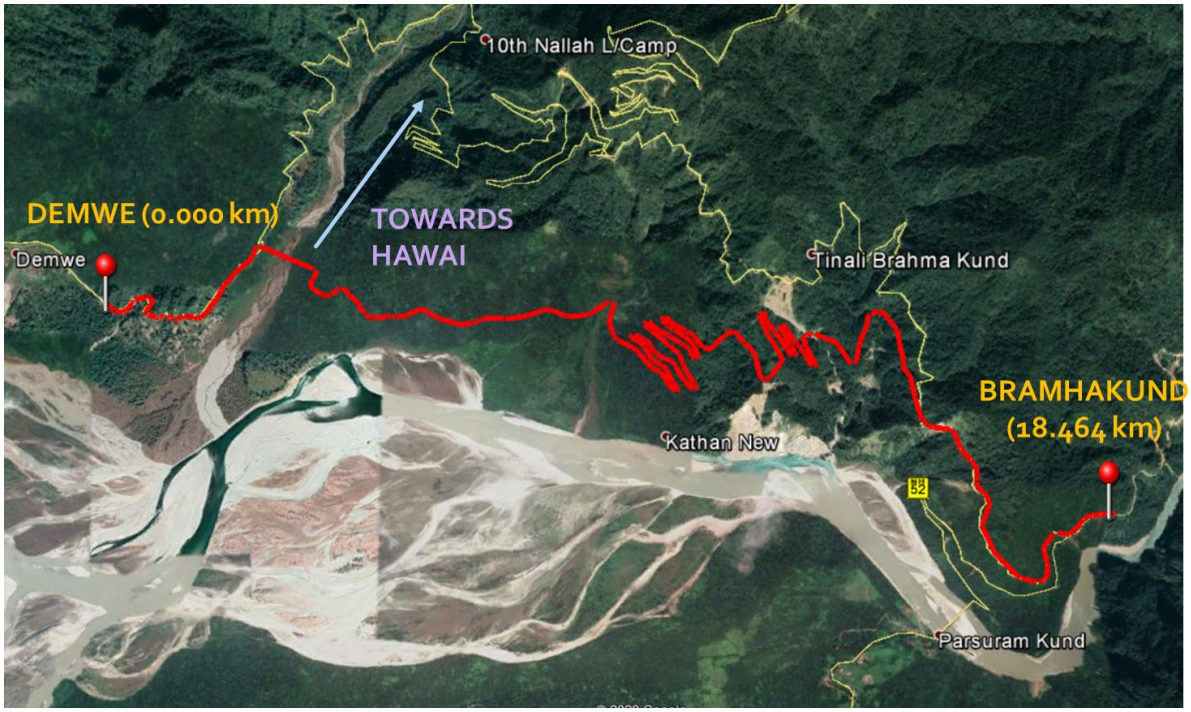
Brahmakund/Parasuram Kunda: a place of pilgrimage is situated in the lower reaches of the river Lohit at about 24 Kms. to the North-east (27 degree 51' IV and 96 degree 23'E) of Tezu. Many people from all over India came to this place to offer prayers. Here, more than 70,000 devotes as well as Sadhus take bath every year during Makar Sankranti in the month of January. In the winter season, the people take holy dip to wash off the sins according to Hindu traditions and believe. As per the Kalika Purana, Mahabharata and Bagavat Gita, Lord Parasurama came to this place and took bath to wash away his sins.

3.6 Details of Roads

Table 12: DETAILS OF ROADS

Chainage (Km)		Terrain Type	Location	District
From	To			
0.000	27.075	Steep	Demwe to Brahmakund	Lohit

Figure 8: KEY MAP



3.6 General Overview of Project Highway

The project road is a part of the newly named NH 13 previously known NH 229. The project road takes off from Demwe and ends near the new road from Brahmakund to Arrowa. It passes through Demwe, Tohangam & BRO Camp. The entire length of road (km) falls under Lohit District in the state of Arunachal Pradesh. The road passes through hilly terrain having a land use pattern mostly of forest and built-up. There are some sharp curves which needs to be corrected.

Table 13: EXISTING STRUCTURES/ FEATURES OF THE ROAD

Sl.No.	Features	Description
1	Major Bridge	1
2	Minor Bridge	1
3	ROB	Nil
4	RUB	Nil
5	Flyover	Nil
6	Grade Separated Structures	Nil
7	Service Roads	Nil
8	Culverts	24
9	Causeway	Nil
10	Median	Nil
11	Roadside Drains RR Masonry Earthen	 10.44 km 6.0 km

Sl.No.	Features	Description
12	Junctions	3
13	At Grade Railway Crossings	Nil
14	Road Boundary Stones	Nil
15	Road Sign Boards	Inadequate (Not as per IRC Standards)
16	Bus Bays	Nil
17	Truck Lay Bye	Nil
18	Bus Stops	Nil

3.7 Settlements along Highway

Most of the population of the towns is settled on hill side with some on valley portion of the road. The land-use pattern in the project road is mainly forest with few stretches of built-up.

Table 14: DETAILS OF VILLAGES & TOWNS

Sl. No.	Chainage		Villages Name
	From (km)	To (km)	
1	0/650	1/300	48 BRTF Camp
2	15/900	16/000	Tohangam
3	16/400	16/500	BRO Camp

3.8 Junctions along Highway

There is only 3 junction along this road, which are minor.

Table 15: DETAILS OF JUNCTIONS

Sl No.	Chainage	Junctions	
	From (km)	Type of Junction	Connecting places
1	0.38	Y (R)	BRTF Office
2	15.950	Y(L)	Hawa Camp/Lohit View
3	25.800	Y	Brahmakund-Arrowa

3.9 Existing Structures

The list of existing Highway structures such as major bridge, minor bridge, culverts, vehicular under/overpass, ROB, RUB, grade separators, Flyovers, cattle pass, pedestrian underpass etc. are listed in Tables as below:

Table 16: SUMMARY OF EXISTING STRUCTURES

Sl.No.	Features	Description
1	Major Bridge	1
2	Minor Bridge	1
3	ROB	Nil
4	RUB	Nil

5	Flyover	Nil
6	Grade Separated Structures	Nil
7	Culverts	24
8	Causeway	Nil
9	Cattle Underpass	Nil
10	Pedestrian Underpass	Nil

Table 17: LOCATION OF EXISTING STRUCTURES

Sl. NO.	Chainage	Type	Span Arrangement
1.	0.015	slab	1 X 2.8
2.	0.060	slab	1 X 2.8
3.	0.310	slab	1 X 3.0
4.	0.560	slab	1 X 1.6
5.	0.610	slab	1 X 1.4
6.	0.675	slab	1 X 1.4
7.	0.855	slab	1 X 2.8
8.	0.910	slab	1 X 1.5
9.	1.060	slab	1 X 1.5
10.	1.365	slab	1 X 1.5
11.	1.540	slab	1 X 4.5
12.	1.700	slab	1 X 4.5
13.	1.835	slab	1 X 0.6
14.	15.730	slab	1 X 3.0
15.	16.090	slab	1 X 3.0
16.	16.190	slab	1 X 1.1
17.	16.328	slab	1 X 3.0
18.	16.840	slab	1 X 1.2
19.	17.260	slab	1 X 1.2
20.	17.695	slab	1 X 1.0
21.	17.830	slab	1 X 1.0
22.	18.027	slab	1 X 1.0
23.	18.140	slab	1 X 1.0
24.	18.436	slab	1 X 2.0

3.10 Existing Carriageway and Pavement

The existing road configuration between Demwe to Brahmakund is having uniform single lane carriageway with varying width of earthen shoulders.

The surface of the carriageway is bituminous and the surface of shoulders is unpaved. Generally the condition of the pavement is poor at most stretches.

Table 18: ROAD CONDITION AND WIDTH

Sl No	Chainage		Formation Width	Carriageway			Shoulder		
	From	To		Type	Width (m)	Condition	Type	Width (m)	Condition
1	0	100	20	BT	3.0	G	ER	1.5	1.5
2	100	200	10	BT	3.0	G	ER	1.5	1.5
3	200	300	10	BT	3.0	G	ER	1.5	1.5
4	300	400	13	BT	3.0	G	ER	1.5	1.5
5	400	500	15	BT	3.0	G	ER	1.5	1.5
6	500	600	12	BT	3.0	G	ER	1	1.5
7	600	700	12	BT	3.0	G	ER	1.5	1.5
8	700	800	14	BT	3.0	G	ER	1	1
9	800	900	14	BT	3.0	G	ER	1	1
10	900	1000	14	BT	3.0	G	ER	1	1
11	1000	1500	12	BT	3.0	G	ER	1	1
12	1500	2000	14	BT	3.0	G	ER	1	1
13	15500	16000	10	BT	3.0	G	ER	1-1.5	1-1.5
14	16000	16500	12	BT	3.0	G	ER	1	1
15	16500	16700	12	BT	3.0	G	ER	1	1.5
16	16700	16800	12	BT	3.0	G	ER	1	1.5
17	16800	17000	10	BT	3.0	G	ER	0.5	0.5
18	17000	17300	10	BT	3.0	G	ER	1	1
19	17300	17500	10	BT	3.0	G	ER	1.0	1
20	17500	19200	12	BT	3.0	G	ER	1.0	0.5
21	19200	20300	10	BT	3.0	G	ER	1.0	1.0
22	20300	22500	11	BT	3.2	F	ER	1	1
23	22500	24700	12	BT	3.0	F	ER	0.5	1.0
24	24700	27100	10	BT	3.0	F	ER	1.0	1.0

3.11. ALIGNMENT

The horizontal alignment between Demwe to Brahmakund is complicated with many curves and series of hair pin bends. The said section mainly passes through hilly terrain in most of its length and cater to the design speed of 20 km/hr. The existing road had 417 nos of curves.

Some stretches in this road are severely affected by land slide. The locations are enlisted below.

Table 19: LAND SLIDE AFFETED AREAS

Sl No	From	To	Severity
1	3.380	3.400	Moderate
2	4.250	4.300	Moderate
3	5.300	5.400	Moderate
4	6.700	6.800	Severe

Sl No	From	To	Severity
5	7.200	7.300	Moderate
6	8.930	8.970	Severe
7	9.110	9.140	Severe
8	10.960	10.980	Moderate
9	11.420	44.600	Severe
10	12.280	12.300	Moderate
11	12.420	12.470	Severe
12	13.600	13.700	Severe
13	13.780	13.820	Moderate
14	16.530	16.580	Moderate
15	17.540	17.590	Severe
16	18.180	18.230	Moderate
17	18.460	18.480	Severe
18	19.000	19.200	Severe
19	21.120	21.180	Moderate
20	21.250	21.300	Severe
21	21.620	21.650	Severe
22	22.600	22.620	Moderate

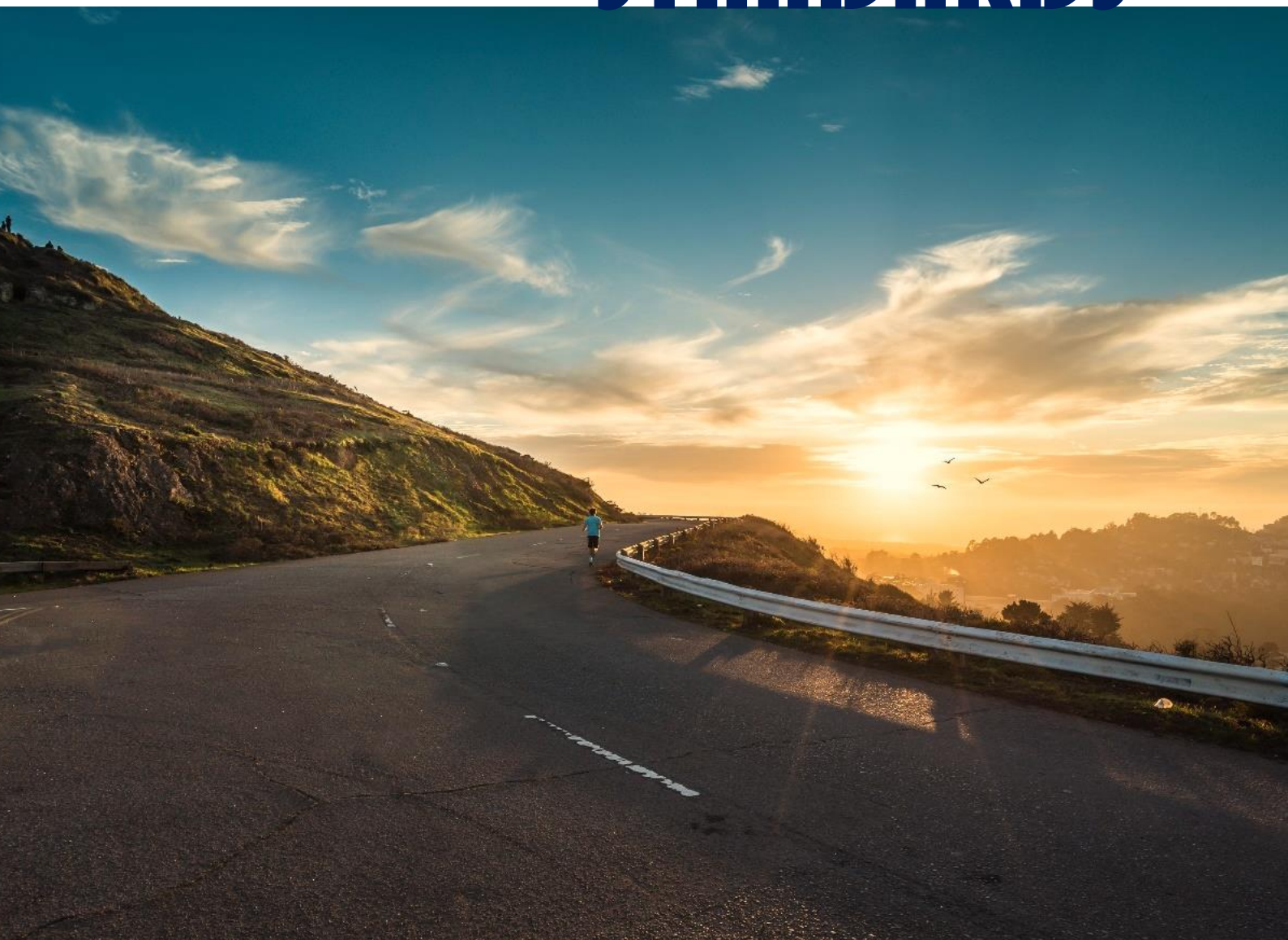
3.12 Other Existing Structures

The list of other structures like school, colleges, other educational institutions, Petrol Pump, hospital & police station is listed below.

Table 20: LIST OF OTHER IMPROTANT STRUCTURES ALONG THE CORRIDOR

Sl No	Location	LHS/RHS	Details
1	0/650-1/300	RHS	48 BRTF CAMP

PRELIMINARY DESIGN AND DESIGN STANDARDS



CHAPTER 4
PRELIMINARY DESIGN AND DESIGN STANDARDS

4.1 GENERAL

The primary purpose of this assignment is to Study the "Feasibility for Two laning with paved shoulders configuration of National Highways of Arunachal Pradesh namely NH 13". The scope of Consultancy Service covers all aspects of Project preparation activities of proposed improvements. These improvements will consist of widening and strengthening of pavement with all ancillaries such as the improvements of cross section elements, sight distance consideration, horizontal curvature, gradients, intersection and geometries; widening/ strengthening/reconstruction of culverts and bridges; drainage; location of toll plazas, bypasses, junction improvements etc at reasonable cost to provide optimum efficiency in track operation and maximum safety.

4.2 GOAL & OBJECTIVES

The aim is to provide maximum safety in the design of the highway geometry, pavement, shoulders, embankments and other pertinent components for an uninterrupted flow of through traffic along the project stretch with the provision of:

1. Road junctions for cross traffic at appropriate locations.

4.3 HIGHWAY DESIGN STANDARDS

The formulation of the design standards is required in order to avoid any inconsistency in design from one section to the other and provide desired level of service and safety. For this project, it is proposed to follow design standards given in the IRC codes, guidelines and special publications. IRC SP:73-2015 "Two laning of highways through Public Private Partnership" and IRC SP:48-1998 "Hill Road Manual".

4.4 APPROACH

While designing improvement works it is aimed at providing maximum safety to the road users. Accordingly, the highway geometrics, carriageway widths, and other pertinent components have been proposed for an uninterrupted and smooth flow of traffic along the project corridor.

4.5 DESIGN STANDARDS

The geometric design standards outlined below have been followed for the horizontal alignment and vertical profile. The design standards of all the elements of a highway corridor can be grouped into the following categories as given in Table below.

Table 21: DESIGN ELEMENTS

Sl no	Category	Design element
1	**Design capacity**	Design service volume standards Design capacity standards
2	**Geometric Design**	Design Speed Cross sectional elements Sight distance Horizontal curves Vertical curves
3	**Pavement design**	CBR, Traffic, Structural strength
4	**Grade separators and Cross drainage structures**	Underpass Flyover/ ROBs Bridges and culverts
5	**Intersections and interchanges**	At grade intersections Grade separated intersections Acceleration and deacceleration
6	**Slope protection**	Side slopes Slope protection
7	**Drainage system**	Longitudinal, cross drainage
8	**Safety measures**	Guard rails & safety barriers Traffic signals Road signage & pavement markings Footpaths and sidewalks

4.6 Capacity standards and width of carriageway

The width of carriageway is decided based on the following "Projected Traffic Volume" as on the date of commencement of the Project.

Table 22: CAPACITY STANDARDS

Sl no	Traffic volume PCUs	Carriageway width (in m)	Maximum Capacity (PCUs per day)
1	Upto 1000	Single lane (3.75 m)	2000
2	1000 – 2500	Intermediate lane (5.50 m)	6000
3	2500 – 7500	Two lane (7 m)	15000
4	Above 7500	Two lane + Paved shoulders (10.0 m)	18000

4.7 Sight Distance

It is necessary that sight distance of sufficient length is available to permit drivers enough time and distance to control their vehicles to avoid accidents for safety on roads.

Two types of sight distances are considered in design of hill roads which are:

- Stopping sight distance which is the clear distance ahead needed by a driver to see, analyse, and react on seeing an obstacle.
- Intermediate sight distance

The values of both sight distances and criteria for measurement are given in tables

Table 23: STOPPING AND INTERMEDIATE SIGHT DISTANCE

SPEED	DESIGN VALUES- METERS	
	STOPPING SIGHT DISTANCE	INTERMEDIATE SIGHT DISTANCE
20	20	40
25	25	50
30	30	60
40	45	90
50	60	120
65	90	180
80	120	240
100	180	360

Table 24: CRITERIA TO MEASURE SIGHT DISTANCE

SL. NO.	SIGHT DISTANCE	DRIVER'S EYE HEIGHT	HEIGHT OF OBJECT
1	Safe Stopping Distance	1.2m	0.15m
2	Intermediate Sight Distance	1.2m	1.2m

The stopping sight distance is the absolute minimum in case of hill rods and shall be ensured regardless of any considerations while designing the road. However, intermediate sight distance shall be tried to achieve while designing the road geometries. Overtaking sight distance shall be considered for the road stretches in plain terrain and hilly terrain.

4.8 Horizontal Profile

Horizontal alignment in road design consists of straight sections of road, known as tangents, connected by circular horizontal curves. Circular curves are defined by radius (tightness) and deflection angle (extent). The design of a horizontal curve entails the determination of a minimum radius (based on speed limit), curve length, and objects obstructing the view of the driver. The other considerations to finalize the horizontal profile are:

- Radius

- Design Speed
- Side Friction Factor
- Superelevation
  a) Runoff
  b) Runout

4.9 Vertical Profile

The Profile of the Project Corridor has been finalized on the basis of DTM data collected during the topographic survey. In addition to the standards and guidelines set in this chapter, there are other considerations to finalize the vertical profiles, which are presented below:

- Minimum distance between two PVIs (Point of Vertical Intersection) is 150m.
- Minimum longitudinal gradient is 0.5%, for longitudinal drainage for Kerbed Pavements.
- Minimum length of a vertical curve is 30m.
- Minimum K (rate of change of vertical curvature) value as 75 for the summit curve and 45 for valley curve.

4.10 Cross Sectional Elements

4.10.1 Carriageway

The project road has undivided carriageway of single lane throughout the length of road. Proposal for widening of the carriageway from single lane to two lane has to be carried out as per IRC SP 73-2015 and IRC SP 48:1998.

4.10.2 Shoulder

The Project Road has an earthen shoulder of 0.5 to 1 m at different stretches.

4.10.3 Drainage

Requirements for provision of drains as per guidelines of IRC: SP: 50-2013 and IRC: SP: 42-2014 has been checked. The HFL of adjoining ground is below the bottom of Sub grade level due to the hilly terrain. Considering a very high annual average rainfall and the proneness to lanslides due to the soil type, the existing drainage provisions has been found insufficient. Proper drainage plan has been provided to ensure the drainage of rain-water without causing harm to the pavement layers and the hill section.

4.11 Embankment Design

The design and construction of the road in embankment and in cuttings shall be carried out in accordance with Section 300 of MORTH Specifications and the requirements and standards and specifications given in the section. The height of the embankment has been decided on the basis of final road levels. The following principles shall be kept in view while fixing the road level:

i. No section of the road is overtopped. Top of subgrade shall be at least 0.5 m above the general ground level.

ii. The bottom of sub-grade shall be 1.0 m above the high flood level(HFL)/level of water table.

4.11.1 Materials and Physical Requirements

Sourcing of materials for embankment and subgrade construction, as well as compliance with environmental requirements in respect of excavation and borrow area under the applicable laws. The material to be used in sub-grade shall satisfy the design CBR at the specified density and moisture content. The embankmentand sub-grade shall be compacted to satisfy the minimum compaction requirements given in clause 305 of MORTH Specifications.

4.11.2 Structureal Features and Design of Embankment

Embankment with height 6.0 or more above shall be designed in accordance with IRC: 75 taking into account slope stability, bearing capacity, consolidation, settlement and safety considerations based on geotechnical and investigation data.

Side slopes shall not be steeper than 2H:1V unless soil is retained by suitable soil reatining structures

The side slopes and the earthen shoulders shall be protected against erosion by providing a suitable vegetation cover, kerb channel, chute, stone/ cement concreteblock pitching or any other suitable protection measures depending on the height of the embankment and susceptibility of the soil to erosion.

Embankment has been designed for ensuring the stability of the roadway. High embankments (height 6m or above) in all soils has been designed from stability consideration as per IRC-75, IRC SP-58 & MOSRTH-Guidelines for Design of High Embankments.

4.12 Pavement Design

Designs for new pavement and overlays have been done in accordance with IRC requirements. The preliminary designs are carried out on the basis of sub grade 4 day soaked CBR. The design of new flexible pavement has been carried out as per IRC: 37-2012 and IRC: SP: 73-2015 as per the design requirements for new pavement sections:

i) Flexible pavement shall be dsigned for a minimum design period of 15 years, subjected to the condition that design traffic shall not be less than 20 msa.

ii) Stage construction shall not be permitted.

Flexible overlays have been always as per IRC: 81-1998 for 10 years of design period. The crust component of the paved shoulder has been kept matching with the main carriageway crust.

The new flexible pavement structure shall comprise of Bituminous Concrete wearing course on bituminous base course of Dense Bituminous Macadam (DBM). Below the bituminous layers, a Granular base with well-graded aggregates in the form of Wet Mix Macadam (WMM) base has been laid on top of GSB layer. All these layers has been constructed to the requirements of MORT&H specifications.

4.13 Cross Drainage Structures

Drainage structures basically comprise of Major bridges, Minor bridges and culverts. The sections of the culverts and bridges have been planned as per sections of IRC SP 73:2015 and IRC SP 84: 2015.

i) All structures shall be designed in accordance with the relevant Codes, Standards and Specifications, Special Publications and Guidelines of the IRC. Construction of all culverts, bridges and grade separated structures shall conform to MORTH Specifications for Road and BridgeWorks.

ii) All bridges shall be high level bridges.

vii) Suitable provision shall be made for retaining the earth in the median portion either by extending the abutment wall or constructing a new retaining wall. The abutment wall shall have provision for taking the discharge from the median. Care shall also be taken to merge the wing wall/return wall and flooring of the old bridge with those of the new bridge.

viii) Any utility service to be carried by the structures shall be specified in Schedule 'B' of the Concession Agreement.

4.14 Intersections

The existing intersections, which are deficient with respect to the minimum requirements shall be improved to the prescribed standards. Additional land, if any, required for improving the existing intersections shall be provided by the Authority. The types and locations of new Intersections, and grade-separated Intersections shall be based on requirements stipulated in IRC: SP: 41, IRC: 5, IRC: 92 and MORTH Specifications for Road and Bridge works.

4.15 Drainage System

For efficient drainage system for the entire Project Highway including structures, directions contained in Clause 309 of MORTH Specifications, IRC: SP: 42, IRC: SP: 50 and IRC: SP: 90 as relevant shall be followed.

Table 25: SLOPE FOR CAMBER

Element	Recommended slope

Lanes and shoulders with Bituminous Concrete Surfacing	2.5%
Lanes and shoulders with Cement Concrete Surfacing	2%
Cross slope in Granular shoulders	3%

4.16 Road and Traffic Signs

4.16.1 Signage Plans

Proper signing and striping (delineation) are very critical for the safety and guidance of a driver. Signage plans showing the guide signs, and regulating signs at all appropriate locations have been developed. Guide signs showing the locations of and distance to all major crossings, towns and villages have been installed at the appropriate locations. Regulatory signs, including the speed limit sign, toll signs and signs for traffic have been installed at appropriate locations. The signs have been reflector type so that they can be seen easily in the dark. Also, the guide signs at major junctions have been illuminated type and have been mounted on poles so that they can be easily seen. The lettering size used for designing the signs and location of signpost has been based on the proposed design speed and clear visibility. The material specified for manufacturing signs has been based on international standards. Use of reflectors has been made, so that the lanes are clearly visible at nighttime. Different reflectors have been used for the medians striping and the lane striping so that the opposite traffic can be properly guided.

4.16.2 Road Signs

All road signs are proposed to be provided conforming to standards of "Code of Practice for Road Signs" (IRC: 67-2012) and "New Traffic Signs" (IRC: SP: 31-1992) Latest type of reflective and fluorescent sign boards, in appropriate sizes, have been installed. The signs are broadly categorized as below:

(i) Mandatory/Regulatory Signs: These signs are mostly for giving instructions and are mostly circular generally red and blue colors and sign shown in black or white.

(ii) Cautionary/Warning Signs: They are mostly triangular with red border and black sign.

(iii) Informatory Signs: These are mostly rectangular with blue or green background and sign in white. Advance direction sign can be mounted on steel, brass portal frame fixed across the carriageway at a height of 5.5 m above the pavement grade at the center of roadway and visible from a distance for the vehicles approaching.

4.16.3 Florescent Signs

It is proposed to use "Florescent traffic signs" for better working conditions and safety especially at night.

4.17 Utilities

Appropriate provisions are considered for various utilities e.g. Water line, gas pipes, telephone cables, Sewerage line, electric conduits etc. along or across the Highway to prevent the road being cut or dug at later stages, similar provision has been made along the cross-drainage works, bridges and underpasses.

4.18 Design Standards for Structures

The detailed inventory and condition survey of the existing structure has been conducted. Based on detailed survey the proposal for structural arrangement has been finalised. The methodology and standards to be adopted are illustrated below.

4.18.1 Materials

Concrete Grade:

Grade of concrete in various elements shall be kept as follows for moderate conditions of exposure

Reinforcement:

Only Thermo Mechanically Treated (TMT) Fe-500 bars conforming to IS: 1786-2008 shall be used as reinforcing steel.

Exposure condition:

Moderate exposure conditions will be considered while designing various components of all the structures.

Structural steel:

All structural steel, castings and forgings, fasteners (bolts, nuts, washers and rivets), welding consumables and wire ropes and cables shall conform to the provisions of IRC: 112 – 2011.

Bearings:

Elastomeric bearings has been proposed for simply supported superstructures. These bearings shall be designed and supplied by the approved manufacturers. The loads and forces on the bearings has been calculated to enable the manufacturer to design these bearings and these shall conform to Cl. 2005 of MORTH's Specifications for Road & Bridge Works (5th Revision).

Expansion joints:

The following types of expansion joints shall be adopted:

Compression expansion joints have been proposed for superstructures having movements up to 40 mm. The compression seal type expansion joints shall conform to Cl. 2609 of MORTH's Specifications for Road and Bridge works (5th Revision).

Miscellaneous:

- Cement concrete wearing course has been proposed over the deck slab. ·
- Drainage spouts with gratings at the top has been provided on the bridges to ensure proper drainage of surface water. ·
- An approach slab, 3.5m long and 300mm thick, resting on the bracket taken out from the dirt wall has been provided on both sides of the bridge resting on the 150mm thick levelling course. The gap between the approach slab and dirt wall has been filled with bituminous joint filler sealing compound. ·
- Weep holes has been provided behind abutment and wing wall to avoid building up of hydrostatic pressure behind them. Weep holes has been provided 150mm, above the low water level or bed level whichever is higher.

4.19 IRC Codes

The scope of our work is limited to Preliminary Designs only. The GAD of structures based on preliminary designs has been prepared. Following IRC/IS codes used for preliminary designs.

Table 26: DESIGN STANDARDS TO BE FOLLOWED

IRC:5-2015	Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)
IRC: 6-2014	Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Fourth Revision
IRC: 18-2000	Design Criteria for Prestressed Concrete Road Bridges (Post- Tensioned Concrete) (Third Revision)
IRC: 21-2000	Standard Specification & Code of practice for Road Bridges. Section – III Cement Concrete Plain & Reinforced (Second Revision)
IRC: 22-2015	Standard Specification & Code of practice for Road Bridges. Section – VI Composite Construction (First Revision)
IRC: 24-2010	Standard Specification & Code of practice for Road Bridges. Section – V Steel Road Bridges (Second Revision)
IRC: 45-1972	Recommendations for Estimating the Resistance of soil below the maximum Scour Level in the Design of Well Foundations of Bridges.
IRC:73-1980	Geometric Design standards for Rural (Non-Urban) Highways.
IRC:78-2014	Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (First Revision)
IRC: 83-1999	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-I Metallic Bearings (First Revision)

IRC: 83-1987	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-II Elastomeric Bearings
IRC: 83-2002	Standard Specification & Code of practice for Road Bridges. Section – IX Bearings, Part-III POT, POT-CUM-PTTE, PIN & Metallic guide bearings.
IRC: 89-2010	Guidelines for Design & Construction of River training & control works for road bridges.
IRC: SP:13-2004	Guidelines for the Design of small Bridges and Culverts
IRC: SP:33-1989	Guidelines on supplemental Measures for Design, Detailing & Durability of Important Bridge Structures.
IRC: SP:35-1990	Guidelines for inspection and maintenance of Bridges
IRC: SP:37-2012	Guidelines for evaluation of load carrying capacity of Bridges.
IRC: SP:40-1993	Guidelines on Techniques for strengthening and rehabilitation of Bridges.

For items not covered in the above specifications, provisions of IS codes, Sound Engineering practice, Technical Literatures/Papers & provision of relevant codes of other nations have been considered.

4.20 Project Highway Drawings

4.20.1 Horizontal and Vertical Alignment Drawings

The existing horizontal and vertical profiles of the Project Highway have been shown with proposed design alignment drawings. These drawings are included in Volume II. The geometric standards of the existing road are not confirming with relevant IRC standards and provisions of "Manual of Standards" for 2- lane Highways. The radius of circular curves and the lengths of transition curves have been improved. To obtain optimum and accurate designs, the designs has been developed by using Advance Software like MX-ROAD.

4.20.2 Typical Cross Sections

Depending upon the requirements of improvement in different stretches of the Project Highway the Typical cross sections applicable to particular stretch of the road.

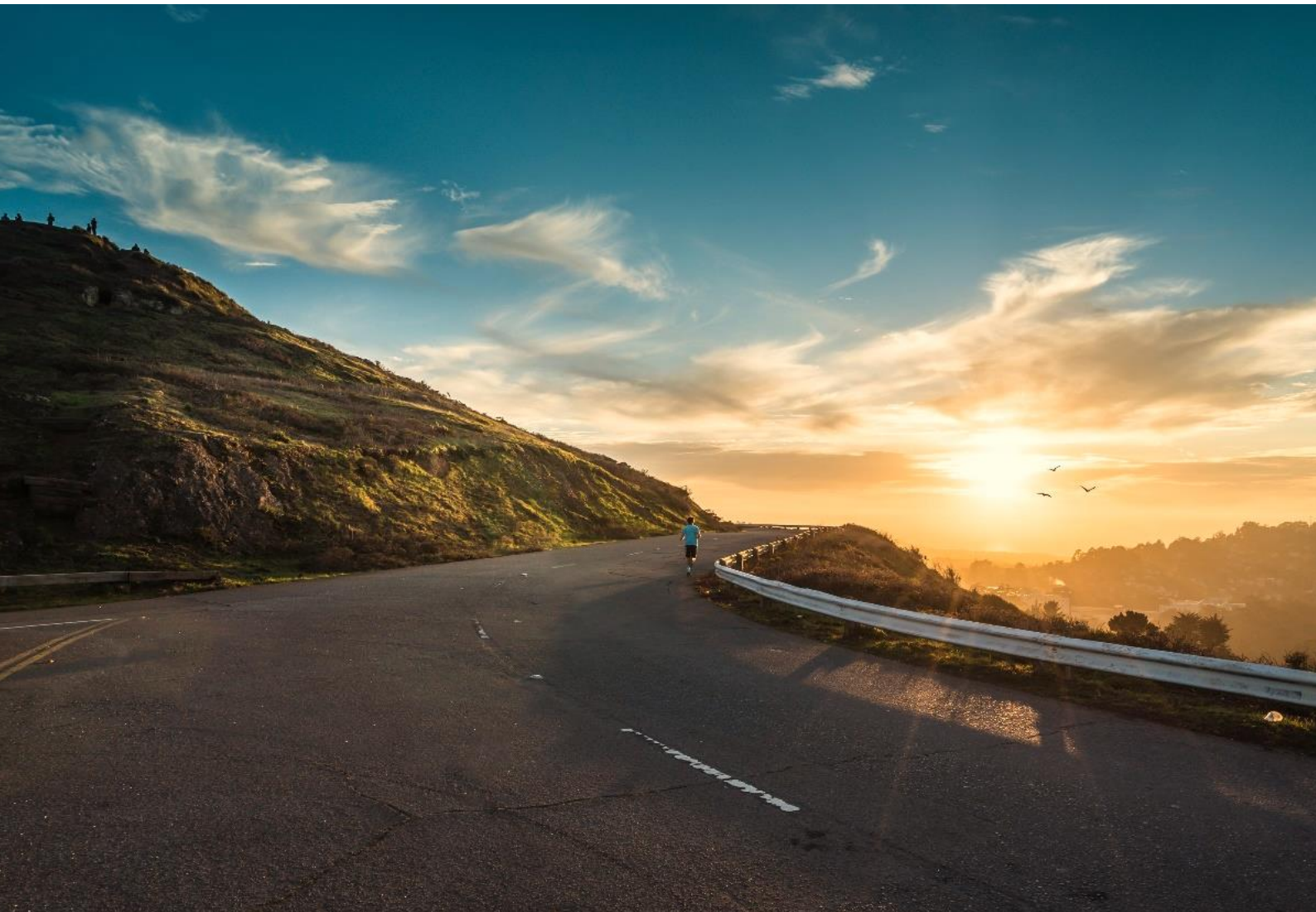
4.20.3 General Arrangement Drawings for Structures

The General Arrangement Drawings of the proposed structures to be constructed included in Volume VI.

4.20.4 Miscellaneous Drawings

The Miscellaneous Drawings for typical details of road signs, road markings, kilometre stone and hectometre stone, standard junction, bus bay layout, toll booth, Toll Plaza layout, W-Beam crash barrier and Overhead Sign board details, as proposed are included.

SURVEYS AND INVESTIGATIONS



CHAPTER 5
SURVEYS AND INVESTIGATIONS

5.1 General

Primary consideration for feasibility study of a road is that overall cost of transportation (i.e. the cost of initial construction, traffic operation and maintenance) be minimum without adversely affecting the environment and society. All operations need advance planning of methodology in logical sequence.

The available topographic maps, GT Sheets and photographs are being studied. Detailed reconnaissance surveys have been done to outline the procedure for the detailed investigations to follow. The reconnaissance study identifies:

- Topographic and physical features of the project and surrounding region including environmental features.
- Alignment alternatives, realignment requirements and need for bypasses and grade separators.
- Traffic pattern and homogenous links.
- Locations for conducting diverse traffic surveys.
- Preliminary inventory of pavement, carriageway type, bridges and structures, intersections, urban/congested areas.
- Requirements for conducting supplementary investigations.
- Extent of land available and additional requirements for widening.

5.2 Road Inventory Survey

An inventory of the Project Road (PR) has been carried out with visual observations supplemented with topo-survey. All existing details like terrain, land-use, surfacing type and width, shoulder type & width, subgrade, local soil type, curve details, intersection details, retaining structures details, location of water bodies, height of embankment or depth of cut, cross drainage structures, road side facilities, existing utility services, general drainage conditions etc., were recorded. The road inventory has been referenced to the existing kilometre posts established along the roadside. The data have been collected in sufficient detail, compiled & presented in tabular form. The data have been stored in computer files using utility packages, such as EXCEL etc. A detailed road inventory is presented in the Appendix.

The project road starts from Demwe on NH 13 at 0/000 km and ends in Brahmakund at chainage 18/464 km. The project road passes through hilly terrain.

Generally the horizontal alignment of the Project Road is mostly in rural area flared up with barren/ agricultural land use. In the built-up areas both residential cottages have developed. A detail of the land use pattern along the project road is given in Road Inventory.

The detailed inventory on existing carriageway reveals that the project road stretch comprises of single lane carriageway with 0.5 to 2 m earthen shoulder. The details of the carriageway have been presented in the inventory. The type of pavement is flexible with very high embankments.

5.2.1 Pavement/ Road Condition

Pavement Condition Survey was done for collecting the basic information of the road structure & based on this the road can be demarcated into (i) sections of more or less equal / uniform performance; (ii) that is classified into similar characteristics or (iii) obtain homogeneous sections. This operation consists primarily of visual operations supplemented by simple measurements for rut depth using a 3-meter straight edge. The criteria for classification of pavement sections has been derived from IRC-81-1997 which also explains that, It is not practical to modify the overlay design at frequent intervals; it will be preferable if the length of each section be kept at a minimum of 1 km except in the case of localized failure or other situations requiring closer examination where minimum length of section may be suitably fixed.

In case the pavement shows severe distress or signs of premature failure further investigation would be necessary to ascertain the causes & design remedial measures.

5.3 Topographical Survey

The topographical survey has been carried out using Total Stations. The five categories of surveys are:

- Establishing of control points at 5 km intervals
- Traverse along the existing road and establishment of bench marks (BMS)
- Cross-sections at 50 m intervals and at critical locations.
- Longitudinal section levels along final centre line at 30 m in straight sections and at 10 m interval in curved sections including fixation of cardinal points with a pair of reference points.
- Collection of details of all features such as structures (Bridges) utilities, existing road etc.
- For topographic surveys extended to a width of 30m beyond either side of the centre line of the proposed divided carriageway or the land boundary whichever is more is surveyed. Where existing road crosses the alignment, the survey extended to minimum 100m either side of the road centre line and will be of sufficient width to allow improvements, including at grade intersections to be designed.

- Longitudinal and cross-sections for major and minor streams over 500 meters on both sides of ROW and 100 meters beyond the abutments.
- Location and type of services and utilities

An open traverse could lead to cumulated errors of angles. Hence, every 5 km the traverse has been closed to limit cumulative errors. The benchmarks have been referenced to GTS BMs of the Survey of India. A separate team has carried out this task. The ground cross-sections and details of features are referred to as the BMs. Separate teams concurrently with the traverse team have carried out these tasks. The levelling of the longitudinal section along the final centre line (FCL) and fixation of cardinal points has been carried out.

The readings from the Total Stations have been registered using data base software and then transferred to the survey model of the MX Road Software to prepare the DTM of the area surveyed. The DTM and the longitudinal profile of the FCL have been computed by MX Road software and drawn using Auto CAD on A3 size sheets showing 1 km sections (1:2500).

For junctions/intersections, additional areas have been surveyed (ground sections, topographical features and utilities) as required. During this Survey, all utilities within the areas surveyed are identified, and noted; complementary data has been collected from the competent bodies to complete the process.

The list of PBM and TBM along the road alignment is as attached in Volume 2 of this report.

5.4 Traffic Surveys

The number and locations of traffic survey stations have been identified after reconnaissance. The traffic Engineer has monitored and trained the surveyors to collect the required data for the traffic calculation. Survey and count sheets are spot checked on a regular basis and data registered in the field office. Data collected includes:

A. *Secondary Data Collection*

I. Previous Traffic Count Data

II. Statistical Information Economic Indicators

III. Seasonal Variation

IV. Accident Statistics

B. *Primary Data Collection*

5.4.1 Classified Traffic Volume Count Survey

Direction-wise classified traffic volume count survey are carried out for 24 hours 7 days. The vehicle classification system is basically confined to all vehicular traffic as per Table -1 of IRC: 64 -1990. The primary data collected is analysed to bring out the hourly and daily variations and is

presented in tabular form along with a Pie Chart showing composition pattern, classified hourly average traffic and a graphical representation of average hourly variation of the vehicles. Keeping in view the vehicle classification system given in IRC codes the following generalized classification system is used to record the classified volume count.

Table 27: LIST OF VEHICLES FOR CLASSIFIED VOLUME COUNT

Motorized Traffic	Non-Motorized Traffic
2- Wheeler	Bi Cycle
3- Wheeler	Cycle- Rickshaw
Passenger Car	Animal Driven Cart
Utility Vehicle	Hand Cart
Bus	Other Non- Motorized Vehicle
LCV	
Truck – 2 Axle Rigid Chassis	
Truck – 3 Axle Rigid Chassis	
MAV- Semi Articulated	
MAV- Articulated	

All results are presented in tabular and graphical form. The survey data is analysed to bring out the hourly and daily variations. The traffic volume count per day is averaged to show a weekly Average Daily Traffic (ADT) by vehicle type. The Annual Average Daily Traffic (AADT) is worked out by applying seasonal factors. The relevant traffic volume data from secondary sources is also be compiled.

Table 28: TRAFFIC DATA

Sl. No.	CVD	PCU
1	43	158

5.4.2 Traffic Demand Estimates

Traffic projections are based on sound and proven forecasting techniques. Traffic demand estimates are such that, it will establish possible traffic growth rates in respect of all categories of vehicles, taking into account the past trends, annual population and real per capita growth rate, elasticity of transport demand in relation to income and estimated annual production increase. The other aspects including socio-economic development plans and the land use patterns of the region having impact on the traffic growth, the projections of vehicle manufacturing industry in the country, development plans for the other modes of transport, commodity movement behaviour is also be taken into account while working out the traffic demand estimates. The traffic demand estimates is done for a further period of 15 years from completion of work.

5.5 Pavement Investigations

5.5.1 Pavement Composition

In order to ascertain pavement composition trial pits (1m x 1m in plan) were dug at every 1 km interval (staggered left & right) or at each major change in the pavement condition, whichever is less. For each test pit the following information has been recorded

Table 29: EXISTING CRUST DETAILS

Subsection	Existing Pavement Details			
	G.S.B (Moorum) in mm	W.B.M. in mm	B.T in mm	Average Existing Crust in mm
0/000 - 1/000	158	205	43	363
1/000 - 2/000	158	213	45	371
2/000 - 3/000	163	225	47	388
3/000 - 4/000	155	205	42	360
4/000 - 5/000	165	200	47	365
5/000 - 6/000	158	218	44	376
6/000 - 7/000	168	210	47	378
7/000 - 8/000	167	200	43	367
8/000 - 9/000	173	215	46	388
9/000 - 10/000	168	213	43	381
10/000 - 11/000	158	210	47	368
11/000 - 12/000	158	220	-	378
12/000 - 13/000	153	213	44	366
13/000 - 14/000	150	213	45	363
14/000 - 15/000	175	200	43	375
15/000 - 16/000	160	218	38	378
16/000 - 17/000	185	198	44	383
17/000 - 18/000	168	215	42	383
18/000 - 19/000	158	220	43	378
19/000 - 20/000	156	210	35	366

5.5.2 Pavement Roughness

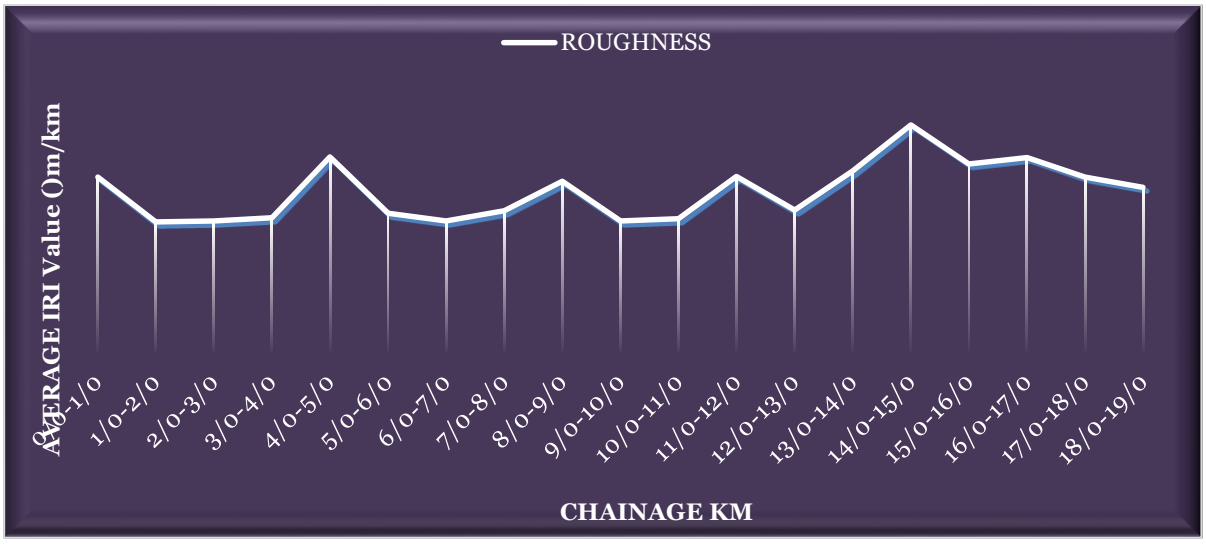
The Vehicle Mounted Bump Integrator (VMBI) which is a response-type road unevenness meter mounted in a vehicle to monitor pavement unevenness. It records the displacement of the vehicle chassis relative to the rear axle per unit distance travelled, usually in terms of counts/km or m/km. Since each vehicle responds differently to unevenness due to its own unique springs and shocks, as these changes over time with wear, it is necessary to calibrate each vehicle against a standard unevenness measure.

Two runs, one on each direction of wheel path have been carried out by maintaining a running speed of 30kmph. The Kilometre values of roughness in International Roughness Index (IRI) observed on project road have been tabulated in Table below and graphically presented in Figure below. Details of the survey results are present in Appendix.

Table 30: PAVEMENT ROUGHNESS VALUE

Sl. No.	Chainage in km	Roughness Index(Y) in mm / km	Remarks
1	0/0-1/0	3046.666	Average
2	1/0-2/0	2272.492	Good
3	2/0-3/0	2286.074	Good
4	3/0-4/0	2340.402	Good
5	4/0-5/0	3399.798	Average
6	5/0-6/0	2421.894	Good
7	6/0-7/0	2286.074	Good
8	7/0-8/0	2462.64	Good
9	8/0-9/0	2978.756	Average
10	9/0-10/0	2286.074	Good
11	10/0-11/0	2326.82	Good
12	11/0-12/0	3060.248	Average
13	12/0-13/0	2476.222	Good
14	13/0-14/0	3155.322	Average
15	14/0-15/0	3956.66	Poor
16	15/0-16/0	3277.56	Average
17	16/0-17/0	3386.216	Average
18	17/0-18/0	3046.666	Average
19	18/0-19/0	2870.1	Average

Figure 9: ROUGHNESS VALUE



5.5.3 Benkelman Beam Deflection Survey

Benkelman Beam Deflection Technique is useful in evaluating the strengthening requirements of the existing flexible road pavements. The basic principle of deflection method considers the performance of flexible pavements which is closely related to the elastic deflection/ deformation of pavement under the wheel loads. The amount of pavement deflection under an applied design wheel load or its rebound deflection on removal of this load is a measure of the structural stability of the pavement system. Larger rebound deflection indicates weaker pavement structure indicative of strengthening and/or higher overlay thickness for the pavement.

Structural strength surveys for existing two lane pavements using Benkelman Beam Deflection Technique were carried out in accordance with the procedure given in IRC: 81-1997 "Guidelines for Strengthening of Flexible Road Pavements using Benkelman Beam Deflection Technique". On the Project Highway the BBD test has been conducted in 26 stretches, with each stretch of 1 km length for each set of test.

5.5.3.1 Calculation of Deflections

To get a single value of rebound deflection from three field values (Initial, Intermediate & Final Readings) following steps are followed:

Table 31: DEFLECTION CALCULATION STEPS

Step 1		Double the field observations (readings): Do, Di & Df are doubled values. This is done because the dial gauge is fixed such that distance between probe end and fulcrum of beam is twice the distance between fulcrum and dial gauge.
Step 2		Let Initial Reading be Do (doubled), Intermediate Reading be Di (doubled), &Final Reading be Df (doubled) & XT & YT is rebound deflections in mm in case 1 & 2 respectively.
	Case 1	If Df - Di < 0.025mm XT = rebound deflection = 2 (Df - Do) = twice the difference between final and initial readings
	Case 2	If Df - Di ≥ 0.025mm YT = rebound deflection = 2 (Df - Do) + 2x2.91 (Df - Di)
Step 3		After this temperature & seasonal corrections were applied to get final (corrected) deflection from which, mean, standard deviation and characteristic deflection are obtained.

5.5.3.2 Characteristic Deflection

The statistical analysis of all the measurements done in the field and corrections applied as required was done as under:

Mean deflection= $X' = \Sigma X/N$

Standard deviation= $\sigma = \sqrt{(\Sigma (X' - X) 2/ (n -1)}$

The characteristic deflection for design purposes has been taken as Characteristic deflection Dc in mm= X + 2 σ for major arterial roads (like NH & SH)

Dc = X + σ could be considered for all other roads but for this project it is not applicable. Here,

X' = Individual deflection in mm

X = Mean deflection in mm

n = Number of deflection measurements

In the formula for standard deviation, division by n-1 and not n follows the established statistical theorems.

In the same km on road, readings were staggered with respect to 25m on either side, Left Hand (LHS) and Right Hand (RHS). The observations of LHS were taken while going and RHS while returning, involving a difference of several days. Hence, calculated characteristic deflection for LHS is bound to be different for RHS in the same km. The representative characteristic deflection for the same km is the maximum of the two and not the average for the obvious reasons.

Based on homogeneous pavement characteristics, the characteristic deflection value in 2 homogeneous sections is as below;

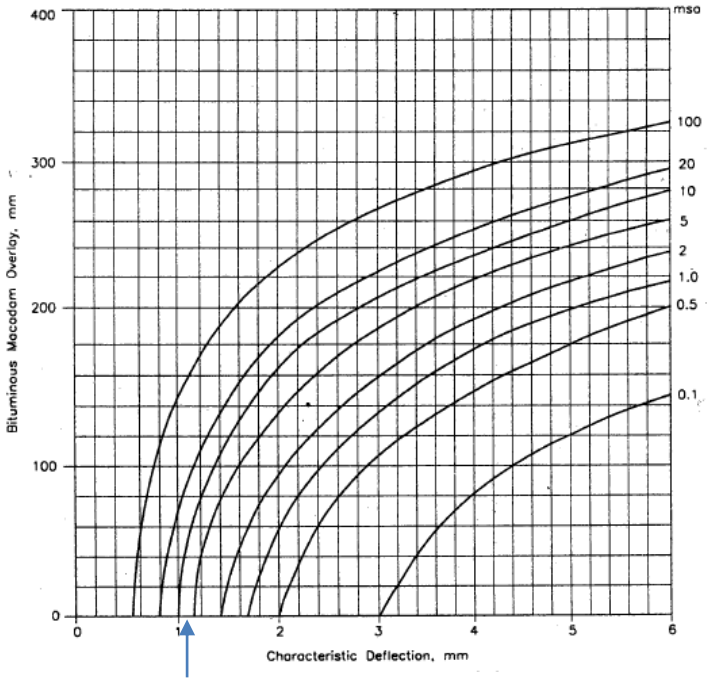
Table 32: DEFLECTION CHARACTERISTICS OF THE PROJECT ROAD

NO. OF TESTS	LOCATION OF TEST POINT	MEASURED DEFLECTION (FROM COLUMN 9 TABLE 1 TO 11 IN mm)	TEMPERATURE CORRECTION FACTOR IN mm	AFTER CORRECTION FOR TEMPERATURE mm	CORRECTION FOR SEASON	CORRECTED DEFLECTION mm	MEAN DEFLECTION X (mm) (CORRECTED VALUE)	STANDARD DEVIATION (mm) OF CORRECTED VALUE	CHARACTERISTIC DEFLECTION ,mm as per equation(4) (mm)
1	2	3	4	5	6	7	8	9	10
20	0/000 - 1/000	12.193	+ 0.12	14.593	1.26	18.3872	0.9194	0.1232	1.17
20	1/000 - 2/000	7.4946	+ 0.11	9.6946	1.36	13.1847	0.6592	0.074	0.81
20	2/000 - 3/000	7.5674	+ 0.10	9.5674	1.33	12.7246	0.6362	0.0846	0.81
20	3/000 - 4/000	7.8546	+ 0.09	9.6546	1.28	12.3579	0.6179	0.0758	0.77
20	4/000 - 5/000	8.66	+ 0.07	10.06	1.41	14.1846	0.7092	0.0874	0.88
20	5/000 - 6/000	15.753	+ 0.05	16.753	1.34	22.449	1.1225	0.1517	1.43
18	6/000 - 7/000	10.5076	+ 0.05	11.5076	1.38	15.8805	0.8823	0.2764	1.44
20	7/000 - 8/000	7.5	+ 0.07	8.9	1.32	11.748	0.5874	0.086	0.76

NO. OF TESTS	LOCATION OF TEST POINT	MEASURED DEFLECTION (FROM COLUMN 9 TABLE 1 TO 11 IN mm)	TEMPERATURE CORRECTION FACTOR IN mm	AFTER CORRECTION FOR TEMPERATURE mm	CORRECTION FOR SEASON	CORRECTED DEFLECTION mm	MEAN DEFLECTION X (mm) (CORRECTED VALUE)	STANDARD DEVIATION (mm) OF CORRECTED VALUE	CHARACTERISTIC DEFLECTION ,mm as per equation(4) (mm)
20	8/000 - 9/000	10.3206	+ 0.10	11.9206	1.31	15.616	0.7808	0.1097	1
20	9/000 - 10/000	8.0492	+ 0.09	9.8492	1.35	13.2964	0.6648	0.0894	0.84
20	10/000 - 11/000	9.2546	+ 0.12	11.6546	1.35	15.7337	0.7867	0.1196	1.03
20	11/000-12/000	13.346	+ 0.00	13.346	1.38	18.4175	0.9209	0.1682	1.26
18	12/000-13/000	6.8092	+ 0.10	8.8092	1.35	11.8924	0.6607	0.171	1
20	13/000-14/000	13.2314	+ 0.08	14.8314	1.38	20.4673	1.0234	0.1531	1.33
20	14/000-15/000	15.306	+ 0.08	16.906	1.33	22.485	1.1243	0.1965	1.52
20	15/000-16/000	13.9276	+ 0.00	13.9276	1.3	18.1059	0.9053	0.1508	1.21
20	16/000-17/000	14.8368	+ 0.07	16.2368	1.33	21.5949	1.0797	0.1757	1.43
14	17/000-18/000	10.413	+ 0.08	12.013	1.32	15.8572	1.1327	0.4837	2.1
12	18/000-19/000	7.2346	+ 0.09	9.0346	1.31	11.8353	0.9863	0.4017	1.79
20	19/000-20/000	13.8584	+ 0.00	13.8584	1.29	17.8773	0.8939	0.1676	1.23

The average deflection comes out to 1.19 mm projecting the deflection value in the Deflection graph provided in IRC: 81-1997 we get 120 mm overlay. The flexibility of the project road is very less due to the deterioration of the bituminous layer at most of the stretches. Considering the condition of the road, an overlay of 610 mm with 130 mm BT layer is provided.

Figure 10: OVERLAY CALCULATION



The following snapshots shows BBD Being carried out in the stretch.

5.5.4 Sub grade Characteristics &Strength

The testing of soils for classification & mechanical characteristics has been as per terms of reference. "Testing of three sub-grade soil samples for each design section or three samples for

each soil type encountered, whichever is more has been done". Thus testing for sub-grade soil at each test pit includes:

In-situ density & moisture content

Field CBR using DCP

Characterization (Grain size & Atterberg's Limits)

Laboratory moisture-density characteristics (modified AASHTO compactions)

Laboratory CBR (uncooked & 4 day soaked compacted at 3 energy levels)

5.5.5 Investigation of Subgrade

The borrow areas were first identified by visual inspection and enquiries along the project road and adjacent areas. The soil samples from the project corridor were collected, and the required tests as per specification & IRC/BIS codes were done. Grain size analysis was done for particles smaller than 4.75 mm. For particles having size between 4.75 mm and 75 microns, sieve analysis was done (wet sieving) and for particles smaller than 75 microns, Hydrometer analysis was done. CBR test, Atterberg's Limit, DCPT and moisture contents were also determined. Material found satisfactory can be used for construction activity. The result sheet of DCPT is attached in the Appendices.

Table 33: CBR OF SUBGRADE SOIL ALONG THE PROJECT STRETCH

Sl. No.	Soil sample collected at Chainage	Grain size analysis					Atterberg's Limits			Proctor Compaction		California bearing ratio test (Remoulded at FDD & FMC)			DFS in %	Group of soil as per IS 1498 – 1970
		Fine Gravel In % (20mm To 4.75mm)	Coarse Sand In % (4.75mm To 2.00 mm)	Medium Sand In % (2.0mm To 0.425mm)	Fine Sand in % (0.425mm To 0.075 mm)	Silt & Clay in % (0.075mm To 0.001mm)	Liquid Limit In %	Plastic Limit In %	Plasticity Index in %	Maximum dry density in gm/cc	Optimum moisture Content in %	C.B.R Un-soaked in %	C.B.R Soaked for 4 days in %	Moisture content after 4 days Soaking in %		
1	0.000 km	7.36	6.18	14.78	11.57	60.11	39	19	20	1.822	13.2	8.5	4.9	15.5	30	CI
2	5.000 km	20.95	17.71	27.52	13.27	20.55	28	20	08	1.98	9.6	18.2	11.4	12.5	0	SC
3	10.000 km	22.50	8.35	15.01	12.90	41.24	31	17	14	1.985	9.5	20.6	12.2	12.2	10	SC
4	15.000 km	20.77	10.02	15.73	17.81	35.67	30	16	14	1.977	9.8	17.8	10.8	13.3	10	SC
5	19.220 km	26.62	15.54	20.81	12.09	24.94	28	20	8	2.012	9.3	20.8	12.8	12.0	0	SC

5.5.6 Investigation of Material for Construction

The investigation of different quarries was conducted from different places where stone aggregates and sand are available. Samples were collected and tests were performed in accordance with IS: 2386 (Part III), IS: 120 (Part I), AASHTOT182, IS: 624-1971, IS: 2380 (Part V). The crushers and other sources are approved by the department.

The borrow areas were identified in and around and along the project road. The suitability of borrow material is established from laboratory testing.

5.5.7 Investigations of Other Construction Materials

Availability and suitability of other construction materials like Fly ash, coarse sand, local sand and bricks were investigated. Samples were collected and required tests performed in the laboratory. Cement, Steel and Bitumen are manufactured items and readily available.

5.5.8 Drainage System

Requirement of roadside drainage system and the integration of the same with proposed cross drainage system have been worked out for the entire length. Improving storm water drainage in built-up areas using vertical drains as per IRC: SP: 50-1990 has been adopted.

5.5.9 Investigations for Structures

We have made an inventory of all the structures (bridges, viaducts, ROB, culverts, etc.) along the road under the project. The inventory for the bridges, viaducts and ROB's shall include the parameters required as per the guidelines of IRC-SP: 35-1990. The inventory of culverts was presented in a tabular form covering relevant physical and hydraulic parameters.

5.6 Hydraulic and Hydrological Investigations

Special Publication No. 13 ("Guidelines for the Design of Small Bridges and Culverts") and IRC: 5-2015 ("Standard Specifications & Code of Practice for Road Bridges, Section I General Feature of Design"). These investigations were carried out for all existing drainage structures along the road sections under the study. Study on topography (topographic maps), storm duration, rainfall statistics, topsoil characteristics, vegetation cover etc. were done so as to assess the catchments areas and hydraulic parameters for all existing and proposed drainage provisions. The findings of the desk study have been further supplemented and augmented by a reconnaissance along the area. All-important hydrological features were noted during this field reconnaissance. Information on high flood level (HFL), low water levels (LWL), discharge velocity etc. were collected from available past records, local inquiries and visible signs, on the structural components and embankments. Local inquiries were also made with regard to the road sections getting overtopped during heavy rains.

5.6.1 Condition Surveys for Bridges, Culverts and Structures

Thorough inspection of the existing structures done and prepared a report about their condition including all the parameters given in the Inspection pro-forma of IRC-SP: 35-1990. The condition and structural assessment survey of the bridges / culverts / structures was carried out. Summary of inventory of structures has been provided in Chapter 3.

TRAFFIC SURVEY, ANALYSIS AND FORECAST

CHAPTER 6
TRAFFIC SURVEY, ANALYSIS AND FORECAST

6.1 GENERAL

Traffic is one of the most important components of road project study. The study of traffic & travel characteristics is conducted to assess the nature and magnitude of traffic problems on the project road. A correct assessment of the existing traffic condition along with past traffic flow trends forms a basis for further analysis of estimation of traffic flow for the horizon years. As the travel is the derived demand due to interaction of numerous socio economic activities, it is also imperative to study the growth of the socio-economic, demographic profiles in the project area influencing the travel demand.

Presently traffic facilities on the project road in terms of pedestrian sidewalk in urban area, access control, road signage and markings are non-existent or at best highly deficient. Certain sections on the road, heavy movement of goods traffic poses serious problems of traffic operation resulting in high degree of traffic congestion. Other problems along the highway are inadequate sight distance, poor road geometrics, kerb side parking, and non-conforming land use activities along the roadside and other encroachments within right of way.

6.2 BACKGROUND

The project road starts from Demwe on NH 13 at 0/000 km and ends near the new alignment of Brahmakund to Arrowa at 18/464 km chainage. The road passes through the major settlements of 48 BRTF Camp, Tohangam and BRO Camp.

6.3 OBJECTIVE

For making the proper assessment of traffic volume, base year traffic and its projection, Consultants have carried out the necessary traffic surveys and investigations. The base year traffic data is the primary input for determination of future traffic demand. With a view to estimate the base year traffic volume in respect of goods and passenger carrying vehicles, the Classified Traffic Volume Count (CTVC) surveys was conducted. As there is no major town along this road the requirement of OD survey is not found. For the purpose of traffic estimation and projections the year 2017-18 has been taken as the base year.

6.4 IDENTIFICATION OF HOMOGENEOUS SECTIONS

The project road has been considered as 1 homogeneous section with respect to variation in traffic volume based on location of major intersection and minor settlements. The homogeneous sections are given in Table below.

Table 34: HOMOGENEOUS SECTIONS

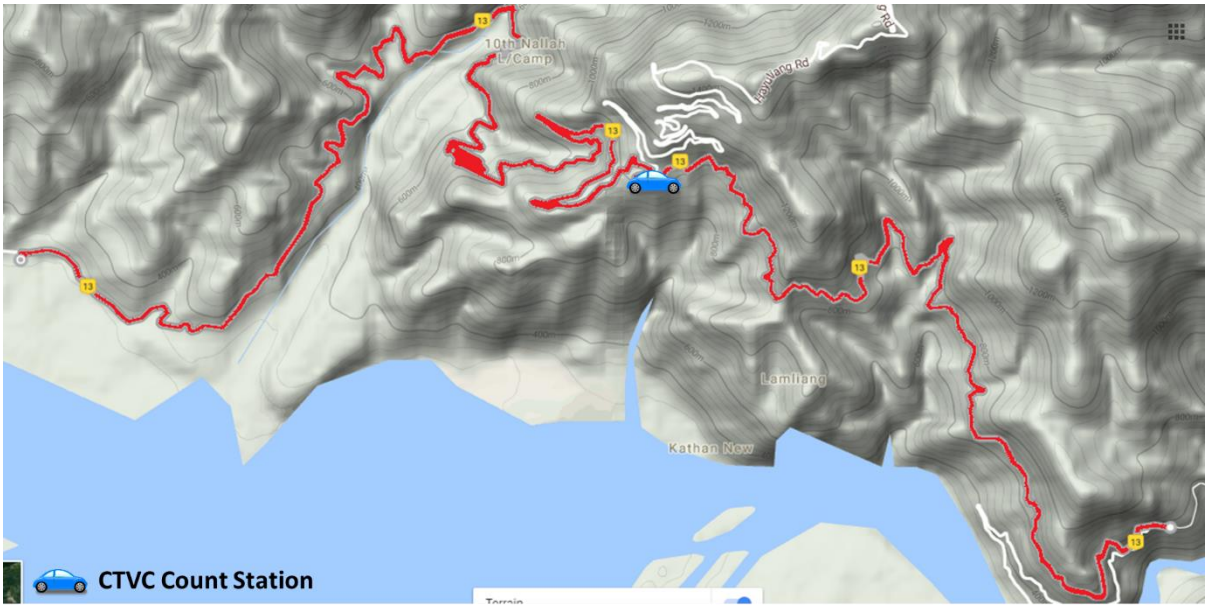
Homogeneous Section	From km to km	Length (km)	Remarks
HS1	0/000 km to 18/464 km	18.464 km	Demwe-Brahmakund

Based on the homogeneous section proposed above, traffic survey has been performed at locations and schedule mentioned in the table below.

Table 35: PROPOSED LOCATION FOR TRAFFIC SURVEY

Sl no	Type of survey	Duration	Location
1	Classified Volume Count	7 days	Tohangam Junction (17/300 km)

Figure 11: TRAFFIC COUNT STATIONS



6.5 Classified Traffic Volume count

The Classified traffic volume count is carried out at 1 locations in the 1 homogeneous stretches in the month of April 2017. The vehicle classification has been done on the basis of IRC SP 19-1991 and IRC 9-1972. The purpose of the survey is to calculate the Average Daily Traffic (ADT) on all the traffic homogeneous sections and to convert the traffic into PCU, for Capacity Analysis and fixing of concession period. Vehicle classification and PCU factors adopted are presented in Table below.

Table 36: PCU VALUES

Category of Vehicles	PCU Value
Two Wheeler	0.5
Three Wheeler	1
Car/Taxies	1
Jeep/Van	1

Category of Vehicles	PCU Value
Mini Bus	1.5
Bus	3
LCV Passenger	1.5
LCV Freight	1.5
Two Axle	3
Three Axle	3
Semi Articulated	4.5
Articulated	4.5
Cycle	0.5
Rickshaw	2
Animal Cart	8
Hand Cart	2
Others	2

Under the present study, manually 7 days traffic volume counts were carried out at 1 locations for 24 hours in the month of June of 2017. The survey stations have been located away from urban agglomerations and villages to minimize interference of local traffic. The summary of the daily traffic count at all survey locations is presented below.

Table 37: DETAILS OF TRAFFIC SURVEY AT 17/300 km CHAINAGE

	Day - 1	Day - 2	Day - 3	Day - 4	Day - 5	Day - 6	Day - 7	ADT
Two wheeler	25	11	37	32	25	23	36	27
Three Wheeler	1	0	0	0	0	0	0	0
Cars/Taxies/Van	69	68	68	69	91	88	64	74
LCV	16	27	35	41	39	60	53	39
Bus/ two axle	3	16	4	2	1	0	1	4
Three Axle	0	0	0	0	0	0	0	0
Multi Axle	1	0	0	0	0	0	0	0
others	0	0	0	0	0	0	0	0
Total Vehicles	115	122	144	144	156	171	154	144
Total PCU	120	162	151	153	165	190	165	158

Table 38: DETAILS OF TOLLABLE and NON-TOLLABLE TRAFFIC

Vehicle type	HS 1
Car/Taxies	74
LCV	39
Bus	4
Three Axle	0
Multi Axle	0
ADT TOLLED	117
PCU TOLLED	145
Two Wheeler	27
Three Wheeler	0
Others	0

Vehicle type	HS 1
ADT NON TOLLED	27
PCU NON TOLLED	13.5
ADT Total	144
PCU total	158.5
Percentage non Tolled	18.75

The non-toll-able traffic is higher in percentage. So, the toll to be recovered from the project will non-viable.

6.5.1 Hourly Variation of Traffic

Average hourly variation of traffic at the location is shown in figure below. It is observed that at survey location traffic flow in day and night has considerable variation in volume. Peak flow happens in afternoon hours 12.00-3.00 PM.

Figure 12 : HOURLY VARIATION OF TRAFFIC AT THE SURVEY LOCATIONS

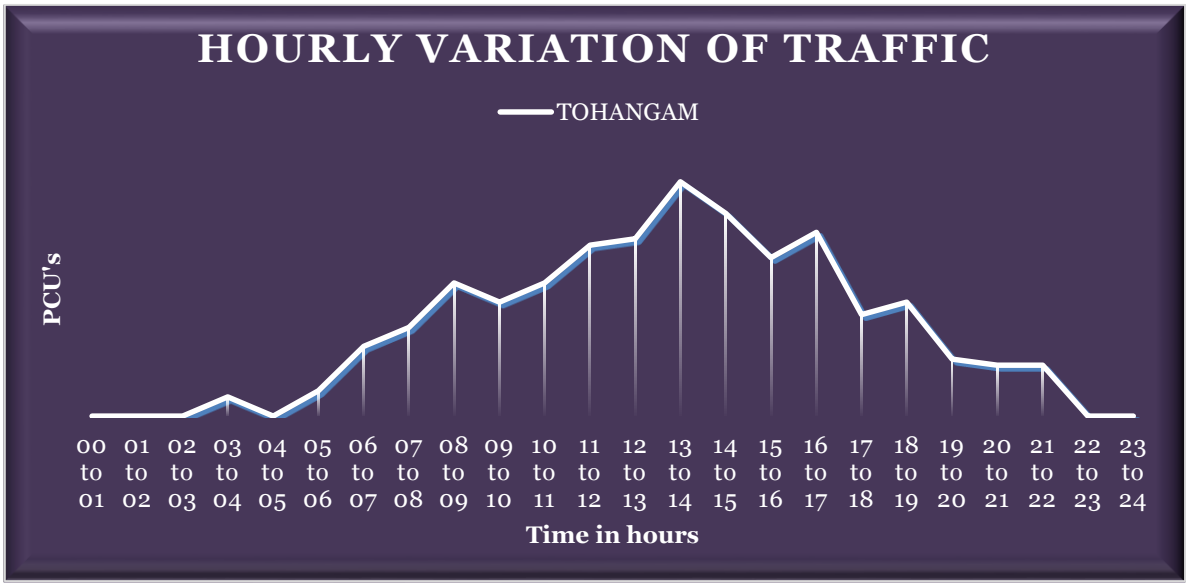
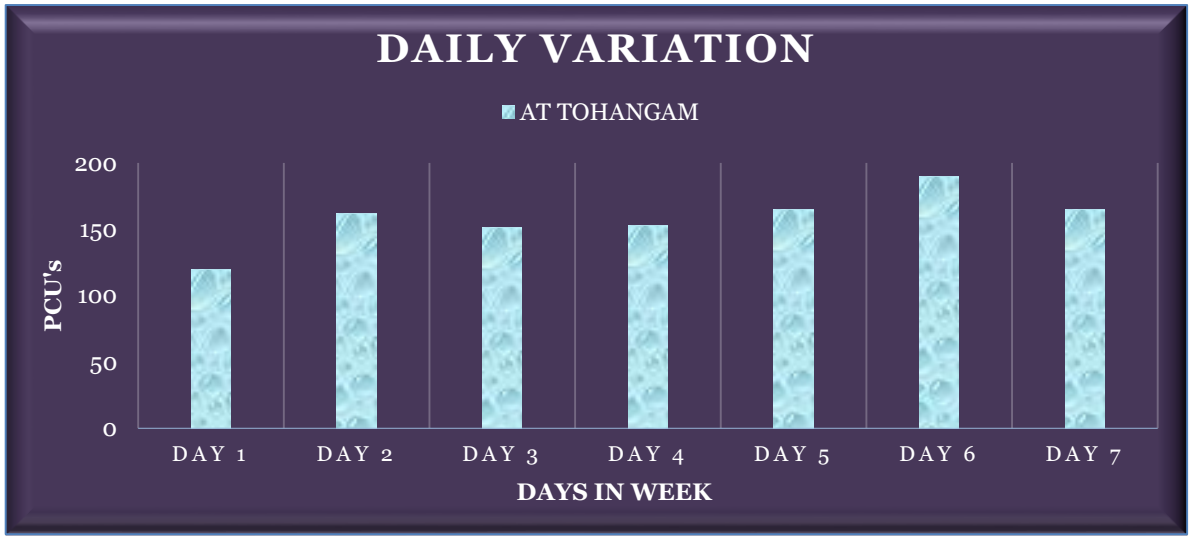


Figure 13: DAILY VARIATION OF TRAFFIC



6.5.2 Composition of Traffic

Seven days average composition of traffic at each count location is presented in the form of pie-charts in Figure 16. Table 39 shows the average composition of traffic at each location.

Table 39: AVERAGE TRAFFIC COMPOSITION AT COUNT LOCATIONS

Type of Vehicles		Location 1 (AT TOHANGAM JUNCTION)	
		Nos	%
Toll-able vehicles	Car/Taxies	74	51.39
	LCV Passenger	39	27.08
	Bus	4	2.78
	Three Axle	0	0.00
	Multi Axle	0	0.00
	ADT TOLLED	117	81.25
Non toll-able vehicles	Two Wheeler	27	18.75
	Three Wheeler	0	0
	Others	0	0
	ADT NON TOLLED	27	18.75
ADT Total		144	

Figure 14: VEHICLE COMPOSITION CHART AT TOHANGAM (16/400 KM)

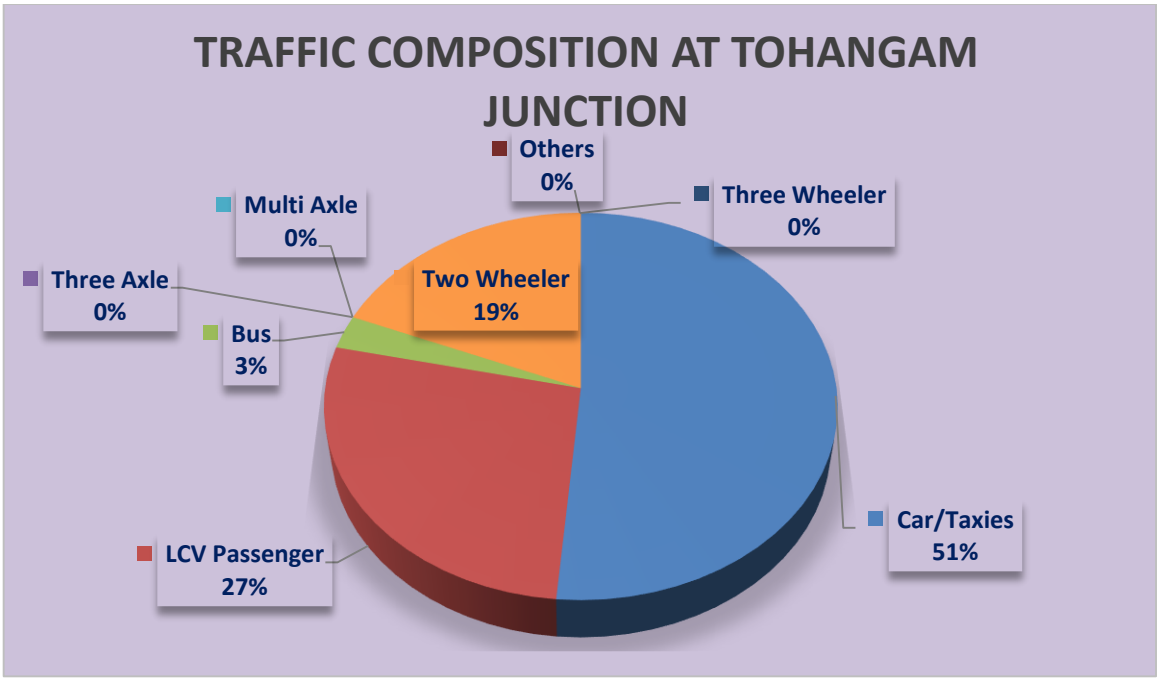
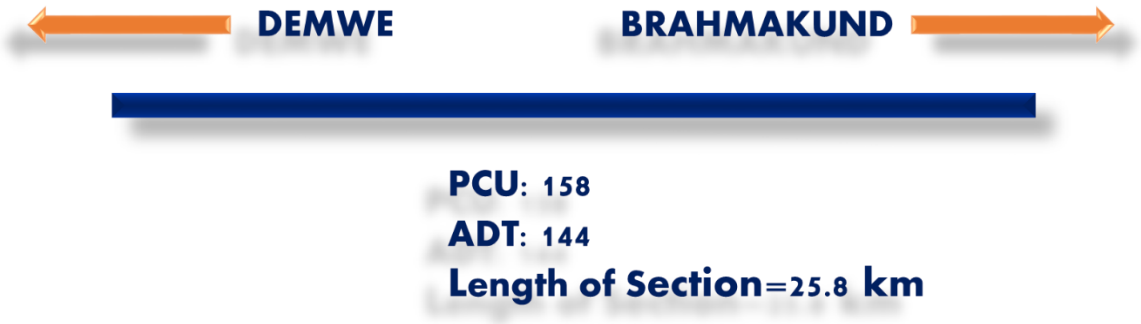


Figure 15: PROJECT ROAD WITH HOMOGENEOUS SECTIONS



6.6. Traffic Forecast and Management

6.6.1 General

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. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out near accurately. 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 in future, which necessitates realistic estimation of traffic growth rates. Traffic growth on a road facility is generally estimated on the basis of historical trends. In the present case, traffic growth rates have been estimated using elasticity method as per IRC: 108 – 1996. Demand changes are usually because of shifts in the pattern of economic activities in the surrounding regions. Hence, future traffic estimation

necessitates a preview, however imprecise, of the probable pattern of future growth of the economy.

6.6.2 Growth Traffic Projections

The seven days volume counts obtained during the traffic survey work has been analysed both in terms of Vehicle and PCUs. Average daily traffic (ADTV) for the project road has been assessed based on Traffic Survey Counts and other factors. As project is being checked for feasibility on DBFOT pattern, the concession period has to be taken maximum 30 years. Therefore traffic forecast has been made for 30 years period including construction period of the project road.

The projected traffic volume has been presented in the table below. Based on the projected traffic volume, the capacity has been augmented in terms of widening the carriageway as well as improvement of geometrics.

6.6.3. Projection of Toll-able Vehicles

The project road has been envisaged to be constructed on BOT basis which anticipates the projection of vehicles that can be charged for using the road facility. Therefore, traffic has been projected mode wise for the project life period. For this purpose, the vehicles of similar dimensions and character have been classified. The vehicles which can be levied toll tax are (i) Car/jeep/taxi, (ii) Standard buses, (iii) LCV and Mini buses, (iv) Standard trucks of 2 Axles, (v) Trucks- 3 Axles, (vi) Multi-axle and Articulated Trucks and (vii) Loaded tractors.

Table 40 : PROJECTED TRAFFIC FOR 15 YEARS AT TOHANGAM

Duration	Two wheeler	Three Wheeler	Cars/Taxies/Van	LCV	Bus/ two axle	Three Axle	Multi Axle	others	Total Vehicles	Total PCU	CVD	No of Years
2017	27	0	74	39	4	0	0	0	144	158	43	Base Year
2018	29	0	78	41	5	0	0	0	153	169	46	Construction Year 1
2019	31	0	82	44	6	0	0	0	163	182	50	Construction Year 2
2020	33	0	87	47	7	0	0	0	174	195	54	Operation Year 1
2021	35	0	92	50	8	0	0	0	185	209	58	Operation Year 2
2022	37	0	97	53	9	0	0	0	196	222	62	Operation Year 3
2023	39	0	102	56	10	0	0	0	207	236	66	Operation Year 4
2024	41	0	108	59	11	0	0	0	219	250	70	Operation Year 5
2025	44	0	114	62	12	0	0	0	232	265	74	Operation Year 6
2026	47	0	120	66	13	0	0	0	246	282	79	Operation Year 7
2027	50	0	126	70	14	0	0	0	260	298	84	Operation Year 8
2028	53	0	133	74	15	0	0	0	275	316	89	Operation Year 9
2029	56	0	140	78	16	0	0	0	290	333	94	Operation Year 10
2030	59	0	147	82	17	0	0	0	305	351	99	Operation Year 11
2031	62	0	155	87	18	0	0	0	322	371	105	Operation Year 12
2032	66	0	163	92	19	0	0	0	340	391	111	Operation Year 13
2033	70	0	172	97	20	0	0	0	359	413	117	Operation Year 14
2034	74	0	181	102	21	0	0	0	378	434	123	Operation Year 15

6.7 Capacity Analysis

The traffic (AADT) at both survey locations is projected to analyses the concession period based on the traffic capacity parameters. Maximum capacity for 2 Lane (7.00m) with paved shoulder is considered as 18,000 PCUs. The growth rate of 5 % is considered for all types of vehicles.

Table 41: ESTIMATION OF LOS

Year	V/C	A	B	C	D	E	F
		0.6	0.7	0.8	0.85	0.9	1
2017	0.0088	✓					
2020	0.0108	✓					
2025	0.0147	✓					
2030	0.0195	✓					
2035	0.0256	✓					

6.8 Million Standard Axles (MSA)

Design method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life. The project road has been divided into one homogenous sections with respect to variation in traffic volume based on location of major intersections & major settlements. Design Traffic in MSA for 20 years is tabulated below.

Table 42: MSA DETAILS

Homogeneous section	From km to km	Length in kms	Design MSA	Adopted MSA
Demwe-Brahmakund	0.000 km-18.464 km	18.464 kms	5 msa	5 msa for bituminous crust 20 msa for non-bituminous crust

IMPROVEMENT AND ENGINEERING PROPOSALS

CHAPTER 7
IMPROVEMENT AND ENGINEERING PROPOSALS

7.1 INTRODUCTION

This chapter is intended to give brief descriptions concerning the various improvement proposals for the up-gradation of existing NH 13 road to intermediate lane from Demwe to Brahmakund with 18.464 km project stretch. The improvement proposal is based on the findings from various engineering surveys and investigations carried out on the project road section.

Improvement proposals for a highway essentially consist of two components, viz. Geometric and Structural. Geometric improvement deals with visible dimensions of roadway and is dictated by the traffic and economic considerations. Geometric design involves several design elements such as horizontal and vertical alignments, sight distance considerations, cross sectional elements, lateral and vertical clearances, intersection treatment, control of access, etc. The structural component deals with the pavement and embankment design aspects, i.e. the ability of the highway to adequately carry and support the vehicle / wheel loads over the design period. The improvement proposals for the proposed up gradation & widening to intermediate lane configuration system includes the provision for the following major items:

- Geometric improvements and realignments
- Pavement
- Road junctions
- Bridges and CD structures
- Safety
- Road Appurtenances

7.2 Geometric design proposals

The proposal for the improvement of the geometric elements of the existing road includes:

- Improvement to the cross sectional elements
- Alignment design

7.2.1 Improvement to the cross sectional elements

Lane width:

The standard lane width of the project highway shall be 3.5 m, hence the two lane shall be 7 m.

Earthen shoulders:

1 m earthen shoulders is proposed to the valley side of the carriageway. On the hill side, 1 m hard shoulder is proposed.

Cross fall:

The cross-fall for the pavement & hard shoulder is 2.5% with a crown at the inner edge. The cross-fall for granular shoulder is 3%.

Proposed ROW:

The typical cross sections to be followed in the project stretch are detailed in Volume VI: Drawings.

7.2.2 Development Scheme

The most important fact in deciding the side of widening is the availability of land. Secondary factors include presence of environmentally; religiously and socially sensitive features such as Heritage Structures, other monument structure and so on. The following criteria have been used with suitable inter-alias weight age in terms of their influence in governing the decision on the side of widening.

- Available ROW from the existing center line;
- Location of utility lines;
- Abutting land use;
- Adjacent cultural properties;
- Geometric improvements necessary;
- Location and type of trees required to be cut;
- Socio Economic affected person;

Improvement of existing alignment has been done in following ways which will have significant beneficial impact in terms of :

- Minimizing Displacement
- Reducing resistance to the project
- Minimize the impact on the existing trees/local environment.
- Maximum benefit in terms of road geometry, pavements, shoulders, embankments etc.
- Uninterrupted flow of through traffic along the Project stretch
- Avoid future possibility of installation of speed breakers by the local administration / public
- Avoid adverse impacts of the crowded areas along the project stretch

The summary of widening scheme proposed is as below:

Table 43: SUMMARY OF IMPROVEMENT PROPOSAL

Sl.No.	Widening Scheme	Length	Remarks
1	From 0. 000km to 18.464 km	18.464 km	Hilly Terrain

The development schemes are as follows:

Table 44: DETAILS OF CROSS SECTION

SL NO	TYPE OF CROSS SECTION	DETAILS
1	TYPICAL-I	Two lane carriageway with 1.5 m hard shoulders on both side widened on the existing alignment. Lined drain on the hill side.
2	TYPICAL-II	Two lane carriageway with 1.5 m hard shoulders on both side in the green field section. Lined drain on the hill side.

Figure 16: TYPICAL CROSS-SECTION 1 (Existing-Section)

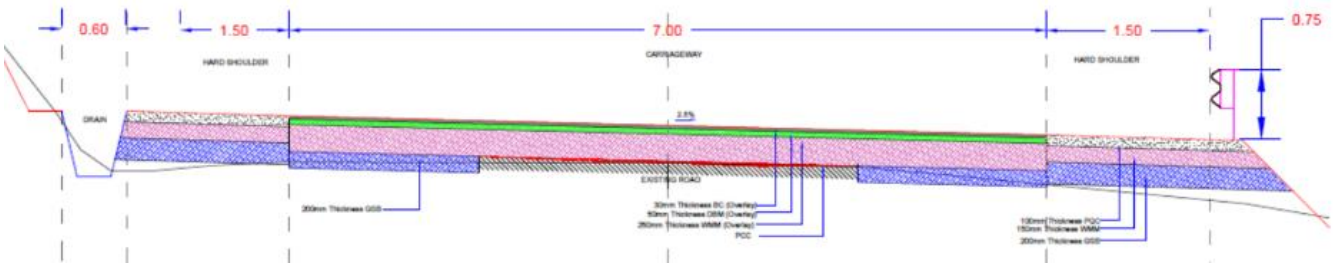
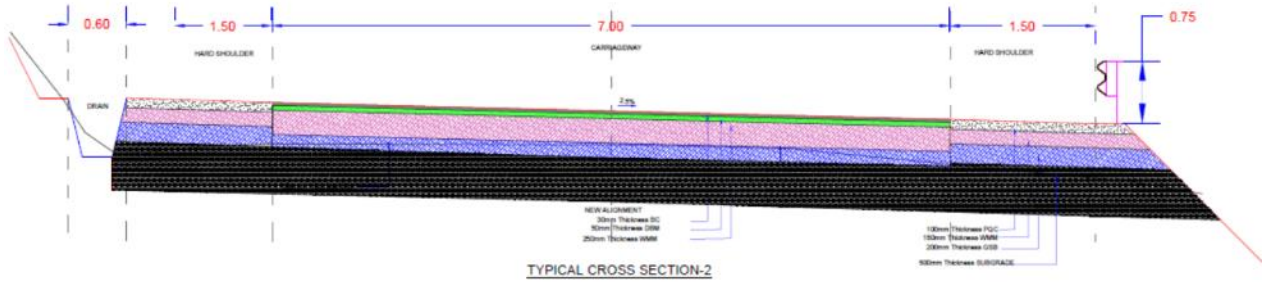


Figure 17: TYPICAL CROSS-SECTION 2 (Green Field-Section)



7.3 Alignment Design

The entire geometric design has been based on the ground modelling by highway MX design software. The design of proposed alignment for 2-lane with hard shoulders has been carried out based on the widening scheme as discussed above.

Horizontal alignment:

The proposed road is planned within existing ROW and hence no vivid improvement of the curves is possible.

Vertical alignment:

Vertical Alignment is designed for minimum criteria of Intermediate Sight Distance (ISD). The existing road profile is reviewed on the basis of cross-sections taken at regular intervals with the help of Digital Terrain Model (DTM). Additional culverts have been proposed depending upon the site specific conditions/profile.

7.4 Pavement Options

For the purpose of pavement design the project road is divided into single homogeneous sections as detailed in the traffic chapter.

The purpose of the pavement study is to make analysis of different pavement alternatives to provide a basis for selection of the most advantage solution, considering all costs occurring during the life of the pavement, viz., construction costs, maintenance costs and costs for the road users.

In pavement option study, the following is studied in detail:

- New flexible pavement on the widening part and for full reconstruction stretches
- Flexible overlay over the existing pavement
- Flexible Pavement for partial reconstruction stretches of existing pavement.

The different pavement design methods for above pavement options are studied and applied, which are given in Table below

Table 45: CODE FOR PAVEMENT DESIGN

Pavement option	Option type	Design method
1	New Flexible pavement	IRC 37:2018
2	Flexible overlay	IRC 81:1997

The pavement existing thorough out the project length is flexible in nature. The project envisages widening to two lanes with hard shoulder of the existing single lane carriageway for augmenting the capacity of the project road and significantly extending its service life. Pavement Design includes strengthening of existing single lane by providing appropriate bituminous overlay thickness.

The general design procedure for the flexible pavement for the proposed road from Demwe to Brahmakund for widening portion as new construction as well as strengthening of existing carriageway has been followed as per the guidelines of IRC: 37-2018 – "Guidelines for the design of flexible pavements" and IRC: 81-1997- "Guidelines for Strengthening of flexible road pavements using Benkelman Beam Deflection Technique" respectively. For the pavement design, the information is required with regard to the parameters such as volume of traffic, pavement condition; borrow area soil characteristics and properties of the existing subgrade. Growth rate is required to predict the traffic over the design life and axle load spectrum is necessary to calculate the Vehicle Damage Factor (VDF) for the design traffic calculations.

New pavement design is based on the design traffic (msa) and the subgrade strength, however the overlay design will vary for each homogenous sections based on its structural and functional adequacy.

7.5 Design of New Flexible Pavement

The flexible pavements are usually referred as a layered structure comprising generally bituminous surface like Bituminous Concrete (BC) and Dense Bituminous Concrete (DBC), 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 will principally depend 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 will 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 are generally made up of locally available aggregates.

7.5.1 Traffic Growth

Pavements are designed to serve the traffic needs adequately over a period of years. Traffic growth must therefore be anticipated when determining structural requirements of the pavement. From the traffic growth projection data as explained in this report, a weighted average growth rate of 5.0 percent per annum is estimated for the commercial vehicles.

7.5.2 Design Traffic

Design Traffic of 20 years has been adopted for the design of new pavement carriageway. Overlay has been designed for the 10 years.

Lane Distribution Factor

The lane distribution factors adopted for the project are as given under:

• Two lane carriageway: 50 per cent of the number of vehicles in both the direction

Vehicle Damage Factor

The numbers of equivalent 8.16 t standard axles for the different categories of commercial vehicles have been determined on the basis of the axle load surveys.

7.5.3 Pavement Design

IRC: 37-2018 method is adopted for the design which is based on the Mechanistic - Empirical approach, and provides catalogues for design of flexible pavements. The design catalogue gives the standard pavement compositions. The design relates to six CBR values ranging from 2 to 10 per cent and six levels of design traffic 10, 20, 30, 50, 100 & 150 MSA. The pavement compositions specified in design catalogue for adoption are relevant to bituminous surfacing (BC and DBM), base course (WMM / WBM) and granular layer of GSB.

Soil exploration was conducted from borrow areas for the construction of fill / embankment and sub-grade. The soil types tested so far along the road stretch may be classified as Clayey Sand. The CBR values (4-days soaking) using Modified Proctor Compaction and at OMC have been found to vary from 4.9% to 12.8%. Thus, the design CBR of 8 percent for sub grade is adopted in the pavement design analysis.

7.6 Rehabilitation of Existing Pavement

Flexible overlay is suggested over the existing pavement in order to enhance its structural and functional quality. Bituminous overlay in the form of BC and DBM is recommended as an overlay to support the design traffic of 10 years or 100 msa, whichever is less. BBD testing, test pit investigation, pavement condition survey and testing of the existing subgrade have been carried out to assess the requirements of strengthening. The overlay design is done in accordance with IRC: 81-1997 “Guidelines for Strengthening of flexible road pavements using Benkelman Beam Deflection Technique”.

7.7 Crust and Overlay Design

Based on the design the pavement of main carriageway for design traffic of 20 MSA for non-bituminous courses & 5 MSA for bituminous courses with a minimum design period of 20 years. The crust of the pavement to be widened is designed and the overlay thickness is decided basing upon the BBD deflection characteristics. The table below shows the adopted thickness of each layer both in widening portion and the overlay portion.

Table 46: CRUST DETAILS

Sl. No.	Chainage (km)		Crust			
1	From	To	GSB	WMM	DBM	BC
	0.00	18.464	200	250	50	30

7.8 Design of Structures

The rehabilitation of existing structures and proposal of new structures have been established on the basis of detailed inventory, Horizontal Alignment, vertical profile, geotechnical investigation, hydrological study etc.

7.8.1 General Conditions of Structures

The structures found on the project road can be categorised as bridges and culverts. The other structures like ROB, RUB, Underpasses, and Flyover etc. are not found in the project stretch.

7.8.2 Bridges

There are 13 nos of minor bridges and 2 no of major bridges.

Table 47: DEVELOPMENT PROPOSAL FOR BRIDGES

Sl.No.	Existing Type	Proposed Type	Recommendation	Nos.
1	RCC Slab	RCC Slab	New construction	1
		RCC Slab	New Construction	8
2		RCC T Girder	New Construction	3
3		PSC Girder	New Construction	2
4		Steel Girder	New Construction	2
5		Composite Girder	New Construction	1

7.8.3 Culverts

There are 24 nos. of culverts existing on the project road, where 20 are proposed for reconstruction, 4 for new construction and 54 new culverts on the alignment.

7.8.4 Improvement Proposals

The improvement proposal includes repair, rehabilitation, widening and reconstruction of the culverts and bridges which are in poor condition. The improvement proposals are summarised in the following table.

Table 48: ABSTRACT OF IMPROVEMENT DETAILS ON CULVERTS IN PROJECT ROAD

Sl.No.	Existing Type	Proposed Type	Recommendation	Nos.
1	RCC Slab	RCC Box	New construction	4
			Reconstruction	20
			New	54

A specialized team having relevant experience and expertise has inspected all the structures. Based on the defects observed, a comprehensive repair and rehabilitation plan is to be prepared for repair and rehabilitation of the distresses bridge components.

7.8.5 Common repair/ rehabilitation measures (For all structures)

i. Expansion joints shall be made functional.
ii. Existing wearing coats to be get repaired.
iii. Some plastering works shall be done in the cracked/distresses portions of the existing bridges.
iv. Existing railings shall be replaced with crash barriers and foot path shall be cast.
v. Remove vegetation from the structures; vent way and revetments around abutments.
vi. Replace / rehabilitate damaged stone pitching on embankments.

vii. Approach slab to be constructed on both sides.

7.9 Improvement and Upgradation of Road Intersections

The following intersections are proposed for improvement.

Table 49: INTERSECTIONS PROPOSED FOR IMPROVEMENT

Sl No.	Chainage	Junctions	
	From (km)	Type of Junction	Connecting places
1	0.380	Y (R)	BRTF Office
2	2.00	Y	Towards Hyauliang
3	15.350	Y(L)	Intersection with existing road
4	18.410	Y	Parsuramkund

7.10 Longitudinal Drains

To facilitate the drainage along the whole stretch of the project road, lined drains has been provided with catch-pits on the hill side for a total length of 18.464 Km along the whole road.

7.11 Traffic Safety Measures

Design of proper junctions, all other measures such as crash barriers, road signs, road marking, turn lanes etc. have been provided as per road safety standards prescribed by MoSRT&H. These have been shown in the drawing volume.

7.11.1 W-Beam Crash Barrier

W-Beam Crash Barrier has been proposed on the valley side for protection for vehicles from falling in valley. Total length of 14.280 Km has been provided.

Table 50: 1.5 M BREAST WALL PROVISION

Chainage From	Chaiange To	Total
270	330	60
430	550	120
600	680	80
750	1070	320
1130	1230	100
1930	2050	120
2500	14000	11500
14250	14500	250
15400	15750	350
16100	16450	350
16550	16650	100
17100	17500	400
17600	17700	100
17800	18230	430

7.11.2 Breast Wall

The breast wall is to be provided at the following chainages which are tabulated below.

Table 51: 2 M BREAST WALL PROVISION

Chainages	From	To	Length	
Left	0	2000	2000.00	m
Left	3060	11000	7940.00	m
Left	13400	13600	200.00	m
Left	13800	14100	300.00	m
Left	17900	18100	200.00	m
Left	18250	18400	150.00	m
			10790.00	**m**

7.11.3 Retaining Wall

The breast wall is to be provided at the following chainages which are tabulated below.

Table 52: RETAINING WALL PROVISION

Sl	From	To	Length	m	
1	3090.00	6610.00	3520.00	m	2 m Height
2	7700.00	8040.00	340.00	m	
3	7110.00	7290.00	180.00	m	
4	13480.00	15750.00	2270.00	m	
5	11000.00	11200.00	200.00	m	3 m Height
6	13400	13430	30	mt	10 m height
7	13070	13465	395	mt	

7.11.4 Gabion Wall

The gabion wall is to be provided at the following chainages which are tabulated below to safeguard against slidding zones..

Table 53: GABION WALL PROVISION

Sl.NO.	Chainage (From)	Chainage (To)	Length (m)
1	2600.0	2900.0	300.00
2	11000.0	11300.0	300.00
3	14100.0	15100.0	1000.00
		Total =	1600.00

7.11.5 Reinforced Earth Wall

The RE wall is to be provided at the following chainages which are tabulated below to safeguard against slidding zones.

Sl No.	Chainage		Deduct CD Length	Stretch Length (m)	Vertical Height of Retaining Structure (m)
	Start	End			
1	11300	13300	145	1855.000	8.000

7.12 Road furniture and other features:

The road furniture, traffic safety features and other facilities included in the design are:

· Bus Shelters

· Road Markings

· Traffic Signs

· Kilometre Stone Details

· 200m Stones and Boundary Stones

Way side amenity at 18/200 km

Overhead sign boards at the start of the project road. The section of the signboard is provided in the drawings volume.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

CHAPTER 9: ENVIRONMENTAL AND SOCIAL IMPACT APPRAISAL

9.1 PRELIMINARY ENVIRONMENTAL ASSESSMENT

The preliminary Environmental Examination for the proposed project has been undertaken as a parallel exercise with the Engineering Analysis, so as to bring out the environmental concerns in planning and the proposed design. The basic aim of the present study is to assess the magnitude of actual and potential environmental concerns due to widening of the project highway.

This is also to ensure that the environmental considerations are given due weightage, in the design of proposed highway improvements being studied. Basic idea is to minimize adverse environmental and social impacts with best possible engineering solutions at the optimal cost to make development environmentally sound and sustainable.

The main objective of the environmental assessment shall include:

- ✓ To classify the type of environmental assessment required,
- ✓ To delineate the major environmental issues and identify the potential hotspots, which requires further study i.e. scope for EA,
- ✓ To recognize the potential environmental concerns,
- ✓ To determine the magnitude of potential impacts and ensure that environmental considerations are given due weightage while selecting and designing proposed highway improvements.

9.2 BOUNDARIES FOR ENVIRONMENTAL ASSESSMENT

The total length of the existing road under consideration is 26.947 km, which starts from Demwe and traverses through towns of Tohangam, BRO Labour Camp and ends at Brahmakund Tinali. The project road passes through the district of Lohit of Arunachal Pradesh State. The area of direct influence will be confined in a linear fashion along the corridor where the construction activities take place. The road is proposed to be widened into two- lane with paved shoulder for which ROW supposedly, is available. Therefore, the area of direct influence of 10 meters on either side has been considered.

However, for various other environmental Components, which are likely to have a broader area of influence, a distance of 10 Km on either side of the road (as per the MOEF Notification of Environmental Impact assessment, Government of India, 2006) has been used to define the indirect area of Influence. Thus, the term project influence area referred in this chapter therefore, covers both direct and indirect area of influence.

9.3 Inventory of Environmental Features

9.3.1 Secondary Data

Secondary information on various environmental components such as physiography, soil, geology, drainage, forest, ambient air quality, land-use, demography etc. have been collected from old reports & various published sources to examine the baseline status of the environmental features in the project influence area.

9.3.2 Local Concerns

In addition to the secondary data collected and the inventory information obtained, discussions with the stakeholders including the local people and government officials have been held so as to provide a realistic assessment of any significant/specific socio-environmental concerns due to proposed project. These discussions helped in incorporating the views of the stakeholders.

9.4 Baseline Environmental Assessment

The baseline environmental status of the project influence area is based on the field survey within proposed ROW and within the indirect area of influence, i.e., a radius of 10 km from the centreline of the road by environmental team, as well as data collected from various secondary sources. It will help in assessing the magnitude of potential impacts both beneficial as well as adverse due to the proposed project activities on the environment.

9.4.1 Natural Resource Base

9.4.1.1 Land, its quality and used

The state of Arunachal Pradesh has been divided into two physiographic zones-valley and hills, and Lohit is one of the hill districts of Arunachal Pradesh.

The Lohit district is situated on the north-eastern extremity of Arunachal Pradesh. It lies approximately between the latitudes 27®-33'N and 29°-22'N and the longitudes 95°-15'E and 97°-24'E. The. latitude of 28°N crosses the district at its broadest part and the longitude of 96°E runs through its longest part. Lohit, the largest among the districts of Arunachal Pradesh, is comparatively less known in the geological literature, probably because of the difficult terrain conditions and limited accessibility. Nevertheless, the record of geological observations in this district dates as far back as to 1825.

Physiography

The terrain may be divided into three main physiographic units as follows:

- The plain-belt of Lohit forming the eastern continuity of the upper Assam plains is drained and often inundated or marooned by the powerful westerly flowing Dibang, Lohit, Kamlang and partly Noa-Dihing rivers. These rivers pour a large volume of waters to the Brahmaputra.

- The lesser Himalayan region rising abruptly from the Lohit plains and comprising a rugged mountainous and forested terrain with conspicuous, north west-southeast ridges with altitudes above 3000 m in its middle reaches.
- The higher Himalayan region, which is normally snow-clad, rises to altitudes around 5200 m. The comparatively low ridges of the lesser Himalayas gradually rise to high snow-covered areas, particularly in the watershed of the Lohit (Tellu) river. The Lohit and Dibang rivers and their important tributaries emerge from the higher Himalayan region. The Kamlang and Noa-Dihing rivers on the south emerge from the Dapha Bum range of the lesser Himalayas. The Dibang Valley is probably the most awe-inspiring, whereas the Lohit River is the longest antecedent system emerging on the northern side of our frontier.

The climate of the district is subtropical monsoon type. The district has alluvial, lateritic black regur and red ferruginous type of soil. The district is mostly covered by forest and only small percentage of total geographical area is under agricultural use (2.13 percent) and settlement (1.45 percent).

9.4.1.2 Forestry

The Lohit District extends over 11,402 km^2 of geographical area of which the forests occupy 9667.44 km^2 reckoning to 84.79%. However, difficult terrain, inaccessibility to sizeable area, and exclusion of projected areas restricted the inventory to 2896.82 km2 of which the Reserved Forests (RF.) occupy 1545.32 km^2 and Unclassed State Forests (U.S.F.) cover 1353.50 km^2. The Forests occurring in the District are typical Tropical Evergreen Forests and Moist Deciduous Forests with dominance of Dipterocarpus macrocarpus (Hollong) and Terminalia myriocarpa (Hollack). In addition to these, Miscellaneous Forests, Bamboo and Riverian Forests also occur in the tract. The inventory results reveal 74.61% of the forest area "supporting tree vegetation, of which Dense Tree forests occupy 4.43%, moderately dense forests 37.61%, open tree forests 19.95%, and balance under young crop, regeneration and Bamboo growth.

From the legal perspective the forests of the state have been classified as:-
i) Reserved Forest (RF), (ii) Protected Forest (PF), iii) Wildlife Sanctuaries (WLS), iv) National Parks (NP), v) Anchal Reserved Forest (ARF) and vi) Village Reserved Forest (VRF).

The ownership right of these forests is vested with the state and has been legally notified. However, in case of Anchal Reserve forests, land is given to the communities with the understanding that 50 per cent of forest produce is to be utilized by the communities and rest should go to the government. The Unclassified State Forests (USF) are yet to be properly surveyed and demarcated. Unclassified State Forests are under the dual control of the Revenue Department and Forest Department. The Revenue Department issues land possession certificate (LPC), while the Forest Department deals the matters related to transit and trade of forest produces.

Table 55: DISTRIBUTION OF LEGAL FORESTS (IN SQ KM.) IN THE DISTRICT OF LOHIT (ARUNACHAL PRADESH)

No.	District	Reserved Forest	PF	ARF / VRF	WLS	NP	USF
1.	Lohit	**4233.53**	------	249.19	**783.0**	-----	1266.481

Source: Statistical Abstract of Arunachal Pradesh-2014

Lohit is basically an agricultural district and all the resources depend upon the agricultural output. Water is evidently the most vital element in the plant life and is normally supplied to the plants by natural rain. However, the total rainfall in a particular area may be either inadequate or is ill-timed.

9.4.1.3 Agriculture

Agriculture is the mainstay of the people of the district. Major food crops produced in this district are Paddy, Maize, Millet, Wheat and pulses, and a total of 17905 ha area cultivated under different crops. There is no major irrigation scheme in the district, but a good number of minor irrigation schemes have been constructed. During 2005-06, through 17 canals 159 ha irrigation potential has been created. Net area irrigated is 62 ha while gross area irrigated is 70 ha. Because of limited surface water source, the agricultural practice is basically mono-cropped. With the assured irrigation from ground water sources, more areas can be brought under permanent cultivation with multi cropping pattern.

9.4.2 Geology, Soil

Lohit District is a mountainous tract. On account of the existence of the hill ridges and the valleys its topography assumes typical character. The hill ridges are situated haphazardly. As soon as one ends the other ridge starts either parallel or in opposite direction. At these intervals the wide or narrow valleys get the foothills constituting 20 per cent to total geographical area of district. The wide and narrow valleys share 35 per cent each to total geographical area. The rest about 10 percent is the snow clad peaks. Due to typical topography the rivers are undulated. There are numerous streams and rivers and are drained by principal river Lohit, Naodihing etc. These principal rivers of the district are drained by the westerly flowing Brahmaputra. These rivers have rendered the human habitations into geographical isolations. At the same time these rivers possess high hydro-power potential. It could be developed as a good industry. The vast natural resources have drawn the attention of the Government during recent years.

Geomorphologically, Lohit district can be broadly divided into two categories Structural hills and Piedmont plains. Structural hills consist of valleys and ridges of definite trend lines. Piedmont plains are the plains in the foot hill belt of structural hills. All the major settlements like Tezu, Namsai etc. comes under piedmont plains.

The nature and properties of soil vary according to regional variations. In the hilly regions, the soil generally contains high humus and nitrogen due to extensive cover of the forests. The soil along the foothill areas is alluvial, loamy or sandy loam mixed with gravel and pebble brought down by rain from higher attitudes. The soil in the valley is rich in organic content. The soil is mainly acidic in nature. The soils in the district can be divided into a) plain alluvial soils up to 305 m attitude and b) hilly soils above 305m. The plains soils consist of the following types.

1. Older Alluvium Type

It represents the formation of higher level terraces in the foothill areas, consisting mainly of coarse sand and organic matter. It covers parts of Man Bum and Namsai forests on the east, Lohitpur and Timai in the middle and Roing to Sonitpur area on the west. The soil is generally loamy and brownish in colour.

2. Silt Type

It comprises the area next below the terraced type. The high silt content of this area is confined to the present flood plains on the banks of the big rivers and their tributaries. This type consists or comparatively recent alluvial deposits characterized by shallow surface layer of silt with a sub-soil of coarse sand sometimes mixed with pebbles and boulders. The soil is sandy and comparatively poorer.

3. Low Level Type

It includes depressions and swamps which remain submerged under water for sometimes during the rainy season. The surface soil is generally clay.

9.4.3 Climate and Rainfall

The climate is cool and highly humid in lower elevations and in the valleys. The cold season prevails from the later part of November to February and is followed by frequent thunderstorms in the pre-monsoon season from March to May. Very heavy and frequent monsoon showers continue from May to about the middle of October. There is hardly a day during this period when it does not rain.

The climate of the district is largely influenced by the nature of its terrain. Climate is sub-tropical (rather cool), wet and highly humid in the lower elevations and in the valleys. The area falls in heavy rainfall belt and average annual rainfall is 5179 mm.

9.4.4 Land-Use Pattern

The land-use pattern along the project corridor is mainly forest land. No industrial belts are found in this stretch. The built-up area mainly composes of sheds with small kiosks are situated near to the project stretch.

9.4.5 Water Resources

The only source of water along this stretch is the tributaries of river Lohit flowing on the valley side.

9.4.6 Water Quality

The district is totally covered by hills with slopes more than 20%. Since the poor quality ground water is only a localized phenomenon, the block-wise poor quality area has been taken as nil. Water qualities as well as quantity are major concerns in the rural sector of the hill district. Biological contamination of drinking water supply combined with scanty quantity has been a major cause of most of the ill health. Because of the shortage of safe drinking water many people use the available surface water for drinking and domestic purposes from any source. The people illegally break the water pipe and tap inviting another problem of the hazard.

9.4.7 Air Quality

Ambient air quality of the area is moderately polluted as per the discussion with the State Pollution Control Board personnel's owing to the highway passing through hill locks prone to erosion.

9.4.8 Noise Level

Since the traffic volume on the project road is not much and the highway is generally passing through open hills, noise is not a major problem at present. The noise level becomes insignificant near the built-up areas but is in permissible levels.

9.5 Ecological Resources

9.5.1 Trees/Vegetation within corridor of impact

The road alignment passes primarily through rich agricultural fields. Ecological assessment indicates that many trees exist (on both sides of the road) within the R.O.W.

9.5.2 Wildlife

The project highway does not pass through any ecologically sensitive area.

9.6 Assessment of the Impact on the Environment of the Project

9.6.1 Impact on the Topography and the Geology

During the construction it is expected small negative impact on the performance of the preparation works on the location. As there is no land slide zones during the performance of the excavation, there is no danger of appearance of landslips. The potential of appearance or deepening the erosion processes as a result of the construction and exploitation of the highway can be seen from the analysis of the geo-mechanical characteristics.

9.6.2 Impact on surface water and groundwater

During the preparation of the field for newly aligned roads and establishment of constructional zones around the route of the highway, there can be pollution of the surface waters and groundwater of temporary character in shape of erosion and disposal of sediments and surrounding stream flows. The erosion appears mostly because of the removal of the soil cover. The pollution of the stream flows can occur as a result of leakage of the fuel and oil from the equipment and the vehicles, as well as different waste which is created during these activities.

Typical impacts on the quality of the waters as a consequence of the road drainage are the changed levels of heavy metals, salinity, blurring of the waters and dissolved oxygen. On the other hand, these changes in the water quality, even in regions with high humidity, are often temporary and localized as a consequence of the variations of the water quantity.

9.6.3 Impact on the Air

The emissions in the air during the construction will appear as a result of the exhaust gases from the constructional mechanization. Within these emissions will appear polluters as SOx, NOx, CO, VOC etc. Generally, it is expected less concentrations of these polluters, for which it is expected fast dispersion of the open regions in which the project is performed, and it is also potentially expected jeopardizing small number of people, because of the small number of settlements to which the route is approaching. Dust will appear as a result of the soil works and the activity of the preparation of the field and clearance, excavation, mining in rock etc.

It is expected that the effects from these impacts to be of local and short-term importance. In the operational phase, emissions will appear from vehicles which will run along the highway, i.e. from:

- System of exhale gases;
- The casings of the monitors through the exhaust pipe
- Carburetor, reservoir

On this level of planning it can be assumed that the frequency of the traffic along the highway will be with limited volume. In case of increased frequencies of traffic, (increasing which can mostly by with seasonal character), it is possible to appear necessity of application of appropriate biological measures for protection of air pollution.

9.6.4 Impact on Soil

The activities of construction and setting on the highway directly will damage the soil quality and it will reflect on the change of the specific geological characteristics. The soil works, that will potentially have an impact on the soil characteristics and, accordingly, to the soil quality, are:

- Removal of the surface layer of the soil (humus)
- Smoothening of the surface – Compaction to the necessary density
- Performance of quarries and dumps for removal of the remained excavated soil material

The impact in the construction phase on the soil pollution is assessed as negative with insignificant size and of temporary character. For the operational phase characteristic are impacts connected with the soil quality damage as a result of the emissions of the pollutant from the traffic. Along the route of the highway there is an agricultural land. Certain zone beside the route of the highway will be endangered due to the pollution which will occur because of the traffic.

9.6.5 Impacts Caused by Waste Management

The primary forms of hard waste which will be generated during construction phase will be:

- Excess excavated soil and sand
- Packing waste
- Debris and construction waste
- Waste tires (of constructional mechanisation)
- Waste oils and greases (from construction mechanisation)
- Communal waste of working site camps (construction sites).

For managing excess excavated material, it will be made appropriate disposal sites. Their location is chosen according to the geo-mechanical elaboration and confirmed with this Study, considering that the criteria like avoiding catchment areas of rivers, avoiding areas with sensitive habitats, i.e. valuable areas, are respected. For managing construction waste, it will be done segregation of the inert material and the same will be removed on location determined by the local authorities. In case of creating waste with dangerous character, the same will be given to the licensed company.

It is not expected creating waste during the exploitation due to the fact that resting site or any other construction in the area of the road is not planned.

9.6.6 Impacts Caused by Increased Noise and Vibration

The construction of the highway is connected with a series of activities which cause vibration, like using construction mechanisation and eventual rock mining during performing of the vertical alignment for the parts of the route which lead to excavation. The impacts from the vibration are expected to be insignificant, and to have an impact mainly on a local level. Along the highway it is not expected excessive noise because of the relatively low frequencies of traffic. However, the highway is approaching the some settlements. These locations are potentially endangered due to harmful noise.

9.6.7 Impact on the Area and Visual Effects

The area, in the range of the construction zones, established along the highway will be clearly changed during the construction. Main receptors of the new look of the area in phase of setting the construction will be the local population and the passengers which pass through the local roads. In phase of usage, it is expected the visual effect of the highway to be insignificant.

9.6.8 Impact on Social Elements of Environment

The following positing effects on the population are expected due to this project:

- Possibility for employing qualified and unqualified workers
- Purchase (expropriation) of the land in a private ownership

Taking into consideration in most, the route of the highway passes through many settlements, the construction activities of the same locations of the construction will have direct impacts on the human health. The construction phase will require temporal or permanent expropriation of the farmland and the urbanizing land in private property (residential areas in the suburb of the settlements, weekend houses etc.).

9.7 Measures to Reduce the Negative Impact on the Environment

9.7.1 Measures to reduce the impact on topography and geology

The following measures will be applied to prevent erosion of big volume during remediation of the landfills:

- Careful planning of the construction works with a goal to decrease the negative effects and to provide preventing erosion.
- Decreasing the size of the location, because of the minimizing the land which is under a negative influence, and stopping the erosion and polluting the soil
- Restriction of the movement of the vehicles and usage of mechanisation which put a smaller pressure of the area
- Precise performance of the construction works, avoiding leakage of vehicles. The vehicles should be constantly maintained to prevent leakage.
- Appropriate clearance of the material which is spilled on the spot.
- Minimizing the loss of vegetation along the construction site
- Construction works cannot run in heavy rains,
- Decreasing of the speed and volume of the polluted area drain.
- Implementing preventing measures for landslides, stabilizing the incline if necessary

9.7.2 Measures to Reduce the Impact on Surface Water and Groundwater

The measures for protection of the surface waters and groundwater are reduced to consistent application of good construction practice during the construction works connected with the highway, i.e. preventing erosion, managing sediments, maintaining construction mechanization out of the areas sensitive on releasing the waste waters etc. Protection on surface and ground waters quality, in operational phase will be reached with application of appropriate system of drainage of the washing out waters from the pavement area.

9.7.3 Measures to Reduce the Impact on Air

For mitigation the impacts on environment in the construction phase, it is suggested performing a strict control on the constructional methods and the used mechanization and other equipment. As an eventual measure during the operational phase it is suggested planting a green belt in the sideways of the road which will prevent wider dispersion on air pollution caused by the traffic along the route of the road.

9.7.4 Measures to Reduce the Impact on the Soil

For reducing the impacts on the soil, there will be taking measures for preventing leakage of polluting materials and oils from constructional mechanization in the surrounding soil, the eroded areas will be rehabilitated and safely stored and the construction materials and construction waste will be removed.

In operational phase, the measures to reduce the impacts are identical with the measures for mitigation of erosion.

9.7.5 Measures to Reduce the Impact Caused by Waste Management

Because of protection of the environment (soil, waters and region), it is predicted application of statutory regulation orders relating to the waste management. Additionally, it is suggested preparation of plans for waste management of the construction locations in order to enable recycling of recyclable materials, and also to separate the dangerous fractions for the purpose of their appropriate collecting, storing and giving to licensed companies which deal with this kind of waste. In order to avoid pollution of the environment with constructional waste and solid waste during the exploitation of the highway, it will implement a ban for disposal of the same along the route in the road.

9.7.6 Measures to Reduce the Impact Caused by Noise and Vibration

The measures for mitigation of the impacts caused by noise and vibrations in construction phase include: Careful planning on preparation works in order to decrease the noise, avoiding equipment which will emit noise more than 90 dB, control on constructional methods and usage of mechanization and regular maintenance of the equipment because of the possible decrease of

the noise, careful planning on time of the works in the settlements (ex: ban on construction in certain period during the day or night, as well as seasonal bans during the mating of certain animal species and/or birds), avoiding loud sound signals in the settlements/decease of the disturbing the peace of the citizens, limiting the speed of the constructional vehicles, especially in the towns etc. The route of the highway approaches many settlements.

9.7.7 Measures to Reduce the Impact on the Area and Visual Effect

The measures for mitigation of the impact on the environment, beside the recommendations for mitigation, reducing the size of the construction site, application of good practises for designing and construction, careful maintenance and appropriate maintenance of the order 25 and cleanness of the construction site, also include fast disposal of the constructional waste of the approved places, filling the holes/quarries made during excavation of sand by the excavated material, repairing the footpaths and roads right after finishing the works with the performance of the highway and re-vegetation of the inclines, careful closing of the construction sites/places for waste disposal/cleaning of the construction site after finishing with the construction works/re-vegetation of the region and completing the construction activities with removal of all obstacles.

9.7.8 Measures to Reduce the Social Impact

Among the measures for reduction of the social impact in the construction phase are the measures for protection of the workers from workplace injuries, measures for compensation of the citizens whose property is expropriated and measures for compensation of the citizens whose property is with reduced value because of the pollution of the surrounding land. In the working phase of the highway, it is expected positive impacts on the population and the human health, especially regarding the improving the communication, the transport of people and goods, so due to that reason, there aren't any measures predicted in this phase.

9.8 Regulatory Clearances

Regulatory Clearances required as per the new alignment

Table 74: LIST OF REGULATORY CLEARANCE REQUIRED

Sl.No	Required Clearances
1	Forest Clearance
2	Civil designs from Chief Engineer, Central Design Office, I&CAD Department
3	Permission for water extraction from Irrigation & CAD Department

9.9 Policy, Legal And Administrative Framework

The legal framework for addressing the environmental components are governed by National and State legal frame work which are covered under the Environmental (Protection) Act, 1986, and Rules, 1987-2006 (various), The Motor Vehicular Act,1988 and Central Motor Vehicles Rules, State Motor Vehicles Rules, Noise Pollution (Regulation and Control) Rules, 2000. Government of India has prepared various National Policies, Acts, Rules to protect exploitation of natural resources and improve the environment and to safeguard forest and wildlife of the country. Similarly, the legal framework and principles adopted for addressing the resettlement issues in the project have been guided by the existing legislation and policies of the GOI and the Government of Arunachal Pradesh. Prior to the preparation of the compensation Plan, a detailed analysis of the existing National and State policies is very much essential. Brief description of applicable environmental regulations related to the proposed development is given below:

9.9.1 Environment (Protection) Act, 1986

The Environment (Protection) Act is the most comprehensive law on the subject. The law grants power to the Central Government to take all measures necessary to protect and improve the quality of environment and to prevent pollution of the environment. In terms of responsibilities, the Act and the associated Rules requires for obtaining environmental clearances for specific types of new/expansion projects (addressed under Environmental Impact Assessment Notification, 14th September 2006) and for submission of an environmental statement to the State Pollution Control Board annually.

9.9.1.1 Environment (Protection) Rules, 1986

These rules lay down the procedures for setting standards of emission or discharge of environmental pollutants. The rules prescribe the parameters for the Central Government, under which it can issue orders of prohibition and restrictions on the location and operation of industries in different areas. The Rules lay down the procedure for taking samples, serving notice, submitting samples for analysis and laboratory reports. The functions of the laboratories are also described under the Rules along with the qualifications of the concerned analyst.

9.9.1.2 EIA Notification, 2006

As per the Environmental Impact Assessment (EIA) Notification, 14th September 2006 and its amendment up to April 2011, new projects or activities require Prior Environmental Clearance. Projects have been grouped under Category 'A' requiring clearance from Expert Appraisal Committee (EAC) of MoEF, GoI and Category 'B' requiring clearance from the State Expert Appraisal Committee (SEAC). The concerned Committee (EAC or SEAC) will finalize the ToR on the basis of Form-1, proposed TOR & Pre-Feasibility/ Feasibility Report. Environmental Impact Assessment study is to be carried out as per the ToR provided by the Committee. Public Hearing

is required for Category 'A' project. List of projects requiring Prior Environmental Clearance is given in the "SCHEDULE" of EIA Notification.

9.9.2 Forest (Conservation) Act, 1980 and its amendment

This Act provides for the conservation of forests and regulating diversion of forestlands for non-forestry purposes. When projects fall within forestlands, prior clearance is required from relevant authorities under the Forest (Conservation) Act, 1980. State Governments cannot de-reserve any forestland or authorize its use for any non-forest purposes without approval from the Central Government. For diversion of forestland, the project proponent needs to apply to the State Government. Depending on the area required to be diverted, the proposals are cleared by MoEF Regional or Central Offices provided that the cost of compensatory afforestation, cost of rehabilitation of endangered/rare species of flora/fauna, and the net present value of the forest resources are deposited upfront with the state Forest Department.

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

9.9.3 Wildlife Protection Act, 1972

This Act empowers the Central and State Governments to establish National Parks and Sanctuaries; to formulate rules and designate authorities for the maintenance of National Parks, Sanctuaries and Zoos; to protect and conserve the flora and fauna. Vide Circular No. 11-9/98-FC dated 4-12-1998 issued by the Asst. Inspector General of Forests states that the Ministry of Environment and Forest has taken a decision not to permit development activities inside National Park/Sanctuaries and Tiger reserves areas that are not in consonance of Section 29 of the Wildlife (Protection) Act, 1972.

9.9.4 Biodiversity Act, 2002

The Biological Diversity Act, which came into force in February 2003, aims to promote conservation, sustainable use and equitable sharing of benefits of India's biodiversity resources. It provides for establishment of a National Biodiversity Authority at national level, State Biodiversity Boards at state level and Biodiversity Management Committees at the level of Panchayats and Municipalities. The National Biodiversity Authority shall play a regulatory role

with regard to access to biological resources by foreign citizens and grant of intellectual property rights. It shall play an advisory role in matters relating to the conservation, sustainable use and equitable distribution of biological resources.

9.9.5 The Water (Prevention and Control of Pollution) Act and Rules, 1974-1975

This Act represented India's first attempts to comprehensively deal with environmental issues. The Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. The act was amended in 1988 to conform closely to the provisions of the EPA, 1986. It set up the CPCB (Central Pollution Control Board), which lays down standards for the prevention and control of water pollution. At the state level, the SPCBs (State Pollution Control Board) function under the direction of the CPCB and the state government.

9.9.6 The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987

To counter the problems associated with air pollution, ambient air quality standards were established, under the 1981 Act. The Act provides means for the control and abatement of air pollution. The Act seeks to combat air pollution by prohibiting the use of polluting fuels and substances, as well as by regulating appliances that gives rise to air pollution. Under the Act establishing or operating of any industrial plant in the pollution control area requires consent from the state boards. The boards are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes. To empower the Central and State Pollution Boards to meet grave emergencies, the Air (Prevention and Control of Pollution) Amendment Act, 1987, was enacted. National Ambient Air Quality Standards (NAAQS) for major pollutants were notified by the CPCB first time in April 1994 and further notified in 16th November 2009.

9.9.7 Ancient Monuments and Archaeological Sites and Remains Act, 1958

The legal requirement is to obtain from ASI a no-objection certificate if any protected cultural property is within 10km of the project.

9.9.8 The Land Acquisition Act (LA) of 1894

The private land acquisition will be guided by the provisions and procedures outlined in this Act. As per the LA Act, the District Collector or any other officer designated will function as the Land Acquisition Officer on behalf of the Government. There is a provision for consent award to reduce the time for processing if the land owners are willing to agree for the price fixed by the Land Acquisition Officer. The option of acquiring lands through private negotiations is also available.

9.9.9 National Rehabilitation and Resettlement Policy, 2007

This policy strikes a balance between the need for land for developmental activities & protecting the interests of land owners and others. The benefits under the new policy are available to all Project Affected Persons (PAP) & families whose land, property or livelihood is adversely affected by land acquisition, involuntary displacement due to natural calamities, etc.

9.9.10 National Resettlement and Rehabilitation Policy (Ministry of Rural Development, Department of Land Resources), 2007

In India, compensation for land acquisition (LA) and resettlement assistance for project-affected people is generally governed by the Land Acquisition Act (1894), which has been amended from time to time.

A National Policy on Resettlement and Rehabilitation (NPRR) 2007 was adopted by the Government of India (GOI) to address the issues not addressed in the LA Act and also to cover development induced involuntary resettlement of people.

The policy aims to minimize displacement and promote, as far as possible, non-displacing or least displacing alternatives. The policy also aims to ensure adequate rehabilitation package and expeditious implementation of the rehabilitation process with the active participation of those affected. The policy also recognizes the need for protecting the weaker sections of the society especially members of the Scheduled Castes and Scheduled Tribes. The objectives of the National Rehabilitation and Resettlement Policy are to:

- Minimize displacement and to promote,' as far as possible, non-displacing or least-displacing alternatives;
- Ensure adequate rehabilitation package and expeditious implementation of the rehabilitation process with the active participation of the affected families;
- Ensure that special care is taken for protecting the rights of the weaker sections of society, especially members of the Scheduled Castes and Scheduled Tribes, and to create obligations on the State for their treatment with concern and sensitivity;
- Provide a better standard of living, making concerted efforts for providing sustainable income to the affected families;
- Integrate rehabilitation concerns into the development planning and implementation process; and where displacement is on account of land acquisition, to facilitate harmonious relationship between the requiring body and affected families through mutual cooperation.

9.9.11 National Rehabilitation and Resettlement Policy, 2013

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 is an Indian Parliament act that regulates land acquisition and laid down

rules for granting compensation, rehabilitation and resettlement to the people affected in regions in the absence of any state Act.

Table 75: APPLICABILITY OF ENVIRONMENTAL REGULATIONS

Sl No	Environmental Regulation	Applicability in the Sub-project
1	Environment (Protection) Act, 1986	Not Triggered
2	EIA Notification, 2006 and its amendment up to April 2011	Not Triggered
3	Coastal Regulation Zone Notification (CRZ), 2011	Not Triggered
4	Forest (Conservation) Act, 1980 and its amendment	Triggered
5	Wildlife Protection Act, 1972	Not Triggered
6	Biodiversity Act, 2002	Not Triggered
7	The Water (Prevention and Control of Pollution) Act and Rules, 1974-1975	Not Triggered Due to raising & strengthening of Embankment, there will be no discharge of pollutants into the water bodies located adjacent/ close to the embankment.
8	The Air (Prevention and Control of Pollution) Act, Rules and Amendment, 1981, 1982, 1983, 1987	Not Triggered
9	Ancient Monuments and Archaeological Sites and Remains Act, 1958	Not Triggered As there are no ancient monument and Archaeological site, no ancient monument or building as notified by ASI (Central/ State List) will be affected.
10	The Land Acquisition Act (LA) of 1894	Not Triggered
11	National Rehabilitation and Resettlement Policy, 2007	Not Triggered

ENVIRONMENTAL MANAGEMENT PLAN

PRE-CONSTRUCTION STAGE

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
PRE-CONSTRUCTION STAGE					
Pre-construction activities by Project Implementation Unit					
P.1	Land Acquisition	The acquisition of land and properties (Govt. /private) will be carried out in accordance with the Rehabilitation Action Plan as prescribed by Govt. of AP, as per the entitlement framework for the project. APWD has to ascertain that any additional environmental impacts resulting from additional acquisition of land shall be addressed and integrated into the EMP and other relevant contract documents.	LA Act 1984 and its Amendments, R&R Policy AP Govt. R&R Policy.	EMU of APWD, Revenue Dept., NGOs, Collaborating Agencies	EMU of APWD
P.2	Preservation of Trees	As far as possible maximum efforts to minimize the list of trees proposed to be felled by suitable on the spot adjustment of engineering designs at the time of execution. Tree cutting is to proceed only after all the legal requirements including attaining of In-principle and Formal Clearances from the Forest Dept. / SEIAA / MoEF are completed after which a joint enumeration of the trees to be cut is prepared by the PIU in association with AP Forest Development Corporation (MFD), and Forest Department. Subsequent approval orders from the divisional forest officer having jurisdiction over the area are to be issued to fell the trees in compliance with the AP Timber and other forest produce transit rules 1980 and AP Forest Act. 1972. The felling has to be carried out by the MFDC. In the event of design changes, additional assessments including the possibility to save trees shall be made if necessary separate proposals for felling of such trees submitted to the Divisional Forest officer concerned after joint enumeration to issue tree felling and conversion orders. Systematic corridor level documentation for the trees to be cut and those retained. A separate list will be maintained	MoRTH 201.2 Guideline 1 (Guidelines for arrangement with Forest Department)	Contractor Agency engaged by EMU of APWD	Supervision Consultants and EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		by the PIU / APWD in a bound register for each contract package of the corridor duly signed by the site in charge, contractor and designated officer of the FDC ltd., so that no such unmarked trees will be cut or removed from the corridor.			
P.3	Tree Cutting	Trees will be removed from the Corridor of Impact before the actual commencement of the construction work to prevent traffic problems and accidents. No construction activity and tree felling should be simultaneously taken up in any location of the package, which has not been cleared by the regional C.C.F. or the MoEF Govt. of India for any reason what so ever. felling, logging, stacking of fire wood and passing of timber are to be synchronized with the corridor development action plan for each package and removal of the converted materials shall be taken up by the responsible agencies as per tree cutting and removal guidelines of this report subject to any other stipulation that may be prescribed by competent authority of Forest Department.	MoRTH 201.6 Guideline-1 (Guidelines for arrangement with Forest Department)	Contractor Agency engaged by EMU of APWD	Supervision Consultants and **EMU of** APWD
P.4	Relocation of Community Utilities and Common Property Resources	All CPRs (common property resources) such as stand posts, bore wells, wells, ponds, water supply lines, sewage lines, drainage systems, optical fibre cables, telephone and television cables together with electric power supply lines shall have to be removed and relocated outside the corridor before commencement of the road improvement activity. The aim of such precondition is to reduce stress to the local population and to prevent un necessary loss of man-days along with law and order situations, accidents, and pollution and traffic problem. While relocating these essential but hazardous CPRs, care should be taken to prevent accidental fall into bore holes, pits, drains and demolition sites by provision of barricades and covers over such sites whether it is a residential or non-residential area. In case of schools, colleges, hospitals, govt. offices, gram Panchayat market places or weekly market areas extra care has to be taken to ensure construction of the boundary wall and buildings as the case may be, so that no accident occurs. Early completion of the schools	RAP document of APSRP.	**EMU of** APWD, Concerned Agencies, Contractor	EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		and college buildings and boundary walls may be planned for execution during the summer vacation, so that the impact on the day to day activity of such institutions are minimized with total avoidance of freak accidents. In case of hospitals and govt. buildings, staff quarters, weekly markets and kisan markets, extra care has to be taken to prevent unusual hardship to the public on account of demolition and discontinuance of the functioning of such facilities by providing new accommodations /new constructions as the case may be before demolition of the existing structures ahead of the actual road constructions. The relocation sites for CPRs mentioned above shall be in consultation with the respective local administrative authorities, concerned departments in addition to the local gram sava as the case may be and finalized with environmental considerations. In case of any doubt or any problem the views of the site engineer, supervision consultant and the local administration has to be ensured by the contractor executing agency prior to finial execution.			
P.5	Relocation of affected Cultural and Religious Properties	Religious structures, statues, mandaps and boundaries coming within the RoW has to be demolished after alternate sites are selected for relocation of the structures where total replacement is necessary in consultation with the management committee / trustee / Endowment authority and after disbursement of due compensation amount under the active support and cooperation of local administration as these are very sensitive issues warranting special attention. No such structures be destroyed or removed and relocated without the knowledge and consent of interested parties and location decided after the involvement of local civil and police administration. These activities must be completed before commencement of the physical road improvement activity in that part of the package. Any such construction of religious sites other than the boundary walls with site enhancement measures and approach roads should not be taken up by the contractor or PIU since compensation is being	Annexure (List of CPRs)	EMU of APWD, NGOs, Contractor	Supervision Consultant EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		paid for all such structures. In case of approach roads and boundary walls detailed designs and action plan has been provided in the drawings enclosed to the environmental management plan in the tables above for each of the components under impact. Care should be taken to ensure the drainage and garbage disposal of such sites very near to the road so as to prevent generation and accumulation of polluting materials which is a normal feature in and around many of these structures. Garbage collection bins and soaks pits for waste disposal may be provided as an additional measure in consultation with the local managing trustee.			
P.6	Orientation of Implementing of Agency and Contractor	The APWD shall organize orientation sessions and regular training sessions during all stages of the Project. This shall include on-site training (general as well as specific to the context of a sub-project). These sessions shall involve all staffs of the APWD involved in the implementation of EMP, Environmental Specialists of the PIU and the Contractors.			
Pre-construction activities by the Contractor/Environmental Expert of Supervision Consultants (SC)					
P.7	**Field Verification and Modification of the Contract Documents**				
P.7.1	Joint Field Verification	The Environmental Expert of Supervision Consultant and the Contractor will carry out joint field verification with the site engineer to ascertain the possibility to saving trees, environmental and community resources wherever such representations or suggestions in writing have been received and forwarded by the project authority or by the site engineer in accordance with the local situations. In all such cases the interested organization, authority, expert, the executing and supervising agencies together with the local administrative set up, has to undertake a joint field verification for assessing the pros and cons of such demands /suggestions to assess the need for any additional features, changes in the design and implementation of the activities, earlier approved by the competent authority. The complaints /suggestions /changes together with the		Contractor/ Environmental Expert of S C	EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		observations and expert opinion of the joint verification team containing the need for additional protection measures, or changes in design /scale/nature of protection measures including the efficacy of enhancement measures suggested in the EMP, shall be reduced to a written document containing all the details with date, time, place and signature of such individuals.			
P.7.2	Assessment of Impacts due to Changes /Revisions /Additions in the Project Work	The Environmental Expert of SC will assess impacts and revise /modify the EMP in consultation with the site engineer in accordance to the recommendation made by the field survey party and the project document/s in the event of changes /revisions (including addition or deletion) in the project's scope of work.		Contractor/ Environmental Expert of SC	EMU of APWD
P.7.3	Crushers, hot-mix plants and Batching Plants Location	Hot mix plants and batching plants will be located away from settlements and agricultural operations, commercial establishments to the extent possible taking care to avoid nearby wildlife movement corridors and forest areas in the vicinity. Such plants will be located at least 200 m away from the nearest village /settlement preferably in the downwind direction. The Contractor shall submit a detailed layout plan for all such sites and prior approval of Environmental Expert of SC shall be necessary. Arrangements to minimize dust pollution through provision of windscreens, mist spray units, and dust encapsulation will have to be provided at all such sites. Specifications of crushers, hot mix plants and batching plants should have to comply with the requirements of the relevant current emission control legislations and Consent / NOC for all such plants shall be submitted to the S C and APWD. No such installation by the contractor shall come into operation until and unless all legal clearances are obtained from the competent authority.	MoRTH 111.1 Air Pollution Control Act, and Noise Rules Guideline-2 (Generic Guidelines for environmental friendly construction methodology)	Contractor/ Environmental Expert of S C	EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
P.7.4	Other Construction Vehicles, Equipment and Machinery	All vehicles, equipment and machinery to be procured for construction, will confirm to the relevant Bureau of Indian Standard (BIS) norms. The discharge standards promulgated under the Environment Protection Act, 1986, will be strictly adhered to. The most efficient and user friendly equipment confirming to the latest noise and effluent emission control measures available in the market shall be used in the Project. The Contractor shall maintain a record of PUC for all vehicles and machinery used during the contract period, which shall be produced by the contractor or its authorized representative to the Executive officer of APWD for verification whenever required for ensuring the continuity of such use by the contractor at the time of inspection of statutory authority and environment impact monitoring body.	Air Pollution Control Act, 1981, and Noise Rules and Motor Vehicle Act, 1988 Guideline-12 (Guidelines for storage handling use and Emergency response for Hazardous Chemicals)	Contractor/ Environmental Expert of Supervision Consultant	EMU of APWD
P.8	Identification and Selection of Material Sources				
P.8.1	Borrow Areas	Finalizing borrows areas for borrowing earth and all logistic arrangements as well as compliance to environmental requirements, as applicable, will be the sole responsibility of the contractor. Where borrow areas other than the Govt. land is brought under operation by the contractor to meet the additional requirement or for speedy completion of works, legal and fail safe documentary permission from the land owner shall have to be obtained by the contractor prior to activating such borrow areas. An authentic copy of such document shall have to be submitted to the SC and the site engineer along with test reports showing the standard of the material available from the borrow area along with documentary details of the land. Such locations finalized by the contractor shall be reported to the Environmental Expert of Supervision Consultant and who will in turn the report to APWD. Location of selected borrow areas is listed in the location and lead chart of quarries, borrow areas for the project.	Guidelines /Criteria for evaluation of borrow areas	Contractor/ Environmental Expert of S C	EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		Most of the haul roads to the designated borrow areas and quarry sites have been provided with WBM or Black Top paved roads except shorter distance from the road to actual site of removal. Except for haulage of sand and earth all other roads are either bituminous or WBM surface roads or murrom topped roads, which will be useable throughout the year by minimum maintenance and repair along with strengthening of pot holes and diversions at construction sites. The kutcha /earthen road requiring strengthening during rains and winter months shall have to be taken up for improvement as and when so required to reduce air and water pollution, logistic problem and generation of dust through frequent sprinkling of water and repairing of the haulage road besides proper coverage of the loaded vehicles by waterproof tarpaulin. Speed limit should be fixed by the SC and the environment expert for operation of haulage vehicles with record of entry and exit to the quarry area in order to keep track of the movement of vehicles, personnel and timing of movement in shape of a logbook. This has to be maintained by the record keeper placed at the entry & exit points of such haulage roads as a traffic control measure, besides standing instruction regarding slowing down of movement while passing near populated areas, schools, colleges, courts etc. In addition to testing for the quality of borrow materials by the Supervision Consultant, the environmental personnel of the Supervision Consultant will be required to inspect every borrow area location prior to approval.			
		Without the prior consent of the land owner/s no agricultural land or any private property be used as a haulage road by the quarry operator /contractor. In all such cases, where the contractor has to use alternate connecting roads to quarries and borrow areas passing through private land, an agreement as per the terms and conditions agreed to between the land owner and contractor shall have to be executed before competent authority indicating the map and the location of the proposed haul road with survey no.s, khatian no.s and kisam details as per the Govt. Record of Right (ROR). There should be a precondition in all such cases of private land to restore the	Guide lines for use of private property as quarry /borrow site.	Contractor/ Environmental Expert of Supervision Consultant	EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		original condition of the land soon after the use of the said land is dispensed with. The contractor will consult the Environmental Expert of Supervision Consultant before finalizing the haulage network and also take necessary approval from the expert. Supervision Consultant in turn shall have to report all these facts with documentary proofs of quarry site, borrow areas, distance from the project, road location of haulage road with a reference to plot no., khatian no. duration of the activity, area to be operated etc. including pre conditions to be fulfilled at the time of use and at the time of abandoning the sites to the APWD.			
P.8.2	Quarry	Contractor will finalize the quarry for procurement of construction materials after assessment of the availability of sufficient materials and other logistic arrangements. In case the contractor decides to use quarries other than recommended by DPR consultants, then it shall be subjected to technical evaluation of quality for conformation of the physical standard fixed by the IRC that has been selected as suitable for use on the specific corridor. The contractor will procure necessary permission for procurement of materials from Directorate of Mines Govt. of AP, District Administration and State Pollution Control Boards, written approval from the local Tahesildar to operate, depositing required fees to operate such quarry and shall submit a copy of the approval and the rehabilitation plan to the APWD and Environmental Expert of the Supervision Consultant. No quarry would be selected in and around adjacent to forest boundary, wildlife movement path, breeding and nesting habitats, reserved forest, national parks and sanctuaries etc. Contractor will also work out haul road network and report to Environmental Expert of Supervision Consultant who shall inspect and in turn report to APWD the suitability of such haul roads from biodiversity and environment angles. Before approval of such haul roads other than the existing (under use) the procedure as enumerated for borrow areas has to be followed and documentary	MoRTH 111.3 Annexure - 3.2	Contractor	Environmental Expert of SC and EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		evidence with maps showing site details accompanied with copy of revenue records submitted to APWD through the SC.			
P.8.3	Sand	Quality sand shall be procured from riverbed adjacent to the corridors i.e. from river Godavari in NH-16 at other places up stream free from silt and other impurities. For this, procurement shall be made after declaration of sand quarry sites by the local Tahesildar with the concurrence of the district Collector with due regard to miner minerals concession rules 2004. In case of selection of new sites for sand quarry, the Contractor has to obtain prior approval and concurrence of the quarry site from competent district authority and the Environment expert of the SC keeping in view the objection and convenience of the local population, which may restrain such activities for their own security and safety. This is because many times removal of sand from riverbed results in change of the watercourse endangering embankment and the nearby habitation. This also impacts the embankment adversely when haulage is through the embankment. All these things are to be looked into by the SC and Environment Expert before agreeing to the proposition of the contractor for new sand quarry sites. Where the supplier of sand is another party other than the contractor, the authentic copy of the lease agreement that has been executed between the local Tahesildar and the supplier has to be submitted to the Executive Engineer of the project before any procurement is made there from. To avoid accidents and caving in of sand banks at quarry sites it should be removed layer by layer and digging dipper than the permissible limit has to be avoided at all costs. Such quarry should be barricaded 10mtr away from the periphery on all sites except the entry point, so as to prevent accidental fall of domestic cattle, wildlife and human beings. The flood embankment on either side of the river should not be used for movement of tippers and loaders, which are very likely to be damage and destroy such structures. Instead the haulage roads should have to be constructed afresh	MoRTH 111.3 Annexure - 3.2	All riverbeds recommended for sand extraction for the project.	Environmental Expert of SC and EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		avoiding the embankment for safety and security of the vehicles, road users and the habitation along the banks of the river.			
P.8.4	Arrangement for Construction Water	As far as possible all efforts should be made to ensure avoidance of competitive use of a single water source, that may be depleted on account of the stress caused by drawing of water for road construction activity by the contractor. The contractor should use surface water depending on the availability and quality by developing its own water harvesting units in a river bed, digging up sand to store the percolated river water from where water can be lifted using diesel or electric pump sets. In case of nalas and water scarcity areas sinking of bore wells adjacent to nalas and streams may be made, so that while the water requirement for road construction is solved the structures when abandoned will serve as a ground water recharge through suitable modification of the structures, without impacting the purity and competitive users. If there is any subsequent modification in the relevant acts for use of ground or river water for such activities the contractor shall be bound to pay for the royalty due for use of such water as may be decided by the State Govt. from time to time. Use of ground water facility shall be subject to the local legislation and ground water availability and the competent authority for such permission as declared by the State Govt. from time to time shall have to be contacted for issue of necessary permission in this regard. Use of any other water source such as irrigation bunds, ponds, water harvesting structures and damming up of river /stream flow which is likely to strain and deplete the inhabitant in and around, as well as down stream should be avoided. For this the contractor has to obtain the express consent of the local gram sava as well as the group of users including the approval from the environment expert of SC and Executive Engineer. The Contractor will provide a list of locations and type of sources from where water for construction will be used.	Guideline 11 (Guidelines for quarry material)	Contractor	Environmental Expert of SC and EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
P.8.5	Labor Requirements	The contractor preferably shall use unskilled labour drawn from local areas to provide maximum benefit to the local community specially to the SC and ST population along the corridor.	General conditions of Contract Document	Contractor	Environmental Expert of SC and EMU of APWD
P.9	Construction Camp Locations – Selection, Design and Layout	Setting up of the construction camps will be as per the guidelines and details of layout plan. As far as possible construction camps will not be proposed within 500 m from the nearest settlements and 1000m from nearest reserve and protected forest to avoid conflicts and stress over the infrastructure facilities, local community and forest resources. Stock pilling of construction materials and go downs should be sufficiently away from the nearest water source as well as located on higher ground to avoid impact due to flood and pollution of the water source on account of any accidental spillage of stored /stockpiled materials. The waste disposal and sewage treatment shall be such that the environment is not polluted with the waste material, foul odour including the effluents and wastewater generated at the campsite. The designing and setting up of these structures should be as per the site plan of camp site providing for soak pits and carriage of extra sewage by sealed mechanized containers for disposal at designated sites as will be available in the locality with due written permission from the competent local authority. In case of non-receipt of any such permission from the competent authority as stated above the provision of wider safety tanks and storage facility for garbage has to be made at the camp site as an additional measure.	Guidelines for Locations of Construction Camp General conditions of Contract Document	Contractor	Environmental Expert of SC and EMU of APWD
P.10	Arrangements for Temporary Land Requirement	The contractor shall have to carry out negotiations with the landowners for obtaining their consent for temporary use of their lands for haulage roads approach roads, temporary diversions, stockpiling of bulk construction materials, establishment of camps, hot mix and batching plants crusher units under proper agreement detailing the term and conditions agreed to between both the parties	Contract Document	Contractor	Environmental Expert of SC and EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		involved including the conditions governing activities to be ensured during the operational stage and at the time of decommissioning of the project, where such sites are private property. The copy of such agreements shall have to be submitted to the Supervision Consultant and the Executive officer through the environment expert by the contractor along with the declaration through an affidavit sworn in by the land owner before a legal authority competent in this regard as authentic proof of such arrangement. The agreement and the affidavit must contain the details of the land involved with connected records of ownership.			
P.11	Orientation of Implementing Agency and Contractors	The APWD shall organize orientation sessions and regular training sessions during all stages of the project. This shall include on-site training (general as well as in the specific context of a sub-project). These sessions shall involve all staff of Environmental Cells, field level implementation staff of APWD, Environmental Experts of Supervision Consultant and Contractors.	Contract Document	EMU/ EMU of APWD	EMU of APWD

CONSTRUCTION STAGE

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
CONSTRUCTION STAGE					
Activities to be Carried Out by the Contractor					
C.1	**Site Clearance**				
C.1.1	Clearing and Grubbing	Site clearance including clearance of marked trees for felling and removal has to be carried out much before the actual road construction takes place. While doing so maximum care has to be taken for removal of all the overhead power transmission lines, telephone and cable T.V. connections bore wells, stand posts (water taps) wells in proper manner so as not to pollute the underground water sources and aquifers. In addition to this the structures (cabins, commercial constructions, hoardings, statues and temples etc. should have to be compensated for and removed before tree felling as tree felling is likely to damage all these structures and essential connections used by the public. The contractor, under any circumstances will not cut or damage trees. Trees identified under the project will be cut only after receiving clearance from the Forest Dept. / DoEF / MoEF (as applicable) and after the receipt of APWD's written permission in this regard. The tree felling should have to be under taken after due permission for felling has been obtained from the concerned divisional forest officer and the estimated cost of removal of trees submitted by MFDC ltd. gets approved by the APWD. Vegetation above 30 cm girth will be considered as trees and shall be compensated, in the event of APWD's instruction to undertake tree cutting and all trees below 30cm girth at BH has to be uprooted mechanically with ball of earth intact for relocation and transplanting at various degraded sites, embankment of water body, ponds, temples, market places, schools and road corridors to the extent possible for preventing loss of vegetative cover.	MoRTH 201.2 Guideline-1 (Guidelines for arrangement with Forest Department)	Contractor	Environmental Expert of SC, **EMU of** APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.1.2	Generation of Debris from dismantling structures and road surface	Tree cutting should not be carried out simultaneously all along the corridor as this will adversely impact the traffic movement and road safety. It should be carried out on priority basis at locations of diversions, bridge and culvert construction, and such other places where the construction work is scheduled to be started early for various consideration that may be decided by the site engineers the SC and the contractor as per work schedule. All workers involved in the cutting and removal of trees and demolition of structures shall wear safety helmets, gloves, and protective shoes and provided with a batch of emergency medical aid facility for attending to all unforeseen and freak accidents. Records to be maintained on the spot for all trees felled and logs, fire wood, stacks, obtained from such trees in the conversion register, which shall be available for verification by any competent supervising authority of the forest department, APWD, SC and expert of EMP unit. No sooner the trees are felled converted the same has to be kept under watch and ward by the felling agency and steps taken for its authentication by passing carried out at stump site. The passing by any forest officer not below the rank of an ACF of the forest department irrespective of the location of the tree either with in the RoW or the acquisitioned private land and Govt. forest land for quick removal from the RoW to facilitate uprooting of the stumps of such trees. Uprooting of the stumps should start immediately after the logs and firewood are removed from the stump site to speed up the road formation as discussed earlier. As far as possible felling of trees which are located beyond the hard shoulder that is on the slopes of the embankment can be retained for reducing the loss of vegetative cover by careful selection of young and sound trees within 30cm girth and up to 1mtr girth. 🗁 Debris generated due to the dismantling of the existing road will be suitably reused in the proposed construction. The	Guide lines of AP State Pollution Control Board.	Contractor	Environmental Expert of SC, **EMU of** APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		80% of the sub grade excavated from the road surface excluding the scarify layer of bitumen shall be recycled after improving the soil below the subgrade through addition of sand and suitable cementing material for qualitative up-gradation of the underlying black cotton soil. ☞ The dismantled scraps of bitumen surface shall be utilized for the paving the picnic spots or public recreation locations along the corridor to prevent erosion soil contamination and loss of vegetative cover on account of accumulation of such materials along the road and water bodies. The contractor will suitably dispose off unutilized non-toxic debris either through filling up of borrows areas located in wasteland or at pre-designated disposal sites, so selected subject to the approval of the Environmental Expert of SC and local competent authority. All arrangements for transportation during construction including provision, maintenance, dismantling and clearing debris, considered incidental to the work, will be planned and implemented by the contractor as approved and directed by the Environmental Expert of SC/ APWD. The pre-designed disposal locations will be a part of Comprehensive Solid Waste Management Plan to be prepared by Contractor in consultation and with approval of Environmental Expert of SC and approval local competent authority. Debris generated from pile driving or other construction activities along the rivers and streams drainage channels shall be carefully disposed in such a manner that it does not flow into the surface water bodies or form puddles in the area. All dumping sites identified by the contractor has to be ratified by the environment expert of SC in consultation with the local competent authority after joint visit of the locations and signing of documents as a proof of such verification and acceptance. For future management of these dumping yards the contractor shall be responsible by providing barricade walls or embankment if necessary to contain the outflow or erosion of such debris from the dumping site.			

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.1.3	Other Construction Wastes Disposal including Fly Ash	The pre-identified disposal locations will be a part of Comprehensive Waste Disposal & Solid Waste Management Plan to be prepared by the Contractor in consultation with& approval of Environmental Expert of SC. Location of disposal sites will be finalized prior to completion of the earthworks on any particular section of the road. The Environmental Expert of SC will approve these disposal sites after conducting a joint inspection on the site with the Contractor. Contractor will ensure that any spoils of material unsuitable for embankment fill will not be disposed off near any water course, agricultural land, and natural habitat like grass lands or pastures, wet lands, flood plains, eroded slopes, filling up ditches etc. which may pollute the surrounding including water sources. Such spoils from excavation can be used to reclaim borrow pits and shoring up of depression which are not connected to any water source in the locality nor under use by the local people. Non-bituminous wastes other than fly ash may be dumped in borrow pits (preferably located in barren lands) where such borrow pits are not suitable for storage of rainwater to develop pisci-culture or a source of irrigation by development of embankments around. Such borrow pits have to be filled up with non-bitumen wastes and then covered with a minimum 30cm layer of the soil to take up plantation of trees and shrubs to restore the environmental balance. The species suitable for such re-habilitation site shall be 18month old seedling of alstonea, casuarinas, zizyphus, bel, peepal, banyon, babool, chirounji etc. No new disposal site shall be created as part of the project, except with prior approval of the Environmental Expert of SC and concurrence of local competent authority on environment. In case of diversions over private land or productive Govt. land it should be the duty and responsibility of the contractor to ensure rehabilitation and restoration of the impugned /sites before abandoning the area in such a manner that the site so released comes into productive use without extra input what so ever.	Guide lines of AP State Pollution Control Board.	Contractor	Environmental Expert of SC, **EMU of** APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.1.4	Stripping, stocking and preservation of top soil	The topsoil from all sites of cutting/ quarrying/ borrows areas and areas to be permanently covered will be stripped and scraped of to a specified depth of 150 mm and stored separately for reuse as detailed below. A portion of the temporarily acquired area and/or RoW will be earmarked for storing topsoil. The locations for stock piling will be pre-identified in consultation and with approval of Environmental Expert of Supervision Consultant and Site Engineers. The following precautionary measures will be taken to preserve them till they are used: (a) Stockpile will be designed such that the slope does not exceed 1:2 (vertical to horizontal), and height is restricted to 2 m. To retain soil and to allow percolation of water, the edges of the pile will be protected by silt fencing. (b) Stockpiles will not be surcharged or otherwise loaded and multiple handling kept to a minimum to ensure that no compaction occurs. Such stockpiles shall be covered with empty gunny bags or showing and planting of grasses to prevent erosion during rains. It will be ensured by the contractor that the topsoil will not be unnecessarily trafficked either before stripping or when in stockpiles. Such stockpiled topsoil will be utilized for - ↳ Covering all reclamation sites /disturbed areas including borrow areas (not those in barren areas) ↳ Top dressing of the road embankment and fill slopes ↳ Filling up of tree pits, in the median and ↳ In the agricultural fields of farmers, acquired temporarily. Residual topsoil, if there is any will be utilized for the plantation at median and side of the main carriageway.	MoRTH: 301.3.2, MoRTH: 301.7, MoRTH: 301.3.3, MoRTH: 305.3 Guidelines – 3 (Guidelines for borrow area management)	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.1.5	Accessibility	The contractor will provide safe and convenient passage for vehicles, pedestrians and livestock to and from roadsides and property accesses connecting the project road, providing temporary connecting road. The contractor will also ensure that the existing accesses will not be undertaken without providing adequate provisions and to the prior satisfaction of Environmental Expert of Supervision Consultant. The contractor will take care that the cross roads are constructed in such a sequence that construction work over the adjacent cross roads are taken up one after the other, so that traffic movement in any given area does not get affected much.		Contractor	Environmental Expert of S C, EMU of APWD
C.1.6	Planning for Traffic Diversions and Detours	Temporary diversions will be constructed with the approval of the Resident Engineer and Environmental Expert of Supervision Consultant. Detailed Traffic Control Plans will be prepared and submitted to the Environmental Expert of SC for approval, five days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, traffic safety arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, safety measures undertaken for transport of hazardous materials and arrangement of flagmen etc. to regulate traffic congestion. The Contractor will provide specific measures for safety of pedestrians and workers at night as a part of traffic control plans. The Contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. The contractor will also inform local community of changes to traffic routes, conditions and pedestrian access arrangements with assistance from SC and APWD. The temporary traffic detours will be kept free of dust by sprinkling of water three times a day or as required under specific conditions (depending on weather conditions construction in the settlement areas and volume of traffic).	MoRTH: 112 and its amendments Guidelines 7 (Guideline for traffic management during construction)	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.2	**Procurement of Construction Material**				
C.2.1	Earth from Borrow Areas for Construction	No borrow area will be opened without permission of the Environmental Expert of Supervision Consultant. The location, shape and size of the designated borrow areas will be as approved by the Environmental Expert of Supervision Consultant and in accordance to the IRC recommended practice for borrow pits for road embankments (IRC 10: 1961). The borrowing operations will be carried out as specified in the guidelines for setting and operation of borrow areas. The unpaved surfaces used for the haulage of borrow materials, if passing through the settlement areas or habitations; will be maintained dust free by the contractor. Sprinkling of water will be carried out thrice a day to control dust along such roads during their period of use. During dry seasons (winter and summer) frequency of water sprinkling will have to be increased according to the site and climatic conditions in the settlement areas and Environmental Expert of SC will decide the numbers of sprinkling depending on the local requirements. Contractor will rehabilitate the borrow areas as soon as borrowing is over from a particular borrow area in accordance with the Guidelines for Redevelopment of Borrow Areas or as suggested by Environmental Expert of Supervision Consultant.	MoRTH: 305.2 Guidelines – 3 (Guidelines for borrow area management)	Contractor	Environmental Expert of SC, EMU of APWD
C.2.2	Quarry Operations	The contractor shall obtain materials for quarries only after the consent letter from the department of mines Govt. of AP, and the District Administration is received. The contractor will develop a Comprehensive Quarry Redevelopment plan, as per the Mining Rules of the state and submit a copy to APWD and SC prior to opening of the quarry site. The quarry operations will be undertaken within the rules and regulations in vogue.	MoRTH:111.3	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.2.3	Transporting Construction Materials and Haul Road Management	Contractor will maintain all roads (existing or built for the project), which are used for transporting construction materials, equipment and machineries as précised. All vehicles delivering goods subject to susceptible to be blown by wind during the vehicular movement to avoid spilling and air pollution. It shall be the responsibility of the contractor or his agent, sub-agents, sub-contractors, petty contractor, material suppliers whose vehicles use the highways and other roads for transportation of construction materials, to keep the roads clear from any dust, sand, soil, aggregates fallen from the transport vehicle. Contractor will arrange for regular water sprinkling as necessary for dust suppression on all such roads and surfaces where dust generation is a major problem. The unloading of all materials at construction sites should be limited to day time only for safety and avoiding accidents. Screens of hessian cloth, agro net and such other barricading material are to be erected along all construction, dumping and stockpiling sites under use, so that the generation of the dust in the vicinity of such locations can be minimized to great extent.		Contractor	Environmental Expert of SC, EMU of APWD
C.2.4	Construction Water	Contractor will arrange adequate supply and storage of water for the whole construction period at his own cost. The Contractor will submit a list of such source/s from where water will be used for the project to Supervision Consultant and APWD. Such source of water to meet the requirement on this road should preferentially be ground water collected from river or stream bed with prior permission from the Ground Water Board and the District Administration commensuration with the prevalent water act and rules promulgated by the State Govt. Such use shall be from a source other than the common source of water that is used by the local population and wildlife etc. as detailed in preconstruction activity. A copy of the permission so obtained from the competent authority shall have to be submitted to Supervision Consultant and APWD prior to initiation of construction activity.	Guideline 11 (Guidelines for quarry material)	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		The contractor will take all precaution to minimize the wastage of water in the construction process/ operation where ground water and river water is scarce.			
C.3	**Construction Work**				
C.3.1	Disruption to Other Users of Water	While working across or close to any perennial water bodies, contractor will not obstruct/ prevent the flow of water. Construction over and close to the non-perennial streams shall be undertaken in dry season and if such activity is likely to constraint or impact the community water body connected to such streams adequate prior information will be provided to such community for making a suitable arrangement that may lead to peaceful and uninterrupted use of the resource during the time of construction activity. Such water body may be ponds, water harvesting structures (WHS), feeder channels to pond and irrigation bunds etc. In all such cases specific provision of lessening the impact of construction has been elaborated in the design plan of retaining walls, spillways and ghats in Drawing No. APSRP /CEG /SH /ENV /03 Wherever excavation for diverting water flow will is imminent as per the designs available in the DPR the contractor will ensure that such diversion channels have no stepper slopes than 1:2 (vertical: horizontal). Otherwise proper slope protection measures have to be taken as approved by the Environmental Expert of SC and the resident engineer. The contractor will take prior approval of the River Authority or Irrigation Department and SC for any such activity. The APWD will ensure that contractor has served the notice to the downstream users of water well in advance where such diversion of the flow is likely to affect the downstream population subject to the condition that under no circumstances the downstream flow should be stopped putting the wildlife, the aquatic fauna and the shore line settlement under distress. Minimum eco-flow should be maintained in spite of the diversion by ensuring the downstream connectivity to the main channel.	MoRTH:304.3.2	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.3.2	Drainage and Flood Control	Contractor will ensure that no construction materials like earth, stone, ash or appendage disposed off so as not to block the flow of water of any water course and cross drainage channels. In addition to the design requirements the contractor will take all necessary measures to prevent the flooding of the installation well in advance of he rainy season in consultation with the resident engineer and SC by providing cross drainage to manage accumulation of rain water at any construction site. Where necessary adequate mechanical devices to bail out accumulated water from construction sites, camp sites, storage yard, excavation areas are to be presettled and arranged well in advance of the rainy season besides cross drainage systems. The contractor will take all adequate precautions to ensure that construction materials and excavated materials are properly located and enclosed in such a manner that sediment laden water through erosion does not affect the runoff and block the natural flow of water in any water course or cross drainage channel, by a proper watch and ward arrangement for monitoring.	MoRTH:305.3.7 MoRTH:306 Annexure 3.3 Annexure 3.4	Contractor	Environmental Expert of SC, EMU of APWD
C.3.3	Siltation of Water Bodies and Degradation of Water Quality	Contractor will construct silt fencing at the base of the embankment construction for the entire perimeter of any water body (including wells) adjacent to the RoW and around the stockpiles at the construction sites close to water bodies. The fencing will be provided prior to commencement of earthwork and continue till the stabilization of the embankment slopes, on the particular sub-section of the road. The contractor will also put up sedimentation cum grease traps at the outer mouth of the drains located in truck lay byes, which are ultimately entering into any surface water bodies / water channels with a fall exceeding 1.5 m. Contractor will ensure that construction materials containing fine particles are stored in an enclosure such that sediment-laden water does not drain into nearby water bodies.	MoRTH: 306 Annexure 3.5 (Silt Fencing)	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.3.4	Slope Protection and Control of Soil Erosion	The contractor will construct slope protection works as per design, or as directed by the Environmental Expert of SC to control soil erosion and sedimentation through use of dykes, sedimentation chambers, basins, fiber mats, mulches, grasses, slope drains and other devices as will be necessitated according to the local conditions. All temporary sedimentation, pollution control works and maintenance thereof will be deemed as incidental to the earth work or other items of work and as such no separate payment will be made for them. Contractor will ensure the following aspects: • After construction activities of road embankment, the side slopes of all cut and fill areas will be graded and covered with stone pitching, grass and shrub as per design specifications. • Turfing works will be taken up as soon as possible, provided the season is favorable for the establishment of grass sods. Other measures of slope stabilization will include mulching, netting and seeding of batters and drains immediately on shrub and bushes at 30cm interval from line to line across the slope and sprinkling of water on such slopes after completion of the earth work. Regular watering through sprinklers shall be provided at such locations much before the pre-monsoon rains as would be required in the field to encourage bio-engineering stabilization of slopes. In all these cases, seeds of road side weeds such as, Banakolthi (Tephrosia spp.), Banachakunda (Cassia tora), Bala (Sida species), Vetiver grass, Pamarosa grass etc. are the best choice. • In borrow pits, the depth shall be regulated so that the sides of the excavation should not be stepper than 1 vertical to 2 horizontal, from the edge of the final section of the bank. • Along sections abutting water bodies, stone pitching as per design specification will protect slopes. All such stone pitching should have a filter layer to prevent scouring and unsettlement of the pitched surface when the water label recedes. • Refer **Guidelines-8** for soil erosion and sedimentation.	MoRTH: 305.2.2.2 MoRTH: 306.2 Guideline 8 (Guideline for soil erosion and sedimentation control)	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.4	**Pollution**				
C.4.1	**Water Pollution**				
C.4.1.1	Water Pollution from Construction Wastes	The Contractor will take all precautionary measures to prevent the waste water generated during construction from entering into streams, water bodies or the irrigation system by providing safe wastewater soak pits away from any aquifers or water body. Contractor will avoid continuation of construction activity close to the streams or water bodies during monsoon. All waste arising from the project is to be disposed off in the manner that is acceptable to the State Pollution Control Board or as directed by Environmental Expert of Supervision Consultant in accordance to the local legislation for such disposal. The Environmental Expert of S C will certify that all liquid wastes disposed off from the sites meets the discharge standards as specified by the CPCB, Govt. of India.	MoRTH: 111.4 MoRTH: 111.1	Contractor	Environmental Expert of SC, EMU of APWD
C.4.1.2	Water Pollution from Fuel and Lubricants	The contractor will ensure that location of parking lots, garages, fuel/lubricants dumps /storage sites, vehicle, machinery and equipment maintenance and refueling sites are located on high ground at least 500 m from rivers /streams /canal /ponds with proper boundary wall to prevent any accidental leakage or flooding or due to spillage or mishandling. All location and lay-out plans of such sites will be submitted by the Contractor prior to their establishment and will be approved by the Environmental Expert of Supervision Consultant and EMU of APWD, besides the conditions governed by the Central Excise and Explosive substances act etc. Contractor will ensure that all vehicle/machinery and equipments operation, maintenance and refueling will be carried out in such a fashion that, spillage of fuel and lubricants does not contaminate the ground. Oil interceptors will be provided for vehicle parking, wash down and refueling areas as per the design provided for such locations by the constractor.	MoRTH: 111.4 MoRTH: 111.1 Annex 3.6 Petroleum Act and Rules MoEF /CPCB Notifications	Contractor	Environmental Expert of S C, EMU of APWD,

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		In all, fuel storage and refueling areas, if located on agricultural land or areas supporting vegetation, the top soil will be stripped, stockpiled and returned after cessation of such storage. Contractor will arrange for collection, storage and disposal of spent oil, lubricants, grease and sludge and other waste to collection beans kept separately at maintenance and refueling yards for recycling and to dispose of the filtered sludge from filter ponds at pre-identified disposal sites (list to be submitted to SC and APWD) as approved by the Environmental Expert of S C. All spills and collected petroleum products will be disposed off in accordance with MoEF and SPCB guidelines issued from time to time. A certificate to this extent has to be issued by the Environmental Expert of S C in compliance with the guidelines of PCB/ MoEF or any other relevant law in force.			
C.4.2	**Air Pollution**				
C.4.2.1	Dust Pollution	The contractor will take every precaution to reduce the level of dust from crushers /hot mix plants, construction sites involving earthwork by sprinkling of water mist spray, encapsulation of dust source and erection of screen /barriers. All the plants will be located at least 1 km away in the downwind direction of normal wind flow from the nearest human settlement or any other institutions of importance. The contractor will provide necessary certificates to confirm that all crushers used in construction conform to relevant dust emission control legislation from time to time. The suspended particulate matter value at a distance of 40m from a unit located in such a cluster should be less than 500 µg/m^3. The pollution monitoring is to be conducted as per the monitoring plan. Alternatively, operating crushers with valid license from the SPCB shall be used and required certificates and consents of the operator /owner shall be procured and submitted by the contractor to the APWD through Environment expert of the SC.	MoRTH:111.1 MoRTH:111.5 MoRTH:111.9 MoRTH:111.10 Contract Agreement	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		Dust screening vegetation through planting of dwarf bamboos, justacea, vitex negundo, lawsonia inermis on the edge of the RoW or around the crusher sites for all existing roadside crushers besides provision of dust screens. Hot mix plant and batch mix plant will be fitted with dust extraction units and mist spray to keep down the dust emission levels.			
C.4.2.2	Emission from Construction Vehicles, Equipment and Machineries	All machinery and equipments installed or brought under use by the contractor shall have to conform to the latest anti pollution parameters as specified by the international stand and BSI as the case may be. Contractor will ensure that all vehicles, equipment and machinery used for construction are regularly maintained and confirm to the emission standards specified by the CPCB and certification issued for such contrivances obtained from designated /approved authority from time to time. The Contractor will submit PUC certificates for all vehicles/ equipment/machinery used for the project. Monitoring results will also be submitted to S C and EMU of APWD as per the monitoring plan and specified formats.	Motor Vehicle Act	Contractor	Environmental Expert of S C, EMU of APWD
C.4.3	**Noise Pollution**				
C.4.3.1	Noise Pollution: Noise from Vehicles, Plants and Equipments	The Contractor will confirm the following: All plants and equipment used in construction (including that of APWD, aggregate crushing plant) shall strictly conform to the MoEF/ CPCB noise standards and should have latest noise suppression mountings. All vehicles and equipment used in construction will be fitted with exhaust silencers. Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.	Noise Rules 2002 Annex – 3.7	Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		Limits for construction equipment used in the project such as compactors, rollers, front loaders, concrete mixers, cranes (movable), vibrators and saws shall not exceed 75 dB (A) (measured at one meter from the edge of equipment in the free field), as specified in the Environment (Protection) rules, 1986. Maintenance of vehicles, equipment and machinery shall be regular and up to the satisfaction of the Environmental Expert of S C to keep noise levels at the minimum. Construction activity at sites within 100m from habitation, hospitals and 1000mtrs. from forest areas should not be carried out during night. The contractor will not take up any noisy construction activities around educational institutes /health centers, hospitals, silence zones up to a distance of 1000 m from these sensitive receptors at night. Contractor will provide noise mitigation barriers along the sensitive receptors mentioned above including masonry and vegetative screen walls mounted with creepers as per the design drawing No. MSRP /CEG /SH /ENV /04 B at suggested locations. List of such locations for temples, schools, govt. offices. There are 16 temples, 10 schools & colleges, 2 offices, 2 Govt. hospitals. Monitoring shall be carried out at the construction sites as per the monitoring schedule and results will be submitted to SC and APWD. Environmental Expert of SC will be required to inspect regularly such sites to ensure proper compliance of the EMP.			
C.5	**Safety**				
C.5.1	Personal Safety Measures for Labour	Contractor will provide: - Protective footwear and protective goggles to all workers employed on mixing asphalt materials, cement, mortars, concrete working at welding blasting, crusher and stockpiling locations etc. as per the Factory Act 1948.		Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		◴ Welder's protective eye-shields to workers engaged in welding works ◴ Earplugs to workers exposed to loud noise, and at quarries, crushers, compaction, concrete mixing, batch mixing, and drilling, fabricating and heavy machinery operations. ◴ Hard hat or minors helmets shall be provided to all workers supervising staffs and inspecting officials entering into any construction site quarry, borrow areas, loading and unloading sites for safety and security which should be compulsory, irrespective of the rank and file of such personality. ◴ The use of nettings and platforms below and on the sides of overhead construction and excavation, scaffolding activity has to be compulsory to be installed by the contractor to prevent accidental fall of workmen and debris, which are a major source of fatality at all construction sites. ◴ The contractor will comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress. The contractor will comply with all the precautions as required for ensuring the safety of the workmen as per the International Labour Organization (ILO) Convention No. 62 as far as those are applicable to this contract. The contractor will make sure that during the construction work all relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Services) Act, 1996 are adhered to. The contractor will not employ any person below the age of 18 years for any work and no woman of productive age will be engaged in the work of painting containing lead in any form. The contractor will also ensure that no paint containing lead or lead products is used except in the form of paste or readymade paint.			

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		Contractor will provide facemasks for use by the workers engaged in spray painting or manual painting when lead based compound is one of the constituents of such surface to be scrubbed, cleaned and painted. • No smoking and other 'high risk' areas are to be provided with statutory signage besides strict enforcement of PPE with zero tolerance limits for the safety and security of installation and equipment. These guidelines will be reflected in the Construction Safety Plan to be prepared by the Contractor during mobilization and same shall be approved by S C and APWD after proper scrutiny			
C.5.2	Traffic and Safety	The contractor will take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signage, markings, flags, indicator lights, reflectors and flagmen as proposed in the Traffic Control Plan/Drawings and as required by the Environmental Expert of S C for the information and protection of road users approaching or passing through the section of any construction site of activity or diversion. The contractor will ensure that all signs, barricades, pavement markings are provided as per the MoRTH specifications. Before taking up of construction on any section of the existing lanes of the highway, a Traffic Control Plan will be devised and implemented to the satisfaction of the Environmental Expert of S C together with the local police and administrative authorities.		Contractor	Environmental Expert of SC, PIU of APWD, EMU of APWD
C.5.3	Risk from Electrical Equipment (s)	All power transmission lines whether claded or sufficiently covered are potential hazards at construction sites. The Contractor will take all required precautions to prevent danger from electrical wirings and equipment and ensure that - • No material will be so stacked or placed on or installations, which can be a potential danger to affect /inconvenience /fatally injure any road user or workmen so as to cause danger or inconvenience to any person or the public.		Contractor	EnvironmentalExpert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		◴ All such electrical installation and wirings should be out of reach of the road users, wildlife along with operating vehicle, cranes, excavators and loaders fabricating units. Necessary fencing and proper insulation of the supply lines shall have to be ensured by the contractor with proper illumination of work sites and equipment for safety and security. ◴ Loosely hanging and exposed power supply lines, heavily loaded supply lines are the cause of many accidents and fire hazards, which may endanger the life and property of so many individuals during construction /lay off period. The contractor should ensure proper maintenance of such supply routes and closer of all such electrical operating units before leaving the sit of activity every day or night as the case may be. All machines to be used in the construction shall have conformed to the relevant BIS specification codes. The contractor will ensure that such machinery are free from patent defect, and under good working conditions and maintained in good working order as per the owner's manual supplied by the manufacturer through regular supervision, monitoring, maintenance and repair /replacement from time to time as per the schedule of activity such units in consultation with the SC.			
C.5.4	Risk Force Measure	The contractor will take all reasonable precautions to prevent danger of destruction to life and property of public as well as workers on account of flash flood, sudden collapse of structures accidental fire and explosion in and around work sites camps, maintenance unit, quarries, and haulage or roads vehicles carrying hazardous materials. The contractor will make required arrangements so that in case of any mishap all necessary steps can be taken for prompt rescue operation along with provision for on this spot first aid and quick removal of injured to nearest hospital for treatment. Fire extinguishers and firefighting equipments, salvaging equipments for recovery of hazardous chemicals on account of accidents or spillage to be kept ready at camping sites or major construction sites to attend such eventualities. Construction Safety Plan prepared by the Contractor in this regard will identify necessary actions in the event of an		Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		emergency accordingly and get it approved by the supervision consultant and the executive officer of the APWD as per the standard practice adopted under labour welfare activities and factory act.			
C.5.5	First Aid	The contractor will arrange for - ◴ a readily available first aid unit including adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone with life saving first aid kits. ◴ availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital ◴ Equipment and trained nursing /paramedical staff at construction camps.		Contractor	Environmental Expert of SC, EMU of APWD
C.5.6	Informatory Signs and Hoardings	The contractor will provide, erect and maintain informatory/safety signs, hoardings written in local language and English, for the benefit and information of road users and local inhabitants.		Contractor	Environmental Expert of SC, EMU of APWD
C.6	**Flora and Fauna: Plantation/Preservation/ Conservation Measures**				
C.6.1	Road side Plantation Strategy	The tree planting along the corridor within the RoW shall be taken up by local self-help groups (SHG) or forest department as the case may be depending upon the location of the land on the corridor i.e. near and on forest lands the forest department shall take up the plantation activity and elsewhere these shall be carried out by contractor selected for such activity, which may be local self-help groups. Minimum 80 percent survival rate of the saplings will be acceptable, otherwise the contractor will replace dead plants at his own cost. The contractor will maintain the plantation till they handover the project site to APWD after the 3rd year of planting. The Environmental Expert of SC will inspect and monitor regularly the survival rate of all plantations and record his observation in the plantation journal at the time of inspection besides making official correspondence regarding deficiencies or changes improvements, warranted in specific area of activities.		Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
C.6.2	Flora and Chance found Fauna	The contractor will take reasonable precaution to prevent his workmen or any other persons connected with the contract from removing and damaging any flora (plant/vegetation) and fauna (animal) including fishing in any water body and hunting of any animal in and around the road corridor, whether it is a forest or non-forest land, other than permissive activity of fishing in the local non-forest areas with the consent of local authorities and villagers. If any wild animal is found near the construction site at any point of time, the contractor or his representative will immediately upon discovery thereof acquaint the Environmental Expert of SC and the resident engineer together with the local forest authority for immediate necessary action as will be suggested by them. The Environmental Expert of SC and or the wildlife & forestry expert of EMU will report to the nearby forest office (range office or divisional office) and will take appropriate steps/ measures, if required in consultation with the forest officials for rescue or driving out the animal towards the forest.		Contractor	Environmental Expert of SC, EMU of APWD
C.6.3	Chance Found Archaeological Property	All fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on the site shall be the property of the Government and shall be dealt with as per provisions of the relevant legislation. The contractor will take reasonable precautions to prevent his workmen or any other persons from removing and damaging any such article or thing. He will, immediately upon discovery thereof and before removal intimate the Environmental Expert of SC and the EMU of APWD of such discovery and carry out the instructions received from them in dealing with the same while keeping the responsible authority informed of such findings, besides the local police and local administrative authority of the district. The SC will seek direction from EMU of APWD and they from the State Archaeological Department /the district Collector for proceeding in appropriate manner to deal with the chance findings /discovery. Till that time the site and the findings shall be under		Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		strict watch and ward to prevent any pilferage alteration of the findings by the workmen or locals as the case may be.			
C.7	**Labor Camp Management**				
C.7.1	Accommodation	Contractor will follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. The location, layout and basic provision of facilities at each labour camp site will be submitted to SC and EMU of APWD prior to their setting up in the field for approval. The construction of camps will only commence after the written approval from the EMU. In consultation and concurrence of the Environmental Expert and SC. The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner as per the suggestions and guidance provided by the environment expert and SC.		Contractor	Environmental Expert of SC, EMU of APWD
C.7.2	Potable Water	Provision for supply of potable water to all camp sites in the package will have to be in place in such a manner that the sources are free from pollution and contamination. With proper drainage, platforms, storage facility and sanitation measures in position to see that the surplus and waste water flow does not stagnate or create un healthy atmosphere around camp as well as the surrounding agricultural fields, water sources and habitation. Ground water recharging provision through setting up of soak pits away from such water supply system to discharge the waste water shall have to be made by the contractor at each camp site whether the same is over Govt. or private land. The Contractor will also provide availability of potable water within the precincts of every workplace in a cool and shaded area which is easily accessible as per standards set by the Building and other		Contractor	Environmental Expert of SC, EMU of APWD

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996. The contractor will ensure the fulfilment of the following conditions at all work places for the benefit of worker: a) Adequate supply of potable water (as per IS) in every workplace/labor camp site suitably located on high ground and dry place which is easily accessible and regularly maintained for health and hygiene to prevent contamination and communicable diseases. b) All such storage facilities of drinking water will be on raised platform for drainage and safe storage above at least 1m ground above ground to facilitate its use.. c) As far as possible shallow well should not be used as potable source of water unless there is any constraint for boring of tube wells. In all such cases of potable water from open wells, irrespective of its location from polluting environment, regular dis-infection of the water source by application of lime, bleaching powder, potassium permanganate solution have to be ensured at weekly /fort nightly interval. However it should be safe to provide water purifier units in such locations to prevent water borne diseases, where power supply and storage water facility is available. d) All open wells should be covered with a trap door, to facilitate disinfections of water sources while mini hand pumps may be set up to draw water from such wells and prevent accidental contamination /accidental fall into such wells besides avoiding dust and filth from the adjacent road entering the well for which a safe drainage channel encircling the open well should be mandatory to prevent inflow of polluted water from outside. e) The trap door will be kept locked and opened only for cleaning or inspection, which will be done at least once in a month to be monitored and recorded by the camp in charge at each place.			

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		f) Water quality testing of all potable water sources will be done every month as per parameters prescribed in IS 10500:1991, by sample testing of the water periodically. Environmental Expert of SC will be required to inspect the labour camp once in a week to ensure health and hygienic of the work force.			
C.7.3	Sanitation and Sewage System	The contractor will ensure that - ◴ the sewage system for the camp are designed, built and operated in such a fashion that no health hazard occurs and no pollution to the air, ground water or adjacent water courses takes place. ◴ separate toilets /bathrooms /latrines, wherever required, are to be provided for women workers separately with specific signage indicating its exclusive use by them. ◴ All such facilities must have adequate water supply with proper drainage and disposal facility. ◴ All toilets in workplaces are to be located with covered screen walls and of dry earth system which are to be maintained, cleaned and disinfected daily using strong disinfectants. The location of such provisions should not be affecting the air surface water and ground water of the locality or the agricultural fields near by either during summer or rains. ◴ For lavatory purposes the use of portable latrines system are to be brought under use and the night soil so collected has to be disposed of at designated septic latrines, so as to prevent pollution of the workplace and surrounding areas.		Contractor	Environmental Expert of SC, EMU of APWD
C.7.4	Waste Disposal	The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of SC. No night soil should be disposed of at any place other than the septic tank constructed for the workers at the camp site by ensuring the use of portable latrines system mounted on wheels and fitted with			

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Planning and Execution	Supervision /Monitoring
		temporary water sealed containers to store the night soil, which shall be emptied at the nearest septic tank facility of any camp site.			
C.8	**Contractor's Demobilization and Decommissioning of Established Setup**				
C.8.1	Clean-up Operations, Restoration and Rehabilitation	Contractor will prepare site restoration plans, which will be approved by the Environmental Expert of SC. The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. The contractor will clear all temporary structures; dispose all garbage, night soils and POL, as per Comprehensive Waste Management Plan and as approved by SC and accepted by the EMU. All disposal pits or trenches will be filled in disinfected and effectively sealed off. Residual topsoil, if any will be distributed or spread evenly on adjoining/ proximate barren land or affected agricultural land adjacent to the RoW that has been impacted on account of accidental spillage, drainage or erosion of the construction materials as will be identified and suggested by Environmental Expert of SC not below the thickness of 75 mm. All construction zones including river-beds, culverts, road-side areas, camps, hot mix plant sites, crushers, batching plant sites and any other area used / affected by the project will be left clean and tidy, at the contractor's expense, to the entire satisfaction of the land owner in case of private land and to the best satisfaction of the Environmental Expert of SC as well as the site engineer.		Contractor	Environmental Expert of SC, EMU of APWD

OPERATION STAGE

Sl. No.	Environmental Issue	Management Measures	Reference Document	Responsibility	
				Execution/Civil Work	Supervision/Monitoring
OPERATION STAGE					
Activities to be Carried Out by the APWD (EMU)					
O.1	Monitoring Operation Performance	The APWD will monitor the operational performance of the various mitigation/ enhancement measures carried out as a part of the project. The indicators selected for monitoring include the survival rate of trees; utility of enhancement provision for schools, hospitals, water bodies, temples, spur roads, bus stand and sheds at bus stops, sealing of abandoned, bore wells, stand posts, wells, re-sinking of bore wells and noise and dust filter structures at sensitive receptors, site enhancement measures at recreation points, bus and truck lay bye etc. including status of rehabilitation of borrow areas; and utility of noise barriers. The completion of wildlife under passes as per design and specifications with approach corridor plantations and its 3 years maintenance schedule for survival and development into a proper wildlife corridor has to be keenly monitored and evaluated. The rehabilitation of degraded sites along with development and functioning of nalas, streams and gullies after soil and water conservation measures has to be inspected, recorded and timely damages repaired for effective functioning and maintenance of such efforts in the field. Monitoring of the wildlife movement along the wildlife under passes provided for in the corridor.		EMU of APWD /PWD The Forest and Biodiversity wing of EMU of APWD	EMU of APWD /PWD

		Monitoring the function and stability of temporary water holes /water storage tanks provided on either side of the corridor to remove distress of the wildlife during late winter and summer months till the corridor is restocked with necessary avenue plantation and restoration /improvement of degraded /eroded sites.		
0.2	Maintenance of Drainage	APWD will ensure that all drains (side drains, median drain and all cross drainages) are periodically cleared especially before monsoon season to facilitate the quick passage of rainwater and avoid flooding without damaging the spurs and check dams erected to stabilize the course and flow of all such drainage channels. APWD will ensure that all the sediment /oil and grease traps set up at the truck and bus lay bye are cleared once in every 3 months.	EMU of APWD /PWD	EMU of APWD /PWD
0.3	Pollution Monitoring	The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil pollution/contamination are to be continued at pre-designated locations and if necessary at additional locations for comparative study of pre and post-operative data in order to ensure further improvement /modification in the design /methodology APWD may appoint specific pollution monitoring agency for such study or carry it out as per the suggestion /recommendation of the statutory authority, (SPCB).	EMU Environment expert Pollution Monitoring Agency	EMU of APWD /PWD
0.3.1	Atmospheric Pollution	Ambient air concentrations of various pollutants shall be monitored as envisaged in the pollution monitoring plan at pre designated locations to compare it with the pre-construction data and ensure further improvement by collection of additional data at additional location as the situation demands. The avenue plantation raised afresh and the old avenue trees retained are to be periodically checked	EMU of APWD Pollution Monitoring Agency	EMU of APWD /PWD

		with respect to the plantation register for evaluating the effect and importance of avenues along the road. Site enhancement plantations together with plantation to serve as noise and dust filters, environment up-liftment for aviary and amphibian fauna near water sources by relocation of avenue trees are to be monitored and brought into a register of such activity for study of their growth, utility and impact on the biodiversity as well as environmental parameters.		
O.3.2	Noise Pollution	Noise pollution will be monitored as per monitoring plan at sensitive locations where pre construction noise quality studies were conducted. The survival and functioning of the noise filter plantations and noise control walls has to be specifically supervised and monitored for further improvement /replication at other affected points if necessary. The plantation of dwarf bamboos at such locations along the road avenue needs special mention in cyclone ravaged corridor to enforce the control programs. Monitoring the effectiveness of the pollution attenuation barriers, if there is any, will be taken up thrice in the operation period. The effectiveness of functioning of the earth cushion provided at wildlife under passes and viaducts near wet land eco system with trap drain structures at different locations will be monitored and evaluated to study the incidents of reduction in death of amphibians and reptiles at such points in comparison with other control points without such structures for further improvement in the corridor to prevent such destruction of biodiversity.	Pollution Monitoring Agency	EMU of APWD /PWD
O.4.	Soil Erosion and Monitoring of Borrow Areas	Visual monitoring and inspection of soil erosion at borrow areas, quarries (if closed and rehabilitated), embankments and other places expected to be affected, will be carried out before monsoon, during monsoon and after winter rains to regularly record	EMU of APWD /PWD	EMU of APWD /PWD

		and monitor the effectiveness of such structures at monthly intervals for the 1st three years during and after completion of project, so as to evaluate the beneficial effects of each type of activity together with the cost involved for adoption of most effective structures in other areas of road improvement to check soil erosion.		
0.5	Changes in Land Use Pattern	EMU of APWD shall take initiative to move and motivate the Govt. as a facilitator in preparing an action plan to encourage balanced congestion free hygienic environment friendly activity on either side of the developed highway during and after completion of the project. This is to avoid irregular, ugly, unhygienic and destructive ribbon development, close to the road corridor which adversely affects agricultural and water harvesting capabilities and drainage system of the area. The department may strive for effective promulgation of some legislation and guidelines, controlling such unbridled activity, which are self-destructive and distress full for the poor farmers and drainage on the State's Economic Resources. A land use-zoning map may be developed, under which up to a particular distance from the RoW of the alignment especially in new bypass stretches, no development will be allowed. Necessary hoardings along the corridor need be provided in shape of permanent structures to warn and advise encroachers against such activity under punitive action such as forfeiture of the structures and belonging without prior notice besides punitive legal action in the court of law barring any stay over such action by the state from any court of law. Budgetary provisions are to be made to control the ribbon development along project road.	EMU of APWD /PWD, Local Planning Authorities, Revenue Department and Local Civic Bodies EMU of the APWD & Revenue Department, Town planning Authority	EMU of APWD /PWD EMU of APWD /PWD

9.10 Social Impact Assessment (SIA)

Social Impact Assessment (SIA) is predicated on the notion that development interventions have social ramifications and it is imperative that decision-makers understand the consequences of their decisions before they act and people affected get the opportunity to participate in designing their future. Social assessment helps to make the project responsive to social development concerns. Developmental initiatives informed by social assessment alleviate poverty, enhance inclusion and build ownership while minimizing and compensating for adverse social impacts on the vulnerable and the poor. Social Impact Assessment can be defined in terms of efforts to assess or estimate, in advance, the social consequences that are likely to follow specific policy actions (including programs and the adoption of new policies), and specific government actions. It is a process that provides a framework for prioritizing, gathering, analysing, and incorporating social information and participation into the design and delivery of developmental interventions. It ensures that development interventions: (i) are informed and take into account the key relevant social issues; and (ii) incorporate a participation strategy for involving a wide range of stakeholders.

9.10.1 Summary of Applicable Acts and Policies

Applicable acts, notifications, and policies relevant in the context of the project are discussed below. The Project Authority will ensure that project activities implemented are consistent with the national, state, local regulatory/legal framework for Social Considerations.

Table 56: APPLICABLE ACTS AND POLICIES

No.	Acts, Notifications, Policies	Relevance and Applicability to the Project
1	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR 2013)	Provides for enhanced compensation and assistances measures and adopts a more consultative and participatory approach in dealing with the Project Affected Persons (PAPs). The Act took effect in January 2014, however, State of Arunachal Pradesh opposes to the provisions on the ground that being under the Sixth Schedule of the Constitution, land in the State belongs to the individuals and not the Government.
2	National Rehabilitation & Resettlement Policy, 2007 ((NRRP 2007)	Provides limited benefits to affected family (an ex-gratia payment of not less than Rs. 20,000/- and in case land-holder becoming landless or small or marginal farmer in such cases other rehabilitation benefits as applicable.

No.	Acts, Notifications, Policies	Relevance and Applicability to the Project
3	The National Tribal Policy, 2006	Provides an environment conducive to the preservation of traditional and customary systems and regime of rights and concessions enjoyed by different ST communities.
4	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006	Provides for recognition of forest rights to Scheduled Tribes in occupation of the forest land prior to 13.12.2005 and to other traditional forest dwellers who are in occupation of the forest land for at least 3 generations i.e. 75 years, up to maximum of 4 hectares. These rights are heritable but not alienable or transferable.
5	The Right to Information Act, 2005	Provides for setting out the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, the constitution of a Central Information Commission and State Information Commissions and for matters connected therewith or incidental thereto.
6	World Bank OP 4.12 – Involuntary Resettlement	The project requires additional land area for widening and strengthening, junction improvements, realignments, safety provisions, etc. It will also affect structures mainly used for residences, business units, cattle sheds and livelihood of people. Some of them are without any valid pass/permit. All affected under the project, irrespective of a valid pass/permit shall be supported under the project to improve their quality of life or at least restore to pre-project standards.
7	OP 4.10 – Indigenous Peoples	Over 90% of the population in the State belongs to Tribal community, and almost all affected households belong to ST. While a separate IPP report is not prepared, the issues discussed in RAP takes into account this fact and address issues related to indigenous peoples in the RAP. The project shall ensure broad community support for the project based on free prior and informed consultation.

10.10.1.1 Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (LARR), 2013

The Act provides for enhanced compensation and assistances measures and adopts a more consultative and participatory approach in dealing with the Project Affected Persons. Enhanced compensation provision for land acquisition provides for 1-2 times the prevailing market rate (as

determined by stipulated mechanism, primarily relying on officially recorded/registered rates) in urban areas (as determined by the state) and 2-4 times the prevailing market rate in rural areas. The original law also made provision for need for 'consent', while exempting 13 existing laws (having sections governing land acquisition processes for projects coming under its ambit). Subsequently, in 2015 an amendment bill was brought in the bill and enforced through ordinance by the current central government. Key changes made by this bill vis-à-vis the original law are:

The LARR 2013 exempted 13 laws, including the National Highways Act from its purview. However, the LARR 2013 required that the compensation, rehabilitation, and resettlement provisions of these 13 laws be brought in consonance with the LARR 2013 within a year of its enactment (that is, by January 1, 2015), through a notification. The Bill brings the compensation, rehabilitation, and resettlement provisions of these 13 laws in consonance with the LARR Act, 2013. The Bill creates five special categories of land use: (i) defence, (ii) rural infrastructure, (iii) affordable housing, (iv) industrial corridors, and (v) infrastructure projects including Public Private Partnership (PPP) projects where the central government owns the land. The LARR 2013 requires that the consent of 80% of landowners is obtained for private projects and that the consent of 70% of landowners be obtained for PPP projects. The proposed amendment to the Bill, currently under the parliamentary discussion, exempts the five categories mentioned above from this provision of the Act. Being a rural infrastructure project, the above requirement does not technically apply to this project. As per the proposed amendment, projects that belong to five categories do not require social impact assessment. The amendment has not yet passed, but regardless the passage of the amendment, the project has sought to obtain support from the affected community as shown in the chapter on consultation in keeping with JICA Guidelines for Environmental and Social Guidelines. Timeline for LARR 2013 amendment process is as follows.

Table 57: PROCESS OF AMENDING LARR 2013

Date	Action
1 January 2014	LARR 2013 comes into existence, repealing the Land Acquisition Act, 1984
31 December 2014	LARR (Amendment) Ordinance, 2014 promulgated
24 February 2015	LARR (Amendment) Bill, 2015 introduced in Lok Sabha
10 March 2015	LARR (Amendment) Bill, 2015 passed in Lok Sabha with amendments but could not be passed by the Rajya Sabha and remains pending
3 April 2015	LARR (Amendment) Ordinance, 2015 incorporating the amendments made by the Lok Sabha promulgated
10 April 2015	Public interest litigation (PIL) filed in Supreme Court to declare LARR (Amendment) Ordinance, 2015 as "unconstitutional" and ultra vires of the Constitution and as a "colorful exercise of power"

Date	Action
13 April 2015	Supreme Court issues notice in the PIL but refuses to stay the LARR (Amendment) Ordinance, 2015.
11 May 2015	LARR (Amendment) Second Bill, 2015 introduced in the Lok Sabha
13 May 2015	LARR (Amendment) Second Bill, 2015 referred to the Joint Committee of Parliament
30 May 2015	LARR (Amendment) Second Ordinance, 2015 promulgated. The ordinance will lapse if it is not passed by Congress within six months.

Other requirements in the LARR 2013 that may be applicable to this project are the following:

- The LARR 2013 required that if the acquired land remains unused for five years, it must be returned to the original owners or the land bank. The Bill states that the period after which unused land will need to be returned will be: (i) five years, or (ii) any period specified at the time of setting up the project, whichever is later.
- The LARR Act, 2013 states that the Land Acquisition Act, 1894 will continue to apply in certain cases, where an award has been made under the 1894 Act. However, if such an award was made five years or more before the enactment of the LARR 2013, and the physical possession of land has not been taken or compensation has not been paid, the LARR 2013 will apply.
- The LARR 2013 stated that if an offence is committed by the government, the head of the department would be deemed guilty unless he could show that the offence was committed without his knowledge, or that he had exercised due diligence to prevent the commission of the offence. The Bill replaces this provision and states that if an offence is committed by a government official, he cannot be prosecuted without the prior sanction of the government.

10.10.1.2 National Rehabilitation & Resettlement Policy, 2007

The policy, prepared by the Department of Land Resources, Ministry of Rural Development, and Government of India, stipulates the minimum benefits to be ensured for persons displaced due to acquisition of land for public purposes. The objectives of the Policy are:

(a) to minimize displacement and to identify the non-displacing or least-displacing alternatives;

(b) to plan the Resettlement and Rehabilitation of project affected families (PAFs), or project affected households (PAHs), including tribal and vulnerable households;

(c) to provide improved standard of living to PAFs or PAHs; and

(d) to facilitate a harmonious relationship between Requiring Body/Competent Authority (CA) and PAFs.

The Policy is applicable to projects displacing 400 or more families en masse in plain areas, or 200 or more families en masse in tribal or hilly areas, Desert Development Program (DDP) blocks, areas mentioned in Schedule V and Schedule VI of the Constitution of India. Some of the highlights of this policy may be noted as follows:

(i) Recognizes apparent need for additional R&R benefits which must be beyond compensation of loss of land or structure;

(ii) SIA as mandatory component where project is likely to impact 400 or more families en masse (in plain areas), or 200 or more families en masse in tribal or hilly areas;

(iii) Detailed R&R planning in case anticipated displacement is more than 400 families in plains (200 families in hilly/tribal areas). The plan to have details such as extent of land to be acquired with names and identification of affected families, village wise list of affected persons, their profile, agricultural labourers as affected persons, people with livelihood affected, list of occupiers, public utilities, comprehensive list of benefits and packages to be provided to affected persons. Other information include- Resettlement site related details such as location and area, amenities to be provided, schedule for displacement and resettlement;

(iv) Special care to protect rights of weaker sections specifically SC and ST community and affirmative action by way of state obligation for their treatment with concern and sensitivity;

(v) R&R cost (arising out of benefits and packages beyond compensation) will be included as part of project cost;

(vi) Compensation and resettlement activities to be done well in advance of ouster of affected families;

(vii) R&R benefits to be extended to all affected families. Benefits includes possible allotment of house site, one time assistance for house construction to BPL families (quantum aligned with existing house construction schemes by state), Replacement cost basis or land for land approach for PAFs who have become landless or marginal account of project impacts. Stamp duty and other fees to be borne by requiring body. Provisions of assistance for land development, cattle shed, shifting allowance (on actual cost basis), assistance to rural artisans, self-employed for construction of working shed/shop. Conditional provision for employment of those rendered jobless or rehabilitation grant, subsistence allowance for displaced PAFs; and

(viii) Requirement of developing of tribal development plan and recommended consultation with tribal advisory council where project entails displacement of 200 or more ST families.

Consultation with Gram Sabha or Panchayats for land acquisition in scheduled areas.

10.10.1.3 National Tribal Policy 2006

The Scheduled Tribes (STs) have traditionally lived as isolated entities in about 15% of the country's geographical areas, mainly forests, hills, undulating inaccessible terrain in plateau areas, rich in natural resources. The problems and difficulties being faced by the scheduled tribes and tribal areas in the country are to be addressed by the National Tribal Policy, 2006. A periodic review of implementation of various initiatives/measures outlined in the policy is essential to ensure accountability of the different public agencies responsible for implementation and to reveal the practical difficulties in implementation. The objectives of the policy are to:

- Provide an environment conducive to the preservation of traditional and customary systems and regime of rights and concessions enjoyed by different ST communities, and reconciliation of modes of socio-economic development with these.
- Prevent alienation of land owned by STs and restoring possession of wrongfully alienated lands.
- Protect and vesting of rights of STs on forestlands and other forest rights including ownership over minor forest produce (MFP), minerals and water bodies through appropriate legislations and conversion of all forest villages into revenue villages.
- Provide a legislative frame for rehabilitation and resettlement in order to minimize displacement, ensure that affected persons are partners in the growth in the zone of influence, provide for compensation of social and opportunity cost in addition to market value of the land and rights over common property (NPV).
- Empower tribal communities to promote self-governance and self-rule as per the provisions and spirit of the Panchayats (Extension to the Scheduled Areas) Act, 1996.

Protect political rights to ensure greater and active participation of tribal peoples in political bodies at all levels.

Table 58: LAND ACQUSITION DETAILS FOR THE PROJECT ROAD

SL NO	NAME OF THE Aps		ADDRESS	AREA IN Sq.Mt.	AREA IN Acre	SIDE	START CHAINAGE	END CHAINAGE
1	BAKING TAYANG S/O SH. SOYAM TAYANG	LIMSHAH	VILLAGE TAFRAGAM	518.814	0.128	LEFT - UPPER SIDE	0+000	0+060
2	CHENGWA MARO S/O LATE BABRI MARO	MARO	VILLAGE TAFRAGAM	2782.574	0.688	LEFT - UPPER SIDE	0+060	0+315
3	HONEMSO TAYANG S/O LATE SAKHARI TAYANG	TAGESHAH	VILLAGE TAFRAGAM	1675.597	0.414	LEFT - UPPER SIDE	0+315	0+450
4	CHOHENG TAYANG S/O LATE KHUNANGKHO TAYANG	LIMSHAH	VILLAGE TAFRAGAM	1038.194	0.257	LEFT - UPPER SIDE	0+450	0+525
5	PRITAM TAYANG S/O LATE SOBENG TAYANG	LIMSHAH CLAN	VILLAGE TAFRAGAM	10177.121	2.515	LEFT - UPPER SIDE	0+525	1+390
6	SH.GUILA TAYANG , S/O LATE CHOSENG TAYANG	LIMSHAH CLAN	VILLAGE TAFRAGAM	2076.681	0.513	LEFT - UPPER SIDE	1+390	1+565
7	SH. BAPEMSO TAYANG S/O SH. SOYAM TAYANG	LIMSHAH CLAN	VILLAGE TAFRAGAM	3623.907	0.895	LEFT - UPPER SIDE	1+565	1+875
8	SH.BAKHREMSO TAYANG S/O LATE CHOMAHONG TAYANG /NETAM TAYANG	LIMSHAH CLAN	VILLAGE TAFRAGAM	1538.844	0.380	LEFT - UPPER SIDE	1+875	2+000
9	FROM CH-2+000KM TO CH-15+334KM PROPOSED ALIGNMENT	-	-	160051.720	39.550	LEFT - UPPER SIDE	2+000	15+334
10	FROM CH-15+334KM TO CH-18+464 KM	-	-	37273.281	9.211	LEFT - UPPER SIDE	15+334	18.464
	DEMWE TO BRAHMAKUNDA ROAD							
SL NO	NAME OF THE Aps		ADDRESS	AREA IN Sq.Mt.	AREA IN Acre	SIDE	START CHAINAGE	END CHAINAGE
1	SH. DINAMSO TAYANG S/O SH. GUILA TAYANG	LIMSHAH	VILLAGE TAFRAGAM	2618.731	0.647	RIGHT - LOWER SIDE	0+000	0+375
2	SH.BAGEM TAYANG S/O LATE KHUNANGKHO TAYANG	LIMSHAH	VILLAGE TAFRAGAM	1856.099	0.459	RIGHT - LOWER SIDE	0+375	0+600

SL NO	NAME OF THE Aps		ADDRESS	AREA IN Sq.Mt.	AREA IN Acre	SIDE	START CHAINAGE	END CHAINAGE
3	SH.CHOHENG TAYANG S/O LATE KHUNANGKHO TAYANG	LIMSHAH	VILLAGE TAFRAGAM	2624.331	0.648	RIGHT - LOWER SIDE	0+600	1+000
4	SH.CHOWENSO TAYANG (SH. DIAKAPPA TAYANG) S/O S/O SH. BAKHREMSO TAYANG (SH. DIAKAPPA TAYANG)	LIMSHAH	VILLAGE TAFRAGAM	3198.046	0.790	RIGHT - LOWER SIDE	1+000	1+390
5	SH. OBESTO TAYANG S/O SH. CHOHENG TAYANG	LIMSHAH	VILLAGE TAFRAGAM	1358.143	0.336	RIGHT - LOWER SIDE	1+390	1+565
6	SH. YAPEMSO TAYANG	LIMSHAH	VILLAGE TAFRAGAM	3214.365	0.794	RIGHT - LOWER SIDE	1+565	1+875
7	SH. DICEM TAYANG S/O SH. BAKHREMSO TAYANG	LIMSHAH	VILLAGE TAFRAGAM	1023.147	0.253	RIGHT - LOWER SIDE	1+875	2+000
8	FROM CH-2+000KM TO CH-15+334KM PROPOSED ALIGNMENT	-	-	159860.402	39.503	LEFT - UPPER SIDE	2+000	15+334
9	FROM CH-15+334KM TO CH-18+464 KM	-	-	30028.830	7.420	LEFT - UPPER SIDE	15+334	18.464

TRAFFIC OPERATION AND SAFETY PLANS

CHAPTER 10: TRAFFIC OPERATION & SAFETY PLANS

10.1 General

For a good and effective safety planning of the road, the safety designer should first know the project corridor properly and then plan a synchronised work plan to be followed throughout the operation process of the road construction.

The Planning of the safety of the road project should be done in three phases during the operation. The first phase should be planned before the constructional operation starts, the second phase of safety design should commence during the construction process and the third phase shall be employed after the construction ends.

Stages of Planning:

- Pre-construction
- During Construction
- Post Construction

10.2 Scope

The Scope of traffic operation and safety Plan includes the safety of:

- Site / Project Workers
- Road Users
- Construction Machineries / Equipment
- Environment
- Project Assets

10.3 Pre Construction Safety Plan

The stage of construction for a safety plan initiates from the pre-construction stage. The stage of pre-construction for a road project involves the personnel to collect the data of the project corridor and interaction with the road users. So, the safety of the Survey personnel along with the road users during the process of surveying should be given priority.

10.3.1 Steps involved during the Pre-Construction Safety Stage

- The personnel involved in the survey investigation should wear reflectorized dress or jackets so, that the road users approaching can view them from far distance and slowdown in the stretch being surveyed

- The vehicle involved in the survey process should be painted with reflecting colour and marked with company name and parked at proper distance away from the traffic without causing any hindrance
- Road Delineators should be used at the site of survey which should be as per the code of IRC: 79
- Proper Safety should be followed during the work near high voltage power lines, bridges and water bodies
- The personnel involved in the process of survey should be dressed properly which does not cause any hindrance or harm to the person.

10.4 During Construction Safety Plan

In construction, typically safety is treated as a discrete and separate function within the contractor's organization. Much of what we do in safety revolves around incidents, accidents, and losses. We use programs and other strategies to help us control their adverse effects. We train our workers in accordance with safety standards. We measure our success in reduced incidents and by comparing our loss data to national statistics.

Our accidents and losses impact our cost of risk and ultimately our very competitiveness in a highly competitive industry. This also may well diminish our ability to market construction services and/or secure work. Accidents usually do not happen due to fate or intent on the worker's part. They happen because of ineffective processes, inadequate procedures, poor planning or lack of foresight. Therefore, we must get away from the predominantly worker-focused interventions common in the industry, and look into areas that the worker has little or no control over but are the underlying contributing causes of incidents and losses.

10.4.1 Guiding Principles

The construction zone creates an environment where the road user is faced with a series of unusual hazards in the form of unfamiliar routes, substandard horizontal and vertical alignment, adverse cambers, construction equipment etc. the safety practices in construction zones should therefore be oriented towards reducing conditions which lead to such hazards and consequent stress where by risk of accident is increased. The guiding principles for safety in road construction zones are to:

i. Warn the road user clearly and sufficiently in advance
ii. Provide safe and clearly marked lanes for guiding road user
iii. Provide safe and clearly marked buffer and work zones, and
iv. Provide adequate measures that control driver behaviour through construction zones

10.4.2 Components of the Construction Zone

Legal Aspects

The policy under these guidelines is to keep the closure of the roads to a minimum and to ensure that traffic is delayed as little as possible by the construction operations. The traffic management strategies to be used at construction zones should ensure that the traffic safety is an integral and high priority element of the project. This can be ensured by avoiding inconvenience to traffic as far as possible and by guiding the drivers in a clear and positive way. Routine inspections of traffic control elements and traffic operations must be carried out so that care and attention to roadside safety is never slack during the progress of project.

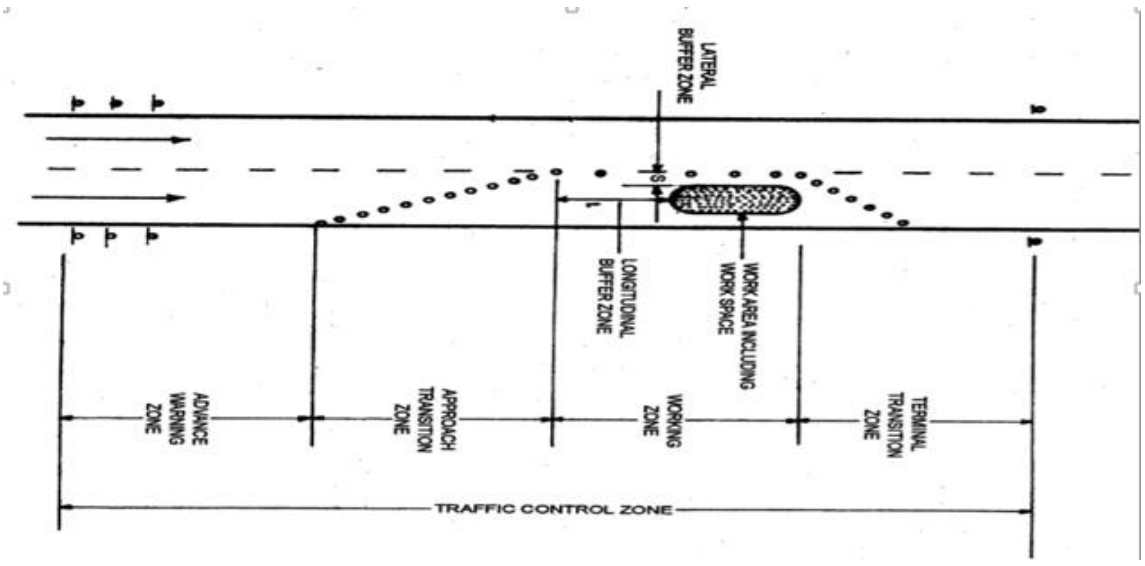
Traffic Control Zone

In rural areas, the problems at many construction zones is accentuated by the availability of only an undivided carriageway, which may involve problems of either the temporary acquisition of ;land for diversions, or the sharing of the limited remaining road space by road users under som4e form of traffic control. In any case it should be ensured that road user is properly segregated from the working zones.

In urban areas where construction zones are likely to be even more constrained, diversions may have to be taken over adjacent sections of the road network in addition to the sharing of road space by road users. The effects of construction zones may, therefore, be felt over a wide area.

The Traffic Control Zone can be divided into three components, that is, the Advance Warning Zone, the Transition Zone, and Working Zone. All construction zones will have a working zone, which is flaked, by a transition zone for each direction of approaching traffic and an advance warning zone will precede these in turn.

Figure 18: ELEMENT OF TRAFFIC CONTROL ZONE



Traffic Control Devices

Traffic control devices individually and collectively perform the following tasks:

i. Warning the road user;
ii. Inform the road user;
iii. Guide the road user;
iv. Modify road user behaviour;
v. Protect the road user and the vehicle;
vi. Ensure safe passage to the road user; and
vii. Provide a safe working area

Figure 19: TRAFFIC SIGNS USED FOR CONSTRUCTION ZONE

Figure 20: PLACEMENTS OF SIGN

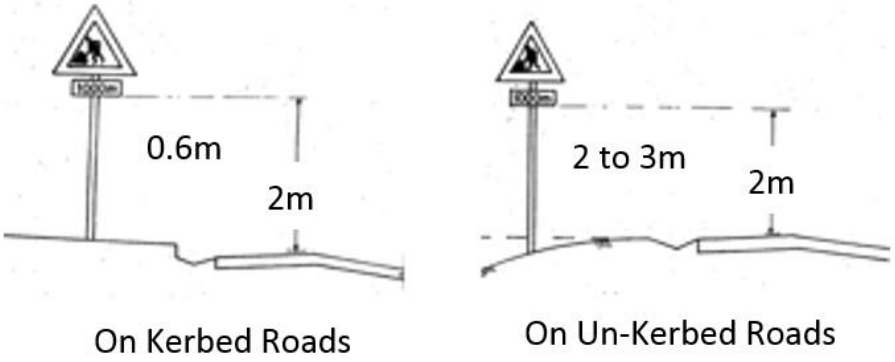


Figure 21: TRAFFIC DEVICES USED IN CONSTRUCTION ZONES

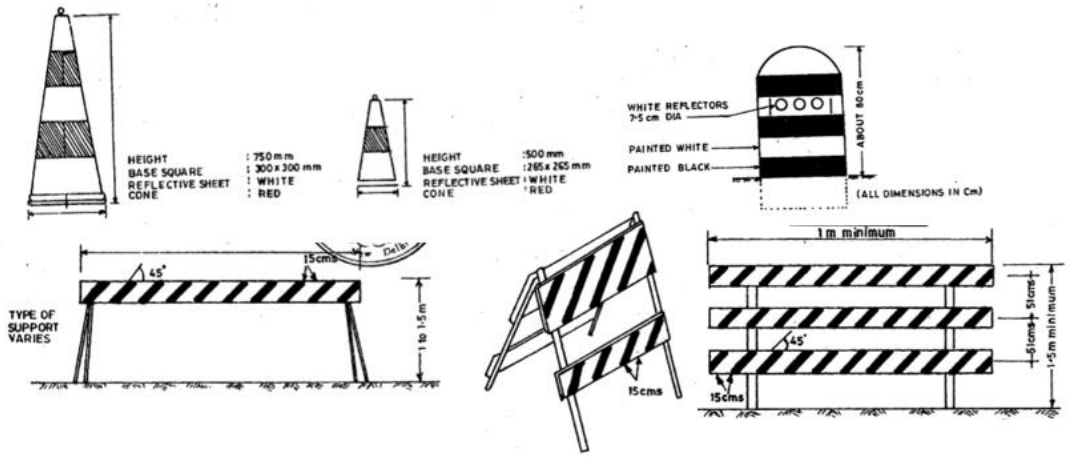


Figure 22: FLAGMEN AT CONSTRUCTION ZONE

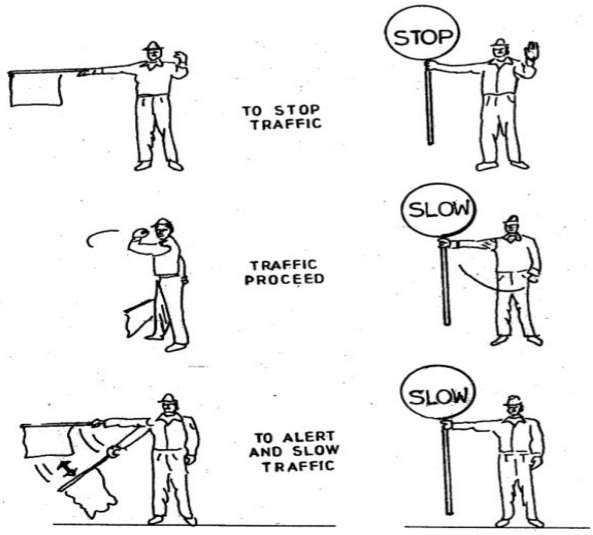


Figure 23: TRAFFIC CONTROL BY STOP/GO BOARDS

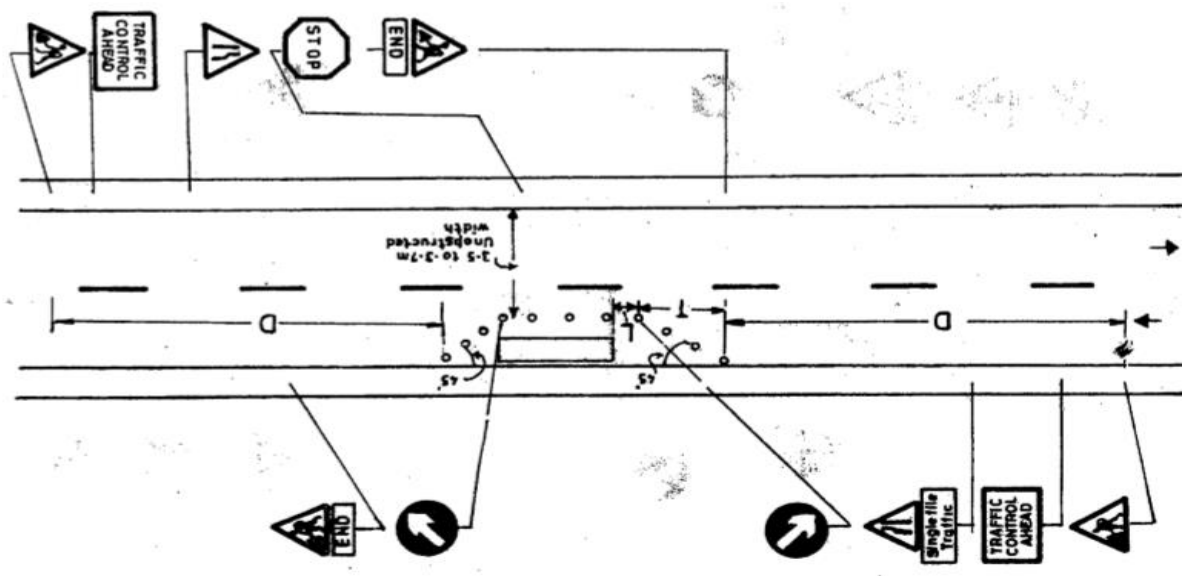
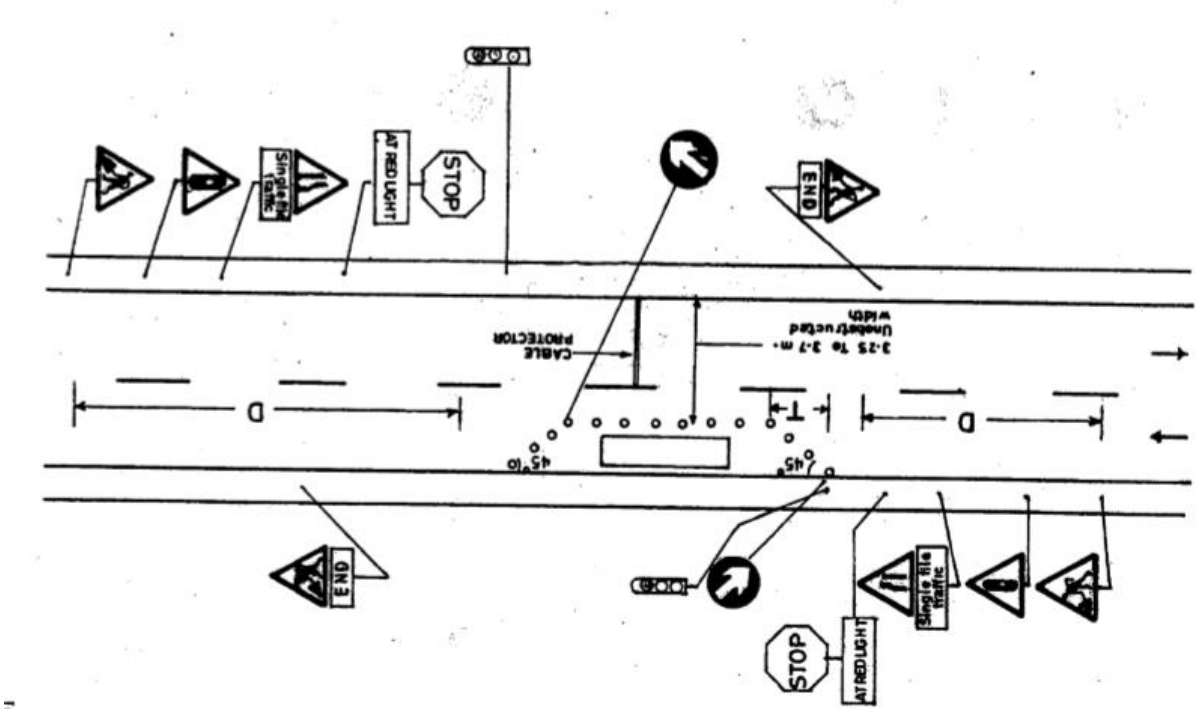


Figure 24: TRAFFIC CONTROL BY PORTABLE TRAFFIC SIGNALS



All works during construction should be followed with safety codes as per provided in the IRC: SP: 55 code. The code provides safety norms to be followed during construction which will directly or indirectly protect the workers and road users during an on-going work.

10.5 After Construction Safety Plan

Even after the construction gets over the risk of accident lurks on the roads. The Engineer must keep an eye on the safety of the road users and in-time make the users aware of the road. The

safety of the users can be executed even after the construction is over by providing the project stretch with proper and adequate signs as per codes and other norms.

Traffic signs are the silent speakers on the road. Be it the person behind the wheel or a pedestrian, having a sound knowledge about road safety is absolutely necessary for all before hitting the roads.

10.5.1 Traffic Signs

Traffic signs give information about the road conditions ahead, provide instructions to be followed at the major crossroads or junctions, warn or guide drivers, and ensure proper functioning of road traffic. Being unaware of road signs is akin to throwing caution to the wind. It can lead to loss of life and property. A person is supposed to be familiar (get through a written or oral test) with the traffic signs and symbols before acquiring a driving license in India.

Road safety signs are primarily of three types

1. **Mandatory Signs**: These signs are used to ensure free movement of traffic and make the road users cognisant of certain laws and regulations, restrictions and prohibitions. Violation of these signs is an offence, as per law.
2. **Cautionary Signs**: These signs make the road users conscious of hazardous conditions on the road beforehand. The drivers, accordingly, take necessary actions to handle the situation.
3. **Informatory Signs:** These signs guide the road users about destinations, distance, alternative routes, and prominent locations like food joints, public toilets, nearby hospitals, etc.

10.6 Road Markings

Road markings are used as a means of controlling and guiding traffic. They are highly important on urban roads and intersections as they promote road safety and bring out smooth and harmonious flow of traffic along guided paths of travel. They also supplement the messages conveyed by road signals and signs. In some cases, they are used alone to convey certain regulation, information or warning that cannot otherwise be effectively made known to the road users.

The main functions of the road markings are to guide the safe and smooth flow of traffic in the following ways:

i) Segregation of traffic
ii) Stop and go
iii) Give way instruction
iv) Overtaking or not

v) Two lanes to one lane/ lane traffic
vi) Inter-vehicle distance
vii) Parking zone or no parking
viii) Speed indication
ix) Direction
x) One way
xi) Pedestrian crossing
xii) Type of vehicles allowed

Types of Road Markings Road markings are basically of two types: Carriageway markings and Object markings.

Carriageway Markings

As the name implies, these are the markings applied to the carriageway. Carriageway markings are of the following categories:

i) Centre line
ii) Traffic lane lines
iii) No-overtaking zone markings
iv) Pavement edge line (both sides)
v) Carriageway width reduction transition markings
vi) Obstruction approach markings
vii) Stop lines
viii) Pedestrian crossings
ix) Cyclist crossings
x) Route direction arrows etc.
xi) Word message
xii) Markings at approaches to intersections
xiii) Parking space limits
xiv) Bus stops

Object markings

Object markings are of the following categories:

i) Objects within carriageway
ii) Kerb marking for visibility
iii) Kerb marking for parking restriction
iv) Objects adjacent to the carriageway
v) Median marking

Figure 25: ROAD MARKINGS FOR STOP SIGNS

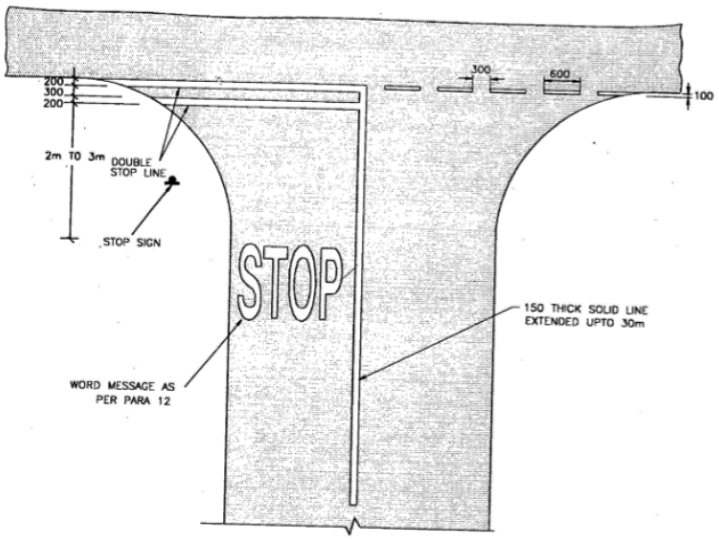
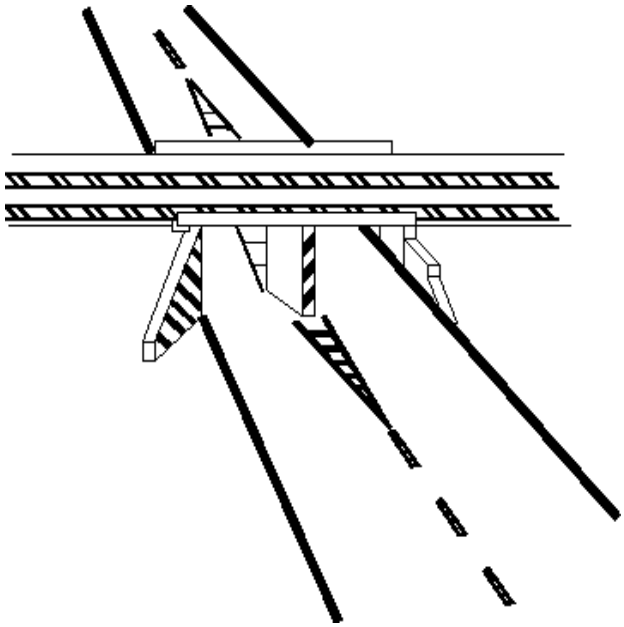


Figure 26: OBJECT MARKINGS TO BE PROVIDED AT PROJECT SITE



Physical obstructions in a carriageway like traffic island or obstructions near carriageway like signal posts, pier etc. cause serious hazard to the flow of traffic and should be adequately marked. They may be marked on the objects adjacent to the carriageway.

Objects within the carriageway

The obstructions within the carriageway such as traffic islands, raised medians, etc. may be marked by not less than five alternate black and yellow stripes. The stripes should slope forward

at an angle of 45° with respect to the direction of traffic. These stripes shall be uniform and should not be less than 100 m wide so as to provide sufficient visibility.

Objects adjacent to carriageway

Sometimes objects adjacent to the carriageway may pose some obstructions to the flow of traffic. Objects such as subway piers and abutments, culvert head walls etc. are some examples for such obstructions. They should be marked with alternate black and white stripes at a forward angle of 45◦ with respect to the direction of traffic. Poles close to the carriageway should be painted in alternate black and white up to a height of 1.25 m above the road level. Other objects such as guard stones, drums, guard rails etc. where chances of vehicles hitting them are only when vehicle runs off the carriageway should be painted in solid white. Kerbs of all islands located in the line of traffic flow shall be painted with either alternating black and white stripes of 500 mm wide or chequered black and white stripes of same width.

Our Project Road is a combination of different type of curves, different terrains, open and built-up areas and also some stretches crosses near sanctuary and animal habitats. So, proper signs and markings should be provided to in-advance warn the road users about these variations.

The Road Signs to be installed along the road stretches should be according to IRC: 67 and the road markings shall follow the code of IRC: 35.

10.7 Safety on Project Corridor

The project stretch accompanies various varying feature throughout its corridor. These varying feature calls to wake for safety consideration. The priority of any road project is its users. And with this responsibility to provide a good communication, comes the safety alert for the road users. A project is valued to be good when the project road is helpful in minimizing the fatalities and provide the best communication facilities.

The road is evaluated viewing the safety of the road user and provisions of safety signs and markings are suggested to be followed for well-being of the road user as well as the project road.

10.7.1 Road Signs at the Curves

Cautionary signs which are triangular in shape with red border with the direction of the curve are provided at the curves. This helps in manoeuvring vehicle accordingly and nullifies the possibility of accident due to sudden appearance of turn. The speed limit signs should also be ruled at sharp curves. These signs are places 200m before the start of the curve. The curves with radius less or equal to 100 m are considered to be sharp curve.

The curves where there is sharp bends and the vehicle is restricted to maintain the design speed, should be marked with speed marker signs showing the speed to be maintained at that stretch.

The sharp curves i.e., the curves with radius less than 100 m should be protected with guard posts or crash barriers.

10.7.2 Provision for Road Studs (Reflective Pavement Markers)

Road Studs is provided to improve the visibility in night time and wet weather conditions. Red-White Bi-directional on shoulder side & Yellow-Yellow Bidirectional on Centre line of No overtaking portions and White- White Bidirectional for centre line of other reaches.

Road Studs are provided at:

- All sections of Project Highway having horizontal curves
- All sections of Project Highway where overtaking prohibited
- Built-up areas
- All Major/Minor Bridge, ROB and all structures (Interchange/Flyover/VUP)
- All junctions and median openings
- All pedestrian crossings

10.7.3 Protection at the High Embankments

The high embankments are marked as un-protective for the road users as fall from these heights can lead to fatalities. So, the embankments with height above 3 m should be protected at the edges so that the road user is careful about the road profile. These type of embankments should be protected with crash barriers. So, it is recommended to use W-Beam crash barriers at these locations.

10.7.4 Road Signs at Built-up Areas

The Built-up areas should be marked with informatory signs signifying the identifying the place with speed limit signs, which should be followed by the road user while entering into the built-up area.

The signs to be provided are Informatory signs and Speed limit signs. These signs should be provided at both the side of the carriageway from both the direction at 200 m before the school.

The school areas should also be provided with safety barricades during the school's arrival and departure time.

10.7.5 Road Signs for Structures

The road user must also be aware of the structures it is approaching to. So, that they can take precautionary measures before riding over it. The structures include culverts, minor and major bridges, ROB, FOB, RUB etc. The objects are too marked with reflectorized paints.

The structures should be indicated as per the markings and devices discussed above. The Object Marking Devices should be provided in one number at every culverts on both the sides of the

structure. The minor and major bridges are objectified with two numbers of Object Marking Devices at start of the structure and end of the structure on both the sides of the carriageway.